LIFE Project Number

LIFE14 CCA/ES/000612

Final Report

Covering the project activities from 16/07/2015[1] to 31/12/2021

Reporting Date[2]

30/04/2022

LIFE PROJECT NAME or Acronym

LIFE ADAPTAMED

Data Project	
Project location:	Andalusia, Spain
Project start date:	16/07/2015
Project end date:	15/07/2020 **Extension date:** 31/12/2021
Total budget:	5.462.678 €
EU contribution:	3.234.049 €
(%) of eligible costs:	59,29 %

Data Beneficiary	
Name Beneficiary:	Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible
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Project Website:	www.leadaptamed.eu

[1] Project start date

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

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

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

1. Table of contents

2. List of key-words and abbreviations

Keywords:
Ecosystem services, adaptive management, climate change, adaptation, Mediterranean socioecosystems, forests, Natural Protected Areas, resilience.

Abbreviations:

AMAYA: Agencia de Medio Ambiente y Agua. Andalusian Environment and Water Agency.
BR: Biosphere Reserve
CAGPDS: Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible.Regional Ministry of Agriculture, Livestock, Fisheries and Sustainable Development (2019-Nowadays).
CC: Climate change.
CMAOT: Consejería de Medio Ambiente y Ordenación del Territorio. Regional Ministry of Environment and Territorial Planning (2015-2019).
CSIC: Consejo Superior de Investigaciones Científicas. Spanish National Research Council.
EU: European Union.
FNR: Life Adaptamed Final Report
MTR: Life Adaptamed Mid-term Report
N&NP: National & Natural Park.
NP: Natural Park.
NPA: Natural Protected Area.
PC: Parque de las Ciencias.Science Museum.
PR-1: Life Adaptamed First Progress Report (similar for PR-2, PR-3, etc)
REDIAM: Red de Información Ambiental de Andalucía. Andalusian Environmental Information Network.
UAL: Universidad de Almería. University of Almeria.
UGR: Universidad de Granada. University of Granada.
UICN Med: Centro de la Unión Internacional para la Conservación de la Naturaleza para la cooperación en el Mediterráneo; International Union for Conservation of Nature, Centre for Mediterranean Cooperation.

3. Executive Summary

The project main objective is to protect key ecosystem services provided by 3 iconic and representative Mediterranean Natural Protected Areas (hereinafter NPA) to local inhabitants and their socioeconomic sector, thorough adaptive management actions oriented to increase ecosystems adaptation capacity towards climate change (hereinafter CC). The three NPA that are the subject of this Life Project are:

- Doñana National & Natural Park (hereinafter N&NP) and Biosphere Reserve (hereinafter BR), representing one of the most important Mediterranean wetlands.
- Sierra Nevada N&NP and BR, a Mediterranean high mountain range.
- Cabo de Gata Natural Park (NP) and BR, a subdesertic Mediterranean coastal area.

The project focuses on developing, implementing, monitoring, evaluating and disseminating adaptive management measures, with an ecosystemic approach, addressed to those socio-ecosystems identified as key for the provision of, among others, soil retention, pollination, pastures (net primary production), temperature regulation, water provision, prevention of forest fires and of desertification. These socio-ecosystems and the services they provide are currently being negatively affected by CC and, on the basis of current data, this affection is expected to increase significantly in the future. For this reason, the project actions aim to reduce the negative impact of CC in the area of influence of the NPA and their socioeconomic fabric by focusing on implementing specific adaptive measures addressed to those key socio-ecosystems with a major role in the provision of the aforementioned ecosystem services. As a result of this, an increase in the resilience of the concerned socio-ecosystems is expected, in such a way that their future provision of services will be preserved or even improved if compared to the scenario of no intervention.
The active management actions accomplished within the project are designed, monitored and assessed through collaborative work between scientists and managers working hand-in-hand. The conclusions achieved by the project in terms of which measures are most effective in protecting the addressed ecosystem services have been disseminated through a wide range of dissemination activities and materials. These dissemination activities are some of the key outputs of the project. They include: a very active website managed along with several social media platforms (Facebook, Twitter and Instagram), a traveling exhibition, two temporal exhibitions (Window to Science) in the Science Museum, a symposium with the participation of scientists, stakeholders and managers from NPA, volunteer camps, two teaching units and six best practice technical guides. Along with all these results, a distributed information system has been specially developed for the project. It serves as a collaborative platform among the Andalusian Global Change Observatory Network and it will be an important product in the after-Life strategy, expressing the results achieved in the framework of Life Adaptamed and facilitating future collaborative schemes in the topic of global change. This Information system has been designed according to the international standards in which the existing global change observatories are actually integrated: LTER (Long Term Ecological Research network) and EML (Ecological Metadata Language), and observing the INSPIRE Directive. This is essential to ensure transferability, replicability and uptake of the project.
In relation to the functioning structure of the project, it has a Director, a financial coordinator and two technical coordinators. There are three scientific entities, each one of them responsible for the scientific supervision of the project in each one of the NPA, working together in each area with technicians from the environmental administration, both from

coordinating beneficiary (CAGPDS) and AMAyA. Besides, there is a Communication Team integrated by one member from each one of the beneficiary entities, with an especially active participation from the two entities responsible for the spread and dissemination of the project results: IUCN and Parque de las Ciencias.

During the project, the project plenary has conducted many Steering Committee meetings, seven monitoring missions and more than 40 other meetings, aimed to improve communication and decision making between partners for the optimal course of the project. During the first year of the project, most efforts were focussed on implementing those preparatory actions designed to ensure effectiveness and efficiency of central actions, in order to ensure the results to be obtained from the project meet the desired objectives (actions A1, A2, A3, A4, A5 and A8). Vast data has been compiled to ensure that the decisions made for the implementation of central actions incorporate the best available scientific knowledge and hold consensus between partners involved. Within the framework of Action A7, four Action Plans have been ratified and approved as planned. The three administrative projects needed to tender actions C1, C2 and C6 were written and processed as foreseen in action A8. In conclusion, the objectives associated with these preparatory actions are considered largely achieved. Action A6, being a preparatory action for a communication action, has been active for several years, being developed satisfactorily. Special mention is needed for Action A10, as in the second part of 2016 and, especially during 2017, important efforts were made on the framework of this action. Its main objective was to characterize the initial state in the plots where the central actions have taken place, in order to allow the identification of the most effectively tested management alternatives according to the objectives defined for the project.

In relation to active management activities, the central actions of the project that were expected to be executed directly by AMAYA (actions C3, C4 and C5) have been implemented satisfactorily. Although some of them started with a few months delay from the planned schedule, this delay did not have any effect on the objectives of the actions, which have been met thoroughly and successfully. However, those actions dependent on public tender for their implementation (actions C1, C2 and C6) have suffered an important delay due to delays in the administrative procedure in order to attend to all the legal requirements, recently strengthened as a result of a modification of the Spanish Law for Administrative Procedure. Ultimately, these actions were able to be implemented as planned without incident other than the aforementioned delay. The consequences of these delays were resolved by requesting an 18-months extension, which has allowed the subsequent follow-up actions to be successfully implemented (actions D7 and D8).

Several meetings were conducted to agree on structure and data capture flows and protocols within action C7, whether all partners together or through local actions D1, D2 and D3. These actions included scientific support, knowledge transfer and coordination with REDIAM. Efforts were made to incorporate in the Distributed Information System some previously existing data related to CC and, mainly, new data generated by the project. This action has been developed according to the planned schedule.

In relation to the communication and dissemination of results, great efforts were made through a strategy based on our website (www.lifeadaptamed.eu) and the project's social networks. Likewise, numerous materials have been published, among which we highlight five ecosystem management manuals that collect a good part of the learning acquired during the project and all the existing knowledge about the functioning and management of certain key habitats such as the pine forests, the mountain *Quercus* forests, the jujube tree habitats, the Mediterranean mount of Doñana or the high mountain scrub. Additionally, a manual of good practices has been published in relation to the governance of protected areas in a context of climate change. Likewise, we would like to make a special mention to the set of designed field posters (8

different designs), since they incorporate true narratives regarding extremely innovative topics (ecosystem services, climate change, adaptive management) and represent a field-scale dissemination task that has very few precedents in the NPAs involved in the project.
Other important communication and dissemination actions have been developed, like two Window to Science in the Parque de las Ciencias and a temporary exhibition that has visited numerous educational centers and will be in operation within the Post-Life phase.
In the networking activity the Life Adaptamed Management Team and the scientists of the project have attended several international workshops, some national scientific events, several congresses, workshops and seminaries where the project has been presented and where the preliminary results have been disseminated.

4. Introduction

Climate related problem/issue addressed.
Life Adaptamed Project addresses focal problems in terms of adaptation to climate change in Mediterranean ecosystems of southern Europe. The pilot areas (Doñana, Sierra Nevada and Cabo de Gata) and the target ecosystems (high mountain, mountain forests, Mediterranean forest of different types and arid ecosystems) are representative of strategic environmental gradients from the point of view of the identified climate problem. This approach improves the possibilities of exporting and transferring the solutions acquired to other equivalent ecological situations. In this sense, many of the communication and dissemination actions have been designed with this porpoise. On the other hand, all the methodological approaches carried out have been duly documented in order to avoid replicability under the same methodological framework. Life Adaptamed actions are aimed to explore strategies for adapting to climate change with the aim of protecting a compendium of target ecosystem services. These services have been previously identified and duly integrated in the compilation of designed indicators. Climate change is currently affecting the quantity, quality and other properties of ecosystem services provided by the protected areas of southern Europe. Among these impacts we want to highlight a reduction in its ability to fix carbon, to hold biodiversity (that is also involved in a remarkable amount of services and ecosystem functions tasks) and to provide essential supply and regulatory services. The objective of Life Adaptamed has been to improve the resistance and resilience capacity of certain target ecosystems and we believe we have made great progress in this regard. Many of the effects on the ecosystems will begin to be seen in the medium and long term, although for now we have been able to verify a clear improvement in the self-organization capacity of natural processes with important consequences for the protection of ecosystem services that are extremely threatened by climate change.

Solution to be demonstrated/verified by the project.
The solution that is intended to be demonstrated or verified by Life Adaptamed relies on the development of adaptive management strategies that improve the adaptation to climate change of the key ecosystems of southern Europe. The final aim of the project is the protection of ecosystem services endangered by climate change.

Description of the technical/methodological solution
The design of ecosystem management actions is subject to an experimental procedure that will allow us to highlight conclusions about the best solutions. This experimental system has been designed by some of the scientific teams with a more outstanding trajectory in these areas throughout Europe. In the case of the adaptation of pine plantations, different degrees of intensity of treatment have been established in relation to tree extraction. The subsequent

management of the forest residues generated by the treatments is also evaluated. Both methodological approaches will allow us to know the consequences on the adaptation capacity of the ecosystem after experimental management strategies. In the case of Mediterranean forests (dominated by species of the genus *Quercus*) the strategy lies in the intensity of pruning and thinning, in the management of wood waste and in the suitability of complementary plantations (of cork oak and associated scrubland) and installation of fences that prevent the effects of an excessive herbivory. The Mediterranean high mountain shrubland ecosystems are seriously impacted by climate change. Here, the methodological approach consists in exploring the most appropriate propagation strategies of key species. We also take into consideration elements of traditional land management such as the irrigation channels (calling 'acequias de careo', dating from the Arabs' time) as facilitating tools with high potential for the mitigation of climate change in the mountain. At arid environments of southeastern Iberia, Life Adaptamed is working on the elimination of invasive vegetation and the recovery of traditional techniques of tillage and grazing whose main goal is the protection of soil. Soil plays indeed an essential role in terms of adaptation and mitigation to climate change in these endangered environments.
The Indicator System has been designed to allow the observation of processes from different perspectives and scales: from a fine scale, recorded at the field level (i.e. soil samples, plant cover evolution or animal population trends), to a scale based on observations from space (i.e. LandSat, Modis and Sentinel satellites). These approaches shape a methodological multi-scale framework never before put into practice in order to evaluate the ecological effects of different management strategies. Moreover, it is also new and pioneer to link this complex methodological design from the ecological functioning for the ecosystem services.

Expected results and climate action related benefits.
The expected results involve a decalogue of good practices that have been reflected in management manuals for each of the target ecosystems (5 management manuals plus one regarding good practice for a better governance for an adaptive management of CC in NPAs). The experimental design allowes the obtaining of scientifically tested results, aimed at defining management practices ready to be carried out by the environmental administration (which, in this case, acts as coordinating beneficiary). In a more conceptual framework, Life Adaptamed allows the introduction of innovative concepts in the management of NPAs, such as a philosophy of conservation and valuation of ecosystem services or concepts associated with the implementation of adaptive management procedures. Furthermore, this project also introduces the philosophy of 'solutions based on nature', resilience or governance as focal elements in adapting to CC. Finally, it is important to highlight the role of Life Adaptamed as a link between researchers and managers, establishing a working space, shared goals and common language for the benefit of a regional adaptation strategy.

Expected longer term results
Beyond a change in the philosophy of adaptation to CC in protected areas, Life Adaptamed has produced the conceptual basis in relation to good practices of management of the ecosystems involved in the project. Some of the results of the project are expected to come in the post-Life phase. This is due to the slow response times shown by many of the ecosystems managed in the project scope. In relation to the post-Life stage, the Coordinating Beneficiary is already taken into consideration the main criteria and concepts provided by Life Adaptamed for the planning of other forest management projects in Andalusia or even for the restoration of degraded ecosystems. Without any doubt, this should be considered a great result that came before the end of the project.

In this sense, the knowledge generation and the conceptual framework of Life Adaptamed should have a very valuable implication in the definition of the elements that contribute to improving the policies of the EU. The results obtained and expected in the frame of this project will be especially appreciable in the contribution to strategies for the protection and promotion of biodiversity and in terms of adaptation, and even mitigation, in the face of CC.

5. Administrative part

Project management process
Some administrative modifications related to the project management process or formalisation in writing of commitments through different signed documentsare arevincluded in this epigraph.

The bank account number of the coordinating Beneficiary has Changed. This change was communicated to the monitoring team and European Commission by e-mail on 24/11/2021. Attached in **Annex 5.3**.

The Coordinating Beneficiary was renamed Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible (Regional Ministry of Agriculture, Livestock, Fisheries and Sustainable Development) by order of the President 3/2020, of 3 September, of the Vice-Presidency and on the restructuring of Regional Ministries. Attached in **Annex 5.2**.

In the rest of the beneficiaries there have been no further variations in business name since the communication in the Mid-term report regarding IUCN.

The following is the description of signatures of the Associated Beneficiaries from the beginning to the end of the project:

Coordinating Beneficiary CAGPDS:
Said change has been duly informed to the monitoring team and the Commission by e-mail dated 11/24/2021, in which the corresponding documentation was attached:
SECRETARY GENERAL OF THE ENVIRONMENT, WATER AND CLIMATE CHANGE, person signing financial forms (Legal Officer):

- Start of the project – 19/10/2021: D. Francisco José Gutiérrez Rodríguez.
- 20/10/2021 – End of the project: D. Sergio Arjona Jiménez.

Associated beneficiary AMAYA: We detail below the changes that have occurred:
MANAGEMENT DIRECTION, persons responsible for signing financial forms:

- From the start of the project - 21/07/2015: D. Juan Jesús Carandell Mifsut.
- 22/07/2015 – 13/02/2019: D. Antonio Galán Pedregosa.
- 14/02/2019 – end of the project: D. Javier Marcial de Torre Mandri.

Associated beneficiary CSIC:
By Resolution of January 21, 2021, of the Presidency of the State Agency Higher Council for Scientific Research, the signing of any declaration of an economic nature is delegated in matters of Scientific Activity Management- administrative in the head of the Deputy Secretary for Economic Actions SGAAE. So that:

- Start of the project - 30/01/2021: D. Jesús Marco de Lucas. Vice-presidency of Scientific and Technical Research VICYT .

- 31/01/2021– end of the project: D. Miguel Ángel López Barba. SGAAE.

Associated Beneficiary Parque de las Ciencias: the following positions within the organization have changed in relation to the project:
MANAGEMENT ADDRESS, legal persons responsible for signing financial forms:

- start of the project – 06/11/2020: D. Ernesto Páramo Sureda.
- 23/04/2019 - 15/07/2021**:** Dª Cristina González Sevilla (By substitution of the Management Department).
- 09/08/2021 - End of the project:D. Luis Alcalá Martínez

Associated Beneficiary University of Almeria: Change in the person who holds the position of Vice-Rector for Research and Innovation, legal representative who signs the project documents:

- Start of the project- 15/07/2015 al 31/08/2018: D. Antonio Miguel Posadas Chinchilla.
- From 01/09/2018 – end of the project: D. Diego Luis Valera Martínez.

Communication with the AGENCY and Monitoring Team

Communication with the Monitoring Team throughout the project has taken place especially through the monitoring visits held annually, although also through various specific consultations made by the technical or financial coordination of the project at various times during the course of the project.
Communication with the Agency has essentially taken the form of letters, either in response to a request made after consultation with the Monitoring Team, or in relation to the various monitoring visits carried out, one of which was attended by a member of the Agency (IV monitoring visit in May 2019). In many cases, these follow-up letters were accompanied by technical, administrative or financial issues to be taken into account and answered by the project team. These letters have usually been answered through the project monitor at the time of the next scheduled monitoring visit. **Annex 9.1** includes a compilation of all replies given to the Agency in response to the Agency's follow-up letters subsequent to the Mid-term report.
In addition, in order to facilitate the identification of the name of the project actions, for which some sections (e.g. tables) do not include the full name but a short version, **Annex 9.2** includes the short and complete action names, both in English and in Spanish.

Changes due to amendmets to the Grant Agreement

- Letter Amendment No. 1 to Grant Agreement: including a number of clerical errors in that should be corrected.
- Letter Amendment No. 2 to Grant Agreement: agreeing to modify some bank account details in Article I.5
- Letter Amendment No. 3 to Grant Agreement: modification of the definition of conditions for natural persons, submission of VAT certificate and threshold for submission of the certificate on the financial statements.
- Letter Amendment No. 4 to Grant Agreement: updated dates for milestones, deliverables and activity reports foreseen.
- Letter Amendment No. 5 to Grant Agreement: modification of bank account details.

6. Technical part

6.1. Technical progress, per Action

Action A1. Information compile and knowledge generation to design actions to increase adaptacion to CC capacity in pine forests

Foreseen start date: 07/2015 Actual start date: 10/2015
Foreseen end date: 12/2015 Actual (or anticipated) end date: 12/2016

Activities undertaken and outputs achieved

Doñana National Park:

Following the guidelines of Adaptamed Management Team, END (CAGPDS in Doñana) and EBD-CSIC have carried out the following tasks:

- *Collection of information:* A review of the previously raised information concerning the characterization of the forests (mainly information contained in inventories, forestry projects and Forestry Management Plans) and the analysis of the effect of forest management actions (selvicultural treatments). This meant the compilation and spatial location of all selvicultural treatments implemented in the forests included in this project during the last 20 years. A scientific literature review was also conducted.
- *Selection of localities:*Localities were selected in the west sector of Doñana Natural Park for being representative of pine afforestations. The 3 sites selected were located in public land belonging to the Andalusian Government. They include representative vegetation units: afforested forests of stone pine (*Pinus pinea*) planted in two different periods (1940 and 1980-2002)
- *Plot selection and action design:*Within each one of the three localities selected, we established threedifferent plots of 7 ha. Each of these three plots was assigned to a different selvicultural treatment, namely three different cutting intensities (0, 30 and 60% reduction in tree density). Within each 7 ha plot, we established for different plots of 1 ha for monitoring, which were assigned to four different experimental treatments, resulting from a combination of herbivore exclusion (with a 400 m fence) and/or assisted recruitment in 'fertility islands' (seeding and planting with/without nursing structures).
- *Selection of new plots to replace those affected by fire:* Due to unexpected circumstances (the forest fire of June 2017, which affected three of the nine pine-afforestation plots selected in this action), we had to re-open the action and carry out a new plot selection and action design procedure. For this purpose, we crossed the information previously collected in this action with a cartography of the area affected by the forest fire, and selected three new plots, as similar and close as possible, to replace the affected ones. Plot selection was completed by October 2017.

Cabo de Gata Natural Park

Between November 2015 and February 2016 four meetings were celebrated (CAGPDS, AMAYA and UAL) as well as three field trips to establish the technical criteria for the optimal implementation of action C1. Work plots were identified and detailed maps were created. All the historical information on the territory "El Caballón" was compiled (plantation date, treatments, pest monitoring, etc).

Sierra Nevada National Park

In October and November 2015 information on forest management and forest characterization

in Sierra Nevada was gathered and analyzed. In December 2015 specific plots were selected to assess forest evolution after forest management, by repeating floristic inventories plots already characterized in 2005, following the same methodology. In the first quarter of 2016 data analysis was carried out to select the optimal locations for action C1 in Sierra Nevada. During spring 2016 these locations were visited and data was collected to define in detail and economically quantify the actions to be included in the project expected as one of the deliverables of action A8. Detailed maps have also been produced.

Comparison with planned output and time schedule

Planned output was delivered, albeit with some delay due to the need to rearrange some of the design details in agreement with other partners (see below) and to respond to unpredictable circumstances (see above).

The action has been concluded successfully, implying that many project beneficiaries have had to agree on the details of the actions implementation detailed in report A1: EBD-CSIC and CAGPDS in Doñana; UAL, CAGPDS and AMAyA in Cabo de Gata; and UGR, CAGPDS and AMAYA in Sierra Nevada. The results of this action were included in a comprehensive report (see Annex A1.1 to Progress Report sent 01/12/2016). This report included the information collected in Doñana, Cabo de Gata and Sierra Nevada, the actions design, the specifications on how to implement the actions most effectively and the maps.

If relevant, changes in action and correspondence with the AGENCY approving them

There has been one important modification due to the forest fire that affected three out of the nine forest plots in Doñana (June 2017, when action A1 had already finished and the field monitoring had already been accomplished in those plots according to action A10). This has implied re-opening this action and defining 3 extra plots to replace the burnt ones, but monitoring also the burnt plots to be able to obtain extra information in relation to ecosystem restauration after forest fire. This change was communicated to the external monitor and included in the modified budget informed to the AGENCY together with the extension request.

Major problems / drawbacks, delays, including consequences for other actions

Doñana National Park

All the partners involved in the action (Management Team, EBD and END) had to reach a consensus on both plot selection and action design. For that purpose, the first draft of the A1 report had to be re-written to add and modify some details. The first draft was sent on December 2015, but the agreed document was finished in June 2016.

Moreover, the impact of a forest fire on three of the plots (June 2017) forced the team to re-open the action and carry out a new plot selection and action design procedure (completed October 2017).

Cabo de Gata Natural Park

Some problems aroused to compile all existing information on historical actions carried out in the project area. This was scarce and very scattered. This delay has not had any substantial effect on other actions.

Sierra Nevada National Park

The existing information was quite vast and scattered and that has implied a longer execution period for this action than expected. However, no other problems have arisen in this action and this delay has not had any substantial effect on other actions.

Milestones and deliverables

This action comprises one Deliverable and one Milestone. Both of them were duly presented in the Progress report (Dec'16; see Annex A1, Progress Report 1).

Action A2 Information compile to design actions to increase Mediterranean forest adaptation to CC capacity in Doñana.

Foreseen start date: 07/2015 Actual start date: 09/2015
Foreseen end date: 09/2015 Actual (or anticipated) end date: 10/2016

Activities undertaken and outputs achieved

This Action consisted in preparatory tasks for the C2 Action. Plots for Action C2 were selected gathering information of similar actions (mainly cork oak plantations and herbivore exclosures) conducted in the past. Additionally, research projects were checked that could be affected by any of the planned measures (fencing, plantations, sowing, windrows). These areas were avoided. Plots were concentrated in three different areas of the National Park to obtain a representative study case for the Doñana area. The report with the maps and technical details was prepared by CAGPDS with support of CSIC. For the cork oak treatments, 300 individuals were selected using existing information about their distribution within the protected area and including a variety in age and conditions to get a representative sample. Information on the *Phytophthora cinnamomi* was also gathered and indicators monitoring were identified. The report on this particular part of C2 was prepared by CSIC with support of the University of Cordoba.

As result of this action, we have gathered all the needed information to prepare the Administrative Call needed to contract technical support for (1) a laboratory to conduct *Phythopthora cinnamomi* identification and analysis and (2) the forest management included in Action C2. The outcomes for sub-actions 1, 2 and 3 are reflected in A2 report included in Annex A2.1 in the First Progress Report, sent on 01/12/2016.

Comparison with planned output and time schedule

The initial delay was due to a general late start up of the whole project until September 2015. Although reports with the results were prepared without further delay (proposal for cork oak treatment was presented in December 2015 and restoration plots initial design in February 2016), adjustments related to the necessity to fulfil administrative procedures to essay the targeted substance (Fosetyl Aluminium) in a Protected Area were required, which caused additional delay in the task preparation(See further C1 and C2 descriptions).

Major problems / drawbacks, delays, including consequences for other actions

All the partners involved in the action (Management Team, EBD-CSIC and END) had to reach a consensus on both plot selection and action design. For that purpose, the first draft of the A2.2 report had to be re-written to add and modify some details.

Complementary action outside LIFE

The research project “Inductores de resistencia para frenar la destrucción de ecosistemas amenazados por patógenos exóticos: el caso del alcornocal centenario de Doñana (INREPAX) (Resistance inducers to halt the destruction of ecosystems threatened by exotic pathogens: the case of the century-old cork oak forest in Doñana), funded by BBVA foundation was essential for the further development of the cork oak treatment. This research project (led by E Sanchez of Cordoba University) was executed between 2016 and 2018 in Doñana and adjacent areas.

Milestones and deliverables

Two Deliverables were envisaged under this action. Both of them have been duly presented in the Progress report (Dec’16; see Annexes for Action A2 in PR1).

Action A3 Pilot study for the characterization of the dynamics in Ziziphus lotus eco-hydrological complex in Cabo de Gata.

Foreseen start date: 07/2015 Actual start date: 10/2015
Foreseen end date: 12/2015 Actual (or anticipated) end date: 01/2020

Activities undertaken and outputs achieved

The tasks performed by UAL can be assembled in two groups:

1) Generating and collecting environmental information to support the design and justification of protocols for carrying out the action C3.
   - Ecological characterization of the protected habitat 5220.
   - Preliminary study of *Z. lotus* threats: land cover and land use changes, climate change, aquifer overexploitation, herbicides use, and occurring of invasive exotic species from the genus Agave.
   - Preliminary study of the aquifer structure.
   - Characterization of the age composition and spatial pattern of *Z. lotus* population.
   - Assessment of the density and spatial pattern of *Agave spp*.
2) Justification and designing of protocols.
   - Optimal zones to plant individuals of *Z. lotus* (through remote sensing and field data).
   - One protocol for arranging a monitoring network of groundwater and superficial water.
   - One protocol for the densification and spatial structuration of *Z. lotus* population.
   - One a protocol for removing of invasive CAM species (i.e., species of *Agave* spp.).

Comparison with planned output and time schedule

The action was made according to planned schedule.

Major problems / drawbacks, delays, including consequences for other actions

Staff hiring was delayed one trimester, and therefore, the necessary information to implement the action C3 was obtained later. Likewise, based on the preliminary study of the aquifer structure included in the A3 report, the arranging of some wells would fall in private property, and in consequence, the owner's permission is being processed. All of this has caused a general delay in beginning the action C3 with no consequences for the effect of this action.

Complementary action outside LIFE

The complementarity lies in the coordination with multiple lines of research carried out by the University of Almería, mainly in charge of the team responsible for this A3 action.

Milestones and Deliverables

All the objectives due in this action have been achieved and the outcomes can be found in Annex A3.1 included in the Progress Report (submitted 01/12/2016). Milestones envisaged for this action were reached with some delay, but according to the expected quality and functionality to establish the right bases for the implementation of action C3.

Action A4 Pilot study to quantify traditional tillage effect on ecosystem services provision in Cabo de Gata.

Foreseen start date: 07/2015 Actual start date: 10/2016
Foreseen end date: 12/2015 Actual (or anticipated) end date: 02/2018

Activities undertaken and outputs achieved

Between February and October 2016 three meetings were celebrated (CAGPDS, AMAYA and UAL) as well as three field trips to establish work plots and the technical criteria for the optimal implementation of action C4. Work plots for traditional tillage were identified in detail, as well as the traditional terraces or small stone structures to be restored in order to assess the effect of these traditional elements in soil retention and water harvesting.

All the expected results within this action have been achieved. See A4 report included in Annex A4.1 in the Progress Report (submitted 01/12/2016).

Comparison with planned output and time schedule

Although the action was finished with some delay according to the expected time schedule for the reasons explained in the next paragraph, the expected outputs were achieved without any significant delay in the implementation of action C4.

Major problems / drawbacks, delays, including consequences for other actions

- After the field trip made on 03/02/2016 with responsible scientists to Escullos-Paraíso and La Torre rural, the territories initially defined for this action in the approved project, a change in action location was decided. These areas are nowadays widely covered by shrubs and the soil is stabilized, and tillage is not recommended. This was the reason for moving the action to nearby areas without these problems.
- After a deep study of the area, these two work zones were shifted to another one located in the same rural property AL-11511-JA, one that has been traditionally tillaged in the previous years. Although this shift implied a small delay in the implementation of action A4, it has implied no significant delay in the implementation of action C4.

Milestones and Deliverables

The unique Milestone included in the proposal was reached in September 2016 with some delay. The report was attached as an Annex of the Progress report (Dec'16)(Annex A4.1 to PrR-1).

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Action A5 Key ecological and hydrological aspects identification to select optimal locations to restore scrubland in Sierra Nevada high mountain.

Foreseen start date: 07/2015 Actual start date: 11/2015
Foreseen end date: 12/2015 Actual (or anticipated) end date: 10/2021

Activities undertaken and outputs achieved

UGR:

- Review of the scientific literature available about distribution and ecology of high-mountain scrubland in Sierra Nevada. Expert interviews were also done.
- Snow cover (from remote sensing) and climate data (from meteorological stations) gathering.
- Evaluation of modeling approaches (hydrological model, species distribution model) to compute potential distribution maps of *Juniperus* scrubland for Sierra Nevada.
- Creation of distribution map for *Juniperus* scrubland under current climate, using data gathered by meteorological stations (see Annex A5.3 in MTR).
- Future simulations under different climate change scenarios of the distribution of high-mountain scrubland.
- Selection of optimal areas with greatest potential for restoration actions. Field trips to visit potential areas to implement restoration experiments and best locations selection.
- Design of a restoration project according to best existing scientific knowledge and adapted to selected field plots.
- Time planning design for the best implementation of action C5.

AMAYA:

- Snow stations maintenance visits and data collection.

Comparison with planned output and time schedule

After in-deep analysis of WinMed hydrological model, it has been considered not appropriate for the work scale needed to *Juniperus communis* restoration (see complete explanation in annexes A5.1 and A5.3). As we pointed out in our previous report, the WiMMed model is a physical basis model, and as such, it is not fully adequate to simulate ecological processes that must incorporate biotic responses (not only physical ones), as it should be mandatory in an ecological restoration project. Additionally, this model is a tool that is scarcely used by the scientific community, only used by the researchers who have developed it (a tool not widely used in the scientific literature is not a reliable tool for many researchers). For both reasons (exclusive physical basis and very limited use by the scientific community), we have preferred to use a niche model (*i.e.* a model family with a statistical base), which can relate empirical data of presence or abundance with environmental factors. Furthermore, Maxent model is widely used by the scientific community. Thus, for both reasons (model suitability and extended use of the model by the scientific community), we opted for using Maxent model instead of WinMed model, according to the scientific literature available (see Phillips et al. 2006; Benito et al. 2011 and references included in Annex A5.3 in MTR).

Instead, we have firstly reviewed all scientific ecological information about this ecosystem. Secondly, the key biophysical parameters affecting distribution of this ecosystem have been identified; and then several modelling approaches were evaluated. At the end, based on scientific literature and expert interviews, a species distribution model was performed. Using the outputs of this model, and considering the distribution simulations of this ecosystem under climate change scenarios, a selection of optimal locations for the implementation of action C5 was done.

All this information, accompanied with exhaustive field works, was used to carry out a multicriteria evaluation of restoration sites. In the response of our previous report, we were asked to provide further justification on the impacts of this technical deviation on the final results. As we detailed in the Annexes A5.1 and A5.3 in MTR, this technical deviation did not affect the expected results and deliverables of this action, because we fulfilled the milestones and deliverables for this action. More specifically: *(i)* we have gathered all meteorological available information to compute species distribution model of this ecosystem; *(ii)* we have provided more realistic and scientifically validated model with the potential impacts of climate change on the distribution area of this ecosystem; and at the end (iii) restoration areas were selected according to the best scientific knowledge available.

Using all raw data recorded by meteorological stations (Indicator A5.1) and the temporal climate series derived from those data (Indicator A5.2) we carried out potential distribution models to identify the vulnerability areas of Juniper scrublands under the climate change scenarios (Indicators A5.3 and A5.4). Then, a selection of the optimal locations to implement the C5 action was done.

We generated outreach materials about the models supporting this action. All information will be integrated into the information system of the project, but currently could be found at this link http://sl.ugr.es/enebral_dist

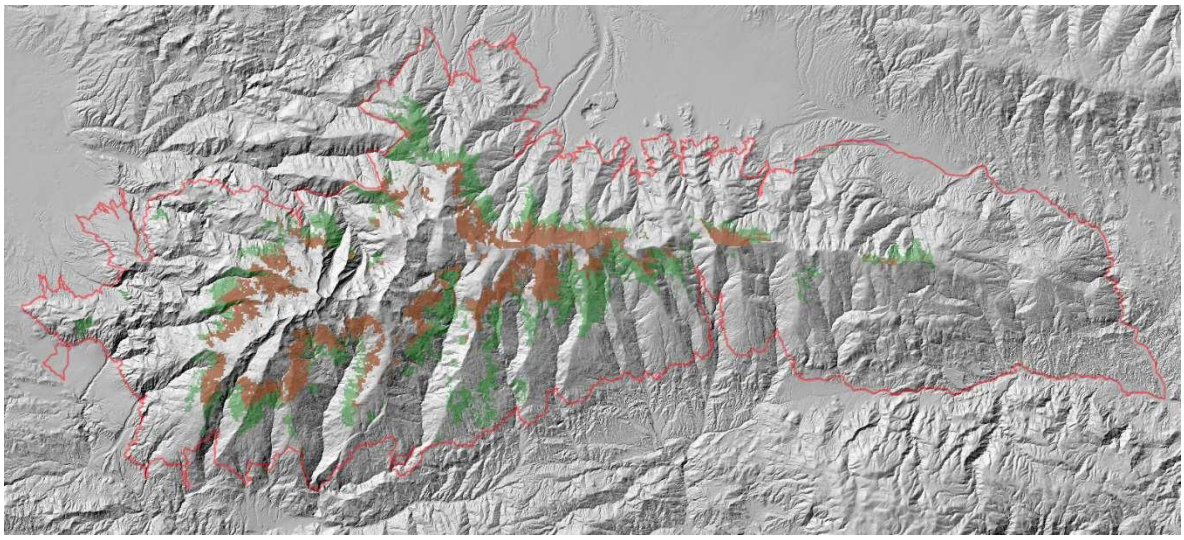

Figure A5.1. Current distribution map of *Juniper* scrubland for Sierra Nevada (green) and simulation of distribution under a climate change scenario for the year 2100 (brown). More info at http://sl.ugr.es/enebral_dist (see Annex A5.3 in MTR).

