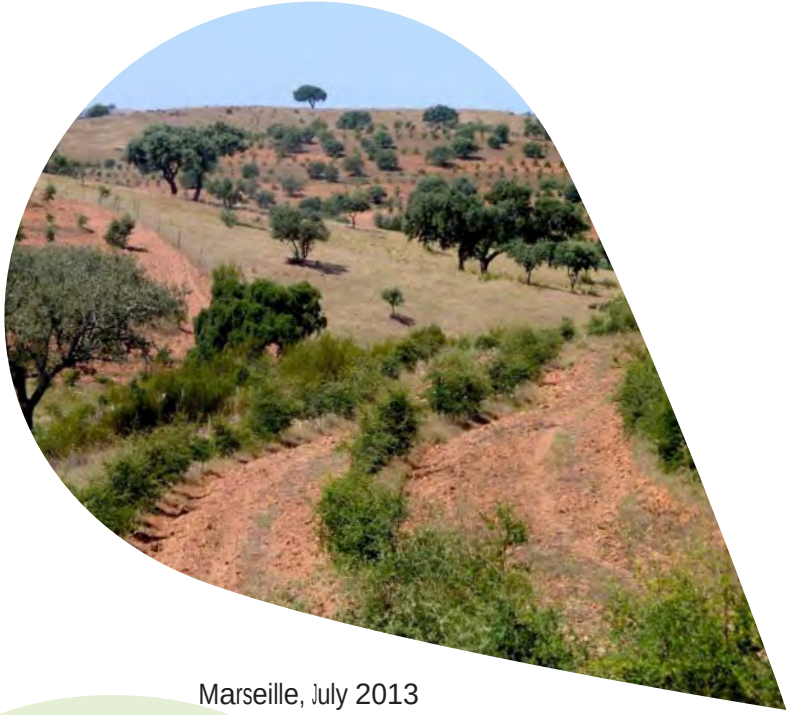
For Climadapt

Adaptation of mediterranean woodlands to climate change

Final capitalisation book

Pilot activities balance and technical conclusions



Marseille, July 2013

Med L'Europe en Méditerranée / Europe in the Mediterranean

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Note: All the deliverables and information related to the FOR CLIMADAPT project can be found on the official website www.forclimadapt.eu, and from March 2015 on the website of the AIFM (www.aifm.org). You can also receive any project publication, in particular the 3 progress books, by simple demand to the AIFM secretariat (info@aifm.org).

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SUMMARY

FOREWORD

Despite the intergovernmental statements at world summits and the alarming conclusions of the Intergovernmental Panel on Climate Change (IPCC) confirmed on several occasions, scepticism continues to speak out here and there. We, who manage and protect the natural and forest lands of many regions of the Mediterranean Europe, face the real impacts. Here, there are increasingly threatened *montados* (agro-silvo-pastoral system of the South of Portugal), over there, an altered evolutional cycle of the young plant communities of the Mount Vesuvius slopes, while somewhere else we see entire dying back Fir forests in the South of the Alps and the Pyrenees, or the risk of wildfire highly increased in the Pine forests of Italy, Greek Islands and Catalonia Pyrenees…

It is no longer just a theory. Our colleagues who are also managers are now confronted with practical realities that they stumble upon every day at their work sites. A major challenge!

When we know that climate change will manifest itself through warming in specific areas, cooling in other areas and globally through a worsening of extreme events (droughts, severe thunderstorms, torrential rains…) and we are not able to know exactly where and how, we understand the disarray of the forest professionals who must plan their actions over the next decades.

This is the reason why we are grateful to the MED Programme and its partners who have allowed us to modestly approach some of the practical and technical questions which we would like to share among us and with all the concerned operators from Europe and the other shores of the Mediterranean. All of this, from where we stand and with limited resources (in particular within the «crisis» context that has affected most of our countries).

As well as the investigation networking programs or the intergovernmental agencies, such as the Silva Mediterranea Committee, our partner via the AIFM, we wish to contribute with the results of this project as field operators.

It should be noted, however, that the Med or Interreg related European programs are not entirely adapted to forest and natural lands concerns because these have different timescales and need longer periods than the three years usually granted to the cooperation projects. In fact, in a forest plantation project, an average of a year is needed to set the modalities and prepare the land, a year to plant and a few years to see it grow and observe the final results.

Despite the technical constraints, we believe we have fulfilled our commitments and reported the advances regarding very useful knowledge and experiments to all the stakeholders who manage territories and are concerned with forests and their adaptation to climate changes.

Ugo LEONE
President of the Vesuvius National Park
Project leader

Abdelhamid KHLADI
President of the AIFM
Technical leader

PART 1 General framework of the FOR CLIMADAPT project

(by Jean BONNIER)

1.1 - BACKGROUND AND PROBLEM STATEMENT

The Mediterranean forests of Europe concern eight countries of the European Union (Portugal, Spain, France, Italy, Malta, Slovenia, Greece and Cyprus) and all the other countries of the north shore (Croatia, Bosnia Herzegovina, Montenegro, Serbia, Macedonia, Bulgaria, Turkey).

Figure 1.1: Map of the Mediterranean basin (source : Plan Bleu, 2009).

Within the Interreg IIC interregional cooperation policy, the project «Problem of the Mediterranean forest» (1999-2002)[1], gathering a partnership of about 200 people, established its climatic, geographic, economic and cultural outlines.

There is no need to explain the project again, but it is worth mentioning that:

- the spontaneous vegetal formations of the Mediterranean regions are basically determined by the Mediterranean climate that is characterised by a cold season with rain (end of autumn, winter and beginning of spring) and a hot and dry season (which means that it does not rain precisely when the plants need water to grow properly),
- these vegetal formations have been broadly established since the end of the last glaciation, about 10 000 years ago, until the appearance and settlement of Man on the shores of the «Middle Sea»,
- they are composed of plants and vegetal systems that came from Asia, Europe and Africa.

The Mediterranean Forest has thus been closely connected to human activities throughout times up to the present days.

But our societies, in particular in Europe, are about to experience radical changes. Our daily life moves away from nature and countryside, except regarding leisure activities. In addition to this, the competition for space makes contractors occupy more natural spaces than they need to.

The partners of the «Problem of the Mediterranean forest» project have admitted that the Mediterranean forests are specially threatened by modern society's indifference. The reality is that words like « forests » or « silviculture » do not hold a prominent place in the Interreg and Med programming documents.

Thus, when the subject is the sustainable planning and development of the territories of the European shores of the Mediterranean, we do not understand how the knowledge, management and protection of forests and

1 - AIFM: « Problématique de la forêt méditerranéenne », dans Forêt méditerranéenne, hors série n°1, 191 pages. Marseille, 2002.

natural lands, which occupy almost 70% of the mentioned territories running along and sometimes penetrating the biggest metropolis like Barcelona, Marseille, Naples or Athens, should not be studied.

After this first project, the partnership expanded via the RECOFORME project « Structuring Networks and Cooperative Action Concerned with Mediterranean Forests » (2003-2006), in which the following bodies were involved : the Regional Natural Park of Alpilles (France), the Region of Murcia and the Generalitat Valenciana (Spain), the Umbria Region (Italy), the General Directorate of Forestry (Portugal), under the authority of the Project leader, the Vesuvius National Park (Italy), and with the International Association for Mediterranean Forests (AIFM) as technical leader.

As a result of this project, and after the concepts and the definitions were established, a method was implemented (see section 1.2 hereinafter), together with a consolidation of the shared approach of the Mediterranean forest and natural lands[2].

At the end of RECOFORME project, the partners decided to remain allies in their approaches and to prepare themselves for the following wave of European programs, Med and ENPI. This willingness manifested itself through two working seminars, one in Rome (Italy) and the other in Marseille (France) in 2006[3], in which three directions were settled in order to prolong the previous works:

- an examination of the methodes of governance of the planning and development of Mediterranean forests and natural lands,
- an experimental survey of the projects' quality
- an assessment of the effects of climatic changes on the evolution of the Mediterranean forests and the development of methods to adapt to the mentioned effects;

Circumstances led to the gathering of the first two items to initiate the QUALIGOUV project «Improving governance and quality of the forest management in Mediterranean protected areas» (2009-2012)[4].

