Adapting the Mediterranean to climate change

MEDACC

Demonstration and validation of innovative methodology for regional climate change adaptation in the Mediterranean area

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Socio-economic impact of the LIFE MEDACC project on the local economy and population

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Executive summary

This deliverable explains the methodologies followed in the project LIFE MEDACC to monitor the socioeconomic impact of the project on the local economy and population.

The first section makes a general introduction to the deliverable objectives. The second section deals with the monitoring of the project effects on population, with special emphasis on job creation and the interaction between stakeholders and researchers. The third section tackles the monitoring of the project effects on local economy, with special emphasis on water saving in agriculture pilot experiences, the energy reduction in agriculture pilot experiences, the forest resilience to drought effects, development of the economic sector bound to research in new technologies, the reduction of climate change threatens and its effects on the economy and, finally, the improvement of socio-economic conditions of mid-mountain areas.

Contents

1. Introduction 4
2. Monitoring the effects of the project on population 5
   2.1. Creation of research jobs 5
   2.2. Creation of local and specialized jobs 5
   2.3. Interaction between stakeholders and researchers 6
3. Monitoring the effects of the project on local economy 9
   3.1. Water saving in agriculture pilot experiences 9
   3.2. Water saving in urban water supply 10
   3.3. Energy reduction in agriculture pilot experiences 10
   3.4. Forest resilience to drought effects 11
   3.5. Forest resistance to wildfires 12
   3.6. Development of the economic sector bound to research in new technologies 13
   3.7. Reduction of climate change threatens and its effects on the economy 13
   3.8. Improvement of socio-economic conditions of mid-mountain areas 14
4. References 15

1. Introduction

As stated in the requirements of a new proposal in the LIFE programme *"…, each proposal must include an action aimed to assess the socioeconomic impact of the project actions on the local economy and population. This can take the form of a study consolidating the data and results over the project lifetime, to be delivered with the Final Report. Projects should aim to increase social awareness and acceptance of the benefits of protecting the environment. Examples of positive effects of the project are: direct or indirect employment growth, enhancement of other activities (e.g. ecotourism) aimed to develop supplementary income sources, offsetting social and economic isolation, raising the profile of the area/region, resulting in increasing the viability of the local community (especially in rural areas)*".

As stated in the Grant Agreement, Action C2 monitors the socio-economic impact of the project on the local economy and population, specifically in:

- Recruitment of research personnel for developing the main project activities during different time durations.
- Iteration between stakeholders and researchers. This iteration will facilitate data exchange, knowledge exchange, formation and capacity building. Stakeholders include public administration, the academic sector, the private sector and NGOs. With the public administration and academic sector, the iteration will be in terms of knowledge exchange and capacity building. With the private sector, the iteration will be in terms of developing new agricultural and forest techniques to reduce water consumptions.

2. Monitoring the effects of the project on population

2.1. Creation of research jobs

LIFE MEDACC project has spent in total € 710.297 in temporary staff in five years. Considering an average salary of € 24.455 (for Catalonia in 2016), the project has generated almost 5,8 jobs/year of research personnel.

2.2. Creation of local and specialized jobs

Different project actions that implied subcontracting has benefit the recruitment of local or specialized personnel, as for example:

- Design of the logo and the explanatory panels of the pilot tests has implied the subcontracting of € 5.490, generating 0,2 jobs of local personnel.
- Construction of the identification panels of the pilot tests has implied the subcontracting of € 3.355,2, generating 0,1 jobs of local personnel.
- The implementation of the forest pilot experiences has implied the subcontracting of € 12.110 during six months, generating 0,5 jobs of local personnel.
- The design and update of the website and the creation of the platform data linked to the website have reverted to subcontract € 16.959,5, generating 0,7 jobs of programmer personnel.
- The translation to English and language revision of deliverables have implied the subcontracting of € 1.314,9 during 1 month, generating 0,1 jobs.
- The development of three soils maps with the scale and variables needed for the project to perform satisfactory action B1 have implied the subcontracting of € 8.750 during 6 months, generating 0,4 jobs.
- The creation of two aerial images using a Remotely Piloted Aircraft System (RPAS) has implied the subcontracting of € 830 during one month, generating 0,04 jobs.
- The agricultural pilot experiences in Muga and Ter watersheds have implied the subcontracting of € 15.959,0, generating 0,7 jobs.
- The technical assistance for monitoring the Management and Monitoring Panel has implied the subcontracting of € 17.975, generating 0,7 jobs.
- The development of a global indicator that quantitatively measures the degree of adaptation of Catalonia to the impacts of climate change has implied the subcontracting of € 3.300, generating 0,1 jobs.
- The technical assistance service to obtain funding for the implementation of adaptation projects in forest fire prevention has implied the subcontracting of € 16.700, generating 0,7 jobs.
- The study of adaptation to climate change in the agricultural sector of l'Alt Pirineu i Aran: risks and opportunities has implied the subcontracting of € 17.500, generating 0,7 jobs.
- The development and calculation of an indicator of the connectivity of bird populations in Catalonia in the context of climate change has implied the subcontracting of € 14.995, generating 0,6 jobs.
- The hydraulic modelling of the coastal drainage system of the left margin of the Baix Ter has implied the subcontracting of € 8.426, generating 0,3 jobs.
- The analysis of the degree of vulnerability and resilience of the municipalities of Catalonia to climate change has implied the subcontracting of € 17.756, generating 0,7 jobs.
- The application of the GIROREG methodology for saving of water in irrigation of fruit trees (apple trees) has implied the subcontracting of € 11.500, generating 0,5 jobs.
- Technical assistance and management service of Life MEDACC has implied the subcontracting of € 19.247,1, generating 0,8 jobs.