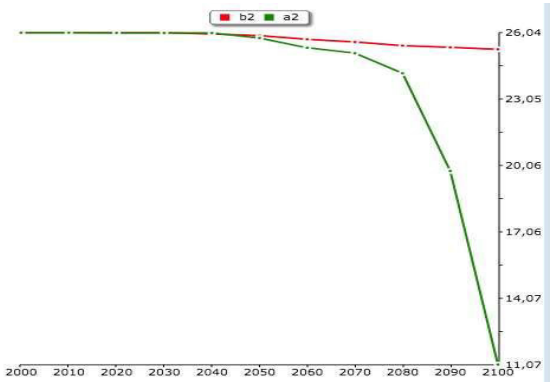

Figure A5.1. Evolution of potential area for *Juniper* scrublands in Sierra Nevada under different climate change scenarios.

Major problems / drawbacks, delays, including consequences for other actions

This action suffered a delay in the start date derived from the general delay of the start of the project. In addition, due to the problems encountered with the use of the WiMMed model, and the need to explore and execute other models (see above and see Annex A5.3 in MTR), this action has been temporarily extended. Despite this temporal delay, there were no impact on the central action C5, since the selection of optimal zones and optimal criteria for restoration actions (C5) were made prior to the moment in which, for biological reasons (juniper phenology) and logistics (possibility of access to irrigation channels and planting areas) action C5 could be carried out.

Possible complementary action outside LIFE

The experience obtained in this action has been used as a case study for a scientific communication which has been drafted to be presented at a scientific congress.

Milestones and Deliverables

A report containing an identification of areas with a higher suitability for C5 action was delivered with the progress report on December 2016 (Annex A5 to PrR-1).

The data base envisaged as a Milestone was duly completed and integrated in two information systems managed by one of the beneficiaries involved in the project: CLIMA information system (CAGPDS; http://www.cma.junta-andalucia.es/medioambiente/servtc5/WebClima/).

Finally, a report based on the model including climate impacts on high mountain scrubland was also completed and attached to MTR (see Annex A5 in MTR). This report was requested as result of the second monitoring visit (Ref. Ares(2017)4729797 – 28/09/2017).

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Action A6 Monitoring and assessment of forest pest effect in oaks, holm oaks and pines in Sierra Nevada.

Foreseen start date: 07/ 2015 Actual start date: 05/2016
Foreseen end date: 06/2018 Actual (or anticipated) end date: 05/2020

Activities undertaken and outputs achieved

An update of the actual knowledge of the insects that predate on oaks, holm oaks and pine forests in Sierra Nevada forests has been made by AMAyA.

The monitoring on oaks defoliator pest group and its effect on vegetative growth and reproductive capacity of holm oaks and Pyrenean oaks was stablished on May 2016 by AMAyA and has continued since then with the planned regularity. To find out all the defoliating-complex components, ten trees (oaks and holm oaks) were marked in each permanent sampling point. For holm oaks, 4 sampling points have been stablished in 2 different areas. For Pyrenean oak 8 sampling points have been stablished in two separate areas, differentiating two heights in each one of them. All the sampling plots have been selected in the most representative locations. Since the beginning of this action, eight monitoring campaigns have been carried out, in spring and autumn, for years 2016, 2017, 2018 and 2019 (more details in tables below).

Holm oak (Quercus ilex)

PLOT NAME	AREA	X	Y	INSTALLATION	MONITORING DATES
Camarate I	Northern slope	477.354	4.116.246	23/05/2016	06/06/2016, 10/10/2016, 11/05/2017, 28/09/2017 18/06/2018, 19/09/2018, 11/06/2019, 28/10/2019
Camarate II	Northern slope	477.515	4.116.285	30/05/2016	06/06/2016, 10/10/2016, 11/5/2017, 28/9/2017, 18/06/2018, 19/09/2018, 11/06/2019,29/10/2019
Cañar I	Southern slope	460.783	4.089.398	24/05/2016	07/06/2016,06/10/2016,09/05/2017, 21/09/2017,11/06/2018,21/09/2018,10/06/2019, 5/11/2019
Cañar II	Southern slope	463.884	4.091.140	07/06/2016	07/06/2016, 06/10/2016, 09/05/2017, 21/09/2017, 11/06/2018,21/09/2018, 10/06-2019, 5/11/2019

In this period, 15 leaf-cut caterpillar species have been detected, as well as 4 oak leaf-galler insects, one mite and other species. Some of the species had not been found before in this mountain chain. The species found are listed below:

TAXA		
Aceria ilicis	*Catocala nymphagoga*	*Malacosoma neustria*
Aleimma loeflingiana	*Cynips divisa*	*Neuroterus albipes*
Andricus curvator	*Dicycla oo*	*Neuroterus numismalis*
Andricus foecundatrix	*Dryobotodes erermita*	*Neuroterus quercusbaccarum*
Andricus kollari	*Dryomia lichtensteini*	*Nycteola sp.*
Andricus quercustozae	*Ephesia nimphaea*	*Orthosia cruda*
Andricus solitarius	*Erannins defoliaria*	*Periclista andrei*
Archips xylosteana	*Euproctis chrysorrhoea*	*Tortricodes alternella*
Biorrhiza pallida	*Gilpinia virens*	*Tortrix viridana*
Brenneria quercina	*Lymantria dispar*	*Trigonaspis brunneicornis.*

The needed enquiries to expert have been launched for the identification of some other new

defoliator species not yet identified.

Oak (*Quercus pyrenaica*)

PLOT NAME	AREA	X	Y	INSTALLATION	MONITORING DATES
Camarate CSR1	Northern slope	477.203	4.115.381	30/05/2016	30/05/2016,4/10/2016,19/05/2017,14/09/2017,06/06/2018,18/10/2018,04/06/2019, 30/10/2019
Camarate CSR2	Northern slope	477.072	4.115.173	30/05/2016	30/05/2016,4/10/2016,22/05/2017, 18/09/2017, 07/06/2018, 19/10/2018,04/06/2019, 30/10/2019
Camarate CIR1	Northern slope	477.647	4.115.992	23/05/2016,	23/05/2016, 28/09/2016, 11/05/2017,29/08/2017, 28/05/2018, 27/09/2018,21/05/2019, 17/10/2019
Camarate CIR2	Northern slope	477.400	4.116.062	23/05/2016,	23/05/2016, 28/09/2016, 11/05/2017,29/08/2017, 28/05/2018, 27/09/2018,24/05/2019, 14/10/2019
Cáñar CSR1	Southern slope	462387	4091228	01/06/2016	01/06/2016, 06/10/2016, 18/05/2017, 13/09/2017, 14/06/2018, 19/10/2018, 05/06/2019, 25/10/2019
Cáñar CSR2	Southern slope	462578	4091338	01/06/2016	01/06/2016, 06/10/2016, 18/05/2017,12/09/2017, 14/06/2018, 18/10/2018, 05/06/2019, 25/10/2019
Cáñar CIR1	Southern slope	462401	4090326	24/05/2016	24/05/2016, 26/09/2016, 9/05/2017, 28/08/2017, 5/06/2018, 4/10/2018, 29/05/2019, 11/10/2019
Cáñar CIR2	Southern slope	462688	4090575	24/05/2016	24/05/2016, 26/09/2016, 9/05/2017, 28/08/2017, 5/06/2018, 4/10/2018, 29/05/2019, 11/10/2019

Objectives: In relation to holm oak and oak pests, according to schedule. In relation to pine pests the objectives were be achieved following new methodological approach explained before. All the results, both from field monitoring and documentation review, including the management recommendations have been included in the final report of this action (see Annex O01).

Comparison with planned output and time schedule

The differences with the planning showed in the approved version of the project are due to an error in the approved version. This error has been corrected to adapt the monitoring in action A6 to the life cycle of pests to be studied, as it was more convenient to start the pest monitoring in spring rather than autumn. This adjustment in the beginning of the action has had no effect on the results and outcomes, as the schedule of the action has been adjusted accordingly without any impact to other actions of the project, maintaining the same three-year monitoring expected in the approved proposal. Monitoring done: 4 years(Spring and Autumn campaigns in 2016, 2017, 2018 and 2019).

Milestone, delayed as justified and requested in the Extension request, was launched satisfactorily according to the new schedule in June 2020, to maintain the length of the monitoring period after the delay in the beginning of the action. (see **Annex O01**).

If relevant, changes in action and correspondence with the AGENCY approving them

After several consults to experts in forest pests in Granada and Almeria provinces, it became clear that there was a vast existing literature and information on pine forest pests coming from different research institutions specially Granada University (Ecology department), the Ecological Balance Network belonging to CAGPDS (Red de Equilibrios Biológicos de la Junta de Andalucía) and monitoring data from Sierra Nevada Global Change Observatory. This review data can be consulted in the report included in **Annex O01.**

Despite existing such a broad knowledge on the effect of *Thaumetopoea pityocampa* on pinus in relation to CC, there is much less research done on the effect CC in relation to oaks pests,

and even less in known in relation to their effect on important aspects for forest conservation such as growth, flowering, fruiting and regeneration. These variables are directly related to the ecosystem services provided by holm oaks and Pyrenean oaks.

FOREST	PREVIUS WORKS	ACTUAL WORKS	SCIENTIFIC PRODUCTIVITY / IMPACT	ACTUAL TRENDS
Pinus sp. (proce-ssionary moth)	Abundant Gorgeous	Abundant	Plentiful. High impacts. Plant-insect interactions.	Vast networks in forest decline. Biocontrol.
Quercus sp. (defoliator pest group)	Scarce	Medium	Medium. Low impact. Identification, distribution and population trends.	Forest pest incidence in forest regeneration progress in Mediterranean basin. "La seca" phenomenon.

Evaluation of 122 documents directly related to work done on these pests was made. Of these, 88 were scientific articles or doctoral theses. The rest were technical reports, dissemination articles or internal reports of the Public Administrations to which we had access. The existing asymmetries between the vast knowledge generated for the sustainable management of defoliators with potential behavior as a plague in pine forests on the one hand, and the little information existing on oaks and holm oaks on the other, can be clearly concluded.
Documents focusing on pine plagues are abundant (especially on pine processionary). They cover a complete range of aspects: basic taxonomic positioning, distribution, population evolution, chemical control and biological control (with parasitoids and bacteria). However, for Pyrenean oaks and holm oaks, relatively old articles that describe the species and their distribution are frequent, but those that emphasize population aspects, spatial distribution, abundance and measures of chemical or biological control are scarce or non-existent.
Therefore, taking into account the little economical resources available for field data gathering in this action, and following the expertise advice, it was considered more useful to achieve the objectives pursued in action A6 by spending the existing resources for field work in improving the actual knowledge on oak and holm oak pests (focusing all the field visits in these tree species). In pine pests, the expertise advice suggested that it was more useful to carry out an in-depth literature review on the vast existing information, bringing to light from all the scientific papers and technical documents available some key management recommendations aimed to improve actual pine management in order to increase the resilience of the ecosystem to forest pests, specially *Thaumetopoea pityocampa,* in a scenario of CC. That is the reason why a reorientation of the action was proposed. This reorientation meant using field survey efforts to know more about oaks pests and their effect on trees growth and reproduction and, thus, on oak forest resilience. The time needed for this in the approved project was underestimated.
The time spent by technicians in the office has allowed: 1) to process this newly acquired field data and 2) to review existing literature and technical reports in order to extract useful recommendations on best management actions to increase pine trees resilience in relation to pests in a scenario of global change. These recommendations for pines and oaks management has been reflected in two of the manuals with recommendations for adaptation to global change of Pyrenean oaks and pine forests. Although this modification has not implied any increase in the action cost, an increase in the usefulness and applicability of the results of this action was achieved. This modification was informed to the project monitor.

Major problems / drawbacks, delays, including consequences for other actions

No problems or negative consequences for other actions have happened.

Action A7 Preparatory action with local communities to define best locations and implementation details in actions C

Foreseen start date: 09/2015 Actual start date: 01/2016
Foreseen end date: 11/2015 Actual (or anticipated) end date: 11/2021

Activities undertaken and outputs achieved (including responsibilities)
In line with the modifications agreed with the coordinator of the project regarding Action A7, the following activities were carried out by IUCN-Med:

- Definition and sending of questionnaires to parks staff and scientific partner responsible.
- Identification of the calendar and list of local actors and dissemination of the event (Progress Report 1- Annex 1a, 1b, 1c meetings contact list for).
- Celebration of the informative events.
- Between May and June 2016, 4 informative meetings were held (2 in the park of Sierra Nevada, 1 in Doñana and 1 in Cabo de Gata) (Progress Report 1- Annex 2a, 2b and 2c Reports of the meetings and Annex 3 post meeting questionnaire).
- Meeting report and questionnaire sent to non-attendees.

In summary, the results obtained are:

- 70 participants took part in the meetings. Participation was extended beyond farmers and livestock breeders to a wider range of actors.
- A total of 4 questionnaires post meeting prepared.
- 85 local actors answered the questionnaires during the meetings and subsequently online.
- 4 action plans elaborated and ratified.

Comparison with planned output and time schedule
Although the time constraints caused by the delay in some of the central actions did lead to a lower number of participants than planned, this action allowed to collect important feedback for adjusting certain actions and gaining support from key stakeholders, as in C2, C3 and C5. In C2, the action allowed to grow awareness among cattle breeders on the effects of herbivory on forest mass and how this affects ecosystem services that sustain their activity. In C3, it allowed to address the controversy about the removal of Agave spp. to protect Ziziphus lotus, by providing evidence on the benefits of the removal of agave for biodiversity in the site. In C5, it allowed to explore with the irrigating communities the most effective solutions in terms of water management and restoration of the "careo" irrigation channels.
The rest of the actions also acquired some criteria from this action, although due to its complexity it was not possible to transfer some recommendations. The social immersion of Life Adaptamed expected from this action was achieved through the informative meetings and the information gathered through the surveys.

If relevant, changes in action and correspondence with the AGENCY approving them
Since the central actions of the project were subject to a public call for tenders carried out by the Andalusian public administration, the initial delay significantly reduced the time available to involve the local stakeholders in the design of the actions. For this reason, the approach of the action was modified and subsequently agreed with the programme (Annex A7.1. from MTR). Instead of co-designing the actions, the local stakeholders were able to provide feedback to enable important adjustments to the actions underway.
As a result, the vision and structure of the action needed to be modified. In order to do this, the technical staff invested more hours than originally expected and thus increased the staff costs. This increase compensated for the reduction of expenses linked to a lower number of events organised.
Regarding the changes in the structure of the meetings: instead of organising a first meeting to

select the most relevant stakeholders, the staff of the parks and scientific personnel were requested to identify these groups through a questionnaire. By applying and extending the collected feedback, is was possible to identify 4 different groups potentially impacted by project actions: one in Cabo de Gata (potentially impacted by C1, C3, C4 actions), one in Doñana (C1 and C2) and two in Sierra Nevada (C6 and C5; and C1). This led to 4 informative meetings, which made it possible to collect important feedback, as well as to provide further explanations about the value of the actions for climate change adaptation and to establish connections that have supported the project implementation and will persist beyond it. Questionnaires were shared both with in-person participants, as well with the ones who weren't able to attend the physical meetings. Finally, feedback from the park managers was collected, to have a broader perspective.
This feedback was integrated into the interventions by the technical staff of the project - considering that the actions were already underway - and compiled in the form of final reports (sectoral plans), which were shared with the meeting participants and project partners.

Major problems/drawbacks, delays, including consequences for other actions
Double time constraint, due to delay in central actions and obligation to launch a public call for tenders by Andalusian public administration, with a strong bureaucratic component.

Possible complementary action outside LIFE
Among the aims of the Parks staff with their public use departments, it is considered to take into account to share experiences with local people, game keepers and irrigation channels management communities. So, this action is complementary to these activities and contributes to defining conceptual frameworks that should help to face and solve problems related to management of this kind of information.

Perspectives for continuing the action after the end of the project
Public awareness and involvement of stakeholders during the post life phase will be a priority for the coordinating beneficiary. So, this action is expected to continue after the end of Life Adaptamed. Methodological approach to do this is now well defined.

Milestones and deliverables
Two Milestones reached at the end of 2016 spring: "Holding of the first meeting (preparatory information action)" and "Sending of surveys".
Deliverable: 4 Sectoral Action Plans drafted and ratified (reached in MTR-Annexes A7.1 to A7.5).

Action A8 Writing of 3 projects for work awardings to implement actions C1, C2 and C6

Foreseen start date: 01/2016 Actual start date: 01/2016
Foreseen end date: 03/2016 Actual (or anticipated) end date: 12/2016

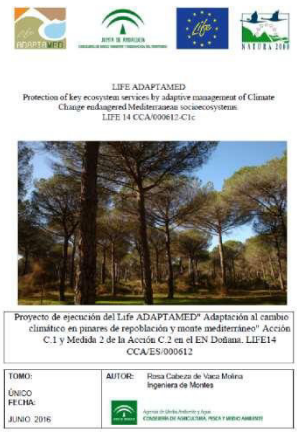
Activities undertaken and output achieved

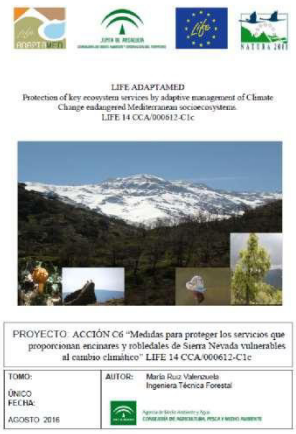
Three projects were written by AMAYA: the first one to implement actions C1 and C2 in Doñana National Park following recommendations in reports A1 and A2 (Annexes A1.1 and A2.1 in Progress Report 1), the second one to implement action C6 in Sierra Nevada National Park and the third one to implement action C1 in Sierra Nevada National Park and Cabo de Gata Natural Park following recommendations of report A1 (Annex A1.1 in PR-1).

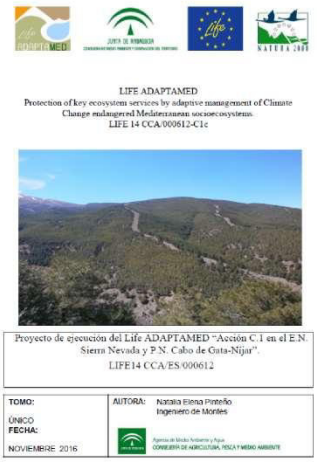
Each one of the projects contains a Technical Memory, a Technical Specifications Document, a Budget and the Maps, along with other required administrative documentation.

These three projects were attached to Progress Report, sent on 01/12/2016 (See projects for Doñana actions in Annex A8.1 of PR1, project for action C6 in Annex A8.3 of PR1 and project for action C1 in Sierra Nevada and Cabo de Gata in Annex A8.5. of PR1).

All the objectives foreseen in this action have been achieved satisfactorily.







Comparison with planned output and time schedule

The first project was launched in June 2016, the second project was launched in September 2016 and the third project was launched in December 2016.

Major problems / drawbacks, delays, including consequences for other actions

The action has been quite complex to fulfil because many project beneficiaries have had to agree on the details of the implementation of the actions included in the projects: EBD-CSIC, CAGPDS and AMAYA in Doñana; UAL, CAGPDS and AMAyA in Cabo de Gata; and UGR, CAGPDS and AMAyA in Sierra Nevada. In addition, the first draft of the projects exceeded the expected budget. Therefore, design modification was needed in all the projects, with subsequent new agreement between all partners, to adjust the project budgets to the amount foreseen in the Adaptamed approved proposal for actions C1, C2 and C6. As a result of this, action A8 has needed more time and more budget than expected.

Milestones and Deliverables

All the deliverables for this action were included in Progress Report 1 (See project for Doñana actions in Annex A8.1 project for action C6 in Annex A8.3 and project for action C1 in Sierra Nevada and Cabo de Gata in Annex A8.5. in PR-1)

Action A9 'Ex ante' assessment of the ecosystem services affected by the Project at a landscape scale

Foreseen start date: 07/2015 Actual start date: 10/2015
Foreseen end date: 06/2015 Actual (or anticipated) end date: 12/2019

Activities undertaken and outputs achieved

UAL has undertaken the following activities:

- Development of methodologies to assess the status of regulating ecosystem services provision. Such methodologies will be implemented in the action D7.
- Download, quality filtering and gap filling data. First, the OLI and TIRS images of Landsat 8 were downloaded. Then, the images with a high percentage of clouds, aerosols, etc. were rejected and finally, the gaps appeared were filled by using MODIS MOD13Q1 images.
- Calculation of ecosystem service indicators. The complete available temporal series of Landsat 8 (September 2013-September 2021) have allowed for calculating indicators related to ecosystem services such as carbon balance (EVI/NDVI), water availability (LSWI) and energy balance (Land Surface Temperature, LST).

Map of mean EVI (Enhanced Vegetation Index) calculated from Landsat 8 images for the period (September 2013-september 2016). EVI mean is an indicator of carbon gains, and will be used to evaluate the response of ecosystems to management actions.

Comparison with planned output and time schedule.

This action was finished right before all the implementation actions started, in order to the optimal achievement of the objectives of the action A9. However, once more data were available before the central actions were implemented, we extended the satellite images processes to provide a complete and comprehensive characterization of the situation before the implementation of the actions. The delay in this action was in accordance with the implementation actions and no problem was detected.

Major problems/drawbacks, delays, including consequences for other actions.

- Gap filling software (Kalman filter time series from pKtools) was a beta version, so a lot of trials and test had to be done.
- Land surface temperature required a different Landsat 8 OLI dataset, increasing the available storage space in the informatic systems. In addition, a new L8 LST split window algorithm was used.
- The existing spatial information about the target ecosystems was not totally adjusted to the requirements of the action D7 because the boundaries and definition of such

ecosystems was outdated. To address this, a revision and update was required to the responsible partners.

- Although, this request has motivated a delay in the action A9, no delays have happened for the main action that depends on this, i.e., the action D7.

Possible complementary action outside LIFE.
This action is complementary to related research projects where University of Almería are already involved. In particular, they are improving a monitoring system for the Spanish National Park Network (REMOTE) from the results obtained here, in addition UAL has applied for a FEDER project call with a proposal to monitor *Ziziphus lotus* matorral in other locations in Iberian Southeast.

Perspectives for continuing the action after the end of the project.
This is a preparatory action that has continued within the Life Adaptamed project through action D7. Action D7 action will be continued after the end of the project.

Was the objective reached? What reactions and feedback were obtained?
All the objectives addressed in this action have been completely achieved.

Deliverables and milestones: Not expected.

Action A10 'Ex ante' assessment of the ecosystem services affected by the Project at field scale

Foreseen start date: 07/2015 Actual start date: 09/2015
Foreseen end date: 06/2016 Actual (or anticipated) end date: 11/2020

Activities undertaken and outputs achieved

This action comprises a compendium of field monitoring approaches aimed to evaluate the state of the previously selected parameters just before the implementation of the central actions. This is one of the most important actions because it involves the assessment of ecological parameters that will allow us to make a comparison of the evolution of the ecosystem mediated by the adaptive management that involve the central actions C1 to C6. The selected parameters are linked to ecosystem functions that are directly related to ecosystem services and project indicators.

The conceptual framework and the approach to measure the target ecosystem function has been included in a '*Life Adaptamed monitoring methodologies report*' (included in **Annex O07**). This report is an important tool because there we establish all the needed detail to replicate the methodologies defined in the project. This will ensure the replicability in these same areas in the future but also allow replication in other sites with similar ecological context. This will amplify the transferability of the project methodological approaches and framework. To define these set of methodologies, several meetings have been carried out between the beneficiaries involved. One of the most important ones was conducted at the Doñana Biological Station (CSIC, Doñana National Park) and allowed scientists of UGR, UAL and CSIC/EBD, and managers and staff of the Protected areas involved in these actions, and in other actions related to the scientific advisory tasks to share knowledge and experiences.

The monitoring scheme designed in the Life Project Adaptamed can be summarized as follow:

A. Biodiversity:

- *Composition, structure and trend of passerine bird communities*: related to biodiversity trend, potential of the community for the seed dispersal functioning surrogates of insects pest control. It includes both overwintering and breeding bird communities.
- *Composition, structure and trend of bat communities*: related to biodiversity trend and insects pest control. This monitoring takes place only in the Doñana site.*Seed dispersal by carnivore mammals*: as surrogates of the potential of this group of mammals to improve the introduction of seeds in the target plots.
- *Composition, structure and trend of small mammal communities*: this monitoring takes place only in the Doñana site, but it is expected to be implemented also at the selected places in Sierra Nevada and in Cabo de Gata during the year 2018. Small mammals are monitored because of their important role as both predators and (cache) dispersers of seeds.
- *Monitoring of reptiles*: also implicated in the seed dispersal function (Cabo de Gata).
- *Abundance and activity of pollinators*: pollination is one of the main drivers for the ecological restoration in forest and grasslands ecosystems. They are key contributors to ecosystem functional diversity, mediate plant regeneration and, through spatial interactions (such as spatial refuges and overspill effects) may sustain ecosystem services such as crop pollination. We use the abundance of pollinator functional groups participating in pollination networks as surrogates of the restoration of this

ecological function in the managed sites.

- *Butterfly monitoring*: these insects are surrogates of several ecological functions that can be linked to the expected evolution of the sites intervened. Butterflies communities' trends should indicate changes in the landscape complexity and other important parameters linked to the planned restoration actions (Sierra Nevada).
- *Composition, structure and trend of soil arthropods*: this group of insects was selectedas indicator of the recovery capacity of the target ecosystems, which is particularly important to key services such as soil fertility and carbon storage. This monitoring was carried out only in Doñana and in Cabo de Gata.

B. Landscape structure:

- *Forest inventory*: selected as an indicator of carbon storage and of the provision of habitat structure, mediates the forest capacity to sustain biodiversity and, therefore,foster a more complex and resilient ecosystem. Forest inventory included annual data of several variables such as tree size (height, stem girth, crown size), canopy and shrub cover, pest abundance; as well as multi-annual data on canopy cover using stereoscopic hemispheric images and LAI measurements.
- *Changes in the diversity and in the plant regeneration*: the regeneration rate should be related to adaptive capacity of the ecosystem. It is also a surrogate of resilience and the primary productivity provided by the forest where the management will be applied.
- *Scrublands cover and grassland plots*: This set of indicators was selected as complementary surrogate of carbon storage capacity, soil conservation potential and habitat structure provisioning. Separate measures, adjusted to the required spatial scales, were applied to the grassland and scrubland strata. In both cases, measurements provided reliable descriptors of plant cover, diversity and structure, and allowed for the estimation of plant biomass. In Doñana, where treatments included herbivore exclusion, detailed measurements of grassland biomass were also obtained.

C: Effect of the Life-Adaptamed interventions

- *Efficiency of the assisted regeneration treatments:* This set of indicators evaluated the success of the assisted reneneraton treatments, in terms of seed escape from early predation, seedling establishment and seedling/sapling.
- *Effect of the P.cinnamomi control treatments:* To evaluate the effect of the control treatments applied in Action C2, and complementarily to the measurements of infectiveness in roots and soil, canopy health indicators were monitored in the 60 trees involved in the intervention.
- *Nest-box and bat refuge occupancy:*This set of indicators evaluated the success of the bat refuge and bird nest-box supply, by evaluating their occupancy, the abundance of bats in the refuge and the breeding success of the occupying birds (and rodents, since an unexpected host, the dormouse *Eliomys quercinus*, was also found using the boxes).

D. Soil related functions: with this monitoring we identify parameters linked to the total amount of Carbon retained in the soil. We also analyze parameters as organic particulate matter, potentially mineralizable carbon or total nitrogen.

Regarding each site included in the project, the specific activities carried out in this action have been:

Doñana:
C2 - Field sampling started with mapping of 300 cork oaks (*Quercus suber*) and recording basic data of the condition of each individual. A progress report was provided. The environmental authorities forced to reduce the experiment to 60 trees as a precautionary measure (the use of fosetyl-aluminium needs a special license in forest areas). A new selection was prepared, based on the former one and an ongoing research project in the area.
From April 2016 to November 2020, field work has been conducted in the study plots where forest management actions were planned (C1 and C2). Fieldwork followed the monitoring procedures produced through the '*Life Adaptamed monitoring methodologies report*' (included as Annex). In Doñana, it included measurements of (i) (v) changes in pine tree size (height, stem girth, and crown spread) (A); (ii) the cover, structure and diversity of shrub and herbaceous vegetation, as well as the biomass of herbaceous vegetation (A); (iii) the abundance and diversity of overwintering and breeding, passerine birds (B); (iv) the relative abundance of herbivorous (rabbit and hare as well as wild and domestic ungulates) and carnivorous mammals, using camera-trap and track analyses (B); (v) the abundance and composition of soil fauna, with a focus on ants as indicator group A); (vi) the abundance and diversity of micro-mammals (rodents and shrews) (B); (vii) the abundance and activity of bats (B); (vii) nest box and bat refuge occupancy (B); and (viii) the activity, abundance and diversity of pollinators, aggregate din functional groups (A). All these measurements were taken on an annual (A) or biannual (twice a year: B) basis, although the contingency of unforeseen factors (most importantly, the Covid-19 pandemic) caused some gaps in this data series. In addition, (ix) the collection of soil samples for the determination of carbon, nutrient and water content took place a single time during the project. Owing to the late response expected in this variables and the delayed application of several treatments, we did not take an ex-post-hoc measurement and will simply use the first measurement as a baseline to be compared with future measurements undertaken in the post-Life.

Cabo de Gata:
A number of biological indicators, such as soil beetles (e.g. Erodius sp.) and steppe bird's diversity and abundance, have been selected as a result of these surveys. Additionally, between May 2016 and July 2017, birds, reptiles, beneficial insects, soil insects and *Ziziphus lotus* demography and morphophysiological attributes were monitored. In this last case, from a total of 41 variables tentatively considered, and after field data collection and analyses, finally 15 variables were chosen as indicators to this monitoring action. Furthermore, biomass and plant diversity under different soil treatments (soil tillage vs non-tillage) have been monitored. Finally, soil samples to measure organic matter content (as indicator of carbon sequestration) were taken for the different treatments in the three central actions (03/17).

Sierra Nevada:
A10 fieldwork in Sierra Nevada involved visits to each one of the 242 hectares considered under the actions C1 and C6 and to the two areas included in the C5 action. During these visits several measures were taken regarding the forest structure, animal communities and soil composition (see '*Life Adaptamed monitoring methodologies report*').
Additionally, several meetings took place to define the monitoring methodologies in order to define criteria to the correct implementation of this action but also for an adequate coordination with other actions (mainly C7, D1, D2, D3, D8, F2 and also all the central actions and the majority of dissemination and communication actions).

Comparison with planned output and time schedule.
This action has needed an extra effort to define a common methodology directly linked with ecosystem functioning and that took into account the existing time series, to have long data to compare with. the adjustment of new methodologies has implied more field visits than previously expected. As for Doñana, there have been difficulties in the administrative procedures to employ two people as additional staff for the tasks associated to A10 and D8 in Doñana by CAGPDS. This has forced EBD-CSIC to assume all the tasks to be done in Actions A10 and D8 in Doñana by themselves, although in the approved proposal both CAGPDS and EBD were responsible for these tasks. Otherwise, the data obtained by the monitoring before the central actions would have been lost for Adaptamed Project.
In addition, the forest fire that took place in Doñana in June 2017 burned three out of the 9 selected plots when the task included in action A10 (the ex-ante field monitoring) was already made by EBD-CSIC. After the fire, the three burned plots were relocated in new similar areas and the field inventories were repeated in the 3 new plots, with an inevitable extra cost. Finally, the Covid-19 pandemia interfered with several planned surveys, most notable those planned during spring 2020. Because of all these reasons explained, the effort needed for this action has been much higher than expected. Thanks to these efforts, however, all monitoring activities have been undertaken in an almost-full basis; and, while the delays in several C1 and C2 actions have affected the balance between the duration of the ex-ante and ex-post data series, the availability of these time series will allow for a complete evaluation of the success and impact of all intervention – particularly, if they are completed further during the post-Life phase.

If relevant, clearly indicate how actions were modified and any correspondence with the AGENCY approving the changes.
In the previous paragraph we explain the major deviations in this action. The delay in the implementation of some central actions (C1, C2 and C6) is explained in their correspondent sections of this report and was communicated to the AGENCY when the 18 months-extension was requested. In the financial information the repercussion of this gap should be checked.

Major problems/drawbacks, delays, including consequences for other actions.
As explained before, the main drawback caused by the extension of the period when this action has been active is the shortening of the period available for the implementation of the action D8. This is the main justification of the proposed extension of 18 months.
Specifically, in the case of the Cabo de Gata Natural Park and Doñana National park, all the insect samples have not yet completely been analyzed, because of the great number of samples and the need for consultation to taxonomical expert. In cabo de Gata, piezometric level was estimated from regional existing data, but after wells were installed, specific data for the area is available. In Doñana, there is a certain unbalance between the extension of the ex-ante and ex-post data series, which limits the capacity to obtain reliable estimates of the success and impact of the applied interventions in the absence of longer-term, complementary data. This limitation was, however, known from the project's start, owing to the slow time-scale of operation of the most ecological process in relation to the 5-year scale of the project.

Possible complementary action outside LIFE.
This action is complementary to other monitoring initiatives carried out within the framework of the global change observatories of Doñana, Cabo de Gata and Sierra Nevada. The conceptual basis of the methodologies implemented to make the interpretation of results compatible has been kept in common. This coordination improves the monitoring of the ecological repercussions of the implementation of life adaptive central actions in the long

term, in a post-life phase. The conceptual framework of this monitoring design is very complete and fully compatible in those methodologies established in the local observatories. In this sense, Life Adaptamed can take opportunity and benefits from previous data series, knowledge and experiences compiled during years of local monitoring at Cabo de Gata, Doñana and Sierra Nevada.

The beneficiary EBD-CSIC developed a practical training program included in the 2-years degree in Forestry run by the Doñana Technical School (IES Doñana) in Almonte, Doñana's local county. Within that training program, students participated in the monitoring of pine-afforestation plots. This activity serves the triple purpose of training local professionals in the project's adaptive management approaches, enhancing the transfer of such approaches to the broader local community, and facilitating the continuation of the project activities after its end. The project run successfully during the first four years, including the development of detailed syllabi and data-acquisition tools and a detailed organizational framework; however, it was interrupted by the Covid-19 pandemic and, during the last two years, has been blocked owing to administrative reasons (the agreement between CSIC and the Andalusian Education Office has expired and progress towards its renewal has been halted since then), compromising the whole effort. This is unfortunate, since this program aimed at being one of the key elements of Doñana's post-Life program.

Doñana's monitoring activities have involved also numerous Erasmus + students from UK, working through an ongoing agreement between EBD-CSIC and the company 3Si.

The beneficiary UAL has also involved students in the field works and in the analysis carried out from the data sets generated. Researchers of the Research Institute and Agrarian and Fisheries training (Andalusian government) have been also involved in some analytical phases of the monitoring.

Action C1. Pine forests adaptation to CC: protection of ecosystem services provision

Foreseen start date: 03/2016 Actual start date: 02/2016
Foreseen end date: 06/2017 Actual end date:11/2020

Activities undertaken and outputs achieved

This action started with a long and complex open tender procurement proceeding carried out by CAGPDS (current CAGPDS). In the project proposal, the period for the tender procurement proceeding for the works included in this action was not included in this Action C1 nor in the preparatory Action A8 (expected to finish by AMAYA once the project work was elaborated and launched). This omission in the project proposal was corrected later and the procurement proceeding included in the updated schedule for action C1. The effective start for the tender procurement was considered in April 2017, as it was then that the hiring file started once the favorable legal advice report was emitted. From April 2017 until December 2017 CAGPDS carried out an intense activity related to the procurement proceeding, including important steps such as the Tender publication in the Official Andalusian Bulletin and several meetings of the Technical Commission for the consecutive sessions of the contracting table.