Nonetheless, regarding the adaptation to climate changes, a second project was created alongside: FOR CLIMADAPT that is the project we are dealing with here. Its partnership has evolved compared to the previous ones. New participants have joined the initiative, namely the Association for the Defence of the Heritage of Mértola – ADPM – in Portugal, and the North Aegean Region in Greece, in order to enrol their daily actions within this collective dynamics for a better integration of climate change within forest management issues. The Forest Science Center of Catalonia (CTFC) also partnered along the way.

Photo 1.1: The Partnership of the QUALIGOUV project, in the field

Since 1999, as these actions took place, the idea of a «shared vision» from Mediterranean people regarding their forests started to emerge and was later able to express itself even better through the establishment of the Collaborative Partnership on Mediterranean Forests[5], which was linked to FAO, and started in Antalya (Turkey) at the First Mediterranean Forest Week in 2010[6], continued in Avignon (France) in 2011[7] and in Tlemcen (Algeria) in March 2013 during the Third Mediterranean Forest Week.

Photo 1.2 : 3ème Semaine forestière méditerranéenne : Outre l'intervention de Lucio do Rosario sur les activités de l'ADPM dans le cadre du projet, un poster a été présenté lors de cet événement d'ampleur internationale.

2 - AIFM 2006: *« Les acquis du projet RECOFORME, Bilan, enjeux et recommandations »* (Achievements of the RECOFORME Project, balance, stakes and recommandations). 56p. Marseille http://www.aifm.org/nos-activites/projets-de-cooperation/recoforme.

3 - AIFM 2006: *« Conclusions de l'atelier de préparation d'un projet d'échanges techniques pour l'élaboration des politiques de gestion forestière dans les espaces naturels protégés méditerranéens »* (Conclusions of the preparation workshop for a technical exchange on the elaboration of forest management policies within Mediterranean protected natual lands). Marseille.

4 - AIFM 2012: QUALIGOUV, Final capitalisation book ; 56 pages and seven attachments. Marseille. http://aifm.org/en/results-and-products-capitalisation-communication.

5 - See Note 12 page 8.

6 - *Forêt méditerranéenne* 2010: First Mediterranean Forest Week in Antalya. Volume XXXI, 4. Special Edition, 132 pages.

7 - *Forêt méditerranéenne* 2011: Second Mediterranean Forest Week in Avignon, Volume XXII, 4. Special Edition, 188 pages,.

This final FOR CLIMADAPT book should allow the following main operators of the sustainable planning and development policies of the Mediterranean territories…:

- the European Union's bodies (Council, Parliament and Commission),
- the States, the territorial authorities (Regions, Departments, Provinces, Councils, Nomarchies…) and their associations (CRPM, ArcLatin,..),
- the natural Parks and the protected areas, and their federations,
- the professional organisations of foresters and industrials, and the inter-branch associations,
- the research and training centres,
- the non-governmental associations and organisations,…

…to consider that as soon as we recognize the reality of climate change that is happening and that will happen, it is perfectly possible for each forest manager to take this reality into account in its intervention projects and programs and in its daily management activities.

To achieve this goal, we recommend taking advantage of the efforts of the numerous other stakeholders invited to join the network, now well-established, of all those related to Mediterranean forests, their knowledge, their protection and their management.

1.2 - FOR CLIMADAPT PROJECT METHOD

Introduction

As mentioned in the foreword, taking into account the climate changes in our daily activities as managers of Mediterranean forest and natural lands might seem challenging: none of us knows exactly how these changes will manifest locally, how forests will react to possible temperature evolutions and to the rainfall throughout the seasons, which will be the genetic abilities of the species (or origins) in response to these changes, etc.

At the same time, when we question the researchers, their conclusions are always of limited operational capacity and usually cautious, which is absolutely normal.

Nevertheless, should we stand still and act as if nothing is happening?

In each of our countries and regions, we and our colleagues, (private owners, public managers, foresters, ecologists or development officers) ask how we should make the least bad decisions as there are no perfect ones. We cannot stand by and do nothing for very long, at the risk of seeing entire stands, even huge areas, deteriorate.

After a fire, the population and the elected people demand quick solutions.

The same happens regarding the degradation of their forests and the problems that some species face to regenerate:

- The foresters ask for advices to take care of their forest,
- The managers of protected habitats are concerned with the adequacy of the measures taken until now, with a constant climate.

1. Objectives

The method used during FOR CLIMADAPT consists of addressing the issue of climate change directly. This implies some explanations and clarifications.

The goal of FOR CLIMADAPT was that each one could:

- develop their own actions within a collective dynamic and within the most sustainable conditions in its territory, in order to get help from the other partners by showing them what they have achieved and taking into account their comments and criticisms during the project,
- gather the common acquired knowledge and transferable elements (tools, methods…) and release them.

This is similar to the approach called «programmed thematic research» that scientists practice, but in our case, it is a cooperation amongst operators which has led us to the following considerations.

2. Field stakeholders are not researchers

Researchers usually have the required availability and means to develop their art. Thus to prepare their experiments, they can rely on:

- a perfect and complete bibliographic review,
- an advanced knowledge of the parcels where the conditions are better for their intended research,
- important material and financial means to install experimental devices,
- qualified staff to ensure the monitoring,
- enough time to assess the results and eventually readapt the protocol as the experiment progresses.

Their main goal is to establish concrete data to be published and spread via scientific mechanisms (magazines, conferences…). This has nothing to do with the way field stakeholders act. Indeed, these ones do not have many means to access to the research results. Generally, the research is not conducted close to the field, the results are often published in not very accessible media and in a language they are not familiar with, and they usually do not have the time or the intermediaries to ensure scientific monitoring and knowledge transfer.

3. Nevertheless there are many curious field stakeholders who strive to ensure constant progress

Who does not have doubts when preparing and implementing a project, including small ones?

- This is why, within the FOR CLIMADAPT framework, we met agents from the Vesuvius National Park who, for many years now, experiment «ecological engineering» which should allow them to stabilize young and fragile volcanic soils, where tourism is high, and who examine the evolution of recent artificial stands established since the last eruption of the volcano.
- In the Guadiana Valley Natural Park (Municipality of Mértola, south of the Alentejo Region, in Portugal), the ADPM activities aim to develop methods to restore the *montado,* a resilient and multifunctional agro-silvo-pastoral system that the agricultural policies implemented were not able to protect.
- In the Mediterranean south of France (Alpes and Pyrenees), the agents of the National Forest Office try to find long term solutions for the dieback of firs stands which went through repeated and increasingly severe droughts.

In general, each of these teams tries hard to get advices from researchers and academics but their actions remain within the management and are not the result of scientific approaches. In fact, we observe that:

- their bibliographic knowledge is restricted,
- they have no methodological framework, especially considering the diversity of situations,
- only exceptionally do they respect rigorous protocols,
- they do not assess the different parts of the works,
- they do not publish and spread their results or the knowledge acquired through their experiments.

Nevertheless, each one separately capitalizes its results and enriches its personal experience and sometimes the experience of its institution.

4. However, there are only a few development tools

In the different countries of Europe and of the Mediterranean Basin, rural development is often practiced through institutions dependant from the States or organized by professionals. There we find engineers and technicians whose function is to transfer the knowledge acquired within the research to the field operator. This service works pretty well within agriculture and breeding, for instance, but is not so well developed within forestry and natural land management.

This is how, in some places, the technical centre has become a research centre, while in other places the development activities dedicate themselves either to the private forest or to the public forests.

In yet other places, a regionalisation process was applied to research, which restricts the dissemination of the innovation to the regional public…

The recent evolutions of the organisation of territories and administrations seem to have forgotten the demands of the forestry development, which must be based on the acquired research knowledge, the exchange and the contribution of experiments done in similar locations and addressing similar problems.

5. The method implemented within FOR CLIMADAPT

The method we have tried to apply has already been tested in other projects from the same family (Interreg or Med). It consists of transferring knowledge to the management operators, to be as close as possible to the researchers' practices without wishing to transform the former in the latter and vice-versa, and via meetings, shared assessments, field visits, etc[8].

We then admit that even modest, clumsy and approximate, the knowledge resulting from the practical experience of the stakeholders deserves to be considered as useful, examined, assessed known ans released.