- Creation of Dissemination materials (calendars, meteorological stations, umbrellas, etc.) has implied the subcontracting of € 7.848,1, generating 0,3 jobs.
- Final financial audit has implied the subcontracting of € 3.950, generating 0,2 jobs.

Description	Subcontracting quantity (€)	Generated jobs
Design of the logo and the explanatory panels of the pilot tests	€ 5.490,0	0,2 jobs
Construction of the identification panels of the pilot tests	€ 3.355,2	0,1 jobs
Implementation of the forest pilot experiences	€ 12.110,0	0,5 jobs
Design and update of the website and the creation of the platform data linked to the website	€ 19.506.6	0,8 jobs
Translation to English and language revision of deliverables	€ 1.314,9	0,1 jobs
Development of three soils maps with the scale and variables needed for the project to perform satisfactory action B1	€ 8.750,0	0,4 jobs
Creation of two aerial images using a Remotely Piloted Aircraft System (RPAS)	€ 830,0	0,04 jobs
Agricultural pilot experiences in Muga and Ter watersheds	€ 15.959,0	0,7 jobs
Technical assistance for monitoring the Management and Monitoring Panel	€ 17.975	0,7 jobs
Development of a global indicator that quantitatively measures the degree of adaptation of Catalonia to the impacts of climate change	€ 3.300,0	0,1 jobs
Technical assistance service to obtain funding for the implementation of adaptation projects in forest fire prevention	€ 16.700,0	0,7 jobs
Study of adaptation to climate change in the agricultural sector of l'Alt Pirineu i Aran: risks and opportunities	€ 17.500,0	0,7 jobs
Development and calculation of an indicator of the connectivity of bird populations in Catalonia in the context of climate change	€ 14.995,0	0,6 jobs
Hydraulic modelling of the coastal drainage system of the left margin of the Baix Ter	€ 8.426,0	0,3 jobs
Analysis of the degree of vulnerability and resilience of the municipalities of Catalonia to climate change	€ 17.756,0	0,7 jobs
Application of the GIROREG methodology for saving of water in irrigation of fruit trees (apple trees)	€ 11.500,0	0,5 jobs
Technical assistance and management service of Life MEDACC	€ 19.247,1	0,8 jobs
Dissemination materials (calendars, meteorological stations, umbrellas, etc.)	€ 7.848,1	0,3 jobs
Final financial audit	€ 3.950,0	0,2 jobs
TOTAL	**€ 206.512,9**	**8,4 jobs**

2.3. Interaction between stakeholders and researchers

The interaction between stakeholders and researchers has been assessed through evaluating the degree of satisfaction of the stakeholders on the project, based on personal questionnaires. A first questionnaire was held to stakeholders in December 2014. The questionnaire was initially sent to 54 stakeholders, obtaining a participation of only a 33%, which is considered a low participation. A new questionnaire was held at the end of project, on March 2018, which was distributed among the stakeholders that participated in the focus groups (a total of 25 questionnaires were answered). The average score on overall satisfaction with respect to their participation in the project was 4,13 out of 5. 68% of people who answered the questionnaire affirmed that, within the framework of the

project, they have increased the network of relationships. 20% affirm that, in addition, a new collaboration has been created or it is expected that some will be created soon.