The documents generated by this process were included in the financial Annexes of Midterm Report.

The procurement procedure was accomplished simultaneously for three work projects as follows:

Project name	Lot	Corresponding action in Life Adaptamed	Awarded company	Allotment amount, VAT included (€)
«Actuaciones Selvícolas en masas forestales para su adaptación al cambio climático incluidas en el Proyecto Life Adaptamed. Life 14 CCA/ES/000612 (File reference: 2017/00001/M).	Lot 1	Action C1 in P.N. Sierra Nevada and P. N. Cabo de Gata	Noceda Servicios Integrales Medioambientales, S.L.	427,218.03
	Lot 2	Action C6	Elena Medialdea, S.L.U.	101,956.57
	Lot 3	Action C1 in P.N.Doñana and Action C2 (sub-action 2)	Forest Jardín, S.L.	361,294.49

At the same time, members of CAGPDS working in LifeAdaptamed as responsible for the supervision of the works in each N.P.A.have also carried out some preparatory tasks, including meetings and field visits with the companies applying for the public procurement procedure to show them the area. Also, field visits with the rangers for the preliminary setting out of the area, to explain them the tasks they should supervise once the works were being carried out, and to agree on some practical details thathad necessarily to be completed in the field, such us the criteria for tree cut selection, collecting areas for wood, etc.
The following tab summarizes the tasks accomplished by the awarded companies within action C1:

Lot	Place	Tasks	Date
1	Sierra Nevada	Selective pine thinning in Pinus pinaster (Jérez Marqueesado, Granada): tree felling.	April-mid. May 2018
1	Sierra Nevada	Selective pine thinning in Pinus nigra (Lanteira, Granada):tree felling.	May 2018
1	Sierra Nevada	Selective pine thinning in Pinus pinaster (Jérez del Marquesado, Granada) and Pinus nigra (Lanteira, Granada): hauling off of trunks with forest forwarder, stacking of trunks in forest trail border, piling & crushing of branches inside the monitoring plots.	June 2018
1	Sierra Nevada	Selective pine thinning in Pinus halepensis (Nacimiento, Almería): tree felling, hauling off of trunks with winch skidder, staking of trunks along contours to prevent erosion, piling & crushing of branches inside the monitoring plots	Nov. 2018- Feb. 2019
1	Sierra Nevada	Selective pine thinning in Pinus sylvestris(Pórtugos):tree felling, hauling off of trunks with forest forwarder, stacking of trunks in forest trail border, piling & crushing of branches inside the monitoring plots.	Dic. 2018-Ene.2019
1	Cabo de Gata	Selective pine thinning in Pinus halepensis (Carboneras, Almería): selective tree felling and crushing of branches	Dic 2018
1	Cabo de Gata	Plantation of Pistacia lentiscus, Rhamnus lycioides, Olea europaea, Lycium intricatum and Quercus coccifera. Installation of protective fences	Ene 2019
3	Doñana	Selective pine thinning in Pinus pinea: cutting of selected pines and all burned pines within the burned plots; hauling off of trunks with mules and forwarder; transport and and piling of trunks with forwarder.Installation of biodiversity boxes for birds and vats.	Feb-March 2019; Oct-Dec 2019 and-Dec 2020
3	Doñana	Selective pine thinning in three new plots of Pinus pinea complement the works after three of the plots were burnt in the forst fire of 2017	October-December 2021

In **Annex O02** photographs of the works mentioned can be found.

Comparison with planned output and time schedule.

Although it can be considered that action C1 has been fulfilled satisfactorily in relation to most of the designed tasks, several circumstances and several setbacks have implied important delays in this action.

The procurement proceeding for the award of the works, starting in April 2017, took almost one year to be concluded and was finished in the 28th of March 2018, when the two contracts for the implementation of works corresponding to action C1, were signed by the two awarded companies (one for Lot 1, action C1 in Sierra Nevada and Cabo de Gata, and another one for Lot 2, action C1 Doñana together with action C2).

In Sierra Nevada and Cabo de Gata works were implemented in 2018 according to the planning compromised by the awarding company, with only the ordinary pause for the works during late spring and summer, as obliged by Andalusian legislation all over Andalusia, due to high fire risk. In Doñana the works started later due to an additional ban to these type of works in the National Park during the nesting period, which lasts the whole spring, as this park is a very important hotspot for birds.

The nesting boxes for bats and birds wereinstalledin March 2019, soon after the works on the field started in Doñana. They are considered as a complementary action aimed to increase biodiversity in the forest ecosystems, to be implemented along with the silvicultural management to increase resistance and resilience in the woods.

Major problems / drawbacks, delays, including consequences for other actions

This action has suffered an important delay in the planned schedule due to delays in the contracting procedure. The Spanish public procedure for public open contracts has been hardened during recent years. Also, the delay previously occurred in the preparatory action A8 has summed to the delay in the contract procedure in Action C1, implying an important delay in the beginning of the silvicultural works. This delay would have had important consequences for other actions, especially for those actions designed to assess the effectiveness of the central actions (Actions D7 and D8) if it was not for the extended execution time for the project. With the approved extension of 18 months, this delayed beginning of the central actions has had no important significant consequences on the rest of the actions of the project.

In Sierra Nevada, plant production for *Pinus sylvestris* subsp. *nevadensis* has not given the expected results and, consequently, the necessary seedlings have not been obtained to guarantee a minimum effectiveness of the plantation expected in the action. That is the reason why that part of action C1, accounting for a small part of the budget, has not been implemented in Sierra Nevada.

In Doñana, the forest fire occurred in 2017 has had two consequences. The first of them is that the installation of fences to limit herbivory had to be postponed in the burned plots, until the burned trees were cut and removed from the environment with safely conditions for the workers. The second consequence has been the need to allocate three extra plots to complement the three burned ones. This has been made through a minor contract procedure which was awarded to the same company, Forest Jardin S. L, and has include identical activities to those designed for the burned plots before the forest fire happened.

Milestones and deliverables:

Deliverables:

- Deliverable in this action, expected at the end of the project, is included in **Annex D16** (Evidence-based policy briefs. Recommendations and conclusions obtained in actions C1, C2, C3, C4, C5 and C6).

Milestones:

- Start of work on the installation of nest boxes for insectivorous birds and bat roosts. Expected date: 01/02/2016. Actual date: 01/03/2019.
- Start of forestry work under Action C:. Expected date: 17/10/2016. Actual date: 01/04/2018.
- Completion of silvicultural works under Action C1: Expected date:30/03/2018. Actual date: December 2021 (3 extra plots, complementary to the 3 burned plots).
- Plantation Pinus sylvestris sbsp. Nevadensis in Sierra Nevada N. P: has not occurred.

Other relevant annexes:

- See photographs of the tasks implemented in this action **Annex O02**.

Action C2. Mediterranean forest regeneration to improve ecosystem services and its adaptation to CC

Foreseen start date: 01/2016 Actual start date: 05/2016
Foreseen end date: 12/2017 Actual (or anticipated) end date: 12/2021

Activities undertaken and outputs achieved

Sub-action 2

This action started with a long and complex open tender procurement proceeding carried out by CAGPDS. In the project proposal, the period for the tender procurement proceeding for the works included in this action was not included in this Action C2 (expected to start at the moment when the awarded company would start the silvicultural works in the field, being CAGPDS the only responsible Beneficiary for this action) nor in the preparatory Action A8 (expected to finish by AMAYA once the project work was elaborated and launched). This was due to an omission in the project proposal that has been corrected now by including procurement proceeding for the works in Action C2 within the schedule for Action C2. As the procurement proceeding has implied an intense participation of CAGPDS, who is the main responsible Beneficiary for Action C2, this has been considered the most coherent way to correct this omission. The effective start for the tender procurement was considered in April 2017, as it was then that the hiring file started once the favorable legal advice report was emitted. Before then, only some minor steps in the procurement procedure were taken, such as the acceptance of the request for counting admission or the favorable inform emitted by the Project Supervision Office. However, it was from April 2017 until December 2017 when CAGPDS carried out an intense activity related to the procurement proceeding, including important steps such as the Tender publication in the Official Andalusian Bulletin and several meetings of the Technical Commission for the consecutive sessions of the contracting table.
The documents generated by this process are included in the financial Annexes. The steps of this process carried out by CAGPDS during the period included in this Midterm Report, without incurring any costs in the project, can be consulted in MTR-Annex C2**.**

This procurement procedure has been accomplished simultaneously for three work projects:

Project name	Lot	Corresponding action in Life Adaptamed	Awarded company	Allotment amount, VAT included (€)
«Actuaciones Selvícolas en masas forestales para su adaptación al cambio climático incluidas en el Proyecto Life Adaptamed. Life 14 CCA/ES/000612 (File reference: 2017/00001/M).	Lot 1	Action C1 in P.N. Sierra Nevada and P. N. Cabo de Gata	Noceda Servicios Integrales Medioambientales, S.L.	427,218.03
	Lot 2	Action C6	Elena Medialdea, S.L.U.	101,956.57
	Lot 3	Action C1 in P.N.Doñana and Action C2 (sub-action 2)	Forest Jardín, S.L.	361,294.49

Other contracts executed under this action have been:

Sub-actions 1 and 3

Activity	Awarded company	Implementation date
First sampling Phytophthoracinnamomi	Agricultura y Ensayo S. L.	nov 2019 – feb 2020
Second sampling Phytophthora cinnamomi	Empresa SICOP Sistemas de Control de Produccion. S.L.	Enero 2021-Abril 2021

The works in this action have consisted of the following:

Sub-action 2:
Exclusion of livestock in areas of high ecological value affected by herbivory processes: this is one of the main problems for the natural regeneration of scrub and trees in the Doñana protected area. For this reason, 75% of the 54 hectares where works have been implemented have been protected from grazing, by fences or by piles made with branches ("entaramados"). Inside these plots, key plant species in the context of the Doñana Mediterranean forest have been sown and planted (see next section).
Assisted recruitment in 'fertility islands': the objective has been to achieve the improvement of a heterogeneous forest with a high presence of species characterized by their high production of fruits dispersed by zoochory (cork oak acorns, mastic and olive tree), which subsequently trigger the colonization of surrounding areas. The creation of small-sized plantations allows both the creation of shelters and favorable microclimate zones as well as support for the survival of seedlings and saplings during their first summer drought (by means of irrigation). Eight fertility islands were established (four within the exclusion and four outside it, see before) in which a total of 1280 seeds and 88 seedlings of cork oak, wild olive and mastic were sown and planted - that is, 160 seeds and 11 seedlings per island. Half of these fertility islands were protected by 'entaramados' (accumulations of branches in order to protect the soil and seedlings). The seeds were planted during autumn, and received three irrigations during the summer period. The materials used for the construction of the 'entaramados' were obtained from the remains of the forestry actions described in action C1.

Sub-actions 1 & 3
Evaluation of the impact of the pathogenic fungus Phytophthora cinnamomi*, experimental treatment and evaluation of results*: the most important factor in explaining the decline of cork oaks in Doñana and in other parts of the Iberian Peninsula is infection by the exotic oomycete *P. cinnamomi*. Being an exotic species, the cork oak lacks natural defenses against the attack of this pathogen. Currently, the occurrence of severe droughts in the presence of P. cinnamomi is the main cause of the great mortality of cork oaks and holm oaks in the Iberian Peninsula. The actions carried out in Life Adaptamed have included the preliminary survey of 300 cork oaks, distributed throughout the Doñana Natural Area, to determine their potential degree of affectation and select those on which action was going to be taken. After this, (1) a previous sampling of the cork oak individuals selected for the test (treatment and control) was carried out, to quantify the previous degree of affectation in soil and roots; (2) treatment with Fosetyl-Aluminum injections; and (3) a new sampling of the treated and control individuals, one year later, to evaluate the efficacy of the treatment. It is important to highlight that the use of this product, at the time of the trial, was only allowed by official phytosanitary testing companies or by scientific institutions for research purposes. This restriction limited the actions initially scheduled within the project and forced a much longer processing of the necessary permits. For this reason, however, the tests had an important added value, since the results obtained form part of the set of necessary information required by the Administration to evaluate its possible commercial authorization in the future.

Subactions 1, 2 and 3:
At the same time, members of CAGPDS, together with CSIC personal, working in the Life Project Adaptamed as responsible for the supervision of the works in Doñana National Park have also carried out some preparatory tasks, including meetings and field visits. These tasks correspond to the costs incurred in this action in this period.
Comparison with planned output and time schedule

Sub-action 2

In short, we can consider that Action C2 started in April 2017, when CAGPDS started and intense effort within the procurement proceeding for the award of the works included in this action. This procurement proceeding has finished in the 28th of March 2018, whenthe contract for the implementation of works corresponding to action C2-subaction 2 was signed by the awarded company (Lot 3). As happened with the silvicultural works expected in Doñana within Action C1, the works expected in Action C2 in Doñana have not started in spring 2018 due to a ban to these type of works in the National Park during the nesting period, which lasts the whole spring, as birds are really abundant and diverse in this park. During the Summer this type or activity is not allowed for forest fire risk all over Andalusia.

Due to additional delays related to administrative drawbacks, forestry works started at the end of 2019 and had to be suspended in March due to the COVID-19 pandemic. Most works could be finished before spring 2021, except for the plots affected by the wildfire in June 2017, which were finalized in December 2022.

Sub-actions 1 and 3

In case of the treatment of cork oaks, additional environment license had to be issued, which obliged to apply a considerable reduction in the number of treatments and monitoring of trees (selected by CSIC). Treatment of 30 trees was done in November 2019, and follow-up monitoring of 60 trees in autumn 2019 and 2020 (leave condition) and winter 2021 (presence of *P. cinnamomi*).

Major problems / drawbacks, delays, including consequences for other actions

Sub-action 2

This action has suffered an important delay in the planned schedule due to delays in the contracting procedure as well as additional environmental authorizations for the cork oak treatments. The Spanish public procedure for public open contracts has been hardened during recent years. Also, the delay previously occurred in the preparatory action A8 has summed to the delay in the contract procedure in Action C2, implying an important delay in the silvicultural works.

This delay has had important consequences for other actions, especially for those actions designed to assess the effectiveness of the central actions (Actions D7 and D8) and those actions designed to disseminate the results of this assessment in terms of best practice recommendations (manuals in action E1, second Window to Science in Action E6 and Symposium in Action E5). The extension of 18 monthshas allowed to finish all forestry actions, affecting more plots than planned due to the fires, as well as to perform the cork oak treatments although in a reduced number of trees.

Milestones and deliverables:

Deliverable in this action is the Policy brief in included in **Annex D16** (Evidence-based policy briefs. Recommendations and conclusions obtained in actions C1- C6).

The four milestones were achieved in autumn 2019 (start of all actions) and in autumn 2022 when all actions were completed. The above-described delay justifies the delay in the delivery of these milestones.

Other Relevant Annexes:

- **Annex O03**. Description and photos of actions C2 (sub-action 2)
- **Annex O04**: Final report on *Phytopthora cinnamomi* (C2 subactions 1 & 3).
- Main steps in the open tender procurement proceedings carried out by CAGPDS in Action C2 was included in the Midterm Report (MTR-Annex C2).

Action C3 Improvement of resilience and ecosystem services provision capacity in a priority hatitat: Ziziphus lotus

Foreseen start date: 01/2016 Actual start date: 03/2016
Foreseen end date: 12/2018 Actual (or anticipated) end date: 11/2019

Activities undertaken and outputs achieved

The tasks performed by AMAYA are listed below:

- *Ziziphus lotus* fruits harvested during 09/2016 and 10/2016 to obtain seedlings.
- Plantation of 750 two-years old plants as follows: 323 *Ziziphus lotus*, 210 *Retama sphaerocarpa*, 217 *Capparis spinosa* (See A3 report in Annex A3.1. of Progress Report 1 for details). This task was implemented on January 2017. On June 2017 a supplementary watering of these plants was provided. An additional plantation is expected and the end of 2018 to reinforce the effect of the first one.
- Removal of *Agave fourcroydes* and *A. sisalana* individuals in 10 ha. of invaded *Ziziphus lotus* habitat (See A3 report in Annex A3.1. of PR1 for details). This task started in 12/2016, when manual removal of dead matter was implemented. Live individuals had to be removed mechanically between November and December 2017 through an external assistance not expected in the approved proposal. However, this external assistance was considered indispensable to reach the results expected in this action, and was duly requested to the project Monitor.
- During 2017 and early 2018, three meetings were held with experts in hydrology and ecohydrology to improve the design of the wells and to extract as much information as possible for the characterization of the aquifer. In addition, a meeting with the awarded company was held in 2018 to properly coordinate the scientific, administrative and technical work.
- Plantation of 160 *Ziziphus lotus* plants in February 2019.
- Between December 2018 and February 2019, nine boreholes were made and inside of them, 9 piezometric sensors were installed.

Before and after the removing of *Agave* spp. The improving of opened habitat will avoid the recolonization of some animal and vegetal species associated to steppe sites.

Comparison with planned output and time schedule.

All work planned under this action has been completed.

Major problems/drawbacks, delays, including consequences for other actions.

As it is said in the A3 section, due to some wells being planned in municipal properties that belong to the Almería City Council, the needed permissions for land availability produced a

delay of the execution of this action. Several meetings were held with the technicians of the Almería City Council and Regional Water decision-makers to advance in the administrative procedures. Finally the permissions were granted. This delay had no effect in other actions and the action was completed.

Finally, only 9 out of the 10 monitoring wells were installed, as they were considered enough to achieve the expected results of this action. To improve the results, along with the dataloggers a new technology dealing with isotopes has been included, which means a clear improve of the results of the actions, while maintaing the same objectives.

Possible complementary action outside LIFE.
A transdisciplinary-based project about ecosystem services and climate change impact in *Ziziphus lotus* matorrals was developed from November 2017 to June 2018. This project, funded by Fundación Biodiversidad (Spanish Environment Ministry), involved a variety of stakeholders from farmers and environmentalists to managers and science and social scientists, and focused on the perception of ecosystem services by local society, and hence, on the social benefits of Life Adaptamed actions.

Perspectives for continuing the action after the end of the project:
On the one hand, essential information will continue to be recorded for monitoring the ecosystem from the installed wells. On the other hand, maintenance of the actions of planting native vegetation and removal of invasive vegetation will be carried out.

Milestones:

Start of work on soil drilling and installation of instruments (achieved).

Start of work on the removal of Agave spp (achieved).

Start *of Ziziphus lotus* seed collection work (achieved).

Deliverables:

- Deliverable in this action, expected at the end of the project, is included in **Annex D16** (Evidence-based policy briefs. Recommendations and conclusions obtained in actions C1, C2, C3, C4, C5 and C6).

Action C4 Soil conservation and management to protect ecosystem services and adapt to CC.

Foreseen start date: 01/2016 Actual start date: 05/2016
Foreseen end date: 12/2017 Actual (or anticipated) end date: 11/2018

Activities undertaken and outputs achieved

- 1000 linear meters of small walls to prevent soil erosion ("balates and portillos") were rebuilt. 834 meters were rebuilt between 10/2016 and 04/2017 and the 166 additional meters of rebuilt walls was implemented in 11/2018.
- Installation of wildlife refuges for animals.
- Two campaigns to manage 10 hectares of old crops (03/2017 and 03/2018). Three treatments have been applied, 3.5 has were tillaged, 3.5 were sown with grain, and the remaining 3 remained as control.
- Six herbivore exclusion fences (two per type of treatment) of 5 x 5 metres (04/17) were installed.

Restored walls at Cabo de Gata.

Comparison with planned output and time schedule.

- 1000 linear metres of rebuilt walls have been realised, as included in the project.
- The tillage and sowing work has been completed. The effectiveness of the results has been be assessed thorough actions D7 and D8.

Major problems/drawbacks, delays, including consequences for other actions.

- 2017 was an extremely dry year and it was not possible to obtain a cereal harvest, so

this parameter could not be measured.

Was the objective reached? What reactions and feedback were obtained?

- Objectives 1 (rebuilding of walls “balates and portillos”) and 2 (pasture tillage) have been achieved.
- Objective 3 (establishment of a moisture and carbon monitoring network) is also achieved.

Deliverables:

- Deliverable in this action, expected at the end of the project, is included in **Annex D16** (Evidence-based policy briefs. Recommendations and conclusions obtained in actions C1, C2, C3, C4, C5 and C6).

Action C5 Adaptive management in Mediterranean scrubland in Sierra Nevada high mountain.

Foreseen start date: 01/2016 Actual start date: 04/2016
Foreseen end date: 12/2016 Actual (or anticipated) end date: 12/2021

Activities undertaken and outputs achieved

The general aim of this action is to ensure the maintenance of the quantity and quality of ecosystem services provided by the high mountain scrub community in Sierra Nevada. These services are currently being affected by the negative effects of climate change. The maintenance of services depends on the self-organization capacity of the high mountain scrublands ecosystems and on its maturation degree. Mature ecosystems with higher capacity of self-organization are more resistance, resilience and adaptable to the expected changes in the Mediterranean high mountain mediated by climate change. For this purpose, a restoration model of these ecosystems associated with an experimental design has been proposed to generate robust conclusions in this regard.

The main axis of this action consists of a restoration of two traditional irrigation channels (which local name is 'acequias'), one on the northern slope of the Sierra Nevada and the other on the southern slope.

The restoration works of the channels have been focused to facilitate the flow of water, eliminate obstacles, minimize water losses and implement measures that facilitate the control of water flow. For this, the bed of both ditches has been adapted by eliminating the sedimented material that has contributed to the clogging of the structure. The margins have also been fixed. To this end, sites where the water had been generating erosion have been filled and reinforced using stones taken in the surroundings. All the supplies used have been materials typical of the area.

At the same time, the *Juniperus communis* and *Berberis hispanica* seeds plantations were carried out. Many of these plantations have been associated with repaired irrigation channels in order to assess the positive effect on regeneration that may involve an eventual increase of water contributions in the considered microsites. The plantings were carried out in groups of 18 *Juniperus communis* seeds and another 18 *Berberis hispanica* seeds protected from the trampling of livestock thanks to cages with dimensions of 15 cm in width, 30 cm long and approximately 5 cm high. Groups of 10 cages with 36 seeds each in each of the prospected microhabitats. On the southern slope, 4 microhabitats (humid mountain grassland, under rock, dry scrub and associated to *Genista* spp. scrubland) have been prospected, while on the northern slope 5 microhabitats have been prospected (associated to *Juniperus communis* plants, humid mountain grassland, under rock, dry scrub and associated to *Genista* spp. scrubland). This scheme has been replicated twice on the south slope (Bérchules-Trevelez irrigation channel) and three times on the north slope (Haza Mesa irrigation channel).

Additionally, more than one thousand seeds of *Juniperus communis* and five hundred seeds of *Beberis hispanica* have been planted in a nursery belonging to the coordinator beneficiary. Once these seed germinated, they were planted in the field contributing to enhance the success of the action.

The seeds of *Juniperus communis* and *Berberis hispanica* have been obtained from two sources:

1. From the ring ouzel (*Turdus torquatus*) scats. These birds are the main seed dispersal source of some of the main plant species of high mountain scrubland (mainly *J. communis*). The birds make a selection of seeds avoiding those that host a parasite that make it unviable.

2. Directly from the plant.

Previously to the plantation all seeds are subjected to a process of selection, preparation and cleaning.

Finally, plantations of *Juniperus communis* (n= 109), *Juniperus sabina* (n= 130) and *Berberis hispanica* (n= 126) have also been carried out. The planting was carried out taking advantage of the holes that were already made in a fenced plot located at 2,260 meters above sea level. This plot was fenced in 2008, leaving the planting holes made and prepared for a planting that was never done. Taking advantage of these previous actions, we carried out our plantation in October 2020, after the first autumn rains. The seedlings came from seeds collected by ourselves in the action areas. These seeds were collected from ring ouzel droppings (minimizing the chances of damaged seeds, prepared and germinated in the La Resinera nursery, belonging the Coordinating Beneficiary). The plant was subsequently matured for a year in the Hoya de Pedraza Botanical Garden (1,900 m), very close to the plantation area (also belonging to the Coordinating Beneficiary).

Once the seedlings were planted, the soil of the sidewalk was covered with stones to improve moisture retention. The seedlings were duly numbered and individually labeled for subsequent monitoring. We consider that the planting conditions were ideal due to the northern exposure of the hillside, and above all because they took advantage of the planting holes, whose size ensured good water retention. The existing broom cover also allowed moderate shading during the summer.

This action has been implemented entirely by the beneficiary Agency of Environment and Water of Andalusia, except for the technical supervision tasks that have been developed by the coordinating beneficiary and a very active scientific supervision carried out by UGR. Furthermore, the local people belonging to the villages community's irrigators have also taken part in this action acting as advisors of the restoring action. These local communities are the responsible for the management of the traditional irrigation channels, so they have the needed knowledge for an adequate implementation of the restoration works.

Restoration works at the Bérchules ancient irrigation channel.

Comparison with planned output and time schedule.
This action has been conducted in a very similar way to what had been previously planned in the approved proposal. The main modification can be summarized as follow:
To protect the plants and seeds, we have planned in the proposal the installation of fences to avoid damages caused by cattle. Once in the field we have considered that wood mouse caused damages could be also considerable and in this way, we have modified the type of fences. Instead of the fences initially planned, we have installed individual protections for each group of plants. These cages are made of iron and specifically prevent the access of this and other species of vertebrate seed predators. The planted plants have been protected from the cattle thanks to a preexisting fence (see previous paragraph).
The planned schedule following the proposal included the beginning of the action on May 2016 and an end of the works comprised in this action by the end of 2016. The revised schedule included in the First Progress Report (November 2016) included this new planned calendar attending to the needs of the actions. These needs consist in the plantation of plants with a low growth rate that are unavailable in public or private/commercial nurseries and must be collected from seeds in the mountain. Additionally, further works on the adequacy of irrigation channels were implemented until the beginning of winter of 2021 and has allowed us to maintain previous works that had suffered some damage in the previously repaired structures.
The main impact of this delay was on the ecological monitoring actions that depended on the implementation of the management action to evaluate its effects. In this way, enough data have been gathered to allow a first assessment of the ecological impact of the action (see action D8). Anyway, the main impacts of the action on the reference parameters are going to be greater in a long-term time series and the delay in the implementation of the action will affect the amount of monitoring results and the amount of change evidences.

If relevant, clearly indicate how actions were modified and any correspondence with the the AGENCYapproving the changes.
No relevant changes have been implemented apart from the explained modification. The modification has no significant impact on the budget and clearly increases the interest and the impact of the action expected results.

Major problems/drawbacks, delays, including consequences for other actions.
We conclude that this action has been successfully completed and the possible inconveniences have been effectively resolved by the responsible team. The only consequence could have been the one caused for the ecological monitoring actions at a field scale. In this sense, we think that the impact has been low, since the evolution of these ecosystems is very slow and most of the results obtained are expected within a time that exceeds the margins of the project itself.

Possible complementary action outside LIFE.
This action has been carried out in coordination with the activities developed in the frame of the ancient irrigation channels at the local management organism (local communities of irrigation channels management), at the public organism of Spanish National Parks. Other projects that have also been under coordination with our initiative are Memola Project (Mediterranea Montanious Landscapes) and Ecopotential project. Both are research projects funded by the European Comission: Memola project has been funded under the European Union's seventh framework and Ecopotential is being funded under the H2020 programme.
This action has offered a good part of the knowledge expressed in the manual of good practices for high mountain scrubland, considered as a deliverable product in action E1.

Perspectives for continuing the action after the end of the project

The restoration of mountain scrublands included in the Annex I of the Habitat Directive is a focal task for the management team of the Sierra Nevada Protected Area. The experimental approach performed through this action will establish the bases for future procedures. Furthermore, the restoration of traditional infrastructures, such as the mountain ancient irrigation channels, is also an important task within the Park management strategy. The use of these infrastructures as mitigation tools of the climate change in the Sierra Nevada mountain ecosystems and its use as biodiversity restoring tools constitute a novel approach that will imply an added value to the action.

Was the objective reached? What reactions and feedback were obtained?

Yes, the objective has been duly reached because we have been able to put in practice a practical approach to protect the ecosystem services provided by the target environment. As one of the main objectives of the action, the appropriate coordination and joint work with local communities has been satisfactorily reached. This action is, without any doubt, an example of share knowledge and purposes with research group, local communities, and the management staff of the Sierra Nevada National Park.

Milestones and deliverables

- Deliverable in this action, expected at the end of the project, is included in **Annex D16** (Evidence-based policy briefs. Recommendations and conclusions obtained in actions C1, C2, C3, C4, C5 and C6).

Action C6. Ecosystem services protection in oaks and holm oaks sensitive to CC in Sierra Nevada

Status of the action:

Foreseen start date: 9/2016 Actual start date: 03/2016
Foreseen end date: 06/2017 Actual end date: 02/2019

Activities undertaken and outputs achieved

As happened with actions C1 and C2, this action started with a long and complex open tender procurement proceeding carried out by CAGPDS (actually CAGPDS). The effective start for the tender procurement was considered in April 2017, as it was then that the hiring file started once the favorable legal advice report was emitted. Before then, only some minor steps in the procurement procedure were taken, such as the acceptance of the request for counting admission or the favorable inform emitted by the Project Supervision Office. However, it was from April 2017 until December 2017 when CAGPDS has carried out an intense activity related to the procurement proceeding, including important steps such as the Tender publication in the Official Andalusian Bulletin and several meetings of the Technical Commission for the consecutive sessions of the contracting table.

The documents generated by this process were included in the financial Annexes of MTR and the steps of this process carried out by CAGPDS without incurring any costs in the project, can be consulted in MTR-Annex C6.

This procurement procedure was accomplished simultaneously for three work projects as follows:

Project name	Lot	Corresponding action in Life Adaptamed	Awarded company	Allotment amount, VAT included (€)
Actuaciones Selvícolas en masas forestales para su adaptación al cambio climático incluidas en el Proyecto Life Adaptamed. Life 14 CCA/ES/000612 (File reference: 2017/00001/M).	Lot 1	Action C1 in P.N. Sierra Nevada and P. N. Cabo de Gata	Noceda Servicios Integrales Medioambientales, S.L.	427,218.03
	Lot 2	Action C6	Elena Medialdea, S.L.U.	101,956.57
	Lot 3	Action C1 in P.N.Doñana and Action C2 (sub-action 2)	Forest Jardín, S.L.	361,294.49

At the same time, members of CAGPDS working in the Life Project Adaptamed as responsible for the supervision of the works in Sierra Nevada National Park also carried out some preparatory tasks, including meetings and field visits. These tasks correspond to the small costs incurred in this action in this period.

During winter 2019 all the silvicultural works were implemented by the awarded company, Elena Medialdea, S.L.U., following the approved project in very detail.
This action has included silvicultural works in holm oaks and Pyrenean oaks of unsuitable structure (coppice), where an excessive density does not allow a suitable vegetative vigor due to the excess of competition for water, light and nutrients, which gives these masses a great vulnerability to pests. After verifying a non existent or minimal sexual reproduction and a high susceptibility to forest pests, 50 ha have been selected, distributed in four different environmental gradients:

- High elevation (10 ha): upperlimit of distribution of the Pyrenean oak forest in the

area, representing the ecotone with ecosystems dominated by juniper and other high mountain scrub (Locality: Cañar).
- Intermediate level (10 ha): pure Pyrenean oak forest (Locality: Cañar).
- Low elevation (10 ha): mixed Pyrenean oak and holm oak forest (Locality: Portugos).
- Holm oak (20 ha): holm oak located in a subarid zone, where the water inputs it receives are at the lower limit of their requirements Localities: Fiñana and Abrucena).

The execution of this action involves the realization of silvicultural treatments aimed at improving the structure of the mass and vegetative vigor, selecting certain specimens by their proper characteristics to function as parent trees and performing on them actions to eliminate or dose their competence and favor their sexual reproduction.

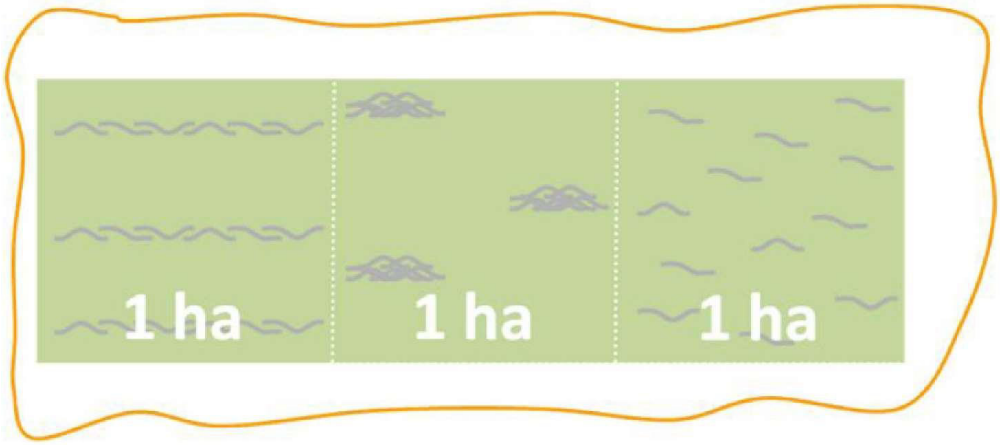
In each location, two different silvicultural treatments were implemented:

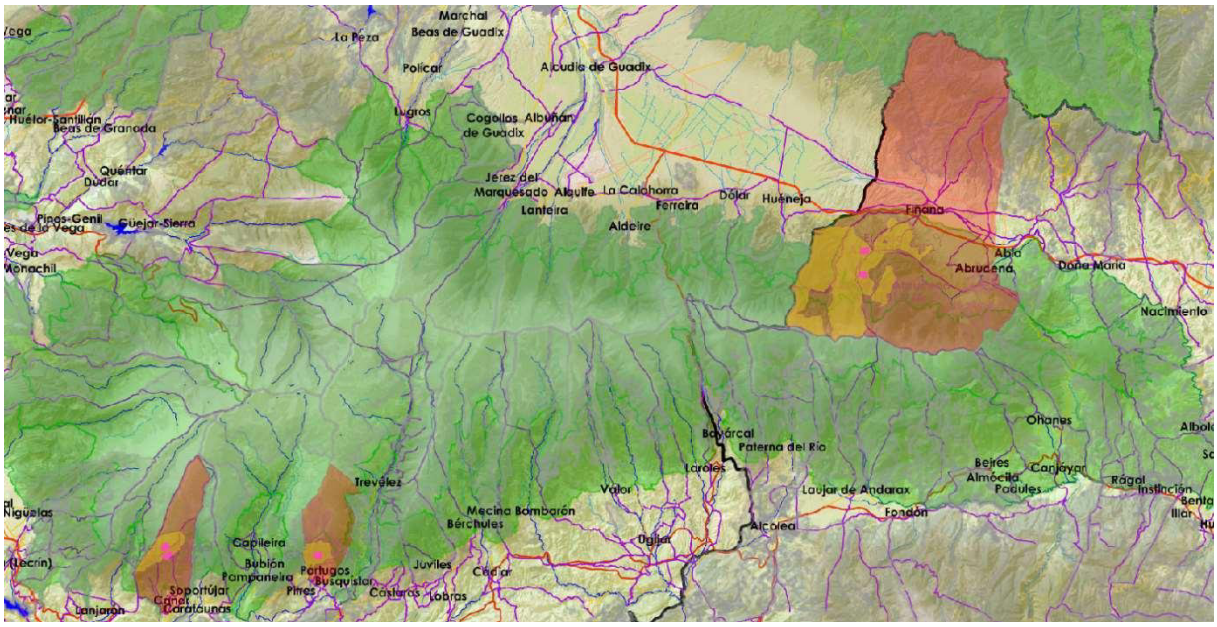
- T1: moderate selective cutting and pruning (5 ha).
- T2: intensive selective cutting and pruning (5 ha).
- Control: no silvicultural works (only monitoring, 4 ha).