We also know that we must first submit this knowledge to the partners because we know they are directly involved. This method creates, in a small scale, a «reflection community» that generates exchanges and instantaneous confrontations amongst its members when they meet in the field. Each pilot site is visited by all the partners, including a quick diagnosis of the locations and a technical analysis of the actions undertaken (« debriefing ») by a Peer group[9].

8 - Bonnier J. 2006 – *« La "communicoopération", une expérimentation menée à terme».* (The «communicooperation», a completed experiment) Forêt Méditerranéenne XXVII. No 4 pages 361-36.

9 - The Peer group is a typical tool of this method: its function is to critically analyse the actions and identify the major knowledge acquired, and finally to capitalise both. Each partner's institution has designated an independent peer, whose function is to explain the local project data and debate on the implementation of the partners' actions. During each technical meeting, on every site, the Peer group has met and debriefed each field visit, giving its opinion and suggestions. At the closing seminar in Herculaneum, the Peer group has also adopted the capitalisation summary presented in this Book (see part 2).

When these visits happen, each group observes, analyses, asks questions, makes comments and learns from the exchanges.

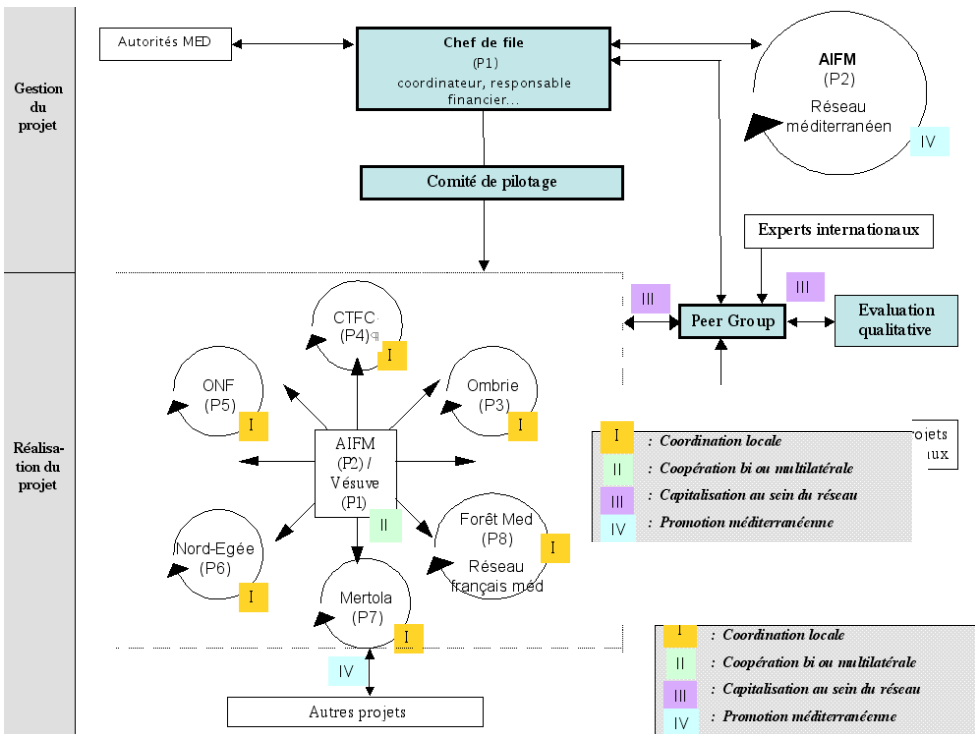
It is, apparently, the best we can do considering the many obstacles that most institutions must face, and in particular:

- the difficulty to travel that the territorial authorities face, considering that, usually, only the elected representatives and the executive managers can move around,
- the short time that the agents have, considering that these agents are asked to act instead of thinking, reflecting and exchanging,
- the lack of training regarding research and experimentation methods, as well as the limited resources according to this perspective (bibliography, expertise and experts' interviews, etc).

While preparing the project and especially with the new partners who had not yet practiced this method, we had to explain that this was an in-depth cooperation that needed the allocation of enough resources for the exchanges to take place. Participating in such an approach is not achieved by quadrupling the budget[10] for on-going actions; it implies foreseeing time and resources for experience sharing and **capitalisation**, namely via regular meetings and field trips.

Despite the difficulties and the limits of this method, we have noticed positive changes, as the acquired knowledge lives on. In fact, when a field operator, a technician, administrative staff or an elected representative of a territory or a local NGO participates in a few meetings of this type and sees for himself the site and the other partners' actions, he becomes better equipped, more informed and more motivated. On the opposite, some executive managers and officials (elected or administrative), who often travel internationally due to their status, rarely go to the field and often remain restrained to the meetings organized in the capital towns.

More detailed information on the method on the website www.forclimadapt.eu



Picture 1.2: Organogram of the FOR CLIMADAPT project.

6. Transferability of the method

This method based on exchange and cooperation is the result of practices already tested in previous projects (RECOFORME, QUALIGOUV). Within FOR CLIMADAPT, this method was confirmed and refined, especially thanks to the smooth functioning of the Peer group.

Within the Mediterranean forests and natural lands, it can now be promoted in two directions:

- The implementation of similar cooperation projects, based on demonstrative actions conducted on representative pilot sites,
- The training of field operators.

We do not need to dwell on the first case too much because this kind of transfer can, for example, be reproduced within the projects promoted by the Collaborative Partnership on Mediterranean Forests. Some activities of German cooperation agencies (GIZ) or French ones (FFEM)

10 - These MED projects are co-financed by the ERDF at a rate of 75%. It means that for each euro from the partner, Europe finances 3 euros.

towards MENA countries *(Middle East and North Africa)* have been established as pilot sites. In these territories, the goal is to observe the climate changes impacts and the reaction to their effects. Our method is well adjusted to this approach.

Our method would prioritize the operational aspect of people to be trained and would propose internships within the structure and throughout the activities of the partners in question instead of long training sessions. This would replace the usual method of lessons taught by experts. The field stakeholders could go, through a «technical twinning» program, to a partner's territory where he would operate with a fellow-member/colleague of the same operational level. In exchange the receiving agents would later go to the «twinning» territories, to check the local situation and analyse the answers given. This situation would obviously be integrated within a more general training program where the experts would not be excluded, instead they would help the trainees to summarize and formalise the acquired knowledge.

7. Sustainability of the approach

We believe that according to the meaning and the spirit of the European programs (Interreg, Med, ENPI, etc.) and of those which will follow (next programming period: 2014-2020), the relationships established within the framework of these partnerships can thrive and prosper. The idea is not to extend each project *ad libitum* but to strengthen the networks established, allowing the partners to participate in new projects even if they are not specifically linked to Mediterranean forest territories management, no matter their areas of action.

For the design of a European policy on forests and natural lands in coherence with the local societies' evolution, it seems useful that projects of this nature should once again be possible. Both the countries of the southern Europe and the countries of the southern shore of the Mediterranean should be involved and increase the number of partner territories implying more field operators.

These new projects should be more centred on training (See point 6.- Transferability of the method) and they could be seen as «technical twinning» as it is foreseen within capitalisation projects framework.

Some of FOR CLIMADAPT partners have been involved in the MEDLAND 2020 project, oriented toward sustainable management of the forest and natural resources.

Others could be linked to the Collaborative Partnership on Mediterranean Forests [12]. It would be an advantage if the European Commission would join the mentioned Partnership and if other important European operators, such as the Conference of Peripheral Maritime Regions (CPMR), could be involved in this approach and enrich the method.

Photos 1.3 and 1.4: FOR CLIMADAPT is based both on major events, in an effort to reach the high level decision makers, and on informal technical exchanges between field managers.