Besides the personal questionnaires, seven focus groups (Action D6) were organized where representatives from different sectors discussed about the challenges and adaptation possibilities of the watersheds. The first three focus groups were developed on 2014, one per watershed:

- Ter watershed: la Tallada d'Empordà, 6th November 2014. Eight participants.
- Muga watershed: Parc Natural dels Aiguamolls, 13th November 2014. Nine participants.
- Segre watershed: Mollerussa, 18th November 2014. Seven participants

A transversal/general focus group was also hold in Barcelona on 10th February 2016 (nine participants). This focus group was designed to include, not only stakeholders from the case-study basins, but also transversals stakeholder from institutions of national scope that have competences and knowledge in climate, water, agriculture and forest.

Thirty-three people participated in the first round of watershed and transversal focus group meetings coming from different sectors: natural areas, administration, university, conservationist/environmentalist, agriculture, community of irrigators, users and demands and services/tourism. The attendance to these groups was considered a success with a 96% of participation.

The three watershed focus group meetings were repeated at the end of the project to assess, throughout the project, how the discourse on adaptation to climate change evolves. The three focus group were developed on 2018, one per watershed:

- Ter watershed: Torroella de Montgrí, 13th March 2018. Nine participants.
- Muga watershed: Parc Natural dels Aiguamolls de l'Empordà, 6th March 2018. Nine participants.
- Segre watershed: Mollerussa, 27th February 2018. Seven participants

25 people participated in the final round of focus group meetings coming from different sectors: natural areas, administration, university, conservationist/environmentalist, agriculture, community of irrigators, users and demands and services/tourism. The attendance to these groups was considered a success with a 100% of participation. The changes of attitudes of the stakeholders were quantified by comparing the answers formulated. 25 forms answered by local stakeholders have been analysed and they represented the same different sectors of the three watersheds. Main results could be summarized as follows:

- The overall project result interest was scored on 4,24 over 5.
- Communication has increased the level of knowledge on climate change adaptation of 3,88 over 5 according of the stakeholder perception.
- Communication has raised awareness on climate change adaptation of 4,27 over 5.
- Stakeholders assess the project usefulness on climate change adaptation on 3,96 over 5.
- Stakeholders assess the project impact on their own entity/sector on 3,76 over 5.

These results suggest that communication is efficient in raising awareness when the target audience is clearly identified.

Through the engagement and participation of stakeholders in the different actions of the project, LIFE MEDACC is contributing to their empowerment and capacity building, helping in the development of a common discourse to face climate change. A good example of the impact of the project so far is the creation of a Water Community Users of the coastal plain of the Muga (CUAPLM) in Muga basin (see Action B2): at the second annual Management and Monitoring Panel meeting held in Figueres on 10th December 2014, it was announced that the LIFE MEDACC would support the setting up the CUAPLM; on 16th January 2015, the first meeting with the Regional Council of Alt Empordà was held in Figueres; on 17th February 2015, an "*Informative meeting for the constitution of a community of users in the basin of the Muga*" took place at La Farinera de Castelló d'Empúries organized by the Council and the Cooperative, with 35

participants; on 15th July 2015, a third meeting was held with the City of Castelló d'Empúries and Geoservei S.L., to discuss next steps to form the CUAPLM and also assess what actions could be supported; on 17th November 2015, the General Meeting of the CUAPLM in Muga basin was held at the City of Castelló d'Empúries. As a result, the statutes were made and rested pending for approval by the General Assembly; on 21st December 2016 the statutes were positively approved by the General Assembly. Finally, the statutes have been sent to the ACA (the Catalan Water Authority) for its final approval.

3. Monitoring the effects of the project on local economy

The implementation of the adaptation measures made natural and human systems more efficient and stronger to the impacts of climate change. For example, some of the measures are addressed to reduce water consumption in agriculture and urban and industrial sectors, leaving water for recovering and conserving the ecological quality of the rivers. In this sense, the project will allow the increase of the quality of life of Catalonia inhabitants, due to:

- Saving resources through increasing the efficiency in the use of resources (e.g. reducing water or energy consumption).
- Development of new economic sectors in the field of adaptation (e.g. new techniques for irrigation).
- Reduction of the threat on local economy (e.g. recovering rural uses).