For each type of treatment, 3 different alternatives for forest residue distribution have been tested:

- Forest residue chopped and distributed along lines (1 ha plot in the left of the image).
- Forest residue chopped scattered, without special distribution (1 ha plot in the right of the image).
- Forest residue distributed in piles without chopping (1 ha plot in the center of the image).

Each 5 ha/treament unit, including 2 ha of buffer area, follow this scheme:





Map with the distribution of the locations where action C6 has been implemented.

Works in Abrucena (top left), Cañar (top right), Pórtugos (bottom lef) and Fiñana (bottom right).

Comparison with planned output and time schedule

After the initial delays suffered in the contract procedure that motivated, together with the delays in the other central actions subject to open tender procedure, the contract was awarded to Elena Medialdea S.L.U in April 2018. However, in Sierra Nevada, the pruning and thinning of oaks is allowed from October until April each year and it is forbidden from May until September for physiological reasons, as in this area the physiological stress for the trees is too high in this time of the year and also during the summer this type of activity is not allowed for forest fire risk all over Andalusia. Therefore, when in October 2018 the works in Action C6

could finally start, they started right away, with no more delays, and they were finished in winter 2019, following the approved project in every detail and with no interruption untion the tasks were finished.

Major problems / drawbacks, delays, including consequences for other actions
Apart from the delay thoroughly explained in MTR, which motivated the need for an 18-month extension in the schedule thanks to which this initial delay has had no important consequences in other actions of the project, this action can be considered successfully achieved.

Milestones and deliverables:

- First milestone expected in this action was achieved in October 2018 (beginning of the works).
- The second milestone expected was achieved in February 2019 (end of the works).
- Deliverable in this action, expected at the end of the project, is included in **Annex D16** (Evidence-based policy briefs. Recommendations and conclusions obtained in actions C1, C2, C3, C4, C5 and C6).

Other relevant annexes:
Main steps in the open tender procurement proceedings carried out by CAGPDS in Action C6 were included in MTR-Annex C6**.**

Action C7 Information System for Climate Change Assessment in Andalusia.

Foreseen start date: 07/2015 Actual start date: 05/2016
Foreseen end date: 06/2020 Actual End date: 12/2020

Activities undertaken and outputs achieved

The main objective of action C7 is the establishment of a Distributed Information System fulfilling the functions of integrating the data obtained by the three Observatories participating in the project, and where the results of the actions carried out by them are integrated, as well as making all information generated in the project available to all researchers.

The information system has been designed as a central node connected, on the one hand, to the Environmental Information Network of Andalusia (REDIAM), and on the other to the existing computer infrastructures at the three participating observatories.

The following describes its components and the progress made by the REDIAM Team (AMAYA and CAGPDS):

- Hardware:

The physical part of the system is constituted by a server installed in the Corporate Network of the Junta de Andalucía. This server has been configured in such a way that it has sufficient processing and storage capacity to manage all the information related to LIFE-ADAPTAMED, both from the observatories and existing in REDIAM. Since it is located in the Corporate Network of the Junta de Andalucía, its connection with the other nodes is guaranteed, as well as its accessibility from abroad.

The main configuration parameters of the server are described in the following tab:

System hostname	adaptamed.agenciamedioambienteyagua.es
Operating system	Ubuntu Linux 16.04.3
Kernel and CPU	Linux 4.4.0-124-generic on x86_64
Processor information	Intel(R) Xeon(R) CPU E5-2640 0 @ 2.50GHz, 2 cores
Real memory	7.80 GB total
Virtual memory	3.94 GB total
Local disk space	216.88 GB total

At present day the installation of the server has been completed and it is fully operational.

- Software:

The logical part of the system obeys the conceptual model included in the attached diagram, and basically consists of:

- A centralized repository of data, whose function is to store all the results thrown by the different actions of the project. The data is stored in the server's local file system. The current state is: implemented, including all the data generated by the three observatories under actions A9, A10, D7 and D8.
- A centralized catalog of metadata, storing all the 'metainformation' about these results. The catalog has been implemented according to Metadata Implementing Rules using

EN ISO 19115/19119 Guidelines based on EN ISO 19115 and EN ISO 19119 for Commission Regulation (EC) No 1205/2008 of 3 December 2008 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata.

- Communication protocols with REDIAM and the Observatories, which keep the central catalog and peripherals updated. The current status is: communication made with all the observatories.
- A map server, which is able to offer LIFE-ADAPTAMED data through its OGC services for visualization and graphic query. MAPSERVER has been chosen for this function, as an open source tool commonly used in REDIAM. The current status is: operative with some services already available.
- A download module, which allows the external user to download or copy the information available on the LIFE-ADAPTAMED server. The current status is: operative.

All these modules are accessible through a web service (developed as part of the E9 action) and work on the following software infrastructure that has already been installed on the server as part of its basic configuration:

- Web Server: Apache Version 2.4.18
- Application server: TOMCAT V8.5.20 on a JAVA virtual machine V1.8.0_171
- Database server: PostgreSQL V9.5.12

Comparison with planned output and time schedule.

Action C7 has been executed as planned in relation to the connection of the central node and Cabo de Gata, Sierra Nevada and Doñana nodes.

Major problems / drawbacks, delays, including consequences for other actions.

No major problems have occurred in this action. Finally, the C7 action has been completed thanks to the resources provided by AMAYA technicians and technicians from companies contracted through External Assistance by CAGPDS in the nodes of Sierra Nevada, Cabo de Gata and Doñana.

Perspectives for continuing the action after the end of the project.

The information system will remain operational after the end of the project according to the needs of the research centers. In is expected to be operational during the post-Life period.

Milestones and deliverables:

No deliverables are expected in this action. In an intermediate stage the Distributed Information System was functional in test mode as expected (31/12/2018) and currently the final version is operational. Although the tool is already finished and uploaded with the existing data, some minor improvements are being made in order to make the tool more practical in relation to the download of the data, allowing several data formats.
See the final version of Life Adaptamed Information System in:
https://adaptamed.agenciamedioambienteyagua.es/

Action D1 Scientific support, connection with REDIAM and knowledge transfer in relation to Doñana actions

Foreseen start date: 07/2015 **Actual start date:** 10/2015
Foreseen end date:06/2020 **Actual (or anticipated) end date:** 12/2021

Activities undertaken and outputs achieved

EBD-CSIC has attended 5 meetings of the scientific committee: 3 general meetings on (09/2015, 03/2016, 22-23/05/2017, 19/03/2019, 09/10/2019, 16/12/2021) and 6 specific meetings (09/2015, 03/2016, 09/2016, 13/01/2017, 23/11/2017, 09/03/2018, 23/01/2019, 24-25/05/2021). Meetings established indicators and monitoring schemes to evaluate the effects of the planned actions, guaranteeing comparisons between the three protected areas. More specific tasks have consisted in the design and supervision of monitoring actions and revision of technical reports for administrative calls. Direct coordination with the personnel of Doñana Natural Area was achieved through several meetings (09/2015, 01/2016, 02/2016, 07/2016 and 11/2017, 10/2020) and a public seminar held in 03/2016 at the Doñana Administrative office. In February 2016 a field visit was made to the Doñana study area with the project coordinators and Doñana managers. In March 2017, a two-days workshop for the harmonization of the monitoring program and manual across the three PAs was held at the Doñana Biological Reserve. Finally, in May 2016 and July 2017, two meetings with REDIAM were held at the EBD headquarters to coordinate the development of a data platform for sharing biodiversity data. Collection and transference of spatial information related to the project actions to contribute to action C7 has been done (vector and alfanumeric information derived from actions A2 and C2).

There are no deliverables foreseen in this action. The result of this action has been the contribution of CSIC-EBD to actions A1, A9 and C7 and their corresponding deliverables.

The Environmental Information Network (REDIAM), integrated by the beneficiaries CAGPDS and AMAyA, has held, on the one hand, meetings to describe the Information System designed for the LIFE Adaptamed project, and on the other hand, it has defined the different bases and guidelines for standardization, methodology and integration of the information generated by part of the Doñana node. In addition, it has provided this node with environmental information related to the Doñana Natural Area or the Andalusian territory, among others, which will facilitate the development of the different actions carried out in the LIFE Adaptamed project.

Comparison with planned output and time schedule.

Action has been developed as planned, and has proved to be of critical importance to adjust the rest of the project to delays or unexpected circumstances.

If relevant, clearly indicate how actions were modified, and any correspondence with the AGENCYapproving the changes.

No modifications. AMAYA objectives achieve a cost decrease in this action due to the improvements carried out in action C7.

Action D2 Scientific support, connection with REDIAM and knowledge transfer in relation to Cabo de Gata actions.

Foreseen start date: 07/2015 **Actual start date:** 02/2016
Foreseen end date:06/2020 **Actual (or anticipated) end date:** 12/2021

Activities undertaken and outputs achieved
The tasks performed in the first period of the project are listed below:

- The Environmental Information Network (REDIAM, integrated by technicians of CAGPDS and Amaya) has held, on the one hand, meetings to describe the Information System designed for the LIFE Adaptamed project. On the other hand, they have defined the different methodological bases and guidelines for standardization and integration of the information generated by part of the Cabo de Gata site. In addition, REDIAM has provided to this node part of the needed environmental information related to this specific Park or even regarding to other parts of Andalusia. This environmental information has been very useful for the implementation of some of the actions carried out in LIFE Adaptamed project.
- University of Almería has provided to REDIAM the requested information to duly contribute to the LIFE Adaptamed general repository (included in Action C7). This implies vector and alphanumeric information derived from actions A1, A3, A4, A7, A9, A10, C1, C3 and C4. These data were received by REDIAM Received share data (A1, A3, A4, A7, A9, A10, C1, C3 and C4) on July 2016. A second phase with all data from actions D7 and D8 was delivered to REDIAM in October, November and December 2021.
- REDIAM has generated from the above mentioned standardized information the different map services (OGC) corresponding to the different actions, lodging them in the server created for that purpose. This integration of data (including a normalization and standardization process) is now finished.
- University of Almería has participated in many field trips and working meetings with the aim to decide together with the management decision makers, the optimal solutions to be implemented in the central actions.
- One report per central action predicted implemented in Cabo de Gata (i.e., C1, C3 and C4) has been written by University of Almería. In such reports, both ecological and methodological justifications, as well as experimental designs and scientific knowledge-based suggestions are provided.
- University of Almería has been also involved in the collection and transferring of spatial information related to the project actions to contribute to action C7.

Comparison with planned output and time schedule.
We have established a framework of permanent collaboration between researchers and managers of the Natural Park of Cabo de Gata-Níjar. As opposed to the traditional management characterized by a lack of monitoring, we have opted for "adaptive management" based on follow-up of actions in order to evaluate the effects of a treatment submitted to testing. We have also put into practice an effective science-policy interface to guide management actions of the protected area. Both approaches have been implemented in Cabo de Gata, proposing key questions from the outset, defining the goals to be pursued with the actions undertaken, and specifying the methodological and analytical details necessary to address these efforts.

The permanent collaboration between researchers and managers was established both in Cabo de Gata with the managers of the Natural park, and in Andalucía with the managers of the Consejería de Medio Ambiente.

If relevant, clearly indicate how actions were modified and any correspondence with the AGENCYapproving the changes:
Already at the beginning of the project, in the first Research Commission of the project, it was detected that it would be very interesting to incorporate soil sampling of the monitored plots, something that would have a very low cost and important benefits for the achievement of the field monitoring objectives (actions A10 and D8). This improvement was dully informed to the Monitoring Team. It was agreed that the UAL partner would be in charge of establishing the sampling protocol and analysing the soil samples, which would be taken in each plot by the same staff in charge of the field monitoring. The minor costs associated with the soil analyses were included in the budget modification communicated together with the extension request.
The results of the soil analyses carried out on the plots made by the UAL in the framework of this Action D2 are included in **Annex O05**.

Major problems/drawbacks and/or delays, including consequences for other actions:
The main problems came from the slowness of the administrative bureaucracy, which has been responsible for the delays in the contracts made, especially with regard to recruitment of personnel that took longer that expected but allowed to satisfactorily meet the complex and demanding staffing needs in the final stretch of the project.

Complementary action outside LIFE:
Outside the scope of the Life Adaptamed project, a multitude of complementary actions have been developed with a complementary framework with action D2. Most of them related to the gathering of scientific knowledge within the framework of research projects, and applying it to new initiatives of management and ecotourism. One example of this is the project LifeWatch INDALO, which includes two actions to collect useful ecological information in Cabo de Gata and is led by the Junta de Andalucía. Another important initiative has been the CO-ADAPTA project supported by the Biodiversity Foundation (Environmental Ministry) where a social process with local companies and citizens has been developed to knowledge transference of ADAPTAMED results (Actions A3 and C3). This process has led to the creation of the “climate change trail”, which has been incorporated into the activities of ecotourism companies. In addition, the network of Global Change Observatories in Andalusia is a complementary initiative to Life Adaptamed which is being worked on in a complementary way to the actions of this Life project. In Cabo de Gata, “The Arid Southeast LTSER platform” within the eLTER (European Network for Long Term Ecological Research) is a good example of complementary action to Life Adaptamed that is already working. Finally, to extend the application of the results of action C3, we are preparing, together managers and scientists for Cyprys and Italy, a Life project proposal for the conservation of the habitat 5220* in the arid zones of Europe.

Perspectives for continuing the action after the end of the project:
Outline the perspectives for continuing the action after the end of the project.
The adaptative model initiated in Life Adaptamed will be continued under the umbrella of the Lifewatch-Eric INDALO project.

Milestones and deliverables: None.

Action D3 Scientific support, connection with REDIAM and knowledge transfer in relation to Sierra Nevada actions.

Foreseen start date: 07/2015 **Actual start date:** 02/2016
Foreseen end date:06/2020 **Actual (or anticipated) end date:** 12/2021

Activities undertaken and outputs achieved

UGR

- Scientific coordination meetings to evaluate methodologies for central actions. Data models designed to allocate information generated in central actions in Sierra Nevada.
- Metadata creation for datasets.
- Adaptation of current existing information system of Sierra Nevada node to the requirements established for action C7.
- Scientific support for actions C1, C5 and C6.

REDIAM(CAGPDS and AMAyA)

The Environmental Information Network (REDIAM) has held, on the one hand, meetings to describe the Information System designed for the LIFE Adaptamed project, and on the other hand, it has defined the different bases and guidelines for standardization, methodology and integration of the information generated by part of the Sierra Nevada node. In addition, it has provided this node with environmental information related to the Sierra Nevada Natural Area or the Andalusian territory, among others, which has facilitated the development of the different actions carried out in LIFE Adaptamed project.

Comparison with planned output and time schedule:

We have established a framework of permanent collaboration between researchers and managers of the National Park of Sierra Nevada. As opposed to the traditional management characterized by a lack of monitoring, we have opted for "adaptive management" based on follow-up of actions in order to evaluate the effects of a treatment submitted to testing. We have put into practice this philosophy in Sierra Nevada, proposing key questions from the outset, defining the goals to be pursued with the actions undertaken, and specifying the methodological and analytical details necessary to address these efforts.

If relevant, changes in action and correspondence with the AGENCY approving them

The permanent collaboration between researchers and managers was established according to planned, both in Sierra Nevada with the managers of the National park, and in Andalucía with the managers of the Consejería de Medio Ambiente.

Along with the field monitoring, it has been included a dendrochronology sampling carried out in the pine, oak and holm oak forests of Sierra Nevada included in the actions C1 and C6 of Life Adaptamed, in the field monitoring plots. This contract was reported in the modified budget reported together with the substantial modification request for the extension of 18 month in the project schedule. The results of this analysis can be found in **Annex O06**.

Major problems/drawbacks and/or delays, including consequences for other actions:

The main problems came from slowness of the administrative bureaucracy.

Complementary action outside LIFE:

Outside the scope of the Life Adaptamed project, a multitude of complementary actions have been developed with a complementary framework with action D3. Most of them related to the gathering of scientific knowledge within the framework of research projects. The best example of this are the project LifeWatch Smart Ecomountains collects useful ecological

information in Sierra Nevada and is led by the University of Granada itself (partner responsible for the D3 action). In addition, the network of Global Change Observatories in Andalusia is a complementary initiative to Life Adaptamed in the which is being worked on in a complementary way to the actions of this Life project. In Sierra Nevada, Global Change Observatory is a good example of complementary action to Life Adaptamed that is already working.

Perspectives for continuing the action after the end of the project:
Outline the perspectives for continuing the action after the end of the project.
The adaptative model initiated in Life Adaptamed will be continued under the Umbrella of the Global Change Observatory of the Sierra Nevada.

Milestones and deliverables: None.

Other annexes:

- **Annex O06.** Report on the dendrochronological work to estimate carbon sinks in the forests of Sierra Nevada within the framework of the LIFEADAPTAMED project

Action D4 Impact monitorig and assessment in actions related to local dissemination, gobernance and final symposium

Foreseen start date: 09/2015 Actual start date: 10/2020
Foreseen end date: 03/2020 Actual (or anticipated) end date: 12/2021

Activities undertaken and outputs achieved:
Assessment forms were prepared for the participants of actions E2 and E5 following the criteria of the monitoring and evaluation guides according to the LIFE Regulation.
In addition, perception surveys were carried out for the participants of the Participatory Bodies of the natural spaces (action E10). For this, a consultant was hired to carry out the surveys.

The outputs of the surveys corresponding to E2 showed that in:

- in Cabo de Gata 82% knew what a protected area was and 73% knew of the existence of other natural spaces in their territory. All participants considered protected areas to be useful both for themselves and for their municipality. 64% of participants considered the workshops useful to improve their knowledge and also 64% knew the meaning of ecosystem services.
- in Sierra Nevada 88% knew what a protected area was and 94% knew of the existence of other natural spaces in their territory. All participants considered protected areas to be useful both for themselves and for their municipality. 59% of participants considered the workshops useful to improve their knowledge and also 59% knew the meaning of ecosystem services.
- in Doñana 76% knew what a protected area was and also knew of the existence of other natural spaces in their territory. 67% considered protected areas to be useful both for themselves and for their municipality. 91% of participants considered the workshops useful to improve their knowledge and also 90% knew the meaning of ecosystem services.

The outputs of the surveys for E5 were gathered in this final document: https://www.lifeadaptamed.eu/wp-content/uploads/2021/12/Conclusiones-simposio.pdf

In E10, one of the main recommendations arising from the process was the creation of climate change adaptation commissions in the Governing Boards, boards of trustees and Participation Councils.

Comparison with planned output and time schedule
For E2, surveys were carried out adapting to the public availability, with a total of:

- 50 in 2016 and 72 in 2021 for Cabo de Gata.
- 22 in 2016 and 65 in 2021 for Sierra Nevada.
- 20 in 2017 and 154 in 2021 for Doñana.

Regarding the E5, 20 surveys were carried out following the original amount established.

In E10, considering the goal of 10 surveys, the project carried out 11 in Cabo de Gata, 13 in Sierra Nevada and 2 in Doñana, as per availability of the board members.

Major problems/drawbacks and/or delays, including consequences for other actions
High presence of other projects and shortage of staff in Doñana led to less participation in E11.

Outline the perspectives for continuing the action after the end of the project. Insights collected in surveys were used to feed the final document of recommendations on governance for the adaptation of natural spaces to climate change.

Milestones and deliverables: None.

Other relevant Annex es: None.

Action D5 Monitoring and assessment of volunteering camps and environmental education

Foreseen start date: 01/2016 Actual start date: 03/2017

Foreseen end date: 01/2020 Actual (or anticipated) end date: 12/2021

Activities undertaken and outputs achieved

Environmental volunteer program

The evaluation of the volunteering activities was carried out individually for each activity, so that the learning derived from these evaluations could be used by other volunteering actions within Life Adaptamed itself or even in other volunteering initiatives that are developed in the parks in which the project is developed. This continuous evaluation has had a retroactive effect on the rest of the project activities. In general, very positive evaluations have been obtained from the participants (see **Annex D.06**), making special mention of the good organization and the innovative nature of the activities contemplated in the different activities. However, although general volunteer programs for actions to restore the natural environment are common, those like this one that affect climate change, adaptation and protection of ecosystem services are more innovative.

Environmental education on adaptation to climate change

The environmental education activities, and mainly the two didactic units developed, have been evaluated following the following methodology:

Test the material produced by putting it into practice by the teachers of the collaborating educational centers before the definitive edition of the material.

Receive contributions from the teaching staff on the suitability of the proposed activities, their curricular integration and other aspects of interest to make this material a useful work tool for teachers.

Involve teachers in a rewarding process of participation/training.

To check the suitability of the Didactic Units, two educational centers have been selected in each of the following Natural Areas: Doñana Natural Area, Sierra Nevada Natural Area and Cabo de Gata-Níjar Natural Park. These NPAs represent emblematic places of study on the impacts of global change. In each natural space, a Primary school and a Secondary school have been chosen where the pilot actions of the Didactic Unit corresponding to each educational level have been carried out. In the Cabo de Gata Natural Park, the selected center teaches the educational levels of Primary Education and Secondary Education, so only one center has been selected.

In general, both Primary and Secondary teachers have positively valued the clarity and usefulness of the didactic units, expressing that it is easy to put into practice thanks to the high quality and clarity of the contents.

However, some institutes (mainly in groups of 1st ESO) have preferred to use the Primary material because the level of the Secondary material has seemed too high.

Among the joint conclusions that this evaluation process allows us, we have verified the importance of incorporating citizenship into decision-making and the implementation of actions on the natural environment. One of the mechanisms that can favour this incorporation are volunteering and environmental education programs, which represent an essential complement to any conservation strategy.

Environmental volunteering activities have great value as they involve citizens in their own management, conservation and restoration actions, allowing them to experience the difficulties and satisfactions inherent to them and create an emotional bond with their development. Among them, citizen science actions offer a promising approach that, in addition to promoting citizen participation and commitment, allows the generation of extremely useful data and information for interpreting environmental changes. Climate change adaptation policies in Andalusia (and, in particular, in the Network of Global Change

Observatories in Andalusia) should be the substrate from which to promote programs that facilitate the implementation of citizen science activities and other volunteer activities. This requires an effort on the part of the competent administration, through which volunteer networks can be supported with the dedication of time by personnel in charge of coordination and dialogue with the protected spaces and specific funds to cover material expenses, logistical support and holding regular meetings. The latter are much needed to strengthen volunteer networks. In the specific case of citizen science initiatives, it is recommended to encourage systems that favour the involvement of the volunteer beyond the mere process of collecting data in the field. The volunteer must also be involved in the sampling design processes and the analysis and interpretation of the results. This will strengthen your link with the activity for which collaboration is requested.

As far as environmental education is concerned, we believe that there is still a long way to go and that the potential of new pedagogical approaches should be duly developed. At each educational stage we detect specific deficiencies. The stage from zero to six years is currently the focus of very few environmental education strategies and therefore we clearly detect a gap in this matter that contrasts with the importance of these ages to begin to lay the foundations for a solid educational strategy. On the other hand, although climate change has recently been included in the curriculum of later stages of Primary and Secondary Education, there are hardly any materials and activities that allow working in a meaningful and experimental way the complex concepts that are required to understand its causes, its effects and the complex synergies that exist between the two. It is proposed to amplify the impact of the generated materials (mainly didactic units, but also the manual).

Comparison with planned output and time schedule

The initially planned methodology has changed based on expert criteria, so that a continuous assessment of the volunteer activities has been carried out with the aim of promoting the positive aspects and mitigating the errors within other volunteer activities of the project itself. In the case of environmental education, the evaluation has been carried out on the didactic units themselves, which has allowed the lessons derived from this action to be implemented in the final results.

Regarding the calendar, the only change has been that the E3 and E4 actions have been affected by the restrictions imposed by the COVID-19 pandemic and have been delayed. Consequently, the corresponding evaluation has also had to be delayed.

If relevant, changes in action and correspondence with the AGENCY approving them

See previous section.

Major problems/drawbacks and/or delays, including consequences for other actions

No problems have arisen, apart from delays in the implementation of some of the volunteer activities caused by the COVID-19 pandemic. It should also be noted that in the case of the action E3, it was not possible to complete the planned training sessions, as explained in the corresponding section. Anyway, no consequences for other actions have occurred.

Complementary action outside LIFE

The learning that this action has allowed and the related actions E3 and E4 have made it possible to incorporate new paradigms into environmental education, volunteering and citizen science in relation to adaptation to CC in protected areas.

Perspectives for continuing the action after the end of the Project

The prospects of giving continuity to this action go through the continuity of volunteering and environmental education actions by promoting continuous evaluation processes such as the one that has been developed in this action.

Milestones

D07. Final evaluation report on the impact of actions E3 and E4

Action D6-Follow-up and evaluation of the "Window to Science" exhibitions, "Meetings with Scientists" and "Traveling Exhibition"dissemination actions

Foreseen start date: 09/2015 Actual start date: 09/2017
Foreseen end date: 04/2020 Actual (or anticipated) end date:12/2021

Activities undertaken and outputs achieved

As an evaluation method for actions E6, E7 and E8, two Focus Groups were planned for each of the actions. Two of them were held in 2017 to assess the first edition of the "Window to Science" -action E6- and, two in 2020 to evaluate actions E7 and E8. In addition, another two will be held in March 2022 to analyse the second edition of the "Window to Science" -action E6-. Compared to others, the main advantage of this method is that it allows interaction among the participants, therefore generating different ideas and opinions, which are very valuable for the objectives pursued in this activity. Each evaluation method is linked to two Focus Groups, an initial one to identify the existing knowledge of the participants and a final one used to evaluate the learning gained through the related activity.

For the first edition of action E6, six participants were carefully selected taking into consideration the sociodemographic heterogeneity of the group, so that half of it had some knowledge or experience in environmental education and the other half had no familiarity with the topic. The first of the Focus Groups was held on the 14th of December 2017 and, the second one after visiting the first "Window to Science," on the 21st of December 2017.

For actions, E7 and E8, a group made out of students, teachers, and parents of students from the education centre IES Bulyana in Pulianas (Granada) were selected. The first of the Focus Groups was carried out in February 2020 and, the second one was held online in May 2020 due to the first state of alarm declared by the Government as a result of the COVID-19pandemic, after having visited the micro exhibition -action E7- and once the meeting with scientists had taken place -action E8-.

The two outstanding Focus Groups for the evaluation of the second edition of Action E6 will be held in March 2022 and willfollow the same methodology as the previous ones.

As for recommendations, participants suggested the use of simpler language, the adaptation of the contents to children's audience, and the possibility of providing more information about the project.

This proposal has a significant social impact. It also highlights the importance of bringing together technical agencies, research centers and universities, social agents, educators, the media, and a science museum as a powerful tool to bring science closer to society and improve its scientific literacy.

Compare with planned output and schedule

The scheduled starting date of Action D6 was not changed. However, there has been a delay in the expected ending date. The Action D6 was expected to finish in December 2021 but the overall delay of the project has postponed the start of the second edition of the "Window on Science" (Action E6) as it depends on the results of the scientific research and finally, the Focus Groups will have to be carried out in March 2022. The outstanding activities of Action D6 have been planned to evaluate mainly Action E6. Moreover, due to the COVID 19 health crisis, restrictions have not made it possible to gather a heterogeneous group of people safely and risk-free to carry out the activity within the timeline schedule.

If relevant, changes in action and correspondence with the AGENCY approving them

There has not been any important modification regarding the foreseen budget for the action.

Major problems/drawbacks, delays, including consequences for other actions.
Due to the delay in opening the second edition of the "Window to Science" (Action E6), the two Focus Groups planned to evaluate this action have had to be postponed until March 2022. Therefore, for the project's completion date, it has only been possible to allocate to action D6 the hours worked by the staff for the planning and preparation of the two Focus Groups that will take place in 2022. Consequently, this has been reflected in the total personnel cost spent that accounted for 72% of the total personnel budget for this action.

Comparison with planned output and time schedule
The scheduled starting date of Action D6 has not been changed. However, there has been a delay in the expected ending date. The Action D6 was expected to finish in December 2021 but the overall delay of the project has postponed the start of the second edition of the "Window on Science" (Action E6) as it depends on the results of the scientific research and finally, the Focus Groups will have to be carried out in March 2022. The outstanding activities of Action D6 have been planned to evaluate mainly Action E6. Moreover, due to the COVID 19 health crisis, restrictions have not made it possible to gather a heterogeneous group of people safely and risk-free to carry out the activity within the timeline schedule.
There has not been any important modification regarding the foreseen budget for the action.

Perspectives for continuing the action after the end of the project
The outcomes obtained in all activities of the D6 action will be applied to effectively engage people in content about climate change and other topics related to the project.

Participants during the Focus Group

The Focus Group participants visiting the Window to Science

Milestones and deliverables
This action did not include any milestone or deliverable

Other relevant Annexes
Annex O08 includes the social impact of actions E6, E7, E8 and D6.

Action D7 Assessment of the results of the central actions using indicators of ecosystem functions through remote sensing and field radiometry.

Foreseen start date: 07/2015 Actual start date: 01/2016
Foreseen end date: 06/2020 Actual (or anticipated) end date: 11/2021

Activities undertaken and outputs achieved

Activities under this action comprise the monitoring of the effectiveness of actions C1, C2, C3, C4, C5 and C6. The monitoring activities carried out included the assessment of indicators of primary production (NDVI), vegetation response to drought (LSWI), albedo and land surface temperature. According to the project goals, the treatments carried out during the core actions were aimed at ensuring the health of the ecosystems in order to maintain the provision of ecosystem services despite the impact of climate change. As these actions always involved the alteration of the vegetation canopy and land cover, it is to be expected that in the short-term the ecosystem functions indicated above would not have recovered. However, for those actions for which we were able to complete a follow-up of 2 or 1.5 years, we observed that the alteration of ecosystem functions was not relevant. This indicates that the treatments aimed at diversifying the forest stands or restoring stages of scrubland in the landscape have been mostly very positive. The recovery of primary productivity values, or of vegetation response to drought, supports these results. In most cases, this recovery was due to the rapid growth of biomass and the diversity of shrubs and grasses in the forest clearings created. The results obtained for the energy balance indicators also point in this direction but should be further evaluated. We hope that after some more time of canopy recovery following silvicultural interventions, all ecosystem functions will be fully restored.

In addition to the general results, we have detected that there were less aggressive treatments in the alteration of ecosystem functions, at least in the short term in which we were able to carry out the evaluation after the central actions. These treatments differed among plant formations and even dominant species. Thus, for instance, the treatments with less impact on ecosystem functioning in Pinus forests of Sierra Nevada were medium intensity clearing in *Pinus halepensis*, low-intensity clearing in Pinus nigra forests, and high-intensity clearing in Pinus pinaster and Pinus sylvestris. In Doñana the less-impact treatment was 30% clearing considering indicators of LSWI, and NDVI, but 60% clearing for albedo and Ts. In action C2 (Doñana) this less-impact treatment was fencing without sowing.

In the arid ecosystems of Cabo de Gata, the interpretation of these results is complex due to the arid conditions that impose a slower ecosystem response, and for the moment, although we cannot conclude which treatment has the least impact on the functioning of the ecosystem, a good recovery of the ecosystem functions can be appreciated after the removal of all agaves. The same could be said for tillage with sowing in action C4, where a clear recovery of ecosystem functions is observed after the restoration of the stone walls (balates).

In action C6 (Sierra Nevada), the treatments that least altered ecosystem functioning after silvicultural actions were mainly intermediate thinning, although in some cases more intense thinning also showed good results.

Comparison with planned output and time schedule.

Planned output includes monitoring activities in the sites where C1, C2, C3, C4, C5 and C6 actions have been developed. All the planned monitoring activities have been carried out. Adjustments to adapt to the impact of the forest fire in Doñana that took place in June 2017 was also done as described for A10 and D8. Because of all these reasons explained, the relative effort applied to these two tasks had to be readjusted – which resulted in an increased effort devoted to A10 and a decreased effort devoted to D8. Thanks to these efforts, all

monitoring activities were undertaken and, after accommodating the aforementioned delays in C1 and C2 actions by adjusting the balance between the duration of the ex-ante and ex-post data series, the availability of these time series will allow for a complete evaluation of the success and impact of all intervention – laying the ground for a long-term evaluation using the data acquired during the post-Life phase.

Major problems/drawbacks, delays, including consequences for other actions.
Problems and drawbacks have been highlighted in previous paragraphs. They have had no consequences for other actions.

Possible complementary action outside LIFE.
As well as the action A10, this action is complementary to other monitoring initiatives carried out within the framework of the global change observatories of Doñana, Cabo de Gata and Sierra Nevada. The conceptual basis of the methodologies implemented to make the interpretation of results compatible has been kept in common. This coordination improves the monitoring of the ecological repercussions of the implementation of life adaptive central actions in the long term, in a post-life phase. The conceptual framework of this monitoring design is very complete and fully compatible in those methodologies established in the local observatories. In this sense, Life Adaptamed can take advantage of previous data series, knowledge and experiences compiled during years of local monitoring at Cabo de Gata, Doñana and Sierra Nevada.

Perspectives for continuing the action after the end of the project.
Coordinating beneficiary and scientific institutions involved in the project are very interested in continuing the monitoring drawn in these actions after the end of the project. The Global Change Observatories designed in each Park should be a good platform to follow monitoring activities at Life Adaptamed sites. The Andalusian Climate Change Law established the adequate legal substratum to put into practice the Global Change Observatories Net as one of its main goals of this law (Article 21). This is a good example of the interest of the Andalusian Government to continue monitoring parameters included under D8 action. Finally, maintaining monitoring teams depend on financial support that currently is not ensured. Anyway, all methods are accurately explained in the '*Life Adaptamed monitoring methodologies report*' and a detailed register of spatial information regarding these monitoring is properly stored (through C7 action) in order to allow replications of methodologies in the same conditions.
As mentioned for A10, the beneficiary EBD-CSIC developed a practical training program included in the 2-years degree in Forestry run by the Doñana Technical School (IES Doñana) in Almonte, Doñana's local county. Within that training program, students participated in the monitoring of pine-afforestation plots. This activity serves the triple purpose of training local professionals in the project's adaptive management approaches, enhancing the transfer of such approaches to the broader local community, and facilitating the continuation of the project activities after its end. We are currently working In overcoming the administrative problems that arose during and after the COVID pandemic, linked to the expiration of the agreement between CSIC and the Andalusian Education Office, with the aim of maintaining this program as of the key elements of Doñana's post-Life monitoring.

Was the objective reached? What reactions and feedback were obtained?
All the objectives addressed in this action have been achieved.

Deliverables and milestones: None.

Action D8 Assessment of actions C1 to C6 at a landscape scale "a posteriori"

Foreseen start date: 07/2015 Actual start date: 03/2017
Foreseen end date: 06/2020 Actual (or anticipated) end date: 12/2021

Activities undertaken and outputs achieved

Activities under this action comprise the field monitoring of the effectiveness of actions C1, C2, C3, C4, C5 and C6. The monitoring activities carried out can be summarised as follows:

C1: In Sierra Nevada, monitoring of birds, carnivorous mammals and butterflies has been carried out within the framework of this action. All the plots that have been subject to treatment and control have been censused during the autumns of 2020 and 2021 and during the spring of 2021. The censuses have consisted of linear transects and have followed international standards for monitoring bird and butterflies populations, a specific method (based on the collection of droppings), although widely tested, in the case of carnivore mammals and a own monitoring methodology (endorsed by experts from the University of Granada) for counting pollinators through functional groups.