12 - The Collaborative Partnership on Mediterranean Forests is a network of about 20 institutions, organised around the FAO Silva Mediterranea Committee and composed of governments from the Mediterranean countries, cooperation agencies such as the French Development Agency (EFD), the French Global Environment Facility (FFEM) or the German Society for International Cooperation (GIZ), international organisations such as International Centre for Advanced Mediterranean Agronomic studies (CIHEAM), the Plan bleu for the Mediterranean, or the European Forest Institute (EFI), research and high education centres, international non governmental organisations such as AIFM, Arc Med or the Mediterranean Model Forest Network (MMFN). More detailed information at http://www.aifm.org/nos-activites/partenariat-de-collaboration-sur-les-forets-mediterraneennes

PART 2 Mediterranean forest and climate change: time to adapt (by Louis AMANDIER)

This chapter is the result of the hard detailed work of the project's Peer group and its President, Louis Amandier. It endeavours to establish a transversal synthesis (according to the different topics) by building bridges between actions undertaken by the different partners. The goal is to achieve shared, general and detailed conclusions to be considered as technical recommendations from the entire partnership to the professionals and the policy makers who might face similar problem statements. We wish this paper to bring about the harmonisation of the levels of knowledge on climate change, which is a crucial phenomenon for our forests, of the strategic policies and of the technical approaches to address this issue.

Level of implication	
Highly implicated	
Implicated	
Low implicated	
Not implicated	
Centralisation - coordination	

Partner	No.
PN Vesuvius -It	1
AIFM	2
R. Umbria - It	3
CTFC - Sp	4
ONF - Fr	5
R. North Aegea - Gr	6
ADPM - Pt	7
Forêt Med. - Fr	8

A reminder of the Peer group mission

The major key roles of the Peer group:

- To help the partners implementing the pilot activities,
- To obtain the necessary information from the group to understand the context of each pilot site and the partners' actions,
- To collectively assess and constructively criticize partners' actions and the way they are implemented, namely at the seminars on the sites,
- To extract the transferable elements within the partnership but also beyond it, towards all the Mediterranean forests.

For further details, see the terms of reference of the Peer group, available in the DVD attached to the present Book, or visit www.forclimadapt.eu

General structure of this synthesis

This synthesis is presented thematically and transversally to the different pilot actions. It does not repeat in detail the information of the progress books and of the Peer group reports produced after the visits to the different sites. You will find specific information about each partner's activities in the Part 3 of the present Final book.

It has been structured according to the four major topic of the FOR CLIMADAPT project:

- 1 - Observe the reality of climate change in the Mediterranean basin and on the FOR CLIMADAPT pilot sites.
- 2 - Adapt the forest management to the expected changes (adaptive silviculture, enrichment plantings, management of dieback stands …) → Stand scale
- 3 - Anticipate diebacks, prevent wildfires, fight the erosion and restore the deteriorated land… → Massif scale
- 4 - Transfer the researchers' knowledge and the experience of the technicians to the managers, raise social awareness and improve the participating governance within the territories → Territory scale and integration of non-forest elements of the civil society.

The different pilot sites are not equally implicated in each of the climate changes topics. Thus, a colourful chart is present in each section briefly characterising the position of each partner according to a yellow-red gradient (from the least to the most implicated). The colour violet is for the AIFM (International Association for Mediterranean Forests), involved in all the subjects because of its role to centralise and release deliverables of synthesis and technical coordination of the project.

1 - OBSERVE THE REALITY OF CLIMATE CHANGE IN THE MEDITERRANEAN BASIN AND ON THE FOR CLIMADAPT PILOT SITES

1 2 3 4 5 6 7 8

1.1. Changes are difficult to distinguish from the usual variations of the Mediterranean climates

Mediterranean climates are intrinsically characterised by rains during the cold season but also by interannual climate variability higher than those of other climates in the world. The perception of huge evolutional trends is therefore extremely difficult.

For example, after a very cold winter with exceptional floods that we have just been through in 2013 in Europe, it is difficult for the general public to understand that the climate is warming or drying!

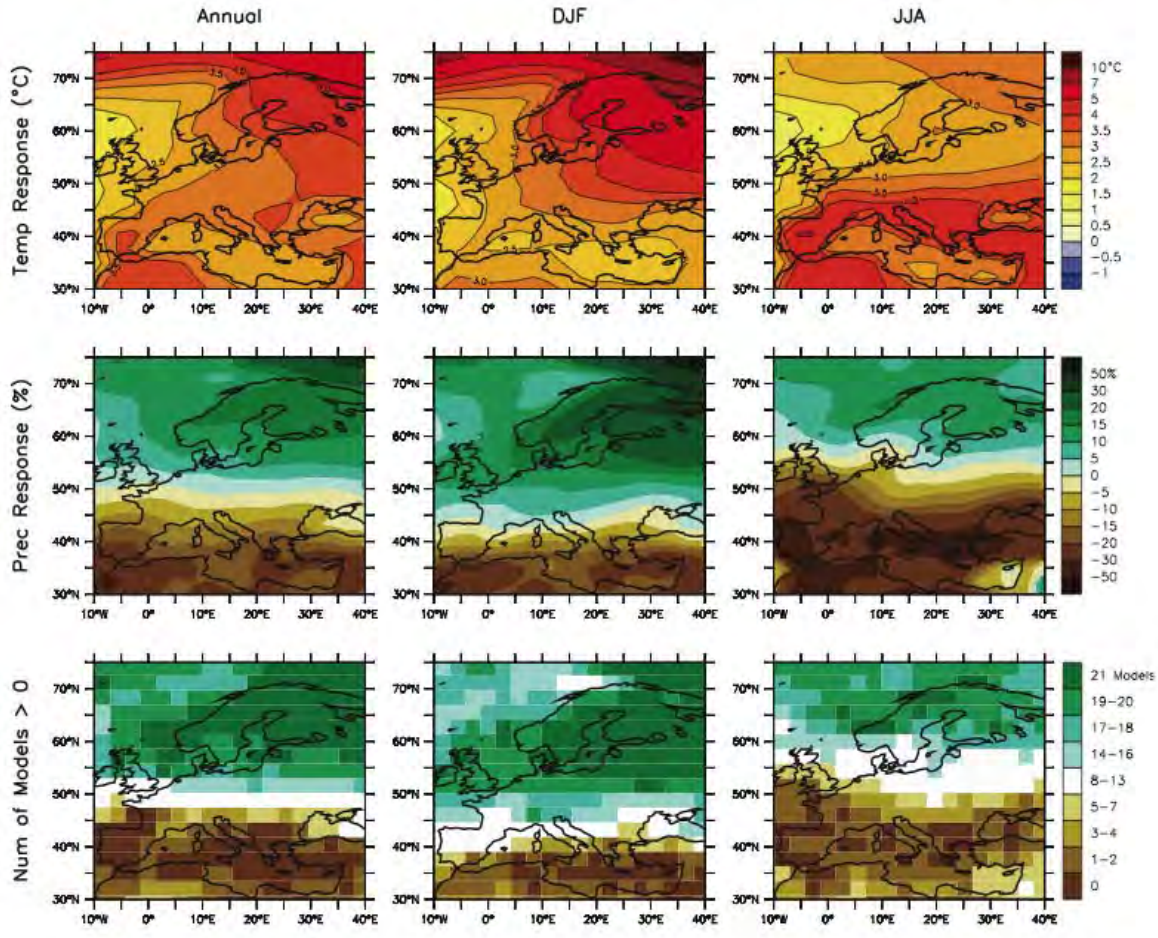
Nevertheless, the international experts from the IPCC (Intergovernmental Panel on Climate Change) confirm the trend towards the warming and the worsening of extreme modelled expressed through specific scenarios, despite the meteorological parameters evolution.

Thus, on a global scale, «the year 2012 was the hottest one since meteorological data have been recorded! » [1].

1.2. More detailed and geographically regionalised climate modelling

Networking maps that show climate models forecasts are becoming more precise. They allow the establishment of regional syntheses that seem to asset that the Mediterranean region will probably be particularly affected by these changes, in particular regarding the decrease in rainfall in the summer (see Picture 2.1).

Nevertheless, the models confirm huge variations even within isoclimatic zones.



Picture 2.1: Evolution of the European climate between 1980 - 1999 and 2080-2099 according to scenario « A1B » from the IPCC.
- *Top: evolution of average annual temperatures.*
- *Centre: evolution of annual rainfalls.*
- *Bottom: number of models foreseeing an increase in rainfalls (among the existing 21).*

1 - Source : mainstream press.