3.1. Water saving in agriculture pilot experiences

The agriculture pilot experiences in the Ter and Muga basin have shown that providing farmers with detailed information of weekly irrigation needs can reduce water consumption in a 40-67% (2014), 14-40% (2015), 14-20% (2016) and 13-40% (2017) in maize crops without affecting the quality of the final product. These percentages represent an average potential water saving of 7,2 hm^3/year:

> Present average water consumption not following GIROREG advices: 4.500 m^3/ha/year; percentage reduction: 32% → 1.440 m^3/ha/year. Maize area irrigated: 5.000 ha. then, potential water saving in maize crops irrigation: 7,2 hm^3/year.

In view of the success in water saving, the project expanded the pilot experience to apple trees crops in 2016 obtaining for that year a reduction in water consumption of 1.397 m^3/ha (26%), again without affecting the quality of the final product. This percentage represents a potential water saving around 2,8 hm^3/year:

> Present average water consumption not following GIROREG advices 5.350 m^3/ha/year; percentage reduction: 26% → 1.391 m^3/ha/year. Apple area irrigated: 1.980 ha; potential water saving in apple trees crops irrigation: 2,8 hm^3/year.

A similar analysis can be done at watershed level, considering all crops. After four annual campaigns (2014, 2015 and 2016 in maize crops; 2016 in apple trees crops), pilot experiences have shown a water saving higher than expected. The pilot experiments occupy a total surface of 3 ha that initially (before the implementation of the pilots) consumed about 16.500 m^3/year. If we consider an average around 20% reduction of water consumption for irrigation with the implementation of the pilot experiments during 2014, 2015, 2016 and 2017 campaigns, water consumption would be about 13.200 m^3/year. If the agriculture pilot experiments were applied to the whole irrigated surface in the Muga and Ter basins (which means a total irrigation demands of 62 hm^3/year in the Muga basin and 198 hm3/year in the Ter basin), water saving would be 52 million m^3/year (this volume, 52 hm^3/year, is equal to the volume of water consumed in the city of Barcelona for 200 days).

The 52 hm^3/year of water savings for all the irrigated surface in the Muga and Ter watersheds can be translated into the economic benefit of water saving. It's known that water price for agriculture irrigation in Catalonia doesn't reflect the real costs of water, but if we consider the water price established for land farmers in the latest irrigation infrastructure built in Catalonia (Segarra-Garrigues channel, 2016), 0,08 €/m^3, the economic benefit of water saving would be around 4,16 M€ /year. In Muga and Ter, it could represent 1,35 M€/year.

3.2. Water saving in urban water supply

The reductions of the flows at the headwaters of the basins over the past few decades and the estimations of estimated future water availability mean that water management policies will be key for meeting demands and simultaneously complying with minimum flows established for each watershed. In this sense, impacts can be reduced by implementing measures that favour the rational use of water resources and the efforts must be centred on reducing demands during situations of recurrent drought, putting new sources of water into place (desalinization and regenerated water), and improving the efficiency of water use (recharge of local aquifers).

And these efforts have been implemented in Catalonia: figure 1 shows the evolution of water volume reservoirs that supply urban demands in the Barcelona Metropolitan Area (more than 4,5 million people) from January 2016 to April 2018. The orange line should be the theorical evolution without putting new sources of water into place; the blue line is the real evolution with "new" water: desalinization, reused water and local aquifers. Be aware that the real evolution means 100 hm^3 of water saved into the reservoirs. The price established for urban water supply in the regional network is around 0,80€/m^3; so, the economic benefit of water saving is about 80 M€.