In the case of birds, the results show a loss of species, although a net gain of individuals of certain species. This indicates an increase in the dominance of bird communities, although the results must be taken with caution because the series of data years after the treatments is not as long as it should be to identify clear and well-separated patterns of climatic factors. Also, in all plots of the project (1 ha plots covering all treatment intensities, all options for forest residues and also control plots with no silvicultural treatments) vegetation inventories combined with forest inventories have been carried out during spring and summer of 2020. These inventories included species regeneration, plant diversity, plant cover, plant abundance, tree growth, tree vitality and also the use of hemispheric ortophotographs to identify changes in structure and vitality patterns. The results show an increase in ecosystem stability and health, related to conservation of regulation services, when comparing plots with treatments and control plots. Differences among treatments are not significant yet due to the little time lapse between the silvicultural actions and the field inventories carried out.Also, the results show clear negative effect of the waste management option that implies the complete removal of branches out of the ecosystem after the silvicultural works. This a priori seems to indicate that the collection and stacking of residues, a forestry operation done after the cutting of trees and before the smashing of the residues, in some cases it could be omitted, as it may be not be sufficiently justified in view of the preliminary results, although these data should be confirmed in the planned Post-Life follow-up before any firm recommendations can be made. On the other hand, the extraction of all the branches for their use in biomass plants would not be recommended for the negative effect on subsequent regeneration and conservation of soil properties.

In Cabo de Gata, bird censuses were carried out in the spring of 2017 and 2021. The results show that the pine forests present in this highly arid area act as an island of diversity, allowing the presence of species more typical of forest environments, thus having an effect on increasing diversity in general.

In Doñana, **Action C1 and C2-subaction 2** were executed simultaneously mainly during the autumn and winter of 2019-2020 and 2020-2021. Additional works were done at the end of 2021 concerning the plots affected by the forest fire of 2017. Actions consisted in the diversification of pine plantations (C1) and restoration of Mediterranean forest and scrubs (C2). Specific actions consisted in placement of nest boxes to increase bird and bat diversity, and the pest control services they provide (C1). Fieldwork followed the monitoring procedures produced through the '*Life Adaptamed monitoring methodologies report*' (included as **Annex O07**). In Doñana, it included measurements of (i) (v) changes in pine tree size (height, stem girth, and crown spread) (A); (ii) the cover, structure and diversity of shrub

and herbaceous vegetation, as well as the biomass of herbaceous vegetation (A); (iii) the abundance and diversity of overwintering and breeding, passerine birds (B); (iv) the relative abundance of herbivorous (rabbit and hare as well as wild and domestic ungulates) and carnivorous mammals, using camera-trap and track analyses (B); (v) the abundance and composition of soil fauna, with a focus on ants as indicator group A); (vi) the abundance and diversity of micro-mammals (rodents and shrews) (B); (vii) the abundance and activity of bats (B); (vii) nest box and bat refuge occupancy (B); and (viii) the activity, abundance and diversity of pollinators, aggregate din functional groups (A). All these measurements were taken on an annual (A) or biannual (twice a year: B) basis, although the contingency of unforeseen factors (most importantly, the Covid-19 pandemic) caused some gaps in this data series. In addition, (ix) the collection of soil samples for the determination of carbon, nutrient and water content took place a single time during the project. Owing to the late response expected in these variables and the delayed application of several treatments, we did not take an ex-post-hoc measurement and will simply use the first measurement as a baseline to be compared with future measurements undertaken in the post-Life.

Action C2-subactions 1 & 3: Despite the previously described works in Doñana (shared between C1 and C2 actions), a treatment of cork oak to increase its resistance to the exotic oomycete *Phytophthora cinnamomi* has been carried out.

C3. Monitoring of soil insects, birds, reptiles, aerial beneficial entomofauna, and seedling survival was carried out under this action in the *Ziziphus* Priority Habitat (Cabo de Gata Protected Area). In the case of insects, sampling was concentrated in spring and early summer, when the ecosystem reaches higher levels of productivity. Regarding birds, 6 annual censuses were carried out, concentrated in spring and autumn, coinciding with the periods of reproduction and migration. Concerning reptiles, there were 4 annual censuses, two in spring and two in autumn. Results showed that the areas invaded by agaves were less diverse for most sampled groups than in the Ziziphus habitat. Agave presence mainly affected the density of beetles, lizards, and birds. Following the elimination of the agaves, a positive effect was observed on recovery birds, by increasing the number of reproductive pairs from typical species of steppe zones. Moreover, the results highlighted the role of the *Ziziphus* habitat as a biodiversity reservoir. For instance, it had a positive effect on beneficial entomofauna, which play an important role in agriculture and natural pest control. Finally, this habitat facilitated the presence of forest species that are not typical of arid zones, showing the buffer effect that Ziziphus provide on this semiarid climate.

C4. Monitoring under this action consists of monitoring soil organic matter, soil respiration, soil moisture, and erosion control by the built walls. A network of soil moisture and respiration sampling points was installed at 3 locations to assess the effect of tillage and seeding (and subsequent litter fall) on carbon and water cycles. Additionally, the diversity of birds associated with traditional crops is studied, carrying out 3 annual censuses between 2017 and 2021. The results show that the reconstruction of the small walls has an erosion control effect, increasing the soil retention capacity. The cultivation and planting of cereals favoured the presence of bird species associated with traditional agricultural areas, some of them of hunting interest

C5. We have installed a net of sensors to evaluate differences of moisture and temperature in the plots installed to analyse plantation and seeding success within selected microhabitats. Sowings were controlled in four periods, two before and two after the summers of 2018 and 2019. The plantations were carried out later (autumn 2020) and two controls were carried out: one before the summer of 2021 and another in the autumn of 2021. The data show marked differences in the seed germination and seedling survival between the two periods compared, both decreasing considerably in 2017-2020 compared to 1996-1998. We consider that this

was due to the different climatology of the years in which the planting was carried out: rainy years in 1996, 1997 and 1998, with more than 835 mm of precipitation per year 27 and dry years in 2018, 2019, 2020, with around 410 mm of precipitation per year (compared to an average accumulated precipitation of 577 mm from 1941 to 2019 (http://climanevada.obsnev.es). These results clearly indicate the importance of climate as a modulator of the capacity of juniper regeneration. In fact, the greater aridity of recent years has collapsed recruitment, which is also manifested in the current demographic structure of juniper, where there are hardly any juveniles. With the data obtained in the planting carried out in the rainy years (1996-1998) we can affirm that the high mountain places where the juniper has the greatest recruitment success are the comparatively more humid sites (near permanent streams and traditional ditches) and the rocks (under the shade of rocks), while in grasslands and open areas there is no recruitment. The sowings carried out in the years 2018, 2019, 2020, which were much drier than the years 1996-1998, offer very similar results in terms of the differential quality of the microenvironments for seed germination and seedling survival.

C6. In Sierra Nevada the same scheme as in the case of action C1 has been followed in the case of animal populations monitoring and vegetation and forest monitorin. That is monitoring of birds and butterflies through linear transects and droppings collection in the case of carnivore mammals duringo autumns 2020 and 2021 and during spring 2021; monitoring of species regeneration, plant diversity, plant cover, plant abundance, tree growth, tree vitality and also the use of hemispheric ortophotographs in spring and summer 2020 to identify changes in structure and vitality patterns in all 1ha plots. The results show similar effects in relation to waste management options. This a priori seems to indicate that the collection and stacking of residues, a forestry operation that increases the cost of silvicultural treatments, could be not well enough justified in view of the initial current results.

Activities under the monitoring of C1, C3, C4, C5 and C6 actions have been carried out by AMAYA with the support of the scientific advisory board of the project through actions D2, D3 and F2. Activities under the monitoring of C2 action and all the C1 monitoring concerning Doñana area have been carried out by EBD/CSIC.

Comparison with planned output and time schedule

Planned output includes monitoring activities in the sites where actions C1, C2, C3, C4, C5 and C6 have been developed. All the planned monitoring activities have been carried out, with an important delay according to approved proposal due to the delay in the implementation of the central actions, which thanks to the approved extension has not had a negative impact in the results achieved inaction D8. However, this initial delay has caused the implementation of ex-ante monitoring action (A10) to be extended, which can also be interpreted as an advantage, since it has allowed us to have a greater volume of information associated to ex-ante monitoringfrom which to characterize the initial state of ecosystems and their provision of services.

If relevant, changes in action and correspondence with the AGENCY approving them

As described above for A10, difficulties in the administrative procedures in Doñana prevented the hiring of additional staff by CAGPDS (now CAGPDS); hence, a modification was requested (and approved) to allow EBD-CSIC to assume all the tasks to be done in Action A10 and D8 by themselves. Adjustments to adapt to the impact of the forest fire that took place in June 2017 were also done as described for A10. Because of all these reasons explained, the relative effort applied to these two tasks had to be readjusted – which resulted in an increased effort devoted to A10 and a decreased effort devoted to D8, specially in Doñana. Thanks to these efforts, all monitoring activities were undertaken and, after

accommodating the aforementioned delays in C1 and C2 actions by adjusting the balance between the duration of the ex-ante and ex-post data series, the availability of these time series will allow for a complete evaluation of the success and impact of all interventions – laying the ground for a long-term evaluation using the data acquired during the post-Life.

Major problems/drawbacks, delays, including consequences for other actions.
Problems and drawbacks have been highlighted in previous paragraphs. Consequences can be summarised as follow:
The time dedicated to evaluating the ecological situation previous to actions implementation through action A10 was increased. Action A10 and action D8 are continuous; the first one attends the state of the art before the implementation of central actionsin the field and D8 action involves the field scale monitored after this point. Thus, we have the opportunity to compare the situation before and after the adaptive management actions.
No consequences for other actions have occurred thanks to the approved 18-month extension.

Possible complementary action outside LIFE.
As well as the action A10, this action is complementary to other monitoring initiatives carried out within the framework of the global change observatories of Doñana, Cabo de Gata and Sierra Nevada. The conceptual basis of the methodologies implemented to make the interpretation of results compatible has been kept in common. This coordination improves the monitoring of the ecological repercussions of the implementation of Life Adaptamed central actions in the long term, in a post-life phase. The conceptual framework of this monitoring design is very complete and fully compatible in those methodologies established in the local observatories. In this sense, Life Adaptamed can take advantage of previous data series, knowledge and experiences compiled during years of local monitoring at Cabo de Gata, Doñana and Sierra Nevada.

Perspectives for continuing the action after the end of the project.
Coordinating beneficiary and scientific institutions involved in the project are very interested in continuing the monitoring drawn in these actions after the end of the project. The Global Change Observatories designed in each Park should be a good platform to follow monitoring activities at Life Adaptamed sites. The Andalusian Climate Change Law established the adequate legal substratum to put in practice the Global Change Observatories Net as one of its main goals of this law (Article 21). This is a good example of the interest of the Andalusian Government into continue monitoring parameters included under D8 action. Finally, maintaining of monitoring teams depend on financial support that currently is not ensured. Anyway, all methods are accurately explained in the '*Life Adaptamed monitoring methodologies report*' and a detailed register of spatial information regarding these monitoring is properly storage (through C7 action) in order to allow replications of methodologies is the same conditions.
As mentioned for A10, the beneficiary EBD-CSIC developed a practical training program included in the 2-years degree in Forestry run by the Doñana Technical School (IES Doñana) in Almonte, Doñana's local county. Within that training program, students participated in the monitoring of pine-afforestation plots. This activity serves the triple purpose of training local professionals in the project's adaptive management approaches, enhancing the transfer of such approaches to the broader local community, and facilitating the continuation of the project activities after its end. We are currently working in overcoming the administrative problems that arose during and after the COVID pandemic, linked to the expiration of the agreement between CSIC and the Andalusian Education Office, with the aim of maintaining this program as of the key elements of Doñana's post-Life monitoring.

Relevant Annexes: Life Adaptamed monitoring methodologies report (**Annex O07**).

Action D9 Socioeconomic study on the project impact on local economy and population

Foreseen start date: 01/2021 Actual start date: 09/2021
Foreseen end date: 12/2021 Actual End date: 11/2021

Activities undertaken and outputs achieved
The expected report including the impact of the project in the local economy and in its population has been produced by AMAYA in collaboration with UGR.
The report includes the economic, social and ecosystem services impact, evaluated based on the actions implemented in the project. It also includes evaluation indicators. This report can be found in **Annex D19**.

Comparison with planned output and time schedule
The work has been completed as planned, in the last quarter of the project execution.

Major problems/drawbacks, delays, including consequences for other actions
None.

Possible complementary action outside LIFE
Not expected.

Perspectives for continuing the action after the end of the project
Not expected.

Deliverables
Report on the study of the socio-economic impact of the project on the local economy and local population (**Annex D19**)

Action E1 Communication Plan and production of diffusion and technical

Foreseen start date: 09/2015 Actual start date: 02/2016
Foreseen end date: 06/2020 Actual (or anticipated) end date: 12/2021

Activities undertaken and outputs achieved

The Communications plan including the strategy for Social Media was jointly developed with the project partners, so as to establish the key messages, target audience, means and methodology. A second sub-action was to elaborate a Corporate Identity Manual (CIM) that was approved by the partners (see Annex E1.2 in PR1).

Three different social media channels were created in the project framework (Facebook, Twitter and Instagram). (See Annex E1.2 in PR1 about the impact of Social Media). At the end of the project, social media followers have grown to 1495 on Facebook, 664 on twitter and 541 on Instagram. Content was produced on a weekly basis, combining infographics, graphic cards, videos, news articles, etc. Guidance sessions on the most suitable content for social media posting were held with the project staff in charge of communication-related tasks. As a result, social media was key to disseminate the value of the actions of the project across a wide audience (from farmers to environmentalists, forest rangers, scientists, staff in protected areas, local associations and public administrations) and also played a key role in promoting the closing event of the project (E5), as it allowed to live-broadcast the talks and allowed online viewers to submit their questions instantly. The live-streaming obtained 1628 views from the Mediterranean region, including southern Europe and North Africa.

IUCN also contributed to the Life Adaptamed web site (www.lifeadaptamed.eu, see action E9) through the definition of the structure and web site map, and content design. 49 web stories were created to explain and disseminate the value of the project actions. This help to reach a total amount of over 88,600 website visits. One general article about the project was published on the IUCN Global website and on Arborvitae (IUCN's online forest magazine)

6 different infographics were produced to feed the website and social media channels.

1600 brochures were produced and delivered in schools, at information points in the area of the pilot sites, as well as to the project partners, who used them in both project events as well as external networking events..

7 short videos were posted on the social media channels of the project.

Three posters were designed following the CIP guidelines. Since they were produced, the posters have been shown in several meetings and they have also been duly disseminated.

3 roll ups were printed and displayed during the events of Action E2 (summer 2016, 2017 and 2021), during the closing symposium (E5), as well as at other partner activities and events.

Two newsletters were sent out in two languages (EN-ES) and distributed through the partner's networks, with 512 recipients for the Spanish version and 908 for the English version. Originally planned every six months, the newsletter was then reduced to one per year and finally replaced by articles about the project in the newsletter of IUCN-Med, which had a bigger audience and was produced in English, Spanish and French:

https://www.uicnmed.org/newsletter/2021/sharing_experiences_from_projects_for_climate_change_adaptation_in_the_euro-mediterranean_region.htm

https://www.uicnmed.org/newsletter/2020/recovering_the_donana_forest_and_controlling_pests_by_restoring_the_habitat_of_the_bat.htm

and one article on the newsletter of the Centre for Mediterranean Integration – Marseille of the World Bank:

https://mailchi.mp/worldbank/uvwbzbrnvg-281750

Moreover, greater effort was put on social media, as it proved to be more effective in reaching broader audiences.

A media kit including key data on project actions and the ecosystem services provided by the pilot sites was produced and shared with journalists.

A special edition of the Quercus magazine - the most popular environmental magazine in Spain – was exclusively dedicated to LIFE Adaptamed.

Five technical publications were produced, dedicated to best management practices for Quercus pyrenaica (alpine forests), pine trees, high mountain shrubs, pre-desertic shrubs and one last one combining the content about the management of Doñana Mediterranean forest. Moreover, a guide on governance to support adaptive management in natural spaces was produced.

Comparison with planned output and time schedule

The production of certain deliverables was delayed due to the later implementation of some of the central actions. As soon as the technical information was made available, it was possible to move forward with most communication deliverables.

Once the project was running, it became clear that the activities that had been planned to disseminate the learnings and results of the project were insufficient. To solve this and complete the work, the team requested an amendment to work with the Quercus magazine on the preparation of a special edition of the Quercus magazine, which has a print run of 18,000 copies and a circulation of 12,000 copies and 5,500 subscribers.

Although the original plan was to send out a newsletter every six months (then reduced to one yearly), as the project evolved it became clear that Social Media was a better solution to achieve greater impact using the available resources more efficiently. For this reason, only two newsletters were produced and news about the project were included in IUCN-Med's newsletter (produced in English-French-Spanish) and in a special issue of the Centre for Mediterranean Integration-Marseille of the World Bank.

Regarding the publications, for practical and strategic purposes, the technical team decided to merge two different publications (the one on pathogens in Quercus suber, and the one on Doñana Mediterranean forests) in one.

If relevant, changes in action and correspondence with the AGENCY approving them

The effort needed to obtain a significant impact on Social Media had been underestimated. For this reason, a Communications agency was hired for a year to take charge of the Social Media channels. After this period, it was considered important to strengthen collaboration among the partners in this sense. As a result, it was requested to allocate budget to manage this task internally, by IUCN staff, to ensure greater internal coordination, communication and more regular meetings between the project partners, so as to work collaboratively in producing comprehensive and impactful content.

Major problems/drawbacks and/or delays, including consequences for other actions:

Nothing to add.

Complementary action outside LIFE:

Nothing to add.

Outline the perspectives for continuing the action after the end of the project.
The manuals produced in the framework of the project have been shared with partner institutions, from universities to administrations and private sector, to ensure a successful transfer of the knowledge and experiences.
The communication strategy included in this action will be continued following the needed consistency with other tasks already considered under the post-Life strategy.

Comparison with the planned activity
Although the needs of this action were greater than originally expected, the impact achieved was also broader, having reached both the online and printed media, and boosted website visits as well as Social Media interaction. New technical features offered by social media, such as live-streamed events have created new dissemination opportunities in the face of pandemic restrictions.

Was the objective reached? What reactions and feedback were obtained?
The objective has been achieved and the reactions to all the materials and activities carried out in the framework of this action have been very well received.

Milestones

- Media Kit for media (**Annex D01**)
- Elaboration of dissemination material (brochures, posters, infographics) (**Annex D02**)
- Good governance guidance for adaptive management (**Annex D09**)
- Pre-desert scrubland best management practices manual (**Annex D10**)
- Best practices manual for adaptive management of pine forests (**Annex D11**)
- Best practices manual on mountain forest management (**Annex D12**)
- Best practices manual on mountain scrubland (**Annex D13**)
- Best practices manual on Mediterranean forest management and best practices manual on cork oak pathogens treatment (both compiled in one document and included in **Annex D14**)
- Final dissemination report (**Annex D22**)

Deliverables
None.

Action E2 Local dissemination on adaptation needs to climate change and governance improvement

Foreseen start date: 09/2015 **Actual start date:** 03/2016
Foreseen end date: 03/2020 **Actual (or anticipated) end date:** 12/2021

Activities undertaken and outputs achieved
Two rows of events were organised to encourage social participation in the area of the project pilot sites: one in August 2016 and another one in September 2021. These events were held in cooperation with the staff of the protected areas, the administration of municipalities or with local NGOs and associations.
In Sierra Nevada, the events were held in the towns of Ugíjar (Museo de Artes Populares, 2016) and Lanjarón (Museo de la Miel, 2021) with a total of 290 participants. In the area of Doñana, the towns of el Rocío and Almonte were chosen, where overall 320 people participated. For Cabo de Gata, the event took place in the marina of San José with a total of approx. 800 participants. Some of the events were scheduled during the same dates as local celebrations, such as the Alpujarra Music Festival in Granada, the Tourist Day in Almeria or the Ecotourism Fair Doñana Natural Life in Huelva. Several of these events were featured on the local media and one of them got coverage from the regional TV channel (Canal Sur).
In all actions, local people were surveyed to track the knowledge about the project and to compare it at the end of the project. These actions also allowed to inform and involve the participation bodies of the three natural spaces about the methodology and results of the project. These organs are composed by a long list of stakeholders and representatives of economic sectors, which exceed the goals of 15 local stakeholders.
Regarding the involvement of local representatives from different businesses sectors, these were:
- in Sierra Nevada (7): D.O.P. Miel de Granada, Asociación Provincial de Apicultores de Granada, Venta del Chaleco, Finca Berta Wilhelmi, Aguas Lanjarón, Cooperativa Las Torcas.
- in Cabo de Gata (6): Cerveza Alborán, Asociación de Empresarios de Servicios Turísticos del Parque Natural Cabo de Gata-Níjar, Hotel Pakita, Subparke, Kayak Cabo de Gata, Casa Miguel San José.
- in Doñana (6): Cuna Platero S. Coop, Asociación de Empresas de Turismo de Naturaleza de Doñana (Atena), Doñana Nature, Babel Nature, Club de Ecoturismo de España, Club Espartanos Matalascañas.

Comparison with planned output and time schedule
In E2, it was agreed to delay the second row of events until the last months of the project to be able to collect more comprehensive feedback from the local populations. The goal of having 200 participants for each site was clearly exceeded.

Major problems/drawbacks and/or delays, including consequences for other actions
In several cases, it was challenging to identify the main stakeholders and make them come together on a same date.

Complementary action outside LIFE
These actions have contributed to strengthen networks, particularly between the local administrations and stakeholders. These networks are expected to be sustained after the project.

Comparison with the planned activity

Despite the challenges in bringing together the scattered populations and obstacles to align agendas, particularly in rural areas or in zones with mountains, the awareness raising activities reached a wider audience than planned.

Was the objective reached? What reactions and feedback were obtained?

Yes. The feedback has been very positive and the action has contributed to improve a very important aspect of the project as is the governance.

Deliverables

None.

Milestones

Final workshop for the local presentation of the project results in the three NPAs (achieved).
Workshop for local presentation of the project in the three NPAs (achieved).


La Alpujarra acoge unos talleres sobre el cambio climático en el Museo de la Miel de Lanjarón

Esta actividad se enmarca en el proyecto europeo LIFE Adaptamed, que lidera la Junta de Andalucía y está coordinada por el Centro de Cooperación para el Mediterráneo de la UICN con la colaboración del Ayuntamiento de Lanjarón, presidido por Eric Escobedo

Action E3 Environmental education on adaptation to climate change

Foreseen start date:1/ 2016 Actual start date: 03/2017
Foreseen end date: 12/2019 Actual (or anticipated) end date: 03/2020

Activities undertaken and outputs achieved

The basis of this action relies on the design and production of two didactic units (Didactic Unit for Adaptation to Climate Change in Protected Natural Areas). A total of six schools have been previously selected attending suitability and potential for the development of the main topics included in this action. We have maintained meetings at these schools to check the suitability of the Life Adaptamed Didactic Unit drafts. Finally, we have monitored, coordinated and made an advisory work to ensure an adequate interpretation of the Life Adaptamed Didactic Unit concepts. Additionally, we have concluded from these meetings many recommendations and amendments focused on improving the results of the draft Didactic Units. The didactic and pedagogical units have been developed in coordination and collaboration with the ALDEA Environmental Education Program. This product is intended to put into practice an effective citizen awareness to include environmental education in the educational group. Finally, a Didactic Unit for primary education (between 6 and 13 years old) and another adapted to Secondary Education students (between 13 and 19 years old) have been developed. A number of 600 copies of each Didactic Unit and the designed file have been delivered.

A total of 3 training courses were initially planned. However, due to the pandemic caused by Covid 19 they could not finally be carried out. The pandemic has greatly limited the possibilities of meeting in educational centres and teachers have seen their usual workload increase while losing the possibility of dedicating time to this type of activity. The training courses planified consisted in three training days aimed at primary and secondary education teachers, participating in the Terral educational project, as a priority, or in other educational projects of the Aldea program.

Photo taken during one of the training days to check the suitability of the Life Adaptamed didactic units with the teachers that are going to implement them in the next step of the action.

Comparison with planned output and time schedule
The objectives have been achieved to a large extent, although a small part has not been achieved as previously explained. This part corresponds to three training days. These training sessions would have provided explanations for the development of the activities contained in the didactic units. We consider that the objectives of the action as a whole have been achieved despite not having been able to complete the training sessions.
Regarding the schedule, the development of this action has accumulated some delay, although the expected completion date (beginning of 2020) has finally been preserved.

If relevant, changes in action and correspondence with the AGENCY approving them.
No modification of the planned action has been made.

Major problems/drawbacks, delays, including consequences for other actions
The piloting in the selected educational centres could not be carried out as a consequence of the pandemic (Covid 19). The beginning of the selection of the educational centres that were going to participate in the training days and subsequent contact with them coincided with the confinement and later with the adoption of exceptional prevention measures that prevented their execution.

Possible complementary action outside LIFE
This action has great potential to be developed outside the Life Program. The didactic units elaborated will be used by the educational community as a very novel didactic resource and in whose elaboration multidisciplinary professional teams have been involved. It is expected that its use will be extended to a greater number of educational centres. Likewise, the didactic units may also be used by the Public Use teams of the protected areas involved in the project and at other levels of the environmental administration. Other non-governmental entities have already shown their interest in incorporating these teaching resources into their environmental education activities.

Perspectives for continuing the action after the end of the project.
The Primary and Secondary Teaching Units will be made available to the non-university Educational Community through the ALDEA Program of the Junta de Andalucía, facilitating their use at many levels, especially for the educational centres participating in the ecological awareness program and education for sustainability on the impact of climate change on the natural environment. See the Programa ALDEA website for more information:
https://www.juntadeandalucia.es/educacion/portals/web/aldea/programa-aldea

Comparison with the planned activity:
Only the piloting in the selected educational centres could not be carried out as a consequence of the pandemic (Covid 19).

Was the objective reached? What reactions and feedback were obtained?
All the objectives have been met except for one, which was an objective of little relevance in the context of the action. Therefore, expectations have been duly met.

Deliverables:
Didactic Units on Adaptation to Climate Change in NPAs (two documents, one for Primary Education and one for Secondary Education, included in **Annex D04**).

Milestones (All of them achieved):
Training day for the coordinators of educational centres of the Doñana N.P.
Training day for the coordinators of educational centres in the Sierra Nevada N.P..
Training day for the coordinators of the educational centres of the Cabo de Gata Natural Park.

Action E4 Environmental volunteering programme on adaptation to climate change

Foreseen start date:1/ 2016 Actual start date: 09/2018
Foreseen end date: 06/2020 Actual (or anticipated) end date: 11/2021

Activities undertaken and outputs achieved:

1. Program for the promotion and awareness of adaptation to climate change in the Doñana Protected Area.

Number of activities completed: 7.
Dates: between 12/2019 to 11/2020.
Participants: 224 people. Students and teachers of educational centres, environmental volunteer groups and representatives of the socioeconomic sphere of the Doñana region.
Activities:

- Actions to raise awareness of climate change and repercussions on the NPA.
- Thematic action for the promotion of participation and awareness aimed at interpreter guides and environmental educators in the Doñana region.
- Participation actions: adaptation of the Mediterranean forest to Climate Change, intervention in natural areas destroyed by forest fires, adaptation of a natural area in the process of rehabilitation and increase in biodiversity.

Assessment: the actions have been highly valued by the participants (average rating of 9 out of 10).

2. Program to promote participation and awareness of adaptation to climate change in the Cabo de Gata-Níjar Natural Park.

Number of activities completed: 10.
Dates: between 11/2020 to 05/2021.
Participants: 15 to 30 per activity.
Activities:

- Thematic actions of environmental awareness and training for adaptation to climate change: the shelter for the little ones and restoration of the coastal ecosystem of Playazo de Rodalquilar.
- Training and participation to favour the self-organisation of ecosystems: The importance of the unknown. Get to know the route of climate change, data collection and analysis around the jujube and visit Los Escullos public estate.
- Awareness and training on climate change: invasion from the sea!! and get to know the lungs of the park (*Posidonia oceanica*).

Assessment: the different activities have been positively assessed by participants.

3. *Program for the improvement of participation and awareness of adaptation to climate change in the Sierra Nevada Protected Area.*

Number of activities completed: 8
Dates: 11/2020 to 04/2021.
Participants: 170.
Activities:

- Management actions: high mountain scrubland and Mediterranean forest restoration, high mountain traditional irrigation channel restoration.
- Educational itineraries.
- Training sessions.

Assessment: high rates of young people involvement. Very positive evaluation by the participants.

4. Environmental volunteer field in the Doñana Protected Area.

Number of activities completed: 21.

Dates: 09/2018.
Participants: 23.
Activities:

- Direct activities for the conservation of natural resources and maintenance of environmental quality.
- Training and informative activities aimed at learning about the environmental and social dynamics of the NPA.
- Recreational and sociocultural activities aimed at active participation.
- Closing day and evaluation of the results of the activity.

Assessment: objectives of the activities have been achieved and the actions have been carried out without any incident, the coordination with the competent administrations in the Doñana area being very satisfactory. The degree of satisfaction has been very high.

5. Campo de voluntariado en Cabo de Gata-Níjar.

Number of activities completed: 10.
Dates: 09/2018.
Participants: 20.
Activities:

- Direct activities for the conservation of natural resources and maintenance of environmental quality.
- Training and informative activities aimed at learning about the environmental and social dynamics of the NPA.
- Recreational and sociocultural activities aimed at volunteer camp participants.
- Clause day and evaluation of the results.

Assessment: objectives have been met. In general terms, the action has had a good assessment, proposing as an improvement a greater durability of the activities and a greater number of resources. The programming has been carried out as planned except for some small modifications. The fusion of the activities into one of longer duration should improve activity performance.

6. Volunteer camp in Sierra Nevada.

Number of activities completed: 10.
Dates: 09/2021.
Participants: 10.
Activities:

- Restoration of habitats for amphibians and reptiles and specific monitoring studies for these zoological groups in a context of climate change.

Assessment: Despite the initial schedule, a consecutive period of 10 days was established. Finally, it was found more convenient to carry out three shifts, for logistic reasons and time availability for the volunteers. The assessment has been quite positive by the participants, with a high evaluation of the team of monitors.

7. Workshop on environmental volunteering and adaptation to climate change.

Number of activities completed: 1.
Dates: 11/2021.
Participants: 40.
Activities: The aim of these sessions was to bring together volunteers from the three protected areas of the project. During these meetings (two days), numerous lines of action and proposals were shared on how to develop volunteer programs in protected areas in the context of adaptation to climate change and the protection of ecosystem services.
Assessment: the activity was very well valued. Experiences have been exchanged and new challenges and new forms of collaboration have been established.

Comparison with planned output and time schedule:
The objectives of this action have been strictly met. Moreover, we consider that we have gone beyond the initial objectives in terms of the learning obtained for the management of groups of volunteers and citizen science for adaptation to climate change. The final workshop on environmental volunteering and adaptation to climate change highlighted all this acquired knowledge, which is intended to be developed in future volunteering activities.
The schedule has been modified mainly due to the global pandemic of COVID-19. Initially there were some deliberate delays in order to improve the coordination of efforts under this action and the rest of the project actions. At the end of winter of 2020 we had to modify our entire calendar and forecasts, which has made it very difficult to achieve objectives and gives special merit to the good results obtained.

If relevant, changes in action and correspondence with the AGENCY approving them
The only modification is the one that refers to the calendar, which is explained in the previous section.

Major problems/drawbacks and/or delays, including consequences for other actions
In general terms, the biggest drawback has been having to delay the initially scheduled actions as a result of the confinement established as a result of the COVID-19 pandemic and, on the other hand, having to adapt the number of participants based on the protection measures and prevention that the health authorities of the Central and Autonomous Administration were publishing, adapting to the existing circumstances at all times.
Due to the perimeter closures of the different municipalities of the natural spaces, in many cases, it has had to select other places to hold the activities.

Complementary action outside LIFE
The complementary actions are many and diverse, and the lessons learned are already makingit possible to improve the focus of the new activities in terms of volunteering in protected areas.

Perspectives for continuing the action after the end of the project
The volunteers who have participated in this action will take advantage of the opportunity to remain linked to the networks of volunteers and citizen science that work in the NPAs after the end of the project. The action has been designed to allow these perspectives to continue.

Comparison with the planned activity
The action has been developed according to initial forecasts, although with some delay.

Was the objective reached? What reactions and feedback were obtained?
The objective has been achieved in all the activities developed within this action, although it has not been possible to meet the dates initially planned for reasons beyond the control of the organisers.

Deliverables:
LIFE ADAPTAMED Manual for Volunteers (**Annex D05**)
Final dossier on LIFE ADAPTAMED volunteer activities (**Annex D06**)

Milestones:
Celebration of the first volunteering camp (achieved)
Celebration of the second volunteering camp (achieved)
Celebration of the environmental volunteering training meeting (achieved).

Action E5. **Euro-Mediterranean symposium for dissemination and training on methodologies for adaptation to climate change and governance**

Foreseen start date: during 2021 Actual start date: 10/2021
Foreseen end date: during 2021 Actual (or anticipated) end date: 12/2021

Activities undertaken and outputs achieved:
From 17 to 18 November 2021, the final symposium of the project held in Malaga brought together policy-makers and experts from public administrations, protected areas, universities, researchers, NGOs and journalists to present and discuss the final results of the project, in addition to creating a forum for exchange of experiences with other climate change adaptation projects in Spain and other parts of the Mediterranean. Talks were offered in Spanish and English with simultaneous translation and shared through live-stream on the Facebook page of the project.
The second part of the event consisted in a training session, covering both the methodological technical aspects of actions C and the governance aspects resulting from the experience carried out in preparatory actions A7 and E10. This session was based on the methodology developed by Parque de las Ciencias de Andalucía:
https://www.parqueciencias.com/wp-content/uploads/2021/03/guia-didactica-micro-exposicion-cambio-climatico-2019_17x24-cm_digital_con-nuevo-logo-junta-1.pdf

The event also included a visit to the newly declared National Park of Sierra de las Nieves, where IUCN aims to apply the learnings of LIFE Adaptamed as a part of a new LIFE project in partnership with the administration of the province of Málaga.

Comparison with planned output and time schedule:
The final symposium generated a high level of interest among the environmental conservation community both within the region of Andalusia and beyond. More than 42 representatives of the Andalusian regional administration, including the General Director of the Natural Environment, Biodiversity and Protected Areas, together with 4 representatives of the administration of Malaga province, 4 representatives of decision-making bodies linked to protected areas and 20 representatives of protected areas attended the symposium in person. There was a highly significant representation of the NPAs of the project, including the directors of the national parks of Sierra Nevada and Cabo de Gata and other protected areas of Andalusia. 10 representatives of Spanish universities, 11 representatives from other projects for climate change adaptation in Spain and the Mediterranean region (including several LIFE projects) completed the audience of the event, which saw more than 90 in-person participants and over 1,600 virtual participants.

If relevant, changes in action and correspondence with the AGENCY approving them
In the context of the pandemic and to facilitate the in-person participation of speakers, as well as further logistical aspects, it was considered more practical to hold the final symposium in the city of Malaga, which has better connections than Granada, as well as a major airport.

Major problems/drawbacks and/or delays, including consequences for other actions
Nothing to mention

Outline the perspectives for continuing the action after the end of the project.
The event was hosted in one of the buildings of the administration of the Malaga province, which is responsible for managing the newly designated NP of Sierra de las Nieves. IUCN-Med is engaging the Malaga administration in the development of a new LIFE Project in this national park, with the aim of applying the learnings from LIFE Adaptamed.