1.3. Expected manifestations of climate change

The major manifestations of climate changes are the following:

Average temperature increase of 3 to 4 °C by 2100

Caution! This does not necessarily mean a decrease in frost risks because the temperature range also tends to increase.

Increased rainfall in winter, lower in summer

This will namely result in an increase of the summer water stress for the vegetation and the Mediterranean forest stands that particularly depend on summer rainfalls. In fact, during the winter, temperatures are too low to allow a correct photosynthetic activity and the subsequent adequate mobilisation of winter rainfalls.

Increased frequency of extreme phenomena

- Droughts,
- Heat waves,
- Cold periods,
- Floods,
- Storms…

At the FOR CLIMADAPT pilot sites scale, the partners made an inventory of the major local impacts of the climate change and the solutions adopted.

Thus, 80% of the partners are already seeing temperature increases and 100% are expecting them in the future. Moreover, 60% are already recording the increase of extreme phenomena and 90% are expecting this kind of phenomena in the future.

From a qualitative standpoint, the following are some of the seen or expected extreme phenomena:

- More frequent extreme heat and water stress events (ONF, CTFC, ADPM),
- Heavy winter rains or heavy snow (ONF),
- Massive diebacks, defoliation and decrease of the stands productivity (PNV, ONF, North Aegean Region, CTFC),
- Spreading of invasive species (PNV),
- Increased wildfire risks (PNV, Umbria, North Aegean Regions, CTFC),
- Phenological changes in plants (CTFC), migrations in altitude or toward the north when possible, or the extinction of specific species (examples: Chestnut trees in the Umbria Region, Scots Pine in Catalonia, *Pinus Brutia* in the North Aegean Region…),
- Increase of pests virulence (namely the *Lymantria* and Processionary caterpillar) and of diseases in the Umbria Region, CTFC).

1.4. Changes in practices interfere with climate changes

To consider the climate evolutions we also need to take into account the important changes that occur at the same time in the agro-silvo-pastoral practices and other economic activities that have a deep structural impact on the territories management.

Thus, land use and landscapes are deeply affected by past uses and the on-going evolutions. And namely by:

- the continuing rural exodus, leading to the abandonment of some pastoral practices and to the extension of non-managed forests that are particularly sensitive to the wildfires,
- the coexistence of intensive agricultural production models with extensive systems,
- the ageing of the population of most of the European countries,
- the urbanisation that occupies more and more lands,
- the urban population movement towards the countryside in some regions, causing a urban sprawl (multiplication of housing complexes or individual houses in natural lands),
- the development of outdoor leisure and sport activities,
- the environmental protection policies, etc.

Synthesis of the results (the figures correspond to the number of partners that gave the answer considered) [2] *:*

		Trend	Temperature increase	Rainfall decrease	Extreme temperatures	Extreme rainfalls
Observed impacts	Strong	1				
	Average	3	5	3	3	
	None	1		2	2	
	Negative					
Expected impacts	Strong	1		1	1	
	Average	4	5	4	3	
	None				1	
	Negative					

2- The full versions of the templates supplied by the partners for this purpose are available in the DVD attached to the present Book. They also give information regarding the measures applied locally to fight these impacts. This information broadly corresponds to the one presented in sections 2 to 4 of this synthesis.

Together with climate changes, these evolutions can have either an increasing effect but also, in some cases, a mitigating or compensatory effect. This makes the observation of these phenomena extremely complex! This is the reason why we often prefer using the expression «global change».

1.5. FOR CLIMADAPT within the global context of climate change observation

Many people and institutions are worried about the world's climate change. How do FOR CLIMADAPT network observations fit in?

The project strives to integrate the dynamics established by specialised agencies and to contribute to the evolution of knowledge regarding these topics.

The major organisations working on this subject are the following:

- International expertise: Intergovernmental Panel on Climate Change (IPCC),
- Research institutes in almost all the partner countries,
- Observations by the specialised services, for example, the French DSF (Forest Health Department),
- The citizens' observation networks, for example in France the Observatoire des saisons (Seasons observatory), or via Internet, for example Tela Botanica (www.tela-botanica.org/).

FOR CLIMADAPT partners' approaches and actions that allow better establishing the connection with this bibliography and institutional context are the following:

- The AIFM's and the Peer group's survey that allowed the development of the « Emberger's Climagram » (see Figure 2.2 hereinafter) and the illustration of the local perception of the phenomena.
- Installation of weather stations (North Aegean Region, CTFC, ONF).
- Establishment of devices for monitoring the landscapes dynamics (Catalonia).
- Mapping of the forest diebacks (ONF).
- Large scale monitoring of plots (Vesuvius).
- The census and the establishment of a database by the French association *Forêt Méditerranéenne.*

1.6. Position of the FOR CLIMADAPT sites on Emberger's Climagram

The Index of Emberger was developed in the 1960s to characterise the different Mediterranean climates using the most commonly collected meteorological data. It summarises quite well the major climate parameters.

$Q2 = 2000\ P / M^2 - m^2$

Considering that :

P = Annual precipitation (mm)

m = winter cold → Average of the minimum temperatures [3] of the coldest month

M = summer heat → Average of the maximum temperatures of the hottest month

Since : $(M^2 - m^2) = (M+m) \times (M-m)$

with $(M + m)/2$ = average temperature

and $(M - m)$ = temperature range

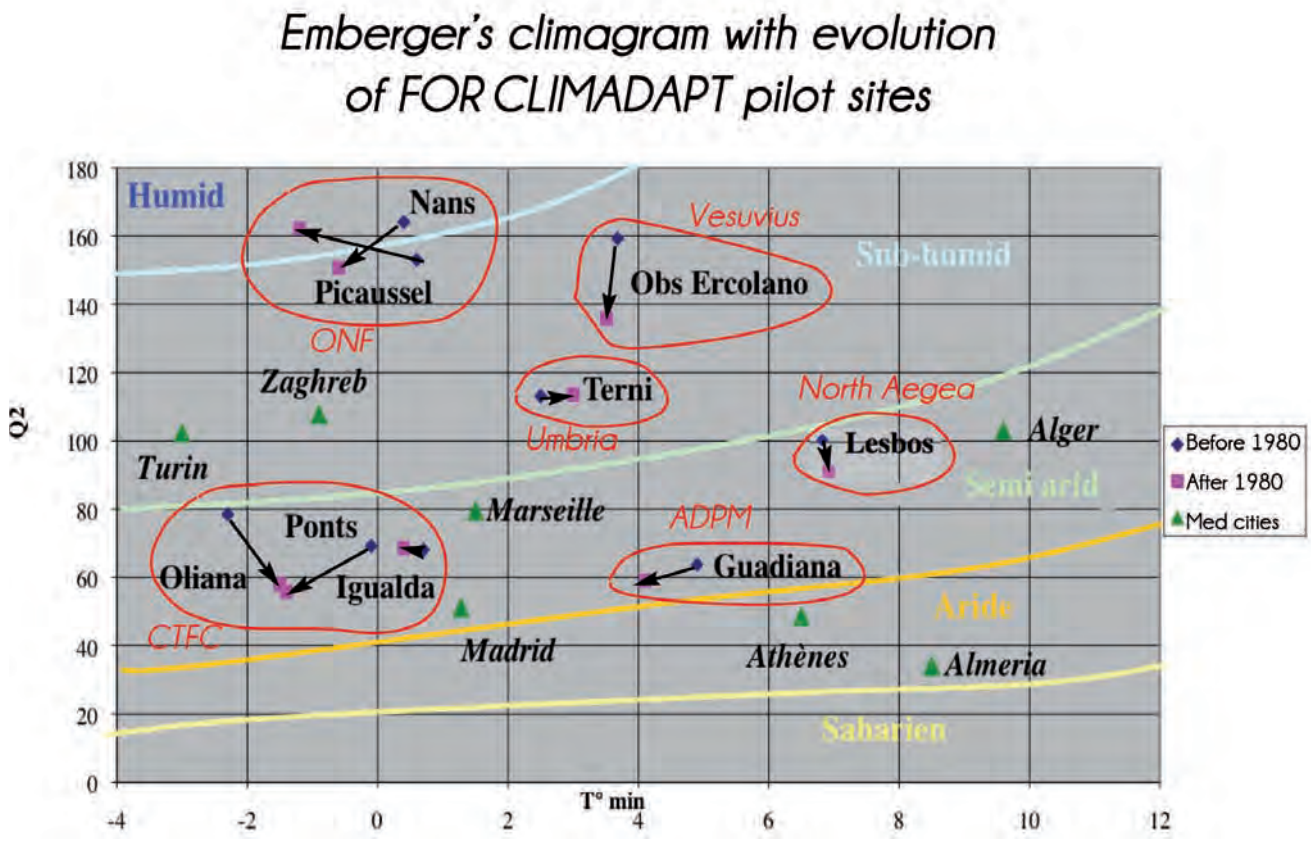
The meteorological stations are positioned in a two dimensional diagram with «m» as the abscissa (average of the minimum temperatures of the coldest month) and the calculated value of the «Q2» index as the ordinate (see above). Bio-geographical criteria allow partitioning the climagram mapping according to different Mediterranean climates [4], from the hottest and driest ones (bottom right) to the wettest and coldest ones (top left).