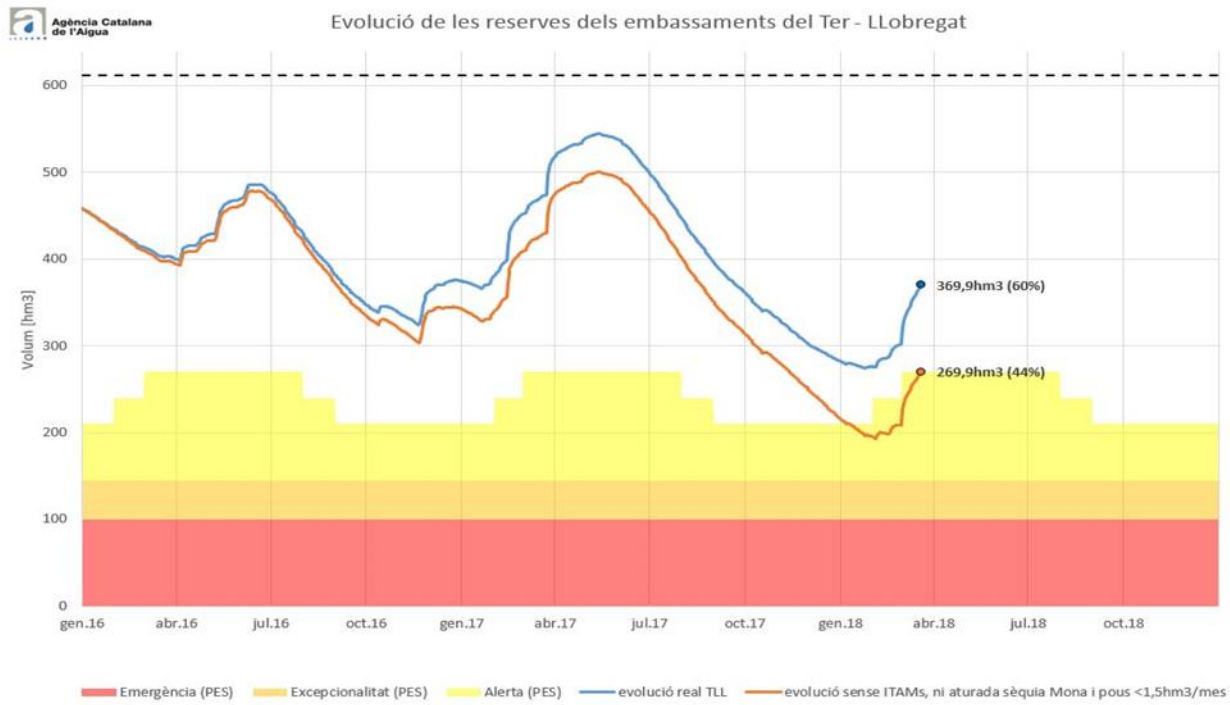

Figure 1: Evolution of water volume reservoirs that supply urban demands in the Barcelona Metropolitan Area from January 2016 to April 2018

3.3. Energy reduction in agriculture pilot experiences

The energy is estimated as the amount of energy needed to pump water to irrigate the pilot experiments in the Muga and Ter watersheds. The energetic ratio is about 0,25 kWh/m^3.

Considering the agriculture pilot experiments were applied to the whole irrigated surface in the Muga and Ter watersheds (which means a total irrigation demands of 62 hm^3/year in the Muga watershed and 198 hm^3/year in the Ter watershed) (see section 3.1), and considering an average reduction around 20% of water consumption for irrigation, water saving would be 52 hm^3/year (12,4 hm^3/year in the Muga and 39,6 hm^3/year in Ter). Approximately in 50% of the agricultural surface

of these two watersheds the water arrives by gravity, and therefore it is not necessary to pump it. Therefore, it could be possible to reach an energy saving of 6.5 kWh/year.

3.4. Forest resilience to drought effects

The forest pilot experience in Requesens (Muga watershed) has shown that forest management can reduce the vulnerability of the forest to suffer the effects of a severe drought. An aerial image of the Requesens area was taken on September 30th 2016 by a Remotely Piloted Aircraft System (RPAS). The aerial image showed a different impact between the non-managed plot (control) and the two managed plots (low thinning and selection treatment). In the control plot, signals of forest decline were clearly observable, where Holm oak trees present a decoloured crown due to the lack of water availability (Figure). More decoloured crowns were also observed outside the plots, where no actuation has been neither implemented and can be also considered as control area. In the contrary, non-visual effects of the drought were observable in the treatment plots (Pascual et al. 2018). A supervised classification of the aerial image was performed using ArcGIS tools in order to quantify the area affected by drought in each plot (Figure 3). The classification estimated that the 10% of the surface of the control plot presented forest decline, whereas in the two managed-plots, the effects of drought were almost inappreciable (0.5% in the low thinning and 0.0% in the selection treatment) (Table 1) (Pascual et al. 2018). This analysis revealed that forest management was key to reduce the vulnerability of Holm oak forests to face the effects of drought.