Comparison with the planned activity
Absolute coincidence between what was planned and what was executed.

Was the objective reached? What reactions and feedback were obtained?
Yes, the objective has been met and all the participants in the symposium have shown their satisfaction with the results obtained.

Milestones:
International presentation symposium of the project results: 17-19 November 2021.

Deliverables:
Proceedings of the international symposium for the presentation of the project results (see **Annex D08**).

Other relevant Annexes:
Programme of the international symposium Life Adaptamed (see **Annex O09**).

Action E6-Climate Change Adaptation "Window to Science"

Foreseen start date: 03/2017 Actual start date: 09/2017
Foreseen end date: 06/2020 Actual (or anticipated) end date: 12/2021

Activities undertaken and outputs achieved

The Parque de las Ciencias has designed and produced two "Window to Science" exhibitions that make up the E6 activity. The first one named "Andalusian Natural Protected Areas: Ecosystems that protect us" was inaugurated on the 23rd of November 2017 and was open until the 15th of January 2018 to make it coincide with the outcome of the initial research results of the project. The second one "Andalusian Natural Protected Areas: conservation through adaptation" was open to the public on the 23rd of December 2021 as a means of scientific dissemination of the results of the project.

The main objective of this activity is to involve society in the LIFE Adaptamed project and disseminate its lines of research, an objective that has been achieved as, up to date, more than 10,000 people have actively participated in the project and over 90,000 have had some involvement in the two "Windows to Science".

The two "Windows to Science" exhibitions have been organised in different areas to describe the activities performed by the other project partners in each of the protected areas as well as the results that have been achieved after the execution of the project in each of them.

The resources used include a juniper forest diorama, a reforestation model of the woodland during the last century, a resilience software program, audiovisuals, graphic materials, scientific publications, and educational workshops.

Several didactic and educational materials have been produced to illustrate the scientific concepts related to the project theme that can be used in other dissemination activities once the project has been completed (see **Annex O10**).
Finally, we can conclude that the development of these proposals has been a successful method for visitors to become involved in the issue of climate change and, in addition to this, to understand the relevance of the adaptive management scheme put into practice in LIFE Adaptamed.

Comparison with planned output and schedule

First edition of the "Window to Science" (23/11/2017-15/01/2018)

The exhibition's conceptualization, design, and production were developed as planned according to schedule. Nevertheless, there was a slight delay in the opening of the exhibition that was postponed until November. The reason being was that Action E6 is highly dependent on scientific results and this became available a few months later. Nevertheless, this delay had no impact on other actions of the project.

The second edition of the "Window to Science"(23/12/2021-30/06/2022)

Both the conceptual and museographic development of this final "Window to Science" and the opening to the public have been postponed until December 2021 due to the general delay of the scientific project, aggravated by the health restrictions due to the COVID-19 pandemic.The closure of several areas of the museum, visitors' capacity limitations, mobility restrictions, and the closing of perimeters of different locations, have had a direct effect on the production of this "Window to Science". The Parque de las Ciencias is an interactive museum that has been significantly affected by these circumstances. This delay in the completion of

action E6 has affected, partly to action D6, as the two Focus Groups that were planned to evaluate this "Window to Science" have had to be postponed to March 2022 (already made).

If relevant, changes in action and correspondence with the AGENCYapproving them
There has not been an important modification regarding the foreseen budget for the action.

Major problems/drawbacks, delays, including consequences for other actions
The most significant drawback has been the delay in the implementation of the two Focus Groups of action D6 to assess action E6.
Due to the delay in the opening of the “Window to Science” to December 2021, the technical assistance expenditure, initially foreseen for the public service expense, has not been totally executed. Instead of 4 months, only the December invoice could be allocated, therefore the technical assistance cost accounted for 74% of the budget for action E6.

Possible complementary action outside LIFE
To this end, the Parque de las Ciencias organised a communication strategy to raise awareness of the initial Window to Science. Before its inauguration in May 2017, the LIFE Adaptamed project was presented at two important public engagement events at the museum: the Science Fair, with a total number of 12,106 people visiting the project's stand, and the European Biodiversity Day, with an attendance of 2,231 visitors.

Perspectives for continuing the action after the end of the Project
The second Window to Science will continue to be exhibited to the public as part of the Museum's educational programme during 2022, after the end of the project. The cost associated with it will be financed by the Parque de las Ciencias.
The museographic design of the two Windows to Science, both the exhibition elements and the pedagogical and educational resources, can be installed in full or partially in other areas of the museum or exhibited in different locations such as schools, interpretation centres, or town halls.
Upon completion of this activity, all the educational resources and materials produced can be used in other activities. Some of the elements presented in the initial Window to Science were used in the micro exhibition (E7), in the meeting with scientists (E8), and even in the second Window to Science exhibition. Once the project ends, all the contents designed and produced will be useful and available to the rest of the partners to continue disseminating the main scientific results obtained and to raise public awareness of the importance of preserving the environment.


Visitors of the first Window to Science - E6


Visitors of the second Window to Science. E6

Visitors of the second Window to Science. E6

Comparison with the planned activity

The first Window to Science was exposed when planned. The Second Window to Science has suffered a delay, meaning that it was open during the last month of the project and it will be accessible to the public during the first six month after the project finished (Post-Life). However, that delay does not affect the effectiveness of the temporal exposition, meaning the double extension of this second window (planned for 3 months) an improve in the diffusion capacity of the action.

Was the objective reached? What reactions and feedback were obtained?

As both Windows to Science were open during the Christmas Holidays, when there is a large number of visitors at the Parque de las Ciencias, the diffusion capacity of action E6 has been higher than originally expected. The feedback from the public for the First Window was very positive (see action D6). The feedback from the second Window to Science, not available yet, is expected to be similar.

Milestones and deliverables:

The first milestone of this action, the opening of First Window to Science, was reached on time. The second milestone, the opening of the Second Window to Science, suffered a three month delay. No deliverable was expected from this action.

Other relevant Annexes:

See **Annex O10** with selected content and images of both Windows to Science (Selection of content and images Windows to Science).

Action E7 Travelling exhibition on climate change adaptation

Foreseen start date: 09/2017 **Actual start date:** 11/2018
Foreseen end date: 09/2019 **Actual (or anticipated) end date:** 12/2019

Activities undertaken and outputs achieved

The action carried out by the Parque de las Ciencias has been the design, content, and production of a small format, travelling micro-exhibition, which is temporarily loaned to educational centres to be exhibited in their premises.

Together with the panels of the exhibition, there are a series of activities described in a didactic guide, which complete this action. The proposed activities are to be carried out by a group of students who, under the guidance of a teacher, will be the ones to organise the exhibition to be presented to the rest of the school pupils and teachers.

The outcome has resulted in an exhibition consisting of 19 display panels with a detailed description in the educational guide, didactic material, models, eight brochures with different experimental activities that can be adapted to all educational levels and a critical thinking fanzine, describing several scenarios to be debated, including various games to complement this debate.

The tours of the travelling exhibition could not be conducted until the 2020-21 academic year due to the COVID-19 pandemic. The micro-exhibition was very well received by the educational centres that remained expectant. Since then, there have been 20 tours and we continue to receive an increasing number of requests from all over Andalusia.

Comparison with planned output and schedule

The outcome of this action has been very satisfying for all those involved, as the contents of the micro-exhibition cover general climate issues, analysis of current events, global and local actions of the Life Adaptamed Project, which are being carried out to mitigate the effects of the climate change in which we are immersed.

The main drawbacks that have caused a delay in the scheduled deadlines have been at an organisational level, as it was difficult to conciliate the work of those involved with the need for meetings to take decisions on the contents and design of the panels. There have been many changes in image, layout, and design content, from a first proposal at the beginning of the 2017-2018 academic year to its completion in February 2020.

If relevant, changes in action and correspondence with the AGENCY approving them

As it has been mentioned earlier, the main difficulties have been at an organisational level, in the definition of content and design, since to achieve the result, with which all the partners are very satisfied, many changes were necessary. These were not able to be carried out easily due to the difficulties in conciliating the work of the personnel involved in the project, with the need to reach agreements on the different issues.

Out of the 19 panels that make up the micro-exhibition, 6 show the contents of the actions of the Life Adaptamed Project and for the same reasons, there have been delays in the delivery, so that the completion of the action has also suffered delays that were overcome thanks to the extension of the project.

Another drawback was the layout and elaboration of the materials that were developed as a complement to the "Fanzine of critical thinking". There were some communications and understanding difficulties with the company that designed the micro-exhibition, with regards to the definition of the image and the materials that were to be produced.

The project envisaged the initial production of 2 copies of the micro-exhibition but, due to the excellent response from schools, it was agreed with the Coordination Team of the LIFE Adaptamed project to produce an additional copyNto give greater dissemination to the project. For this reason, the final expenditure of the "other expenses" cost category has been slightly higher accounting for 112% of the budget.

Major problems/drawbacks, delays, including consequences for other actions
There have not been major problems or drawbacks with consequences for other actions.

Possible complementary action outside LIFE

The micro-exhibition has been used to support the framework of activities related to the "Sustainable Development Goals (SDGs)" organised at the Museum and aimed at the general public, during Science Week in November 2020 and during the Researchers' Night in September 2021. At present, the micro-exhibition and its didactic workshops are also exhibited at the Museum to help raise awareness for the need to act to mitigate the effects of climate change.

Perspectives for continuing the action after the end of the project
Given the increasing number of requests for this micro-exhibition from schools, and considering that this subject will continue to be of interest for a long time to come, it will continue to travel to Andalusian schools for many more years as a museum's proposal.

Photos of the touring exhibition to several education centres (IES Montes Orientales, Iznalloz-Granada y el IES Bulyana de Pulianas-Granada)

Comparison with the planned activity

The only difference with the planned activity in relation to this action has to do with the impossibility of circulating the micro-exhibition among Andalusian schools during the pandemic, and with the difficulty for the centres to work with this material in the first year of face-to-face classes after the pandemic (2020-2021 academic year), when the health recommendations did not allow the joint work of students from different classes or courses, which constitutes one of the fundamental elements of the pedagogy of these materials, oriented towards peer work, with the students themselves being the ones who explain and facilitate the use of materials to other students in the centre. This has meant a delay in the use of materials by schools, which however during the 2021-2022 academic year are demanding them very intensely. It is expected that this demand will continue to exist in the coming school years, since the Life Adaptamed micro-exhibition is part of the requested micro-exhibition loan system of Parque de las Ciencias and there is a high demand for constructivist teaching materials to work on the complex concept of climate change.

Was the objective reached? What reactions and feedback were obtained?

The objective has been reached very satisfactorily. The two units of the microexhibition have travelled to 9 schools in the academic course 2020-2021 and it has been used by 3.600 students approximately. The third unit of the micro-exhibition has been visited by 16.866 people while it was exposed and facilitated through specific workshops held twice a day in the Parque de las Ciencias, between 19/12/2020-05/01/2021 and during April 2021. See other details of the impact of this action in **Annex O08** (Social impact of actions E6, E7, E8 and D6).

Milestones and deliverables

Deliverable for this action is included in **Annex D03** (Catalogue of the travelling exhibition on the project in the Science Museum - Parque de las Ciencias).

The milestone expected for this action, the opening of the travelling exhibition on climate change adaptation was expected for 15/09/2019 and was reached on 26/02/2020 in the Highschool ‘Bulyanas’ in Pulianas (Granada).

Other relevant Annexes

See **Annex O11** with examples of didactic and educational resources of the micro-exhibition.

Action E8- Meetings with scientists

Foreseen start date: 05/2021 **Actual start date:** 04/2021
Foreseen end date: 05/2021 **Actual (or anticipated) end date:** 04/2021

Activities undertaken and outputs achieved
With the occasion of celebrating "Earth Day" on 22 April 2021, an on-line meeting was held with scientists from the University of Granada and the Life Adaptamed project to talk about climate change and its effects. The meeting "The truth about climate change. The science that talks" was attended by more than 60 schools from all over Andalusia, through the Museum's digital communication channels.
This action E8 was initially scheduled to take place in September 2021, coinciding with the inauguration of the second edition of the "Window to Science" (action E6) but, due to the general delay in the development of the whole project, action E8 was held independently of E6, taking advantage of this international celebration of "Earth's Day".
In addition to the commitments of the Parque de las Ciencias with the LIFE Adaptamed project, following the second Focus Group, action D6, the Parque de las Ciencias organised a meeting with scientists in the IES Bulyana in the town of Pulianas (Granada) to evaluate action E7, which consisted of a scientific talk addressed to the students, that would complement the later work carried out with the micro-exhibition "Climate Change. Take it seriously and take action!"
In this session, the scientists explained to the students the actions that were being carried out in the Andalusian protected areas involved in the Life Adaptamed Project and listened to their curiosities and concerns, stressing the importance of sustainability and personal commitment.

Compare with planned output and time schedule
As it has been previously mentioned, the E8 action initially planned in the project has been postponed, mainly due to the overall delay of the project and the limitations of the pandemic, which led to renounce to the in-person nature of the action and instead it had to be carried out online. The results of the streaming format have been far superior to what was expected, as it has allowed having a greater reach than the in-person modality. The meeting with scientists has reached more than 60 schools throughout Andalusia, a number of school children that far exceeds the initially anticipated. It can be said that this change in planning has been very beneficial for the visibility and impact of the E8 action and the LIFE Adaptamed project.

Major problems/drawbacks, delays, including consequences for other actions
Due to the pandemic, it was decided that it was more convenient to hold the meeting with scientists online rather than in person. Consequently, this was reflected in the personnel cost of the staff involved in the event, which was lower than budgeted. Total expenditure amounted to 67% of the personnel budget forecasted for this action.
For other actions of the project, there were no problems or issues arising that entailed consequences.

Possible complementary action outside LIFE
This is a one-off action and does not require any further complementary action beyond hosting the micro-exhibition project on the dates following this scientific talk, preparing the activities and exhibiting them to the educational community, and even reaching out to schools in other neighbouring localities.

Perspectives for continuing the action after the end of the project
The results obtained from Action E8 will be applied to effectively engage people in content about climate change and other topics related to the project

Outline the perspectives for continuing the action after the end of the project
There is no perspective for continuing this action after the end of the project, although similar initiatives with the main concepts dealt with in Adaptamed will very likely happen during the past-Life period.

Comparison with the planned activity
This activity was designed to be face-to-face. However, due to the sanitary restrictions for the Covid pandemic the participation of the teachers and other attendees had to be on-line.

Was the objective reached? What reactions and feedback were obtained?
The objective was reached, with more participants than initially expected thanks to the retransmission of the event in streaming.
There were 1.132 reproductions in Youtube and the meeting was followed by 21.259 people through Facebook, Twitter and Instagram.

Milestones and deliverables:
The Milestone “Meeting with scientists and managers” expected for 30/06/2021 was reached in advance, on 22/04/2021, commemorating the Day of the Earth.
There is no deliverable in this action.

Action E9 LIFE ADAPTAMED website: dissemination, access to information and citizen science on climate change in Andalusia and the Mediterranean

Foreseen start date: 07/2015 **Actual start date:** 02/2016
Foreseen end date: 06/2016 **Actual (or anticipated) end date:** 12/2021

Activities undertaken and outputs achieved
The web page of the project is now fully available. This web site, that can be checked at www.lifeadaptamed.eu, contains detailed explanations about the project actions and also the main topics regarding climate change, ecosystem services and adaptive management, which are in fact the central themes on which the project hinges and which need to be explained to society. The web site contains all the relevant information regarding the project and its actions, including all the dissemination and communication materials edited to date. Furthermore, in the Life Adaptamed web site we include a link to Life Adaptamed Information System. This system is shared with the action C7 and includes important data as:

- Access to data contained at the local observatories.
- Geographical visualizers.
- Catalogue of available information and metadata repositories.
- Citizen science tools.

The web site is also linked to a blog where relevant news about the progress of the project actions is periodically published. The social networks of the project -Facebook and Twitter- are also accessible from the web site.
A media repository has also been developed, where many photographs organised by action, video files and other relevant documents have been included fully available for the visitors of the site.
We are now working on the English translation of the main contents of this site. This work wasn't previously considered in the proposal, but the Life Adaptamed management team considers that a two languages web site should lead to the amplification of its impact.

Comparison with planned output and time schedule
This action has accumulated some delay from the beginning of the project but with the latest updates it can be assumed that this action fully fits the expected results.

Major problems/drawbacks, delays, including consequences for other actions
The delays accumulated have been solved and no consequences for other actions should be taken into account.

Perspectives for continuing the action after the end of the project
The web site of the project will be maintained after the project by the coordinator beneficiary.

Comparison with the planned activity

All objectives have been met.

Was the objective reached? What reactions and feedback were obtained?
Yes, the Life Adaptamed web site is fully operative at this moment of the project and the objectives should be considered as reached.

Deliverable: Página Web LIFE ADAPTAMED: www.lifeadaptamed.eu

Milestones:
Beginning of the public functionality of the project website (30/06/2016; reached).

Action E10 Governance towards active management of CC in NPA

Foreseen start date: 07/2015 **Actual start date:** 06/2016
Foreseen end date: 06/2020 **Actual (or anticipated) end date:** 12/2021

Activities undertaken and outputs achieved

This action aimed to develop the governance model of the NPAs of the project to enhance climate change adaptation, by creating a thematic subgroup within the participation boards. In all of the sites, a first presentation of the project took place during a plenary session, which allowed to present the scope of the project while offering an overview of the programmed actions, including the goals and suggested methodology.

Once the terms of reference for these subgroups had been defined, the actual Participation boards identified the most suitable organs and candidates to take charge of this process. In Doñana, the Biodiversity Committee was appointed as the group in charge. In Sierra Nevada, although the task was initially assigned to the Biodiversity and Infraestructures Committee, for practical reasons, it was the Conservation and Research who finally took charge of it. In Cabo de Gata, due to the more limited resources and structure, the task was initially delayed, until it was assumed by the plenary sessions of the Participation Board (June 2018).

In all three cases, the appointed groups revised and validated the methodology and follow-up reports of the project. The feedback provided by these groups was integrated into a final strategic plan for each of the spaces. The plan for Doñana was presented and ratified in one of the anual plenary sessions. As for Sierra Nevada and Cabo de Gata, the plans were also sent to the Participation Boards presented in plenary.

The learnings and inputs of this process have been compiled in a manual of recommendations for good governance, which was officially presented at the closing symposium of the project.

During the event, a round-table engaged the directors of the parks and Board representatives in a discussion on how to improve governance mechanisms.

Furthermore, the participation boards have also contributed to disseminate the results and yearly progress of the project within the annual reports of the parks.

Comparison with planned output and time schedule

This action has achieved greater cohesion between the different stakeholders of the participation bodies, bringing together researchers, associations, private companies, park managers and many other relevant organisations. In this sense, important connections between professionals from different sectors have been developed. Furthermore, the climate change groups have enabled an important exchange of information, which have supported the cleaning activities of the irrigation channels in Sierra Nevada, as well as to avoid avifauna disturbance during the interventions (for example, during the nesting season), both in Doñana and Cabo de Gata. The inputs collected have allowed to produce the manual of recommendations for good governance, which built one of the highlights of the closing symposium.

However, the pandemic together with the lack of flexibility and response capacities of the participation boards have slowed down the process in a variety of ways. On one hand, the meetings had to be officially called by the boards. On the other, during the pandemic fewer meetings were organised (6 in Sierra Nevada, 5 in Doñana and 4 in Cabo de Gata). As a result, one strategic plan has already been presented and ratified, whereas the other two are waiting for the next plenary sessions. In this sense, the final symposium served as a reminder of the need to ratify these plans. Rather than establishing new formal groups, the parks and partners did their best to carry out the tasks by adapting to the existing structures.

Major problems/drawbacks and/or delays, including consequences for other actions
The protocolary proceedings established for the meetings of the Participation Boards in the Parks made it difficult for the person coordinating action E10 to contact their members. For this reason, the project actions were presented by the partners of the project working Parks (CAGPDS), while IUCN was responsible for the contact and coordination of the climate change groups.

Outline the perspectives for continuing the action after the end of the project.
The governance models and groups created through this action will continue working after the end of the project. Two strategic plans are expected to be ratified during the next plenary sessions. The formal establishment of official climate change commissions has been recommended and will continue to be pursued.

Was the objective reached? What reactions and feedback were obtained?
Yes, despite the little changes, we consider that the main objectives of the actions have been reached. The main goals achieved are: greater cohesion and coordination within the administration and between stakeholders and new cross-sectoral connections established, valuable exchange of information for conservation and land management.

Milestones:
Creación o responsabilización de los subgrupos de los Órganos de Participación de los tres ENP del proyecto (reached).
Aprobación del Plan Estratégico de Adaptación al cambio climático en cada uno de los tres ENP (reached).

Deliverables:
Strategic Plan for Adaptation to Climate Change of the three NPAs of the project (see **Annex D15**).

Other relevant Annexes:
Not applicable.

Action E11 Networking with other LIFE and non-LIFE projects

Foreseen start date: 07/2015 Actual start date: 08/2016
Foreseen end date: 06/2020 Actual end date: 12/2021

Activities undertaken and outputs achieved:
Information on other projects or initiatives linked to Adaptamed has been included in a database, which is permanently updated. UICN Med and the other project partners have published information about Life Project Adaptamed on their own websites. The biannual bulletin of the project has been sent to the more than 6.000 actual members of UICN Med, including the scientific committees in the institution.
Three types of activities have been carried out in this action by beneficiaries of the project:
1) Organization of meetings to exchange experiences and bring together people working in projects of similar interests, while inform other projects about Life Project Adaptamed.

- Organization of a Field visit to Sierra Nevada of the European Forest Communicator Network (UNECE/FAO). 27 experts belonging to the European Forest Communicators' Network (FCN) were informed about the Life Adaptamed project and they showed a great interest due to the differences to other ways to management forest in Europe.
- The annual meeting of the UNECE/FAO Team of Specialists on Forest Communication – the Forest Communicators' Network (FCN) took place from 30 May to 1 June 2017 in Málaga, Spain and was hosted by IUCN-Med. The programme included a field trip to Sierra Nevada in collaboration with the Life Adaptamed Coordinator team in order to show the actions undertaken under the Life Adaptamed project.
  Short summary of presentations and discussions here:
  https://www.unece.org/fileadmin/DAM/timber/meetings/20170530/2017-FCNAnnual_Meeting_Malaga-Report.pdf
  Video: https://www.youtube.com/watch?v=uOixNI3pF6k
  Photos: https://www.flickr.com/photos/121632478@N08/sets/72157684736857815
- Contact has been established with the Forest CO2 project, with whom a meeting in Granada was planned for April 2020 before the alarm for Covid-19 started. Finally the meeting was held on-line during all day on 08/07/2020. Given the complementarity of the work carried out in Forest CO2 and in Life Adaptamed, interesting possibilities for collaboration have arisen, especially with regard to the quantification of CO2 fixation in *Pinus halepensis* and *Pinus pine* forests pinaster. This has motivated the signature of a replicability agreement between Life Forest CO2 and Life Adaptamed that can be find in **Annex O12**.

2) Collaboration with other projects or initiatives:

- As a result of a close collaboration with the National Institute of Agricultural Research and Technology, it has been possible to take hemispherical stereoscopic images in the field plots, within the framework of actions A10 and D8, initially not foreseen in the project. The taking of images and the subsequent use of the software for their processing have been carried out free of charge and with the advice of the group responsible for their design and development (I.P. Fernando Montes), with whom a

meeting was held. They explained some details of the use of the device and free photographic and computer equipment was lent to us.

- Ecopotential (Improving future ecosystem benefits through earth observations, H2020 grant 641762). UAL, CSIC, AMAYA and University of Granada (UGR) are involved in this project.
- EU BON (Building the European Biodiversity Observation Network, FP7-ENVIRONMENT grant 308454). EBD-CSIC and Granada are involved in this project. EBD-CSIC is involved in the design of the information architecture which will be used in the European Biodiversity Portal. Doñana is a testing site in the EU BON project. This experience will be useful to support Action C.7 leaded by REDIAM Team (CAGPDS and AMAYA).
- LTER: Sierra Nevada, through UGR, is part of the Spanish LTER (Long Term Ecological Research) network (http://www.lter-spain.net). This network provides access to analytical tools, harmonised protocols, eco-informatic procedures to manage the information and is also a network of networks working on ecological monitoring. UGR has also participated in several EU projects such as eLTER (H2020 project aiming to vertebrate the European LTER network www.ltereurope.net/projects/eLTER).
- Eco-gradientes (Evaluación de los flujos de servicios de los ecosistemas en gradientes rural-urbanos: aplicabilidad a la planificación socio-ecológica del territorio). Socio-ecosystems laboratory, Universidad Autónoma de Madrid. Participation in workshop celebrated 20/05/2016, Granada. (AMAYA, Technical Coordination Team).
- We Value Nature workshop (Integration of natural capital in decision-making of the public and private sectors for climate resilience and biodiversity in Cabo de Gata-Níjar) hosted in the area of Cabo de Gata. This workshop encouraged local businesses to assess the value (economic, landscape values, etc) of natural resources within their business plans. 30 September 2020. (IUCN, cooperation with the Natural Capital Coalition, the World Business Council for Sustainable Development and Oppla.) Video with results: https://www.youtube.com/watch?v=yRfTcpYAZaA
- From the Marseille office of the Centre for Mediterranean Integration belonging to the World Bank, Life Adaptamed has been shortlisted to be included along with 9 other successful case studies in a publication called "Climate Change and Migration: Inspiring Practices from the Mediterranean", linked to the TRCC program (Territorial Resilience to Climate Change Program). For this, the IUCN partner has been contacted.
- Several telephone meetings and email exchanges have been held to participate in the drafting of the Update of the Andalusian Forest Plan, currently in the review phase.

3) Participation in meetings, workshops, conferences or congresses where Life Project Adaptamed has been presented, with no costs incurred:

- “Cairgorms Research Seminar”, organised by Europarc and Cairngorms National Park. Avimore, Scotland. 21-22 October 2015. (AMAYA, Technical Coordination Team).
- “Integración de la adaptación al cambio climático en la planificación y la gestión de las áreas protegidas en España”. Seminario del Plan Nacional de Adaptación al

Cambio Climático (PNACC). CENEAM, Valsaín, Segovia, Spain. 4-5 April 2016 (CAGPDS).

- Workshop "Learning landscape Partnerships-Research and Protected Areas Working better together" organised by Europarc. Aberdeen (Scotland) 22-24/08/2016. (AMAYA, Technical Coordination Team).
- "Jornada sobre adaptación al cambio climático en la provincia de Granada". 20/12/2017. Diputación de Granada, Granada, Spain. (CAGPDS and AMAYA, Life Adaptamed Management Team).
- Event on land custody by Association of Municipalities of Sierra de las Nieves and AMMA Almijara. "*Taller del Mapa de Potencialidades de Custodia del Territorio y Presentación: Biodiversidad antipandemias y generación de nichos de empleo a través de la Custodia del Territorio y la participación social en la Mancomunidad de Municipios Sierra de las Nieves*" 14 May 2021 (IUCN).
- Participation in the course "Ciencia en la vida cotidiana" organised by Parque de las Ciencias. Talk about "Espacios protegidos, espacios protectores: Adaptar para conservar ante el cambio climático", 17/02/2021 (AMAYA, Life Adaptamed Coordination Team)

4) Participation in meetings, workshops, conferences or congresses where Life Project Adaptamed has been presented, with costs incurred:

- "XIV Medecos & AEET meeting. Human driven scenarios for evolutionary and ecological changes". Seville, Spain. 31st January- 4th February 2017 (CSIC, UGR, UAL and Technical Coordination Team).
- "EU LIFE Platform meeting on Ecosystem Services. Costing the Earth? Translating the ecosystem services concept into practical decision making". Life Viva Grass. Tallin, Stonia. 10-12 May 2017.

5) A draft Database of initiative and projects related to climate change and adaptation management has been built: 58 national projects and 55 international projects have been identified with its contact details. Emails to contact them have been sent to all these contacts in order to inform about the LIFE Adaptamed project and explore potential info sharing.

6) A media trip to the pilot sites in Sierra Nevada and Cabo de Gata, which allowed journalists from national and local media to learn more about the technical aspects and impacts of the project actions, as well as to interview the directors of the natural parks. The trip was attended by 12 journalists and led to the publication of articles on more than 14 media outlets (EFEverde, El País, El Diario.es, ABC, Diario Ideal Granada, Revista Foresta, La Verdad de Murcia, Granada Hoy, El Diario de Almería, Málaga Hoy, Agencia SINC and two interviews on TV (Movistar and Canal Sur TV). 10-11 November 2021 (IUCN)

7) An exchange of knowledge during the closing symposium (E5), which saw the active participation projects working on climate change adaptation, such as LIFE Shara, LIFE Climark, LIFE MidMacc, LIFE Soria Forestadapt, LifeWatch ERIC, H2020 ReNature (Malta) and ADAPT- Nature-based Solutions in the Western Balkans (IUCN ESARO Balkans).

Comparison with planned output and time schedule
The actions undertaken have followed the planned schedule.

Outline the perspectives for continuing the action after the end of the project.
The contacts established have allowed to strengthen bonds, work to develop new project proposals and create transnational and transregional networks working on similar topics that will help to sustain the actions beyond the project.

Comparison with the planned activity
Although in the approved Project an intense travel activity by the Project Management Team (CAGPDS and AMAYA) was expected during the last year to disseminate the results obtained, due to the limitations to face-to-face activities caused by the health crisis hardly any trips or face-to-face events have been carried out in this period. This has caused the entire budget planned for trips and diets not to be spent on this action.

Was the objective reached? What reactions and feedback were obtained?
Yes, all the relationships that this action has favoured have been very fruitful and will probably have an extension once the project is finished.

Milestones and deliverables:
Not expected.

Other relevant annexes:
Annex O12: Replicability agreement signed between Life Forest CO2 and Life Adaptamed.
Annex O13: Compilation of Networking, where some programmes for workshops or events where Life Adaptamed has participated have been included.

Action E12. information panels on the project

Foreseen start date: 01/2016 Actual start date: 12/2017
Foreseen end date: 06/2020 Actual (or anticipated) end date: 11/2019

Activities undertaken and outputs achieved
Fifteen field posters have been made using eight different designs. These designs have been carefully produced to reflect the main concepts that frame the Life Adaptamed Project. The posters highlight the main ecosystem services that each ecosystem provides. This work is very important from the point of view of the dissemination of the results of the project because it is the first time in Andalusia that field posters are designed and installed where they talk specifically about ecosystem services. These infographics are also being used for other aspects related to the dissemination and communication of the project, which imply an optimization of efforts.
5 of these posters have been installed at Doñana (2 related to the action C1, 2 related to action C2, and another 1 attending booths actions), 6 at Sierra Nevada (2 related to action C5, 2 related to action C1 and 2 related to action C6) and, finally, 4 posters have been displayed in Cabo de Gata (2 related to action C3 and 2 related action C4).
This action has been fully implemented by the Beneficiary coordinator, CAGPDS. AMAyA has also been implicated in this action through an advisory role implemented from the technical coordination, Action F1. Scientific advisory board of the project have been also involved in this task through the definition of key concepts that have been finally included in the designs.

Comparison with planned output and time schedule
This action was expected in the beginning of the second semester of the project and, following the schedule, it has been active until the end of the project. The first panel was disposed at field during the first half of 2017, and this implies some delay.

If relevant, changes in action and correspondence with the AGENCY approving them
No significant modification has been made. The unique modification consists in the improvement of the action because initially we have planned a less complex design focused on a brief description of the field works and actions. Currently, the designed panels include more detailed messages about the main topics involved in the project. A set of infographics have also been designed and used in these posters. They have great potential to be disseminated through additional communication actions and tools of the project.

Major problems/drawbacks, delays, including consequences for other actions
No problems or drawbacks have been achieved. The slight delay should be justified with a remarkable delay in the implementation of the majority of central actions (please see actions C1, C2 and C6). We have considered that the best strategy was to link the implementation of each central action to the installation of the corresponding poster at the field.

Complementary action outside LIFE
We have tried to allow an appropriate coordination between this action and the different initiatives in relation to the public use of the Natural Protected Areas. This is not only attending to the messages included in the posters, but also to the location of each poster at the

field. This coordination contributes to highlight the visibility of the posters because they are situated close to the action sites but in areas with the maximum number of visitors.

Outline the perspectives for continuing the action after the end of the project
The posters are now part of the communication strategy of the Natural Protected Areas at the field, so they will be maintained in the future. Once the project is finished, these posters will continue doing their work and communicating essential concepts about climate change adaptation and ecosystem services.

Comparison with the planned activity
All the posters have been designed and installed. The quality of contents exceeded the initially planned.

Was the objective reached? What reactions and feedback were obtained?
Yes, the objective should be considered as completely reached. The main feedback obtained came from the park's visitors who are grateful to enjoy such visual and concise messages about a complex project like Life Adaptamed.

Milestones and deliverables:
No.

Other relevant Annexes:
Information panels on the project (**Annex O14**)

One of the posters located at Sierra Nevada National Park, in association with action C5.

Action E13 Layman report

Foreseen start date: last semester 2021 | Actual start date: 10/2021
Foreseen end date: last semester 2021 | Actual (or anticipated) end date: 12/2021

Activities undertaken and outputs achieved:
A Layman's report of the project was produced in paper and digital format with versions in English and Spanish. It specifies the objectives, actions and results of the project, with the aim of disseminating this content among the general public.

Comparison with planned output and time schedule:
Rescheduling of some events and other obstacles linked to the pandemic led to some delays at the end of the project. For this reason, the work to produce and deliver the report was delayed to the beginning of 2022.

If relevant, changes in action and correspondence with the AGENCY approving them Nothing to add.

Major problems/drawbacks and/or delays, including consequences for other actions:
Medical conditions experienced by some of the project staff due to pandemic

Outline the perspectives for continuing the action after the end of the project.
Copies of the Layman report delivered to all project partners to ensure further dissemination.

Comparison with the planned activity
The initial planning has been 100% fulfilled.

Was the objective reached? What reactions and feedback were obtained?
The objective has been fully met and the result of the generated document has been very satisfactory.

Milestones:
Distribución del informe Layman: started in April 2022.

Deliverables:
Layman Report of the LIFE ADAPTAMED project. See **Annex D18**.

Other relevant Annexes:
None.

Action F1 Project management: CAGPDS and AMAYA

Foreseen start date: 07/2015 Actual start date: 10/2015
Foreseen end date: 06/2020 Actual end date: 04/2022

Activities undertaken and outputs achieved.
The Project Management Team is structured as follows:
Project Director: Francisco Javier Cano-Manuel León, civil servant in the Regional Ministry of Agriculture, Livestock, Fisheries and Sustainable Development (CAGPDS). See Project Director Designation in MTR- Annex F1.4.
Project Coordination Team: Rut Aspizua Cantón and José Miguel Barea Azcón, both technicians in AMAYA.
Financial Coordination: Ignacio Maldonado Lozano (2015-2017) Jorgina Acevedo Puga (2016-04/2018), Jorge Alcaina Nuñez (04/2018-12/2021) and José Luis Artacho (06/2018-12/2021), all of them technicians in AMAYA.

Kick-off-meeting
It was attended by the Project Coordination Team in Brussels on 11/06/2015.