The AIFM's synthesis of the data communicated by the different partners was done based on a series of data over 30 years. The first is located before 1980, the second between 1980 and nowadays, knowing that it is more or less at that transition date that climate changes started to manifest themselves.

We see variations (marked here with arrows) that are far from homogeneous. Globally the aridity increases (Q2 decreases, downward arrows) but the winter cold (m) tends to accentuate.

3 - Caution: the temperatures are in degrees Kelvin (°C + 273).

4 - Source: C. Pierre QUEZEL: Ecologie et biogéographie des forêts du bassin méditerranéens. (Ecology and biogeography of forests of the Mediterranean basin). Editions médicales et scientifiques Elsevier SAS. Paris, 2003. More than 500 p.



Picture 2.2 : Emberger's Climagram with all the project's pilot sites.

2 - ADAPT FOREST MANAGEMENT TO THE EXPECTED CHANGES

Pilot actions : embedded scales

The following synthesis is about the concrete actions undertaken on the sites to counterbalance the effects of the changes examined in the previous section.

To take advantage of the huge diversity of the partners' pilot actions directly and sometimes indirectly connected to climate changes, the topics addressed are grouped not only according to the types of actions undertaken but also according to the embedded spatial scales, from the biggest to the smallest ones.

Stand scale: improve the resistance and resilience of forests through forestry and/or reforestation actions, or even to replace the most sensitive tree species.

Massif scale: anticipate crisis, think in terms of prevention and fight against wildfires and erosion…

Regional scale (and beyond), and integrating the civil society: the priority becomes raising social awareness, improving the territorial governances, etc.

2.1. Different tree species experimented

Different forest species were used within the partners' respective activities framework (reforestation, enrichment planting, ecological engineering actions…). The Peer group thought it would be interesting to establish a summarised database of these species in order to present the advantages and disadvantages of each one of them in an accessible and summarised way. The following table is only an extract of the information given by the Vesuvius National Park. The complete database, including information on the age of the reforestation and the origin of the tree species is available in the DVD attached to the present Book.

SPECIES	Function within the site	Performance in terms of development	Plasticity in response to climate change	Disadvantages
Pinus pinea	Anti-erosion ; pine nuts production	XXX	X	No natural regeneration
Pinus pinaster	Anti-erosion	XXX	XXX	
Piuns halepensis	Anti-erosion	XX	XX	
Pinus nigra	Anti-erosion	XX	XXX	
Robinia pseudoacacia	Anti-erosion	XXX	XXX	Considered as invasive
Genista aetnensis	Colonisation of open environments	XXX	XXX	
Quercus ilex	Pine forests enrichment	XXX	XXX	
Spartium junceum	Colonisation of open environments	XXX	XXX	
Cytisus scoparius	Colonisation of open environments	XXX	XXX	
Alnus cordata	Pine forests enrichment			Used in arid edaphic environment

1 2 **3** 4 5 6 7 8

2.2. Improve the stands resistance and resilience to climate change

Reminder of the species' biological reactions to climate changes

• **Accommodation or phenotypic plasticity** Elasticity and resilience. Mortality if limits exceeded.

• **Genetic adaptation**
From the vast intra-specific genetic variation.
But, most probably insufficient speed for the species with longer life cycle, namely trees...

• **Migration**
In altitude (1°C is approximately equivalent to 150 m upward) already observed by researchers. In latitude (1°C is approximately equivalent to 200 km northward) *but dissemination too slow to monitor the spatial variation of the climate – nowadays much faster than at the time of the latest post-glacial warming, for example.*

Photo 2.1: A young plantation of Atlas Cedar at the ONF pilot site of Nans (Alpes-Maritimes).

2.2.1. Reduce stands' density

The thinning of a forest stand decreases the leaf area index and the water consumption of the stand. The water resources are used by fewer elements making it easier for their needs to be satisfied.

This is a generally accepted assumption, but it must be validated through eco-physiological measurements. In fact, the thinning promotes the development of undergrowth that might compete for water. This is what the ONF is trying to assess in its pilot sites in Aude and in Alpes-Maritimes.

Photo 2.2: Strong thinning on Silver fir at the ONF pilot site of Picaussel (Aude).

2.2.2. Decrease rotation age

For a very dynamic silviculture we can promote the growth of the preserved trees and therefore decrease the rotation age.

This reduction of the risk exposure period constrains the possibility of damages to the stand.

In France it is also the ONF that works on these issues, namely:

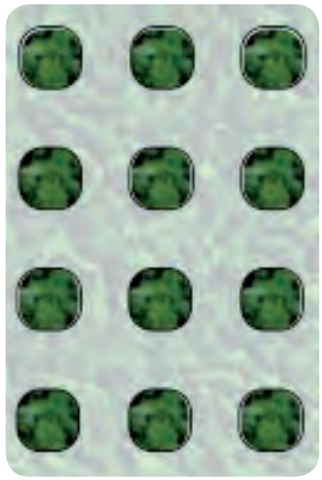
- On the Atlas Cedar (Nans site)
- On the Silver fir (Picaussel site)

Photo 2.3: Example of a correct regeneration of Cedars in a gap of an old stand in Nans (ONF).

2.2.3. Irregular stands' structure

• **Technique of the so-called «Group marking», or more explicitly, «reservation per patches»,** developed in the Umbria Region in very beautiful Holm oak coppices.

About 15 % of the stand's surface is preserved inpatches of some acres regularly distributed. The remaining area is clear-cut. During the following revolution — in about 30 to 35 years — the delimitation of the patches will be different.



BEFORE *AFTER*

Pictures 2.3 and 2.4: Group marking in the Umbria Region

A very homogeneous and regular stand (coppice) can be transformed into a heterogeneous stand. The biodiversity as well as the resistance to climate hazards increase.

Caution! This technique that seems to provide good results in very good seasons is not adapted to mediocre seasons when the preserved trees will find it difficult to make it through the doubled rotation… This remains to be validated in such situations.

• **Technique so-called «thinning by gaps»(CTFC)**

The silvigenesis process is initiated by thinned areas in small clearings that allow a correct natural regeneration. The repetition of these gaps in space and time allows obtaining irregular stands.

2.2.4. Promote tree species combination

All tree species do not react the same way to climate change or to a climate hazard. The combination of different species brings along some guarantee of stability and usually improves the stand's resilience. The two major actions taken toward mixed stands are the following:

- Favour the so-called secondary tree species when there are thinned areas.
- Introduce new tree species within the monospecific stands.

Several enrichment actions took place within the FOR CLIMADAPT project:

The Vesuvius National Park works on these[5] issues trying to favour the autochthonous species (*Fraxinus ornus, Quercus ilex, Q. pubescens*).

Photo 2.4 : The Manna ash produces good enrichment results in the Vesuvius stands.

In the monospecific pine forest of Catalonia, the CTFC (Forest Science Center of Catalonia) has also developed an important program that shows the stands enrichment with hardwood trees *(Sorbus aria, Fagus sylvatica, Quercus sp. pl.)*[6].

5 - See Progress Book No 2 pages 21 to 25.

6 - See Progress Book No 3 pages 28 to 29.

Photo 2.5: CTFC experiments enrichment techniques of monospecific stands of Scots pine (a tree sensitive to climate change) in the Catalan Pyrenees.