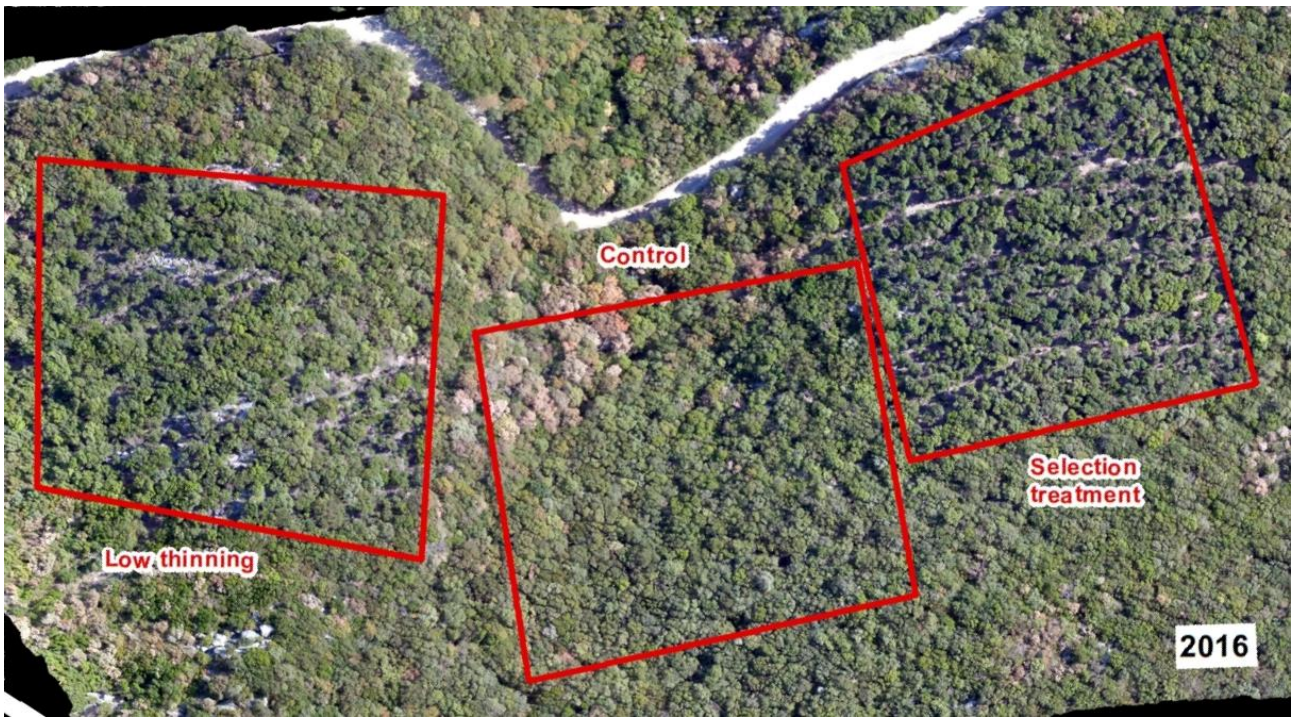

Figure 2. Limits of the Requesens pilot experience (red polygons) over an aerial image created by Remotely Piloted Aircraft System (RPAS), showing the state of the vegetation in 2016.