Monitoring missions with NEEMO:
1st Monitoring mission: Sierra Nevada, Granada (March 2016)
2nd Monitoring mission: Sierra Nevada, Granada (May 2017)
3rd Monitoring mission: Cabo de Gata, Almería (May 2018)
4th Monitoring mission: Doñana, Sevilla y Huelva (March 2019)
5th Monitoring mission: online for pandemic restrictions (June 2020)
6th Monitoring mission: online for sanitary recommendations (May 2021)
7th Monitoring mission: Doñana, Huelva (December 2021)

Scientific Committees:
They have been held once a year, as expected in the project, or even more often in the last two years of the project:
1stScientific Committee: Fuente de Piedra, Málaga (October 2015)
2ndScientific Committee: Sierra Nevada, Granada (March 2016)
3rdScientific Committee: Rodalquilar, Almería (March 2017)
4th Scientific Committee: CIMAS Symposium, Granada (March 2018)
5th Scientific Committee: Sierra Nevada, Granada (October 2019).
6th Scientific Committee: online (May 2020).
7th Scientific Committee: online (November 2020)
8th Scientific Committee:online (March 2021)
9th Scientific Committee:online (September 2021)

Other frequent meetings:

37more in-person meetings among beneficiaries of Life Project Adaptamed, promoted and coordinated by the Project Management Team were held on 11/11/2015 (Fuente de Piedra), 17/11/2015 (Granada), 18/11/2015 (Málaga), 20/11/2015 (Sevilla), 02/12/2015 (Sierra Nevada), 10/02/2016 (Granada), 11/02/2016 (Sevilla), 16/02/2016 (Sevilla), 11/04/2016 (Almería), 12/04/2016 (Sierra Nevada), 03/05/2016 (Doñana), 09/05/2016 (Sevilla), 10/06/2016 (Granada), 16/06/2016 (Almería), 14/09/2016 (Granada), 21/02/2017 (Sevilla),

03/02/2017 (Granada), 21/02/2017 (Sevilla), 09-10/03/2017 (Doñana), 24/03/2017 (Málaga), 06/04/2017 (Granada), 19/04/2017 (Granada), 22/06/2017 (Granada), 05/07/2017 (Sevilla), 14/09/2017 (Granada), 06/11/2017 (Sevilla), 29/11/2017 (Sevilla), 05/12/2017 (Granada), 09/03/2018 (Granada), 03/04/2018 (Sierra Nevada, Granada), 01/10/2018 (Sevilla), 08/10/2018 (Sevilla), 15/11/2018 (Fuente de Piedra, Málaga), 21/11/2018 (Fuente de Piedra, Málaga), 22/01/2019 (Parque de las Ciencias, Granada), 23/01/2019 (Granada), 31/01/2019 (Granada).

During 2020 and 2021 all the meetings have been held online. Before the pandemic caused by Covid-19 most meetings were in person, with only a few online meetings. After overcoming the initial difficulties involved and getting used to them, the greater agility and flexibility they allow, together with the optimization of costs and time, led them to remain as a priority format even after the confinement was over and in person meetings were again allowed.

Comparison with planned output and time schedule.

The Steering committees and Monitoring missions have been held with the planned periodicity. The Project Management Team has worked closely with all the partners, trying to identify and address problems that may occur during the project. The large number of actions included in the project, most of them being actions shared among several beneficiaries, has required the need for continuous agreement and collaboration by different beneficiaries responsible for the same actions, with frequent meetings promoted and coordinated by the Adaptamed Management Team. The coordination effort, as can be seen, has been important. Proximity and green procedure criteria have been considered, especially in the final phase of the project when most meetings have been held in telematic format.

Action F2 Scientific coordination and coordination in connection with REDIAM and knowledge transfer to decision makers

Foreseen start date:09/2015 **Actual start date:** 11/2015
Foreseen end date:03/2020 **Actual (or anticipated) end date:** 12/2021

Activities undertaken and outputs achieved:
We have established a framework of permanent collaboration between researchers and managers of REDIAM. As opposed to the traditional management characterised by a lack of monitoring, we have opted for "adaptive management" based on follow-up of actions in order to evaluate the effects of a treatment submitted to testing. In collaboration with REDIAM we have developed the information system and the data management plan. The DMP is a tool that facilitates the control and management of research data.

Comparison with planned output and time schedule:
The permanent collaboration between researchers and managers of the REDIAM was established according to planned, from the beginning to the end of the project.

If relevant, changes in action and correspondence with the AGENCY approving them
No modification should be highlighted.

Major problems/drawbacks and/or delays, including consequences for other actions:
No problems or drawbacks must be notified and, thus, no consequences for other actions have been detected.

Complementary action outside LIFE
Outside the scope of the Life Adaptamed project, a multitude of complementary actions have been developed with a complementary framework with action F2. Most of them related to the gathering of scientific knowledge within the framework of research projects. The best example of this are the projects framed within the LifeWatch platform in which the research centres and groups responsible for the scientific tasks in Life Adaptamed actively participate. For example, LifeWatch Smart Ecomountains collects useful ecological information in Sierra Nevada and is led by the University of Granada itself (partner responsible for the D3 action). In addition, the network of Global Change Observatories in Andalusia is a complementary initiative to Life Adaptamed in the which is being worked on in a complementary way to the actions of this Life project.

Perspectives for continuing the action after the end of the project:
The adaptative model, and the information system initiated in Life Adaptamed will be continued under the umbrella of the Global Change Observatory of Sierra Nevada.

Milestones and deliverables:
Report on the status of indicators (**Annex D20**).

Action F3 Indicators monitoring

Status of the action:

Foreseen start date: 07/2015 Actual start date: 12/2016
Foreseen end date: 03/2020 Actual end date:12/2021

Activities undertaken and outputs achieved

Within the ***progress performance indicators*** defined in the approved proposal, two different types of indicators were defined: the *project progress indicators* and the *project effectiveness indicators*. All of them have been revised and updated frequently since the beginning of the project, and are fully completed in the Report about the State of the Indicators (see **Annex D20**).

Project progress indicators are related to the efficiency of the proposed activities (central actions) and their degree of implementation. Several indicators of progress related to the main actions of Life Adaptamed are defined by their efficiency (% of implementation according to the initial plan) in a given temporal step, including the units used to measure them (ha, number/ha, m, etc.). This set of indicators has been updated for all the central actions with impact in the target ecosystems before each one of the Monitoring Missions. The final version of the project progress indicators, reflecting the final situation of the project, can be found in **Annex D20.**

Project effectiveness indicators assess whether the technical actions carried out by the project have a quantifiable and positive impact on the functioning of target ecosystems. For this purpose, field monitoring (Action A10) and landscape assessment (Action A9) were accomplished, aimed to characterise the ecosystem situation, in terms of ecosystem services, prior to the main actions. Once the central actions were completely implemented, this same field and landscape monitoring has been repeated (Actions D7 and D8) and the information obtained has been used to calculate the project effectiveness indicators set. In **Annex D20** the final version of this set of indicators can be found.

In all the cases, the technical coordination team has adjusted and filled in the different indicators set, based on their own information and on other information provided by the other members of the project, mainly the three scientific entities (EBD-CSIC, UGR and UAL), but also by AMAYA, UICN and Parque de las Ciencias.

Comparison with planned output and time schedule

This action has been carried out according to planned schedule.

Milestones and deliverables

Two milestones were envisaged under this action: one for 01/2017 and the other one for 30/11/2021. The revision and update of the performance indicators was completed in advance, during the second trimester of 2016, despite that this task was envisaged to 1/2017. The last expected milestone, the delivery of the final report with the definitive indicator performance annex, is fulfilled with this FnR (see **Annex D20**).

Action F4 Post-Life Plan

Foreseen start date: 12/2020 Actual start date: 12/2021
Foreseen end date: 12/2020 Actual (or anticipated) end date: 12/2021

Activities undertaken and outputs achieved

This action has consisted of the preparation of two documents: a "Post Life Plan" which points out the continuity of the spreading and the communication of the results after the end of the project, and the "Strategy for strategy for the future sustainability of Life Adaptamed". The first document establishes 11 subsequent actions to those carried out during the elaboration of the project, and two new measures. For every measure, the involved partners and the commitments made to guarantee the future continuity of Life Adaptamed, are explained in detail. The strategy to improve the future sustainability of Life Adaptamed establishes 7 specific actions framed in 3 strategic mechanisms, which aim to transfer the results of the project to a real management scale. In those sustainability actions the specific agreements that each partner acquires are defined, as well as the financing sources foreseen for their implementation.

The action has been conducted by the project Director of Life Adaptamed -CAGPDS- with technical support from the partner AMAYA. All the Beneficiaries of the project have participated in the elaboration of the measures that affect them and in the commitment of the required future implementation.

Comparison with planned output and time schedule:

There have not been any relevant circumstances. This action has been developed according to what was planned and with the expected deliverables.

Major problems/drawbacks and/or delays, including consequences for other actions:

None.

Outline the perspectives for continuing the action after the end of the project:

The activities reflected in the *Post Life report* and in the *Strategy to improve the future sustainability of Life Adaptamed* have been designed to facilitate the continuity of Life Adaptamed in the short, medium and long term. Therefore, the very content of these documents develops the perspectives of continuity of this action in particular and of the project as a whole.

Deliverables:

Design of a strategy to improve the future sustainability of LIFE ADAPTAMED (See **Annex D17**).

Post-LIFE plan of the project (See **Annex D21**).

Other relevant Annexes:

None.

6.2.Main deviations, problems and corrective actions implemented

The main problems or difficulties encountered on the project have been:

Administrative delays

Actions C1, C2 (sub-action 2) and C6

The works included in these actions rely on external assistance and have required a long and complex open tender procurement process to be carried out by the Coordinating Beneficiary. No particular problems occurred during the procurement process, which length was underestimated in the approved proposal. Also, the Spanish public procedure for public open contracts has been hardened during recent years In short, the three work projects were launched between June and December 2016 (deliverables for Action A8). On 28/03/2018 the three contracts for the implementation of works corresponding to Actions C1, C2 (sub-action C2) and C6 were signed by the three contracting companies.

The impact of these delays has had important consequences for other Actions, especially for those Actions designed to assess the effectiveness of the central Actions (Actions D7 and D8) and those Actions designed to publish the results of this assessment with recommendations for best practices (Manuals in Action E1, second Window to Science in Action E6 and Symposium in Action E5). In order to maintain the objectives of these actions, an extension of 18 months was requested and approved by the AGENCY. Thanks to this extension, the delay of Actions C1, C2 and C6 has had no significant negative effect on any of the project actions nor in the achievement of objectives in Life Adaptamed.

Actions A2 and C2 (sub-actions 1 and 3)

The mapping of the *P. cinnamomi* distribution in the study area (a variable needed for the proper selection of 200 cork oaks for treatment) is one of the outcomes of this preparatory action, yet it depends on the subcontracting of a specialised laboratory. The initial plan was for this procedure to be completed by summer 2016. Due to administrative delays and unforeseen regulatory barriers with the use of phosphonates, it is not yet complete, and the subcontracting procedure will not be completed until (at least) June 2018. At this time, there is no approval for the use of the chemical product in this type of application, although it is approved to be used in agriculture. Unless that situation changes and some approval is soon obtained for experimental purposes, this sub-action will have to be suspended or exchanged by some other alternative that will foster the similar objectives for the action. Different alternatives are being evaluated by the responsible beneficiaries at the moment.

Action C3

The permissions regarding land availability needed for the digging of the monitoring wells expected in this action were delayed. Several meetings were held with the Almería City Council technicians and Regional Water decision-makers. Some months later, the permissions were finally granted by the land owners (Almería/Carboneras City Council) and the contracting company was selected for the digging of the wells. Therefore, the part of the action dealing with the wells was implemented in 2018. The other tasks included in Action C3 were satisfactorily implemented. The delay in the planned timeline with the wells had no impact on other project actions.

Actions A10 and D8

Due to the delay in the implementation of the central actions, the calendar of the ex-ante (A10) and post (D8) monitoring actions at the field scale was modified. This change has also

involved an economic imbalance of both actions. In other words, action A10 finished later than expected and required a greater amount of human and financial resources (see below, financial and organisational problems), while action D8 started later and required fewer resources. One action is a continuation of the other. This circumstance has had the negative consequence that less effort has been devoted to ecological monitoring after the implementation of management actions and the positive counterpart that ex-ante monitoring actions have been reinforced. In the general context of the project, this change should be positively valued because the time for the initially planned follow-up was excessively short and this involves problems when it comes to having a sufficient sample size to infer adequately comparable results. The shorter time invested in subsequent monitoring (action D8) should not be considered a major problem since in any case the slowness with which natural ecosystems evolve means that a significant part of the results will be recorded in the post-Life stage and one more year of data would not have meant a substantial change.

Financial problems:

Action A8

The development of the three work projects was more complex than previously expected. Many project beneficiaries had to agree on the details for the implementation of the actions included in the projects: EBD-CSIC, CAGPDS and AMAYA in Doñana; UAL, CAGPDS and AMAyA in Cabo de Gata; and UGR, CAGPDS and AMAyA in Sierra Nevada. In addition, the first draft of the project plans exceeded the expected budget. Therefore, a design modification was needed for all plans, with a subsequent new agreement between all partners, to adjust the project budgets to the amount provided in the Adaptamed approved proposal for Actions C1, C2 and C6. As a result, Action A8 needed more time, and subsequently more budget, than expected (23,017.31€ in total, compared to the initial proposal of 9,450 €). We can consider that thanks to this improvement in Action A8, actions C1, C2 and C6 have been more efficient. The delay in the schedule meant a delay in the beginning of the award proceedings for Actions C1, C2 and C6. Together with the delay incurred in the award proceedings for these Actions, the only realistic measure that could be taken to overcome this problem while still ensuring the maintenance of the project objectives, was to have an extension of 18 months, as was granted. In relation to the increased costs in action A8, the partner that has assumed that task has been AMAYA.

Financial and organisational problems

Action A10

The time needed to define a common methodology intended to evaluate the state of the target ecosystems prior to the implementation of central actions C1-C6 was longer than had been expected in the approved project proposal. The selection of parameters linked to ecosystem function was a new approach that has required significant dedication from the beneficiaries responsible for this action. The design process for the monitoring protocols shared among the three N.P.A. was long and complicated due to the many actors responsible for them and the data already existing in all three N.P.A., which was taken into account in order to have a long data series for comparisons. But at the same time, the data gathering has had to be refocused to satisfy the project objectives (services-approach). The set of indicators had to be shared for the three N.P.A and had to be able to quantify carbon balance, energy balance, water balance and biodiversity prior to the implementation of the central actions. Also, the adjustment of new methodologies has required more field visits than previously expected. As for Doñana, there have been difficulties in the administrative procedures required to employ two people as additional staff for the tasks associated with Actions A10 and D8 by Coordinating

Beneficiary. This has forced EBD-CSIC themselves to assume all the tasks to be completed in Action A10 in Doñana, although in the originally approved proposal, both CAGPDS and EBD were responsible for these tasks. Otherwise, the data previously obtained by the monitoring of central actions would have been lost for the Adaptamed Project.
In addition, the forest fire that occurred in Doñana in June 2017 burned three out of the nine selected plots when the task included in Action A10 (the ex-ante field monitoring) had already been completed by EBD-CSIC. After the fire, the three burned plots were relocated to new similar areas and the field inventories were repeated in the three new plots, with an inevitable extra cost. Because of all these reasons, this action has required a high level of effort and its cost has largely exceeded the initial forecast.
As **Action D8** is the natural continuation of Action A10, and the effort invested in the homogenization of methodologies and in the optimization of the field sample protocols has resulted in an optimization of costs for Action D8, no exceptional measures have been needed for this Action in Cabo de Gata and Sierra Nevada, except for a cost re-allocation between Actions D8 and A10 by moving part of the budget allocated to Action D8 to Action A10 (always maintaining the same cost categories and beneficiaries). In Doñana, however, the solution is different. The only administrative procedure that would allow the hiring of two people for Actions A10 and D8 as external assistance does not guarantee the expertise needed for these two people due to the administrative procedure applicable for a public body. These two people would need to be non-permanent-public servants and the procedure does not allow the required guarantees in terms of background, education and expertise in field monitoring. Therefore, in order to ensure that the project objectives are maintained, the best possible solution is a budget reallocation from CAGPDS (now CAGPDS) to EBD-CSIC, for personnel costs and associated resources in such a way that the same team responsible for the tasks already carried out in Action A10 can be responsible for the tasks implemented in Action D8. This was reported to the AGENCY in a specific e-mail and was included in the application for a Substantial Modification where total budget was respected as well as the rules of subcontracting and 2%.

6.3.Evaluation of Project Implementation

Methodology applied

Regarding the procedure used in the project in relation to the central actions, a clear lesson learned from the project is that those works subject to an open public tendering procedure due to their amount require an excessively long time for their implementation, which does not allow for their subsequent evaluation or any other type of work to be carried out after their execution and over a prolonged period of time. On the other hand, if what is desired is to involve the local population or other social actors in both the design and implementation phases of the actions, smaller works that can either be carried out directly by project partners (as has been the case for actions C3, C4 and C5) or that can be contracted through another more agile contracting formula, will give better results. In practice, the flexibility allowed by less ambitious works carried out directly by project beneficiaries has made possible a greater adaptation to the needs of local actors, allowing for highly satisfactory results. This was the case for action C3, in the work carried out in on the jujube trees to conserve the population, to get to know the level of the aquifer from which it feeds through the installation of monitored boreholes and the enhancement of the value of the community of entomofauna accompanying the jujube tree for its important role in the biological fight against pests, something very useful for the agricultural producers in the area for whom Life Adaptamed has changed the perception of the importance of the species in their environment. In action C4 the construction of dry stone walls has been carried out in accordance with the traditional techniques used in the area since ancient times. Similarly, the enthusiastic participation of the irrigation community of the Bérchules irrigation channel (‘acequia de careo’) in the tasks of repairing this channel in action C5, thanks to the fact that the flexibility allowed by the action has made it possible to take into account the ancestral experience of the irrigators in the design of the work to be carried out, both in the selection of the sites for action and in the design of the techniques to be used. In this way, in addition to optimising the execution of the action and maximising its usefulness, as has been shown in several press reports based on interviews with the users of the irrigation channel, its maintenance is practically assured. Indeed, thanks to the enormous usefulness for this irrigation community of the fact that the irrigation ditch is now functioning properly, and given the limited maintenance work required once the ditch is operational compared to the works implemented, it is foreseeable that maintenance will continue to be carried out in the Post-Life and beyond by the main users of the irrigation ditch. In this sense, it is essential to count on the knowledge and experience of the local actors and users of the territory in the design of the actions and, if possible, also in their execution or in the supervision of their implementation.

All the central actions subject to construction projects (Actions C1, C2 and C6) have been carried out correctly and in accordance with the approved projects, with the sole exception of the planting of *Pinus sylvestris* subsp. *Nevadensis*, which was not carried out in Sierra Nevada for the reasons explained above. In the case of these actions, the most methodologically complex phase was the actual design of the actions reflected in the works projects (Action D8), which included very novel and complex experimental designs due to the great level of detail required for their execution, ensuring that they were defined at a management scale but would subsequently provide valid knowledge from a scientific point of view, which requires homogeneity, repetition and replicability from the design itself. In general, they have involved the combination of multiple variations in the form of implementation of the work, combining different technical alternatives in small portions of terrain, defined with a high level of detail and often supported by non-natural elements of the terrain (to optimise the number of pixels

of the satellite images to be used for the subsequent analysis of the effectiveness of the actions). This has undoubtedly meant added complexity for the companies that have implemented the works, and therefore also for the people responsible for their supervision: CAGPDS technicians and managers, CAGPDS rangers and project beneficiaries responsible for subsequent monitoring in the field, such as AMAYA and EBD-CSIC, who have also closely supervised the execution of the works in the field to avoid mistakes being made that would make it difficult or impossible to subsequently obtain the conclusions sought with regard to the effectiveness of the actions in terms of conservation and improvement of ecosystem services. In summary, despite the enormous complexity of the actions involved, the satisfaction with their implementation has been very high. However, it should also be mentioned that, once the projects were approved and the works started, there could be no degree of freedom when implementing the actions, which limits the execution and does not allow learning from the process as it goes along to make any small modifications that could improve the implementation, nor to take into account the local actors to adapt the actions to their needs once the projects have been designed and the works have been awarded.
With regard to the dissemination, environmental education and environmental volunteering actions, we consider that they have been one of the greatest achievements of the project. The partner organisations that have participated in the implementation of these actions and the contracted companies already had a long track record and extensive experience in this type of work, which has undoubtedly contributed to the success of the results. In this sense, the methodologies implemented in the project in this type of actions had already proven their effectiveness in the past. For example, for the implementation of the volunteer camps of action E3, companies with extensive experience in the organisation of this type of activities and with a large implantation in the territory have been hired. The teaching materials developed in action E4 were designed with a very constructivist approach, in which students play an active role and carry out meaningful activities clearly linked to their reality and daily experience. Something similar happened with actions E6 and E7, in whose format the partner Parque de las Ciencias already had extensive experience both in travelling micro-exhibitions and in other Windows to Science. For this reason, the methodology used, which sought an active role for visitors to the exhibitions, has been a great success. Specifically, the experimental activities included in the travelling micro-exhibition aimed ‘understanding by doing’ the complex physical processes that interact as the origin and consequence of CC have been based on the experience that this partner has in organising experimental workshops with children every year, both during the school year and during the summer holidays (‘Summer with Science’). On the other hand, the enormous demand for participation by society in issues related to nature conservation and adaptation to CC, as well as the scarcity of innovative and experimental materials to address CC from the perspective of environmental education, have contributed to the enormous acceptance of these actions by society.

In the next chart the **results achieved** are compared against the objectives and expected results foreseen in the proposal:

ACTION		FORESEEN IN THE REVISED PROPOSAL	ACHIEVED	EVALUATION
A.1	PREPARATORY ACTION IN PINE TREES	OBJECTIVES: Review of technical reports, past works and existing data related to the areas and ecosystems to be subject to the work of Action C1 in selecting the most appropriate locations and techniques EXPECTED RESULTS: Report with optimal locations and technical prescriptions for the most effective implementation of Action C1	100%	The report with the technical requirements and optimal locations for the most effective thinning of pine woods in Doñana, Sierra Nevada and Cabo de Gata was prepared in collaboration with scientists and managers in the three N.P.A (Annex A1.1 in PR 1)
A.2	PREPARATORY ACTION IN CORK OAK TREES (DOÑANA)	OBJECTIVES: Prepare the restoration actions foreseen in C2 (Mediterranean forest regeneration). Identify monitoring indicators EXPECTED RESULTS: Identify the best methods and locations to execute the C2 Action.	100% Cartography was prepared (drafts) Monitoring indicators were chosen Two Reports were prepared (restoration plots and cork oak treatment) including 24 bibliographic references, photographs of cork oaks, data base on research projects, previous management actions and land-use planning Nº Expte. 573/09/M/00	Adjustments were necessary afterwards adapting the initial proposals for Action C.2, due to financial adjustment, technical requirements for remote sensing tasks, environmental requirements related with cork oak treatments.
A.3	PREPARATORY ACTION IN *ZIZIPHUS LOTUS* (CABO DE GATA)	OBJECTIVES: Collect and generate relevant technical-scientific information to execute Action C3 in the most appropriate locations and in the most effective manner EXPECTED RESULTS: Preliminary study on the Torregarcía/Amoladeras /Rambla Morales aquifer, preliminary study on the defoliating on *Ziziphus lotus* in relation to water availability, age and distribution characterization of Z. lotus and spatial aggregation of Agave spp.	100%	The results of this action are considered largely achieved according to the content of the report included in Annex A3.1 included in PR1.
A.4	PREPARATORY ACTION TRADITIONAL TILLAGE (CABO DE GATA)	OBJECTIVES: To identify optimal locations and best technical requirements for the most effective implementation of Action C4 EXPECTED RESULTS: Mapping of best locations, technical report with a description of the intervention to be implemented and soil indicators to measure its effectiveness	100%	The results of this action are considered achieved according to the content of the report included in Annex A4.1 included in PR1.
A.5	PREPARATORY ACTION SCRUBLAND RESTORATION (SIERRA NEVADA)	OBJECTIVES: Identify optimal locations and best technical prescriptions for the most effective implementation of Action C5 EXPECTED RESULTS: Review of scientific and technical information available on *Juniperus communis* restoration in high mountain, including technical specifications and optimal locations (biophysical conditions and microtopography)	100%	Although there has been a change implemented in the methodology, the results of this action are considered largely achieved according to information in Annexes A5.1, A5.2, A5.3 and A5.4 included in Midterm Report.

ACTION		FORESEEN IN THE REVISED PROPOSAL	ACHIEVED	EVALUATION
A.6	PREPARATORY ACTION FOREST PESTS (SIERRA NEVADA)	OBJECTIVES: To study the effect of forest plague insects, whose functioning is affected by CC, on the resilience of oaks and pine forests. It includes literature review and field monitoring during 6 campaigns (3 years) EXPECTED RESULTS: Management recommendations for oak and pine forests to decrease their vulnerability to pests in a scenario of CC	*Field effort on Oaks: 133% (4 years instead of 3 and increase in the number of plots) *Effort on pines shifted from field (0%) to a more intense literature review.	Oak forests: 4-year monitoring, 8 campaigns (4 plots for holm oaks and 8 for Pyrenean oaks, 8 campaigns during 4 years: spring and autumn 2016, 2017, 2018 and 2019). Pine forests: no effort in field, intense literature review instead.
A.7	PREPARATORY ACTION PARTICIPATION LOCAL COMMUNITIES	OBJECTIVES: To provide information on the project actions to farming and agricultural communities to ensure proper implementation. EXPECTED RESULTS: At least 100 farmers and 30 irrigators took part to the meetings. 4 surveys carried after meetings. At least 200 stakeholders answered the questionnaire 4 sectoral action plans drafted and ratified	70 participants in total took part in the meetings, extending participation to a wider variety of actors. Involvement of local population in actions (restoration of careo irrigation channels in S. Nevada) and management of conflicts (removal of Agave spp. in C. Gata and herbivory in Doñana) A total of 4 questionnaires post meeting prepared. 85 local actors answered the questionnaires during the meetings and subsequently online. 4 sectoral action plans drafted and ratified (2 for Sierra Nevada and, 1 for Doñana and 1 for Cabo de Gata).	Local stakeholders contributed to make significant adjustments in interventions, although the time constraints did not make it possible for them to participate in the initial design. Furthermore, the action fulfilled its purpose of improving local perception and managing conflicts.
A.8	PROJECT WRITING FOR C1, C2 AND C6	OBJECTIVES: To ensure the correct execution of external assistance through which actions C1, C2 and C6 will be contracted EXPECTED RESULTS: 3 work projects written with all the needed details for the correct implementation of Actions C1, C2 and C3 with external assistance, with all the requirements needed for the public open tender procedure	100%	The 3 projects included in Annexes A8.1, A8.2 and A8.3 attached to PR1 contain all the required technical and administrative specifications, and have been agreed upon by all the technical and scientific responsibles for the 3 NPAs.
A.9	'EX ANTE' ASSESSMENT: LANDSCAPE SCALE	OBJECTIVES: To quantify the state of the ecosystem services targeted by this project before performing the central Actions C1-C6, by using information from remote sensing (MODIS and Landsat) EXPECTED RESULTS: Set of indicators for monitoring the ecosystems and reference levels on how they work, including the quantification of services related to carbon balance, water cycle and energy cycle	100%	Although there is no deliverable in this Action (only in Action D7, a continuation of this one), the required analysis has been completed with very satisfactory preliminary results, as shown by UAL during the Scientific Committee meetings

ACTION		FORESEEN IN THE REVISED PROPOSAL	ACHIEVED	EVALUATION
A.10	'EX ANTE' ASSESSMENT: FIELD SCALE	OBJECTIVES: To quantify the state of the ecosystem services targeted by this project before performing the central actions C1-C6, from data gathered in the field in the monitored plots in the 3 N.P.A through common monitoring methodologies EXPECTED RESULTS: Set of indicators to assess the effectiveness of the central Actions C1-C6 through field monitoring in permanent plots defined within the managed forests. These indicators must be shared by the 3 N.P.A and must quantify carbon balance, energy balance, water balance and biodiversity prior to the implementation of the central Actions	500%	The design of the monitoring protocols shared by the 3 N.P.A. was long and complicated, due to the many actors responsible for them and the already existing data in all 3 N.P.A., which has been taken into account to have long data series to compare with, but at the same time, the data gathering has had to be reoriented to satisfy the project objectives (services-approach). Because of this, this action has required a high level of effort. However, the common methodologies are considered a very interesting result in themselves (see Annex O09 in FNR). Besides, the results of the monitoring in Action C3 have largely achieved the expected outcomes, with extra contributions to the project by identifying a community of insect species beneficiary for the surrounding intensive agricultural area (greenhouses) living in Z. lotus.
C.1	PINE FORESTS ADAPTATION TO CC	OBJECTIVES: To implement adaptive management pine forest at Cabo de Gata, Doñana and S. Nevada EXPECTED RESULTS: 200 ha thinned out (includes cutting pines, removing branches, and taking logs out of the forest), installation of 360 biodiversity boxes to give shelter to 300 insectivorous birds and 60 bats and planting of 250 *Pinus sylvestris* subsp. *nevadensis*.	110% - Except for the plantation in Sierra Nevada. - 3 extra plots have been added in Doñana to complement the 3 burned plots	In April 2018, the silvicultural works started in Sierra Nevada (lot 1) and they will continue until the middle of June. In Doñana,nest boxes were placed in March 2019 and in December 2019 other management actions started. Most was finished in January 2021, except for the burned plots, which finished at the end of 2021.
C.2	MEDITERRANEAN FOREST ADAPTATION TO CC (DOÑANA)	OBJECTIVES: To regenerate Mediterranean forest for an improvement on the ecosystem services provided. EXPECTED RESULTS: Regeneration of 45 ha of Mediterranean forest by seedling Recovery of animal community associated to Mediterranean forest (rabbits, micro-mammals and large reptiles) and reduction in *Quercus suber* decay by stopping *Phytophthora cinnamomi* propagation	100%	This action has suffered an important delay and could not start until November 2019, as explained in another section of this report. A reduced number of cork oaks was treated and monitored (15%) and monitored (40%) for the reasons explained earlier; 100% of exclosures were constructed, 100% of windrows of woody debris were placed, 100% of plantations were done and 100% seeds were sowed between the two years, although sowing times have had to be adjusted to the availability of seed. A replenishment of the plants for planting has also been carried out, which was not foreseen.
C.3	*ZIZIPHUS LOTUS* ADAPTATION TO CC (C. DE GATA)	OBJECTIVES: To improve the resilience capacity at a Priority Habitat (5220). EXPECTED RESULTS: removal of invasive vegetation at 10 ha., 100 to 150 new individuals of *Z. lotus* and 10 wells for the installation piezometers.	95%	Removal of Agave spp. And planting of Ziziphus lotus and associated vegetation have been completed. Installation of wells and piezometers is also completed. Finally, 9 wells were installed instead of 10.
C.4	SOIL CONSERVATION AND MANAGEMENT (C. DE GATA)	OBJECTIVES: To improve the resilience capacity of soils by implementing traditional measures EXPECTED RESULTS: Small traditional	100%	1000 linear meters of small walls to prevent soil erosion ("balates and portillos") were rebuilt. Installation of wildlife refuges for

ACTION		FORESEEN IN THE REVISED PROPOSAL	ACHIEVED	EVALUATION
		retention walls constructed (1000 m) to diminish soil erosion and traditional soil tillage in 10 ha.		animals. Two campaigns to manage 10 hectares of old crops (03/2017 and 03/2018). Three treatments have been applied, 3.5 has been tillaged, 3.5 were sown with grain, and the remaining 3 remained as control.. Six herbivore exclusion fences (two per type of treatment) of 5 x 5 meters (04/17) were installed.
C.5	MEDITERRANEAN HIGH MOUNTAIN SCRUBLAND (S. NEVADA)	OBJECTIVES: To restore high mountain scrublands. EXPECTED RESULTS: Update ancient irrigation channels as useful tools for the restoration of high mountain scrublands.	100%	7.200 of ancient irrigation channels have been restored. More than 8,280 Juniperus communis, J. sabina and Berberis hispanica seeds have been sown. 365 plants of Juniperus communis, J. sabina and Berberis hispanica have been planted.
C.6	OAKS AND HOLM OAKS ADAPTATION TO CC (S. NEVADA)	OBJECTIVES: To protect oak forest at a Mediterranean mountain ecosystem threatened by CC. EXPECTED RESULTS: 50 has of forest managed.	100%	20 ha of Pyrenan oaks, 20 ha of holm oaks and 10 ha of mixed forest with both species. Moderate selective cutting and pruning in 25 ha, intensive selective cutting and pruning in 25 ha.
C.7	INFORMATION SYSTEM FOR CC ASSESSMENT	OBJECTIVES: To establish a Distributed Information System to fulfill the functions of integrating the data obtained by the three Observatories participating in the project, and where the results of the actions carried out by them are integrated, as well as making all the information available to all researchers EXPECTED RESULTS: A fully operative Distributed Information System,interconnected between the 4 project nodes	100%	All the data collected under actions A9, A10, D7 and D8 is stored in Life Adaptamed Distributed System.
D.1	SCIENTIFIC SUPPORT IN DOÑANA	OBJECTIVES: To provide scientific support to the Action developed at Doñana. EXPECTED RESULTS: Establish a flow of scientific advisory and software connections between Doñana NPA staff, EBD and REDIAM.	100%	The task comprising this action has been executed as planned. Additional meetings were planned when necessary, especially to address deviations of the planned management actions. Since 2020 several meetings were done using online platforms which reduced costs of meetings
D.2	SCIENTIFIC SUPPORT IN CABO DE GATA	OBJECTIVES: To provide scientific support to the Action developed at Cabo de Gata. EXPECTED RESULTS: Establish a flow of scientific advisory and software connections between Cabo de Gata NPA staff, UAL and REDIAM.	100%	The active participation carried out by UAL throughout the project has allowed an important boost to the project in conceptual matters, in addition to having materialized its participation in concrete results: - Contribution to Distributed - Information System. - Participation in the two Windows to Science. - Publication of several dissemination materials (ex. Quercus magazine) and participation in media visit. - Active participation in the Life Adaptamed Symposium. - Participation in the elaboration of Effectiveness indicators and KPIs. - Preparation of a manual of good practices for pre-desert scrub and

ACTION		FORESEEN IN THE REVISED PROPOSAL	ACHIEVED	EVALUATION
				its corresponding Policy Brief.
D.3	SCIENTIFIC SUPPORT IN SIERRA NEVADA	OBJECTIVES: To provide scientific support to the Action being developed at Sierra Nevada. EXPECTED RESULTS: Establish a flow of scientific advisory and software connections between Sierra Nevada NPA staff, UGR and REDIAM.	100%	This action has completed normally and has provided the expected results.
D.4	MONITORING AND ASSESSMENT OF UICN ACTIONS	OBJECTIVES: Know the degree of effectiveness and the real impact of the actions mentioned with respect to the dissemination objectives of the Project. EXPECTED RESULTS: E2 - 30 surveys for each of the two workshops E5 – 20 surveys with participants of final symposium E10 – 10 surveys with participatory organs of natural spaces	100%	Data from surveys shows that the population in the areas of the natural spaces have understood and integrated the main concepts of the project and the value of actions. Recommendations have been obtained from the speakers and participants in the symposium. Finally, inputs from the participatory organs have been utilized in the drafting of the strategic plans of each natural space.
D.5	MONITORING AND EVALUATION OF THE FIELDS OF VOLUNTEERING AND ENVIRONMENTAL EDUCATION	OBJECTIVES: This action aims to monitor and evaluate environmental education actions in matter of adaptation to climate change (E3) and environmental volunteering (E4). EXPECTED RESULTS Ten surveys (pre and post action) for each of the classes in which the piloting action on the Didactic Unit on Adaptation to Climate Change is carried out. Two surveys (pre and post action) addressed to the volunteers participating in the volunteer camps of the E4 action in each of the three ENPs of the project. Evaluation report of the impact of the actions carried out in the target groups. One on the "Environmental Education" action and the other on the "Environmental Volunteering" action. Report on the impact of the activities carried out by the environmental volunteers in each of the three ENPs of the project, with special attention to the balance relative to investment and results.	100%	The evaluation of both actions has been carried out satisfactorily and has also been done in such a way that it has allowed feedback and improved the implementation of the actions that were the object of evaluation (E3 and E4).
D.6	MONITORING AND ASSESSMENT OF PC ACTIONS	OBJECTIVES: - To efficiently evaluate the effectiveness of actions E6, E7, and E8. - To engage society in mitigating the effects of CC.. EXPECTED RESULTS: - To create the need for changes in our lifestyle to reduce the effects of climate change and try to stop it. - To raise awareness of the institutional actions that are being carried out to improve our environment and to actively collaborate with those initiatives that are within our reach.	100%	The comments of the participants suggest that the actions under evaluation have indeed succeeded in involving sectors of the population in the fight against climate change. They have also achieved to raise awareness on how a change of lifestyle is necessary to mitigate climate change within each person's reach .