Photo 2.6: Several Mediterranean oaks with bushes were planted in Mértola at the Monte do Vento experimental area.

Photo 2.7: In this «seedling plot» of Downy oaks, the natural selection will eliminate the less adapted genotypes and will preserve those who are more resilient to climate change.

Photo 2.8: Pinus brutia, used in the Lesbos plantations and seedling, should be well adapted to fight climate change.

In the semi-arid plains of the Alentejo Region, in the South of Portugal, ADPM tries to reconstruct the Montado, a balanced agro-silvo-pastoral system, by planting different forest, fruit and even folder tree species [7].

2.3. Enhancing genetic adaptation of local tree species

2.3.1. Stimulate the natural regeneration through seedling

To promote the natural regeneration by seedling, that is, by sexual reproduction, allows expressing the entire genetic variation of the local populations. We hope to increase the chances for the species to adapt itself to the new climate conditions by gradually changing its genotype.

2.3.2. Plant adapted local tree species

It is always interesting to plant local tree species when they are considered well adapted.

2.3.3 Look for more «southern» provenances of local tree species

The provenances from the south of the tree species ranges (for example, South Africa) should be better adapted to the hottest and driest climates. But we must be concerned with their sensitivity to the winter cold or the late frosts. The «mountain» provenances should be preferred but the success of such introductions is not guaranteed. Successes and failures are well known to forest owners.

In its enrichment plantings, the CTFC uses local tree species that are near, instead of the same tree species

7 - See Progress Book No 1 pages 38 to 41.

Photo 2.9: Enrichment planting at 1600 m.

from southern regions. Altitude is also important: similar tests are done at three different levels (1000 m, 1300 m, 1600 m). Results are still partial[8], but they are promising, with higher survival rates after the first winter.

2.4. Replace declining species

When some species start to die back and are in danger of becoming extinct over a determinate area despite the efforts to favour their adaptation, forest owners should look for replacement species able to satisfy the social expectations: production when possible, landscape management, fight against erosion, etc. In humid or sub-humid climate zones, trees can be replaced by shrubs or bushes that will, to the best of their abilities, take on the ecosystemic functions of the initial forest. But in semi-arid zones, the plants recovery is very slow and the risk of desertification is high.

2.4.1. Use of exotic species

These are species that are not present in our countries nowadays but that might have prospered in previous periods as evidenced by some fossil pollen. It is the case of the Atlas Cedar whose introductions in the south of France are often successful (Ventoux, Luberon…). The ONF considers this Cedar as one of the possible major substitutes for Silver fir that is declining in the Alpes-Maritimes (site of Nans) or in Aude (site of Callong)[9].

As for the local species introductions, we should look for the most adapted provenances, namely because of their resistance to cold conditions. The ONF tests several provenances of the Atlas Cedars on the site of Callong .

Different local or exotic species are used in the different pilot operations of the FOR CLIMADAPT project. They are summarised in a list in the projects deliverables (attached DVD).

2.4.2. A vigorous debate between forest owners and environmentalists

Environmentalists claim that the species introduced do not have the fauna or fungi plant communities related to their original region. They believe that deregulations might happen in the ecosystems modified this way. Actually some species could become invasive!

Obviously, we should not play the sorcerer's apprentice and should previously test every species introduction in arboretums, for example. Considering the trees' lifespan, the installation of such tree collections should be done as quickly as possible, completing the existing arboretums that we should review considering climate change.

Most species used in forests are not invasive ones. Even the Black Locust, considered as such by the Vesuvius National Park technicians, progressively gives place to longer living species (oaks, arbutus, flowering ash trees…) within the normal plant dynamics. It is an opportunist pioneer species that can quickly occupy the vacant spaces. Under its crown, the oaks as well as all the other local ecosystem's elements can easily establish themselves.

The introduction of Mediterranean firs next to the local Silver fir of the Southern Alpes is prohibited by environmentalists under the pretext of «genetically polluting» the local Fir. Nevertheless the latter is dying back and many forest owners believe that this introgression could be positive.

The debate thus becomes very philosophical. Compromises could be reached while preserving vast areas of «pure» genotypes and allowing the reforestation of areas that could sustain beautiful, healthy and productive forests…

2.5. Adapt the reforestation techniques

Climate change will make it more and more difficult for plantations (or seedling) to be successful. In fact, plants must be able to deeply take roots to survive their first summer!

8 - See Progress Book No 3, pages 28 to 29.

9 - See Progress Book No 3 pages 37 to 38.

Land	Slope	Soil working
Flat land	0 - 9 %	Deep sub-soiling
Slight slope	9 - 36 %	same for contour lines
Average to steep slope	36 - 81 %	More or less sophisticated banquettes or loosen holes executed with «spider-excavator»
Very steep slope	> 81 %	Difficult and dangerous operation (rocks)…

1 2 3 4 5 6 7 8

2.5.1 Loosen the soil to enhance root growth

In the Mediterranean area, more than in other areas, it is of great importance for a plantation to properly work the soil. Several modalities sometimes implemented in the pilot operations are suggested to fight the constraints of the land.

2.5.2. Use plantation accessories

Soil mulching has proven to be effective to preserve the water for the small trees. It is preferable to choose biodegradable materials to rather than plastic ones: paper, cardboard, agglomerated cork or even localised spreading of compost or of ramial chipped wood.

The shade nettings and the green houses are also highly efficient. Unfortunately, the cost of these accessories very often limits their use to small surfaces…

The irrigation resulting from a few litres of water every 20 days each dry spring and during the first summer can, very often, save a plantation from being a complete failure. The cost of the technique and the availability of this precious liquid are also limiting factors.

Photo 2.10: Plantation and seedling test in the Lesbos Island. Several soil working and brushing modalities were tested in the North Aegean Region (see Progress book No. 3 pages 40 and 41).

3 - ANTICIPATE DIEBACKS, PREVENT FIRES, FIGHT EROSION AND REHABILITATE DETERIORATED LANDS

All preventive or anticipating actions require reasoning regarding the Forest Massif. If most pilot actions related to this subject were conducted on a small-scale, it is because their main goal was to elaborate and test environment prevention or rehabilitation methods that would become reproducible at the massif scale after being validated as technically sound.

1 2 3 4 5 6 7 8

3.1. Monitor and manage stands diebacks

3.1.1. Learn how to observe diebacks

In France, a protocol named *« DEPEUFEU »* (dieback of the deciduous stands) was developed by the DSF (Department of Forest Health). Its basis is the observation of the transparency and uniformity of crowns. A rating system with calibrated photographs was established and is commonly used.

Another protocol, named ARCHI, is based on the architecture of the branching and a specific classification of suckers. It was developed by the IDF (Institute for Forest Development). It allows predicting the near death or resilience of a tree that went through a stress period.

3.1.2. Mapping the deeply affected massifs

Namely thanks to the Geographic Information Systems (GIS) and to remote sensing (aerial/satellite photo…) digital cartography is a more and more accessible and efficient tool to identify stands that might be dying back and set up a crisis management strategy.

Although it was not used for this aim within the FOR CLIMADAPT project, numerous similar actions have been undertaken namely by some project partners. It is the case of the ONF that prepares « Mortality maps » of the Alpes-Maritimes [10].

3.1.3. Make the right decisions in the very short term

A « crisis management protocol » *(protocole de gestion de crise)* proposed by the IDF was presented at the opening seminar organised by the partner *«Association Forêt Méditerranéenne».* This protocol enhances the planning choices according to the observed diebacks.

3.1.4. In the medium term, anticipate diebacks

The eco-climatic niches of the main species can be easily modelled. We can use the example of the Atlantic oak forest, studied by the IDF, or the on-going study on the Downy oak in Provence. These studies allow anticipating the species' behaviour within the perspectives considered in the different scenarios established by climatologists.

Photo 2.11: The Silver fir withers in the Southern Alpes. Which strategy should we adopt? Letting it rehabilitate itself abundantly as it has been doing, knowing that it is not adapted to the climate change? Or trying to replace it with a more resistant species such as the Atlas cedar or even tree species similar to the Mediterranean firs (Abies cephalonica, A. bornmuelleriana, etc…).