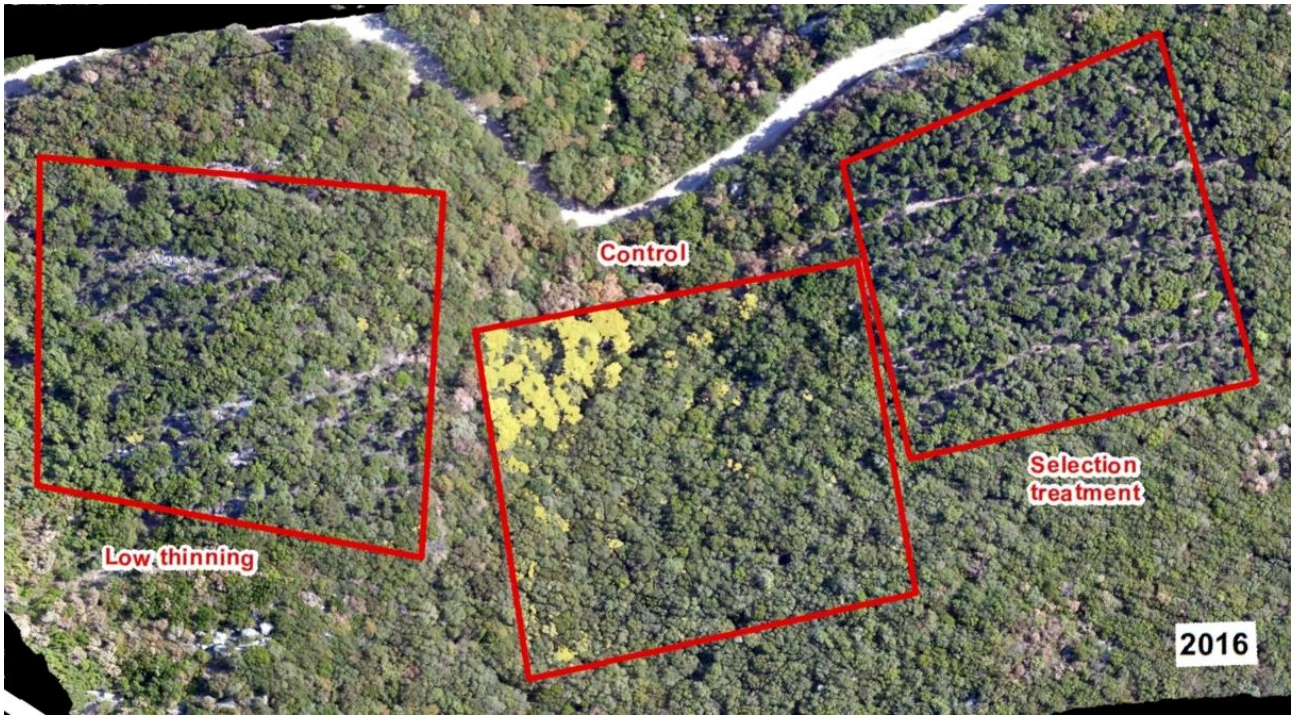

Figure 3. Limits of the Requesens pilot experience (red polygons) over the aerial image of 2016. Yellow polygons refer to decoloured crowns, identified with the supervised classification of ArcGIS.

Treatment	Total surface of the plot (m^2)	Surface affected by forest decline (m^2)	Percentage of surface affected by forest decline (%)
Control	8,232.6	752.1	9.1%
Low thinning	8,340.2	40.8	0.5%
Selection treatment	7,029.8	0.9	0.0%

Table 1. Numerical analysis of the supervised classification including: total surface of each treatment plot (m^2), surface affected by forest decline (m^2), and percentage of surface affected by forest decline (%).

If the same forest management is applied to the whole watershed's forests, the forest vulnerability would be reduced in 124 km^2 of Holm oak forests in Muga watershed, 330 km^2 of Scots pine forests in Ter watershed and 560 km^2 of European black pine forests in Segre watershed.

3.5. Forest resistance to wildfires

Forest fires are one of the most relevant risks in the Mediterranean region. Some studies have pointed out the correlation between changes in climate and the number and surface affected by fires. The vegetation structure is an indicator of the forest combustibility, which measures the quantity of combustible material in the forest, and has a direct influence in the propagation of an initiated fire. The studies of Rothermel in 1993 classified 10 models of forest combustibility depending on vegetation types. In Catalonian forests, the models 4 (dense shrublands and tree or young plantations with high density and biomass and vertical and horizontal continuity of combustible) and 7 (high inflammable shrublands under tree species) are the most combustible forests, with a high susceptibility to fire propagation and high difficulty to extinguish. In the selected watersheds, these two models occupy 50, 30 and 19% of the forest surface present in Muga, Ter and Segre watersheds, respectively.

	Surface in Muga watershed (ha)	% of forest	Surface in Ter watershed (ha)	% of forest	Surface in Segre watershed (ha)	% of forest
Model 4	8.368,0	16,8	43.441,3	20,0	37.728,8	5,5
Model 7	16.224,8	32,5	22.613,8	10,4	94.233,3	13,7

Table 2. Surface and percentage of the combustibility models 4 and 7 in the three watersheds, according to Rothermel classification

The demonstrative activities converted forest of combustibility model 4 (according to Rothermel classification) to forests with model 8 (reduction of shrublands density and promotion of conifers or deciduous trees with lower continuity) and model 7 to model 5 (closed of the tree canopy reducing the presence of highly combustible shrublands and increasing the vertical discontinuity between vegetation layers), both of them having lower combustibility. Although forests occupy the largest surface in Catalonia, few economical resources are being addressed to forest management. For this reason, the future extrapolation of MEDACC project to other forest areas has to be considered with restrictions. At the short term, it is plausible to consider the management of watershed public forests with a current combustibility model of 4 and 7. The surface that would be managed will be, approximately, 150 ha, 1.760 ha and 40.500 ha in Muga, Ter and Segre watersheds respectively. At the long term, forest management may be applicable to the whole watersheds, implying surfaces of 24.590 ha, 66.055 ha and 131.962 ha in Muga, Ter and Segre watersheds respectively.