ACTION		FORESEEN IN THE REVISED PROPOSAL	ACHIEVED	EVALUATION
D.7	ASSESSMENT AT A LANDSCAPE SCALE "A POSTERIORI"	OBJECTIVES: To quantify the state of the ecosystem services targeted by this project after performing central Actions C1-C6, by using information from remote sensing (MODIS and Landsat) EXPECTED RESULTS: Set of indicators for monitoring the ecosystems and reference levels on how they work, including the quantification of services related to carbon balance, water cycle and energy cycle	100%	Satellite imagery time series have been updated, to get 3 completed hydrologic years (September 2013-September 2016). In addition, experimental plots have been updated and checked to avoid geometric fails. With the updated datasets, spatially explicit information about ecosystem services indicators was generated.
D.8	ASSESSMENT AT FIELD SCALE "A POSTERIORI"	OBJECTIVES: To quantify the state of the ecosystem services targeted by this project after performing the central Actions C1-C6, from data gathered in the field in the monitored plots in the 3 N.P.A using common monitoring methodologies EXPECTED RESULTS: Set of indicators to assess the effectiveness of the central Actions C1-C6 through field monitoring in permanent plots defined within the managed forests. These indicators must be common for the 3 N.P.A and must quantify carbon balance, energy balance, water balance and biodiversity after the implementation of the central actions	100%	All scheduled samples have been executed successfully. The only aspect that should be highlighted is that due to the delay in the implementation of the actions, some of the works contemplated in this action have been carried out within the framework of action A10.
D.9	SOCIOECONOMIC STUDY	OBJECTIVES: To quantify the impact of the project on the local economy and its population and carry out a pilot study of economic valuation of ecosystem services. EXPECTED RESULTS: Socio-economic study report attached to the final project report	100%	See Annex D.19 with Report on the study of the socioeconomic impact of the project on the economy and the local population.
E.1	COMMUNICATION PLAN AND PRODUCTS	OBJECTIVES: To Disseminate project results and approach. Expand the scope of actions Offer quality information to influence decisions EXPECTED RESULTS: One Communications plan including a specific Social Media plan One newsletter per year (in two languages: English-Spanish). An informative brochure and a poster for each space. One media kit for journalists. 4 videos (one general and three specific to each natural space). 3 infographics. 6 technical publications (manuals with best practices). 8 roll-ups: one for each partner.	100%	ACHIEVED: One Communications plan including a specific Social Media plan and a Corporate Identity Plan Two newsletters (in two languages: English-Spanish), two articles in IUCN-Med's newsletter (English/French/Spanish) and one in newsletter of CMI Marseille (English/French). An informative brochure and a poster for each space. One media kit for journalists. 6 videos created for Social Media 6 infographics. 6 technical publications (5 manuals on best practices and 1 guide on governance). 8 roll-ups: one for each partner. One special number of the Quercus magazine fully dedicated to the project. 49 web entries leading to more than 88,600 website visits. 1495 followers on facebook, 664 on twitter and 541 on Instagram. EVALUATION: Although the needs of this action

ACTION		FORESEEN IN THE REVISED PROPOSAL	ACHIEVED	EVALUATION
				were greater than originally expected, the impact achieved was also broader, having reached both the online and printed media, and boosted website visits as well as Social Media interaction. New technical features offered by social media, such as live-streamed events have created new dissemination opportunities in the face of pandemic restrictions
E.2	LOCAL DISSEMINATION	OBJECTIVES: To disseminate the project and awareness of climate change and its impacts on nature and human well-being. EXPECTED RESULTS: Six workshops organized. 15 stakeholder representatives for each natural space informed about the project methodology and results 200 people from the local population for each park are informed about the project. 6 producers from local economic sectors for each area involved.	100% Six workshops organized Participation organs of natural spaces (including more than 15 stakeholder representatives informed about project methodology and results More than 6 representatives from local business sectors involved 290, 320 and 800 people, respectively were informed about the project.	Despite the challenges in bringing together the scattered populations and obstacles to align agendas, particularly in rural areas or in zones with mountains, the awareness raising activities reached a wider audience than planned.
E.3	**ENVIRONMENTAL EDUCATION**	OBJECTIVES: to design and to develop a teaching unit about adaptation to climate change. EXPECTED RESULTS: one teaching unit, to carry a pilot activity within the target educational centers and to develop a training day focused on the teacher involved.	90%	The didactic units have been produced. All the objectives have been met except for one, which was an objective of little relevance in the context of the action. Therefore, expectations have been duly met. Only the piloting in the selected educational centers could not be carried out as a consequence of the pandemic (Covid 19).
E.4	**ENVIRONMENTAL VOLUNTEERING PROGRAMME**	OBJECTIVES: Fulfill environmental volunteering activities within the sites involved in the Project. EXPECTED RESULTS: Organization of 1 environmental volunteer training meeting. Realization of 2 environmental volunteer camps. Realization of 1 final dossier. Carrying out 12 environmental volunteer actions. At least 100 environmental volunteers are involved in all 3 ENPs that are part of LIFE ADAPTAMED.	100%	The Life Adaptamed volunteer manual has been edited and all the planned activities have been carried out with a participation above that expected.
E.5	EURO-MEDITERRANEAN SYMPOSIUM	OBJECTIVES: Disseminate project activities and train managers and staff in protected areas from Euro-Mediterranean region on successful methodologies of adaptive management to climate change.	100% 1 training strategy developed. 1 regional dissemination and training workshop	The final symposium of the project united the Andalusian and Euromediterranean community working in climate change adaptation. It strengthened bonds between environmental actors,

ACTION		FORESEEN IN THE REVISED PROPOSAL	ACHIEVED	EVALUATION
		EXPECTED RESULTS: 1 training strategy developed. 1 regional dissemination and training workshop organized. At least 20 representatives of administrations/decision makers informed about the methodology and results of the project. At least 20 representatives of protected areas have received training on methodologies successful adaptation. Minutes of the symposium. Cooperation forum and network of experts (including experts from other similar projects).	organized. 48 representatives of administrations and 4 representatives of decision-making bodies informed about the methodology and results of the project. 20 representatives of protected areas have received training on methodologies successful adaptation. Minutes of the symposium. Cooperation forum and network of experts.	encouraged new synergies, animated the discussion around the ecosystem-service approach to policies and gave full exposure to the results and learnings of the project.
E.6	WINDOWS TO SCIENCE	OBJECTIVES: - To disseminate and raise awareness of the causes and consequences of climate change at a global level. -To disseminate the actions and results that are carried out in the Autonomous Community of Andalusia in the context of the Life Adaptamed Project. -To achieve the commitment of people in society to improve our lifestyle to mitigate the effects of climate change EXPECTED RESULTS: -That the Windows to Science are visited by as many people as possible. -That visitors of the Windows to Science exhibitions convey the message on the need for changes in our lifestyle to mitigate the effects of climate change as well as to help to slow it down. -To disseminate the institutional actions that are being carried out to improve our environment and to contribute to those measures that are within our reach.	100%	-The feedback received from both, the participants in the evaluation methods (D6) and the visitors of the two Window to Science exhibitions, are a confirmation of the achievement of the expected objectives. -As people continue to visit the final Window to Science, as of today it remains open to the public, more people will learn about the actions and outcomes of the LIFE Adaptamed project.
E7	TRAVELING EXHIBITION	OBJECTIVES: -To elaborate support material for the dissemination and learning of the causes and consequences of climate change at a global level. -To disseminate the actions carried out in the regional Autonomous Community of Andalusia as part of the Life Adaptamed Project. -To achieve the involvement of the younger generations in the improvements in our lifestyle to mitigate the effects of climate change. -To involve students in their educational-learning process to ensure that the message reaches the new generations most directly. EXPECTED RESULTS: -That the content of the micro-exhibition reaches as many Andalusian schools as possible.	100% (and continuing to increase in the future)	-This objective has been achieved as the material has been produced and is ready to be distributed to the centers that request it. -The actions, as well as the rest of the objectives, will be disseminated as the exhibition travels to the schools. The feedback received from the educational centers is very positive and leads to changes and commitments in the educational community itself, including schools and families -The demand from educational centers is growing heavily. -Since this exhibition began to travel, it has been exhibited in 20 education centers in the Andalusian community in the provinces of Granada, Jaen, Almeria, Seville, and Cordoba and many more

ACTION		FORESEEN IN THE REVISED PROPOSAL	ACHIEVED	EVALUATION
		-That the message of the need for changes in our lifestyle to mitigate the effects of climate change and try to slow it down catches on within the educational centers that host this scientific exhibition -To disseminate information about the institutional actions that are being carried out to improve our environment and to contribute to those measures that are within our reach.		applications continue to be received. This shows the great interest in the topic, and for this reason, we consider these objectives are in the process of being positively achieved.
E8	MEETING WITH SCIENTISTS AND MANAGERS	OBJECTIVES: -To connect the educational community with the actions of the LIFE project. -To provide students with objective knowledge about the actual actions that will enable them to develop a critical and objective opinion on the subject. -To encourage debate and reflection. To acquire critical thinking and behavior with a commitment to society EXPECTED RESULTS: -That students gather the information that helps them to develop their own opinion. -To learn about the projects that are being carried out in their province and autonomous community region to mitigate the effects of climate change.	100%	Students had the chance to discuss with the researchers to address any possible doubts, so this is considered to be a positive result. During the stay of the micro-exhibition on climate change at the education centers, they were able to gather the information provided by the researchers, change some of their perspectives and achieve a commitment, which, although it might not be directly aimed at stopping climate change, they did become aware of the need to modify some aspects of daily life to minimize the effects of climate change.
E.9	LIFE ADAPTAMED WEBSITE	OBJECTIVES: To produce and maintain a website. EXPECTED RESULTS: A web site according to the project's General conditions.	100%	The result should be considered fulfilled. The web site can be checked here: www.lifeadaptamed.eu
E.10	GOVERNANCE	OBJECTIVES: To promote inter-administrative coordination, as well as citizen participation in the management of natural spaces. EXPECTED RESULTS: 15 technical meetings (5 per park) with the participatory organs of each natural space 3 terms of reference drafted and ratified for the climate change groups Number of components of the groups 3 strategic plans for climate change adaptation (1 per natural space).	100% 14 technical meetings with the participation bodies of the spaces (6 in Sierra Nevada, 4 in Cabo de Gata and 4 in Doñana) 3 terms of reference drafted and ratified for the climate change groups Number of components of the groups: 32 in Doñana, 37 in Cabo de Gata and 15 in Sierra Nevada 3 strategic plans for climate change adaptation (1 per natural space).	Greater cohesion and coordination within the administration and between stakeholders. New cross-sectoral connections established, valuable exchange of information for conservation and land management.
E.11	**NETWORKING**	OBJECTIVES: To connect with similar national and international projects and/or initiatives. EXPECTED RESULTS: Database of key projects / initiatives Monitoring report of networking	100% Database of key projects / initiatives. Monitoring report of networking activities. One media trip	The networking activities have allowed to create new contacts, strengthen bonds with other initiatives and institutions, besides creating transnational and transregional networks working on similar topics.

ACTION		FORESEEN IN THE REVISED PROPOSAL	ACHIEVED	EVALUATION
		activities.	leading to articles on 14 media outlets and 2 interviews on TV.	
E.12	PROJECT INFORMATIVE PANELS	OBJECTIVES: To design, produce and install 15 informative boards in the field. EXPECTED RESULTS: Design, produce and install in the field 15 informative boards.	100%	Fifteen field posters have been made using eight different designs. These designs have been carefully made to reflect the main concepts that frame the Life Adaptamed Project.
E.13	LAYMAN REPORT	OBJECTIVES: To disseminate project results (obligatory action) EXPECTED RESULTS: One Layman report produced Layman reports delivered	100% One Layman report produced. Layman reports delivered.	The Layman report was created as per project specifications.
F.1	PROJECT MANAGEMENT	OBJECTIVES: To ensure adequate coordination of the project and proper implementation of the actions according to project aims. EXPECTED RESULTS: Adequate coordination of the project and proper implementation of the actions according to project aims.	100%	This action has been completed satisfactorily.
F.2	SCIENTIFIC COORDINATION	OBJECTIVES: Scientific advisory, connection with REDIAM and prevent knowledge transferring to managers. EXPECTED RESULTS: Scientific advisory, connection with REDIAM and prevent knowledge transferring to managers according to the evolution of the project actions.	100%	This action has completed normally and has provided the expected results.
F.3	INDICATORS MONITORING	OBJECTIVES: To monitor the project indicators datasets. EXPECTED RESULTS: Revise and update the project progress indicators and the project effectiveness indicators.	100%	The indicators datasets have been revised and updated according to knowledge generated. This action has been fulfilled according to planned schedule.
F.4	**POST-LIFE PLAN**	OBJECTIVES: To establish actuations and agreements of the partners for the continuity of Life Adaptamed EXPECTED RESULTS: Definition of specific actions and future commitments	100% The planned documents Post Life Plan and the Strategy in order to improve the future sustainability of Life Adaptamed	Positive, Post life actions realistic and feasible

Many of the results of the project have been immediately achieved. This is the case of the implementation for the first time of networking by the Andalusian Network of Climate Change Observatories, with shared responsibilities and distributed involvement of the three observatories that have participated in this Life project. This has meant, firstly, a change of paradigm, by incorporating the discourse of ecosystem services in the management of the three NPAs, both through the familiarisation of the managers with this concept and through the work carried out in the corresponding participation bodies.

On the other hand, the vast array of dissemination, environmental education and volunteering activities carried out during the course of the project has enabled important results to be obtained immediately or in the short term, catalysed by the great acceptance of these activities by the local population, the educational community and society in general.

The 6 good practice manuals generated in the project are also an important tangible result of the project which will be widely disseminated during 2022.

Given the time required for ecosystems to evolve, some of the results of the project will be obtained in the medium term, during the post-Life, when the ecosystem-level and field-scale monitoring designed and already implemented in actions D7 and D8 will be repeated. This will allow to better refine the management recommendations given for pine, holm oak, oak and cork oak forests in actions C1, C2 and C6. However, important differences between waste management alternatives are already evident today, as well as differences between treated and untreated areas.

The **effort on replicability** of the project's actions has been present at all times, starting with the very process of designing the actions, oriented to provide recommendations aimed at improving the adaptive capacity of the ecosystems under study not only in National Parks, but also in other areas that do not have such a large budget for their management and conservation. For this reason, expensive solutions have been avoided (e.g. chipping was discarded as one of the possible options to be tested for the elimination of forest residues in actions C1, C2 and C6 due to its high cost) and affordable recommendations have been prioritised for most of the territories. Along these lines, some of the recommendations made include prioritising plantations over sowing in the restoration of scrubland in both arid ecosystems (Action C4) and high mountain ecosystems (Action C5), assessing the possibility of avoiding the collection and stacking of residues after felling and pruning, given that the "in situ" disposal of the residue is more economical and it has also shown good results for subsequent plant regeneration and soil protection (Actions C1 and C6).

The use of Fosetyl aluminium has also been recommended under certain conditions to combat cork oak wilt by *Phytopthora cinnamomi*, and the project has made progress in the knowledge of its application, precautions and effects (Action C2-subactions 1 & 3).

Finally, and although it was not one of the project's initial expected results, a manual of methodologies common to the three NPAs has been designed, including the standardised, homogenised and tested procedures used in the project to assess the effectivity of the central actions on the conservation and improvement of ecosystem services, by combined monitoring at field and ecosystem scales (Actions A9, A10, D7 and D8). As this approach was not present in existing methodologies, it has been considered that this manual may be of great use to other NPAs that want to characterise the effect of their management actions in terms of ecosystem services (**Annex O07**).

Regarding the **effectiveness of the dissemination** of the project, as shown in **Annexes D22 and O08**, the social networks have had an important impact, amplified by the battery of news originating from the media visit. The reception of the volunteering and environmental education activities has been surprisingly positive, with high levels of participation or visits and high demand for the materials produced.

The **European Strategy for Biodiversity 2030** has among its objectives to improve the capacity of European biodiversity to generate ecosystem services and avoid the loss of key elements of ecosystems for the maintenance of their functions. In Life Adaptamed we have worked in this direction through the management of Habitats Directive key ecosystems (for example jujube, high mountain shrubland, mountain *Quercus*), through the management of DH key species: steppe birds and other birds included in the Birds Directive and through the increasing the resilience of ecosystems (buffering the harmful effects of CC on biodiversity). The learning obtained consists of the definition of management strategies for key ecosystems highly oriented towards the conservation of biodiversity in a context of Global Change. In fact, Life Adaptamed's methodological scheme is partly oriented towards measuring changes in biodiversity. For its part, the **European strategy for soil protection** establishes that the carbon storage in the soil can be increased by: selection of forest species, forest mass management, site preparation, care and control of vegetation accompanying the mass,

increased productivity, protection against disturbances and through waste management. At Life Adaptamed we have defined indicators of carbon stock in the soil while maximizing the selection of native species to maximize carbon sequestration in ecological restoration (i.e. high mountain shrubland species, jujube, wild olive, mastic and cork oak). Likewise, the management of cutting waste has also been prioritized. In general, a forest mass management scheme has been drawn up to improve the ecosystem function in the soil (increase the diversity of the scrub) and the role of the soil in maintaining carbon stocks in the ecosystems under study has been studied. In terms of care and control of accompanying vegetation, invasive vegetation has been eliminated. At Life Adaptamed we have been very aware that the mobilization of the products of photosynthesis to the soil is the most effective way to remove carbon from the atmosphere at the same time that the network of NPAs in Europe minimize changes in land use and cover. For this reason, they constitute a fundamental tool for adaptation to climate change, to the extent that they help maintain carbon stocks in the soil.

The **European Forest Strategy** is one of the legal tools on which Life Adaptamed has the greatest impact. This strategy promulgates the management of forest masses for: protection of ecosystem services, increase in the ability to adapt to CC, ecological restoration of forest masses and risk prevention: e.g. pests, other elements that cause decay, fires and soil loss. Life Adaptamed incorporates for the first time an adaptive management scheme to different traditional management strategies that had not been previously evaluated, while defining teamwork strategies between managers and researchers on a regional scale. Our project introduces the concept of ecosystem services as a value of the forest mass beyond other production parameters and places the concept of 'Adaptation' at the center of the management strategy of protected areas. We have a good example of our activity in relation to some of the points promoted by the European Strategy for the forestry sector in the management of pine forests along a climatic gradient, cork oak management, management of mountain Quercus. And as a result we can show a Decalogue of management strategies with detailed instructions for managers of protected areas on how to protect forests and their services in a climate change scenario (management manuals). Our data show that Mediterranean forests are rarely productive due to the economic value of their use (wood, biomass), however, they have the highest levels of forest biodiversity in all of Europe. An adequate forestry strategy must include the assessment of the set of ecosystem services they provide.

The **EU Strategy on Adaptation to Climate Change** promotes, among its multiple objectives, the improvement of the state of key forest masses in the Mediterranean context, as a tool to increase their capacity to adapt to new climate change scenarios. At Life Adaptamed we have worked intensively on the naturalization of forest masses, carrying out tests on different waste management strategies and promoting the ultimate goal of increasing functional biodiversity. More specifically, our work includes the promotion of native vegetation with greater carbon sequestration capacity in a climatic context, the management of repopulated pine forests (these are ecosystems completely at the limit and the work of Life Adaptamed focuses on testing strategies already known but little evaluated through an adaptive management scheme) and the active management of forest masses in order to improve their ability to respond to climate change. By way of preliminary conclusions, we can advance that the types of treatments to improve the adaptive capacity must vary between species and ecological situations. Density reduction, diversity improvement and soil protection are key parameters to modulate the ability to adapt to CC. In general, we also conclude that the adequate management of Mediterranean ecosystems is not well reflected in the European CC adaptation strategy and that each species and each ecological situation implies management particularities that must be considered in the adaptation plans.

Finally, we have also analyzed the potential impact of Life Adaptamed on the **EU Green Infraestructures**. It is a network of natural and semi-natural areas designed and managed to provide a wide range of ecosystem services and protect biodiversity in both rural and urban settings. Life Adaptamed has promoted the maintenance of multifunctional natural areas: all the actions of the project are oriented towards the restoration of ecosystems and the maintenance of multiple ecosystem functions. Indicators have also been designed to monitor ecosystem functions and key ecological processes (net primary productivity, evapotranspiration, nutrient cycling, pollination and dispersal). We have also developed the role of protected areas and actions to restore ecosystems, as key elements for maintaining a network of green infrastructures that contribute to adaptation to climate change. We are transferring the motto to society: “Protected Areas: ecosystems that protect us”.

6.4.Analysis of benefits

With regard to the **quantitative and qualitative environmental benefits**generated by the project, these can be summarized as an improvement in the adaptive capacity of the target ecosystems to the expected disturbances due to climate change. Specifically, for each action this is materialized as follows:

Naturalization of pine forests (*Action C1*): the thinned pine forests, thanks to the dosage of competition between specimens that this action entails, are in a better physiological state and, therefore, in a better condition to resist forest pests and diseases, as well as drought phenomena. Although, given the short time that has elapsed since the intervention, no significant differences have yet been observed between the different crown treatments, in Sierra Nevada there are clear differences between the treated and untreated plots in terms of growth, stability and vitality of the stand, while a more beneficial effect of the more intense treatments can be observed, although this preliminary statement will have to be confirmed in future inventories. On the other hand, a negative effect on plant species regeneration and soil properties is also observed in plots from which whole trees have been removed, compared to plots where branches have been left either cordoned off or scattered on the ground. This seems to discourage the removal of whole trees for the use of branches in biomass plants because of the negative impact it may have on the provision of ecosystem services, as the worse plant regeneration and soil conditions may hinder the persistence of the stand in case of disturbances.

In Cabo de Gata, the results in bird censuses show that the pine forests present in this highly arid area act as an island of diversity, allowing the presence of species more typical of forest environments, thus having an effect on increasing diversity in general.

In Doñana, regarding *C1 and C2 actions* the implementation of the treatments has initially had a negative impact on the diversity and abundance of bird populations due to the impact of the actions carried out. After a period, a recovery of the levels has been detected, which is expected to continue until reaching values higher than the previous ones due to the positive effect on the ecosystem of the limitation of herbivory. The data offered by the occupation of nest boxes also offer good results, which involve an increase in the occupation rate in the treated areas with respect to the untreated ones.

The use of plantations at a detail scale, consisting of sowing and planting with high densities of seeds and saplings in small areas, was considered an adequate option for recruitment in adverse conditions (high herbivory, water deficit) by allowing much care to be devoted more intensively in these areas and promote, in the long term, the spatial and structural heterogeneity of the resulting forest cover.

In the limited monitoring period, the different treatments to reduce herbivory and the nurse effect proved to have an important effect, revealing the severity of the conditions of over-herbivory and water deficit faced by seedlings and saplings of the focal species in these areas. Six months after sowing or planting, and prior to the summer dry season, the survival of seedlings and saplings was very low both in the plots without fences, whether they were in the open field or if they had the protection of the branches (‘entaramados’). Although the exclusion of large herbivores increased this survival, the optimal values are obtained by combining it with the protection of the stumps. The effect is particularly extreme in Matas Gordas, the most open area with the least scrub, where the survival of seedlings and saplings was practically nil in the absence of the herbivore exclusion fence. It is important to highlight the demonstrative nature and the important learning component of these actions. The use of exclusions is not intended, for example, to be scaled as a management tool to ever larger areas

of space; but to indicate, if successful, the need to apply management measures that achieve the same objective (reduction of herbivory pressure, through different techniques such as the reduction of the number of individuals or the modification/flexibility of their spatial distribution). Likewise, the use of 'entaramados' could be adjusted to the availability of materials, but it could also be replaced by the use of other nursery structures - including some species of the thicket itself. Finally, both the spatial analysis of the success of reforestation and the repeated use of these techniques in consecutive years (including those of the Post-Life period), combined with the large differences in the rainfall regime that characterize this NPA, could allow identify the conditions that lead to successful regeneration, and use them for future designs.

In relation to the treatments to reduce the impact of the *P. cinnamomi* fungus, in the survey prior to the control treatments, the proportion of trees that presented soils infected by *P. cinnamomi* was slightly higher in the individuals selected to treat with fosetil (80 %) than in the controls (63%). However, the concentration of inocula in soil (colony-forming units per gram, CFU/gr) was slightly lower for the former (3.6±0.6 versus 7.3±1.5 CFU/gr). The concentration of chlamydospores that is considered an indicator of the threshold of symptomatic infection (61 CFU/gr; Serrano et al. 2015) was not exceeded in any case. Its leaf index, an indicator of the impact of the condition on the canopy, was also comparable (3.4±0.13 vs. 3.1±0.16).

In the survey after control treatments, the proportion of trees showing detectable densities of soil inocula (i.e., colony-forming units in the laboratory test) had decreased slightly for fosetyl-treated trees (from 24 to 22 trees, that is, from the initial 80% to 73%) and for the controls (from 19 to 18 trees, that is, from 63% to 60%). However, the concentration of inoculum in soil was much lower for treated individuals (12.5±6.1 vs 24.9±7.9). This difference increases if we take into account only the individuals with the presence of P cinnamomi in the soil (17.0±8.1 versus 41.5±11.7).

The proportion of trees with roots infected by *P. cinnamomi* was much lower than the rate of infection in soils, and similar in treated and controlled individuals: 23%, that is, almost one out of every four monitored individuals. This proportion is comparable to that of trees in whose soil concentrations of chlamydospores leading to symptomatic infections are detected (20%) for control trees, but far exceeds it for those treated with fosetyl (7%).

The reduction in the amount of inocula in the soil was not accompanied by a significant improvement in the foliar state of the trees, since the foliar index remained at values similar to those of 2019 (3.5±0.12 in treated and 3.1±0.16 in controls). This is consistent with the fact that the proportion of trees with root infection remained similar. The results suggest, therefore, that the punctual treatment with fosetyl-aluminum has a positive effect on the control of the risk of infection by *P. cinnamomi* (number of propagules in the soil), but it is not enough to limit it or improve health of already infected trees. These conclusions are, however, limited by the duration of the monitoring period and it is possible that additional surveys during the Post-Life period will allow the detection of positive effects. In the meantime, we recommend complementing this trial with others that include the repetition of several treatments over time and/or the combination with other control methods (for example, the use of organic amendments) to evaluate their efficacy and the feasibility of their use in wild species and/or in protected areas.

Action C3

Results showed that the areas invaded by agaves were less diverse for most sampled groups than in the Ziziphus habitat. Agave presence mainly affected the density of beetles, lizards, and birds. Following the elimination of the agaves, a positive effect was observed on recovery

birds, by increasing the number of reproductive pairs from typical species of steppe zones. Moreover, the results highlighted the role of the *Ziziphus* habitat as a biodiversity reservoir. For instance, it had a positive effect on beneficial entomofauna, which play an important role in agriculture and natural pest control. Finally, this habitat facilitated the presence of forest species that are not typical of arid zones, showing the buffer effect that *Ziziphus* provide on this semiarid climate.

In *action C4* some structures related to soil retention have been built and a set of experimental plots have been tilled and sown to check the effects of traditional techniques. Also, some fences have been installed to check the effect of removing cattle

Restoration of high mountain scrubland ecosystems (*Action C5*): The data show marked differences in the seed germination and seedling survival between the two periods compared, both decreasing considerably in 2017-2020 compared to 1996-1998. We consider that this was due to the different climatology of the years in which the planting was carried out: rainy years in 1996, 1997 and 1998, with more than 835 mm of precipitation per year 27 and dry years in 2018, 2019, 2020, with around 410 mm of precipitation per year (compared to an average accumulated precipitation of 577 mm from 1941 to 2019; http://climanevada.obsnev.es). These results clearly indicate the importance of climate as a modulator of the capacity of juniper regeneration. In fact, the greater aridity of recent years has collapsed recruitment, which is also manifested in the current demographic structure of juniper, where there are hardly any juveniles. With the data obtained in the planting carried out in the rainy years (1996-1998) we can affirm that the high mountain places where the juniper has the greatest recruitment success are the comparatively more humid sites (near permanent streams and traditional ditches) and the rocks (under the shade of rocks), while in grasslands and open areas there is no recruitment. The sowings carried out in the years 2018, 2019, 2020, which were much drier than the years 1996-1998, offer very similar results in terms of the differential quality of the microenvironments for seed germination and seedling survival.

Increased resilience in Pyrenean oaks and holm oaks (*Action C6*). In Sierra Nevada The results show increased vitality in areas where trees have been pruned or thinned compared to control areas. In relation to waste management options, no significant differences have been observed among them. This a priori seems to indicate that the collection and stacking of residues, a forestry operation that increases the cost of silvicultural treatments, could be not sufficiently justified in view of the preliminary results.

Replicability, transferability, cooperation

Both the central actions and the communication and dissemination actions have been meticulously designed to favor their replication in the future and at different geographical scales. A good example of this is the Life Adaptamed manual of ecological monitoring methodologies and through remote sensing. This was not a deliverable per se, but it has been considered one of the most relevant products in terms of replicability and transferability. At this level, the contribution of the Euro-Mediterranean symposium (action E5) has also been very important, since it has favored this transferability to other working groups and has been a milestone in terms of cooperation in the fields of adaptive management, ecosystem services, adaptation to climate change and long-term ecological monitoring. As a result of this event, a series of conclusions of great impact have been defined on the topics addressed by Life Adaptamed, which also represent a good transferability exercise of the knowledge acquired and cooperation among those attending the event. Finally, the networking actions (E11) have also made it easier for the concepts and learning acquired during the project to be transferred

and have improved cooperation at a scientific and technical level with other initiatives promoted by the Life Program and promoted through other financing sources.

Best practice

If there is one aspect that has characterized the development of Life Adaptamed in terms of being an example of *good practice*, it is undoubtedly the governance model it has put into practice. Thus, the theoretical cycle of adaptive management, in which scientists, managers and local actors participate collaboratively in one or more of the steps that include the design of actions, their execution and subsequent evaluation, whose information will in turn allow the next steps to be adjusted in the light of the new knowledge obtained, has become a reality in the implementation of Life Adaptamed. This translational ecology was the philosophy with which the project was designed from the outset, and the reason why many of the actions have been carried out jointly by several partners, especially those related to the design of the core actions (preparatory actions) and their subsequent evaluation (D actions). This has required multiple meetings and the need to reach agreements, bringing together the visions of managers and researchers in the three NPAs and, whenever possible, also involving other sectors of society. As mentioned in previous sections, the latter has been more effectively and satisfactorily carried out when the actions were not subject to construction projects that constrained their implementation. Overall, although this way of working has been a challenge in terms of coordination and the search for agreements, and has required all the partners to leave their comfort zone, working in close collaboration with people from other entities, experiences and visions, we consider that it has been a very enriching process for both the results of the project and for the people who have participated in its development. Undoubtedly, this dynamic is a very solid base for the development of the Andalusian Network of Global Change Observatories, for which Life Adaptamed has been the first step.

Innovative and demonstration

In terms of the innovative and demonstration nature of the project, it is one of the first projects in which the actions on the ground are designed taking into account the tools that will subsequently be used to evaluate their effectiveness. Thus, for example, in the drafting of the works projects, the experimental design of actions C1, C2 and C6 took into account the grids of the satellite images that were to be used for the remote sensing analyses, so as to optimize the number of pixels included in each action plot. This made it necessary to define the orientation and boundaries of the plots not on the basis of the topographic elements on which the field work usually relies (e.g. contour lines or maximum slope, ravines, firebreaks, etc.), but on the basis of the two perpendicular directions of the satellite image grids. This has made it possible to combine the scales of management and research by maximizing the number of pixels of the satellite images that fall into each of the different actions to be tested.

Policy implications

Life Adaptamed has presented interesting contributions in terms of environmental policies, some of which we believe may represent great interest within the framework of the Green Deal. In point 6.3. of this FNR we analyzes in some detail the contribution of Life Adaptamed to strategies for the protection of biodiversity, for the protection of soils, for the forestry sector, for adaptation to climate change or as a contribution to value and improve the green infrastructure network (we do not go into more detail here to avoid repetition). The knowledge generated in management (e.g. Life Programme) and research projects has enormous potential to be transferred to decision-making processes at the community, national or regional level. One of our conclusions is that this knowledge is not always used to

enunciate these legal documents. Institutions often lag far behind knowledge, responding slowly to problems that require quick responses and a dynamism that is a chimera in the current scenario, but that seems essential in a scenario of global change. The European Commission promotes strategies of enormous importance that could go further if the knowledge generated in projects financed by themselves could flow more quickly. The biodiversity strategy for 2030, the European strategy for soil protection, the strategy in favor of forests and the forestry sector, the implementation of green infrastructure and, of course, the European strategy for adaptation to climate change represent milestones of enormous value. However, sometimes knowledge does not arrive or arrives late due to a lack of dynamism and agility. On the other hand, during a first analysis within the framework of Life Adaptamed, we concluded that an underrepresentation of the specific peculiarities of Mediterranean environments in current regulations and strategies is detected, while these are the most diverse ecosystems of Europe and are at the most endangered and impacted by the detected and foreseen impacts of CC.

It is necessary to better refine the mechanisms through which the financing of management and research at European level is finally transferred in documents with repercussions on decision-making processes. Currently, a series of problems are detected, such as the slowness with which the regulatory framework evolves, the ineffectiveness with which it passes from the published standard to specific actions, communication difficulties between the public administrations responsible for territorial management and the academic world, the difficulties in understanding that territorial managers and scientists have their own skills that should be complementary, and the different languages used in science-management-policy.

7. Key Project-level Indicators

In April 2016, the Life Adaptamed Coordination Team, following the instructions given by NEEMO, completed the online ***Outcome indicators*** database. It was updated and validated according to the European Commission instructions in May 2016 (Life Programme Indicators interface). Later, in February 2018, some updating of this database was completed through the project monitor.

These Outcome indicators evolved to current Key Project-level Indicators. The new version of this database has been updated in 2022 according to the final results achieved at the end of the project (up to December 2021).

A complementary report with the commitments and economic valuation of the sustainability actions by the Beneficiary Coordinator CAGPDS for the sustainability actions 4th to 7th has been made by CAGPDS to estimate some of the costs included in Indicator Values 14.1 and 14.4 in Key Project-level Indicator database. It can be found in **Annex 7** (Report on Future Funding Estimation for Indicator Values 14.1 and 14.4 in Key Project-level Indicators database).