3.6. Development of the economic sector bound to research in new technologies

The pilot experiences may stimulate the development of an emergent technological sector that can have an impact at local scale. This sector could provide local jobs as an economical alternative in the rural areas. The application of this technology will help the improvement of other related economic sectors, such as agriculture and forestry. The percentage of active population in agriculture and forestry that may be impact for the pilot experiences per watershed is around 6% in Muga, 4% in Ter and 11% in Segre.

Pilot experiences will stimulate the development of an emergent technological sector that can have an impact at local scale. This sector could provide local jobs as an economical alternative in the rural areas. Extensive livestock has traditionally reduced the wood biomass at the landscape level, and contributed to the maintenance of cultural mosaic landscapes. These services cannot be attained with mechanical means due to the high cost and non-sustainability over long periods. In contrast, extensive livestock, especially traditional breeds adapted to these Mediterranean harsh environments, may maintain low biomass in open spaces at significantly lower costs, while providing a feasible economic way to maintain alive the mountain Mediterranean societies. On the other side, mountain agriculture was traditionally focused on subsistence cereal products (wheat and rye), cultivated on slopes or terraces. These cultivations were abandoned during the first half of the twentieth century given low possibilities for mechanisation, low productivity and high labour demand. Nevertheless, in the recent decades there are some initiatives to develop new agricultural practices in mountain Mediterranean regions based on high-demanded agricultural products (e.g. vineyards) that may adapt to the climate conditions of the mountains. Cultivation in mountain areas may provide some particularities to the derived products, which are attractive for consumers, in comparison to common cultivations in lowlands. In addition these agricultural practices may contribute to adapt the cultivation of these products to new regions given warmer and more arid conditions observed in lowlands. The application of new technologies will help the improvement of primary sector, including livestock, agriculture and forestry.

3.7. Reduction of climate change threatens and its effects on the economy

In the case of the Mediterranean region, droughts are recognized as one of the most frequent and severe natural hazards and they will increase in frequency and severity according to climate

change projections. A future increase in droughts in Southern Europe will be caused mainly by a decrease in precipitation but also by increased evapotranspiration resulting from a rise in temperature.

Several droughts have been registered in the case-study watersheds in the last decade (2005, 2007-2008, 2012, 2016). The drought which affected Catalonia between 2007 and 2008, one of the largest of last decades, had an important impact on the society, the primary and secondary sector and the natural ecosystems. In this situation, the Catalan government was forced to develop three drought decrees (Drought Decree 84/2007, Decree 257/2007, and Decree 108/2008) which limited the water consumption in the affected areas. Besides, the government was forced to execute urgent actions such as the construction and rehabilitation of emergency wells, the repair of conduction and distribution network, etc. However, the economic cost of this drought was evaluated in 507 millions of euros by the Catalan government. Drought in agriculture ruined the 50% of the cereal production and the 40% of olive production. At social level, restrictions were applied in the consumption of domestic water (swimming pools or water for gardens were prohibited) and the population awareness reduced consumption to notably low values.

The contribution of LIFE MEDACC project is to reinforce natural and human systems, increasing adaptation capacity to face these projected impacts, through tested and monitored alternatives considered in mountain and regional adaptation strategies. In turn, project results will help the adaptation strategy validation.

A Catalan government report (DAR 2013) quantifies the economic losses of the 2012 wildfire in Alt Empordà (10.500 ha affected, mainly in the Muga river basin). They were assessed in 143,7 M€ broken down in 93,89 M€ of forest product losses and 49,8 M€ of other environmental impacts. They not include the losses of the touristic sector due to the decrease in touristic attractiveness. The impact of this kind of wildfires could be drastically decreased with an active policy on adaptive forest management as MEDACC promotes.

3.8. Improvement of socio-economic conditions of mid-mountain areas

The implementation of the adaptation alternatives will make mid-mountain ecologic and human systems stronger and more resilient to the impacts of climate change. LIFE MEDACC considers different landscape management alternatives to improve mid-mountain resistance and resilience against global change, considering their ecological and socio-economic viability. It promotes forest management practices and agriculture development. These alternatives address in a holistic manner rural innovation and renaissance to foster forestry and farming as a way to adapt to climate change, improving the resilience of the whole socio-ecological system by securing key assets, such as water, soil and biodiversity to: i) reduce the vulnerability of the whole system to wildfires, ii) manage the forest in a sustainable way, iii) improve the economic opportunities of marginal areas and iv) halt biodiversity loss.

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