3.2. Observe accurately the vegetal dynamics

The present knowledge of the vegetation dynamics related to ecological stations is based on climate consistency. But the latter is changing rapidly!

Most known phyto-dynamic models, as well as the stations' catalogues must be reviewed. In fact, in the Mediterranean region, the most xerophilic dryad species (e.g. Holm oak) should replace the most mesophilic ones (e.g. Downy oak).

At a smaller scale, the CTFC mapped the evolution of the Pyrenean stands of *Pinus uncinata*. Be careful, land uses modifications interfere with the constraints of the climate change and it is not always easy to distinguish these events.

3.3. Address the increasing risk of wildfire

According to the specialists, more frequent and intense summer heat waves and droughts will undoubtedly lead to an increased risk of wildfires in forests and other natural environments.

3.3.1. Enlargement of the exposed areas

Areas that are until now out of risk in the outskirts of the present Mediterranean zone or in altitude, are, or will be, in the medium term, exposed to fires. These regions, as well as the areas of the Mediterranean countries nowadays designated as «red», should be equipped with means to prevent and fight fires.

Photo 2.12: Detailed observation of the vegetation dynamics in permanent plots installed at the Vesuvius National Park.

3.3.2. Risk increase in the already sensitive zones

In the thermo and meso-Mediterranean zones, traditionally exposed to wildfires for a long a time now, the frequency and the intensity of the fires should increase slightly. Moreover, the synchronisation of the vegetation regrowth periods of the scrubland or shrubs after a first fire leads to the homogeneity of the vegetation landscape. This enhances the risks of starting new fires and increases the spreading speed of the following fires. This vicious circle is well-known on the northern shore of the Mediterranean.

The Mediterranean vegetation has co-evolved by adapting itself to fires and nowadays it mainly includes pyrophytes. These plants produce suckers (like the Cork oak), sprouts (like the Holm oak) or spread by seeding as a result of the fires (like the Aleppo pine). But this adaptation has limits! When fires are too frequent, this capacity is exceeded and the vegetation cover finds it harder to « heal ». The ground is bare, the organic matter is burnt, the first horizon, the most «living» part of the soil is stripped by erosion. This often irreversible degradation limits the ecosystems productivity and reduces their surface water retention function. As typical heavy rains from the Mediterranean regime start falling, runoff, erosion and catastrophic floods become growing concerns.

The semi-arid regions, such as Alentejo in Portugal, are the most threatened ones by this desertification that arises from the degradation of the soils related to wildfires, the increasing climate aridity as well as the poor farming practices.

3.3.3. Outbreak of «convection» fires

According to Catalan specialists [10], climate change influences the low atmospheric layers' circulation. The Saharan air layers sweep southern Europe during the summer, creating new meteorological phenomena. The Mediterranean vegetation reacts to this heat by issuing high quantities of VOC (Volatile organic compound) in a highly inflammable way. «Explosive» wildfires develop over vast surfaces and very quickly. This considerable energy creates convection winds that increase the propagation speed. For firemen and forest inhabitants, the danger is multiplied.

3.3.4. Learn how to «live with fire»

Every prevention measure must be implemented, in particular brushing around the residences and the human infrastructures over at least a fifty meters radius. Even if the fire goes through — because it is difficult to stop it with works – its damages will be less significant. The front of the house might be blackened but the house will not burn down. In terms of resilience, this is the type of improvement that we must look for in inhabited areas.

In forests, the biomass accumulation in the understorey must be limited because when this fuel is burning it generates huge quantities of energy and lethal temperatures for the trees. By contrast, a prescribed burning in low non-dense vegetation can blacken the trunks but many trees will survive.

Photo 2.13: Convection fire.

3.3.5. FOR CLIMADAPT lessons

First and foremost we must learn more about the territories vulnerability by mapping the plant based fuels and the other fire factors. Fire propagation models allow obtaining a cartographic map of the risk that conjugates the patrimonial issues, the plant formation vulnerability and the intensity of the predictable hazards.

These cartographies are used in most countries to improve the territory planning and the location of the prevention works based, as much as possible, on natural barriers: rocks, water bodies, agricultural zones: vines, olive plantations, etc.

In the Umbria Region, for the Valnerina valley, communication has been developed through a fire risk cartography system [11], to allow both anticipating the fire occurrences and making the populations aware of this quite new phenomenon that is still not very integrated within the behaviours.

To fight against fire, we must first get safely close to it and then attack the fire lines where their intensity can be decreased through a diminution of the biomass. It is the role of the fuel cuts, sometimes mistakenly called « firewall », combining the horizontal discontinuities (brushing) and the vertical ones (pruning).

10 - See «Forest fires in Catalonia: current state and perspectives», Progress Book No 3 pages 20 to 21.

11- See Progress Book No 2 pages 28 to 34.

The implementation and maintenance of such works are usually very expensive. This is why the Catalan partner carefully reflects on this subject within the FOR CLIMADAPT project.

The aim is to avoid crown fires that are more intense and more destructive. This way, firemen can safely get close to the flame front with increased security and the damages inflicted to the trees will also be limited. In this case, damages are reversible and many trees survive. Prescribed burns were also identified as a promising path, mainly for the maintenance of such preventive works. When possible, it is also interesting to develop synergies with the breeders in order to develop the pastures using livestock that might efficiently contribute to the maintenance of the understorey.

It is worth mentioning that many cooperation programs were developed within the area of the defence against fire hazards [12] and they integrated the effects of climate

Photo 2.14: The Umbria Region partner experiments different brushing modalities.

Photo 2.15: In strategic areas duly located via cartography and the firemen's experience, a specific and original prevention is being experimented. The idea is a limited and less expensive intervention on the fuel vertical continuity, by suppressing the «fire ladders» that transfer the flames from the low stratum towards the crowns through well targeted pruning actions.

Photo 2.16 : In these semi-arid zones, ***ploughing actions in the direction of the slope should be prohibited.*** *A possibility is to replace the ploughing by a hogging, but the planning of large banquettes sustained by linear plantations of trees and bushes also allows cultivating the soil in good conditions.*
It is a culturally acceptable extension of the ancient agro-silvo-pastoral systems of the montado, very common in Portugal, namely in Alentejo.

Photo 2.17: This small ecological engineering works are done to stabilise eroded slopes. They combine the use of local wood logs and the revegetation with wooded species that have been carefully selected. It is important to respect the proposed standards regarding the logs dimension as well as the plantation density to guarantee the sustainability and the efficiency of the works.

12- The major projects to which FOR CLIMADAPT and/or some partners were associated with are: MED PROTECT « An Integrated European Model to Protect Mediterranean Forests from Fire » ; FIRE PARADOX "Fight fire with fire" ; MED CYPFIRE « Cypress green barriers against fire: a feasible, ecological and economical solution to protect the Mediterranean regions» ; PYROSUDOE « Forest-habitat interfaces and fires », or even the COST Action FP0701 "Post-fire management in Southern Europe".

changes. Numerous references were made to their works during the field trip.

3.4. Prevent soil erosion and desertification

The semi-arid zones are particularly sensitive to these risks that are highly increased by climate change. In fact, the recovery speed of natural vegetation is weakened because of the aridity and the shorter growing periods.

Within this context of environmental fragility, **poor farming practices** are often at the origin of the desertification process. The expected climate aridity increase should accentuate the phenomenon.

In this case, the experience of the Portuguese partner is particularly precious in terms of prevention of both surface erosion and of linear erosion in the valleys.

3.5. Contain localised erosion processes

Within this very specific area, a transferable experience is being acquired by the Vesuvius National Park. It could be compared to the Mountain Land Restoration program (RTM) implemented in France by the forestry services. The idea is to contain bare or unstable ground erosion for several reasons with different devices and materials (in Vesuvius, it is the case of young volcanic soils with steep slope and not well structured) (See Photo 2.17 below).

4 - TRANSFER KNOWLEDGE, RAISE SOCIETY'S AWARENESS AND IMPROVE PARTICIPATING GOVERNANCE IN TERRITORIES

4.1. Transfer knowledge acquired by the specialists to the territorial managers

Scientific knowledge on climate change evolves every month because countless researchers are concerned with the subject in many countries.

Some innovations are experimented at a technical or scientific level and ignored by other publics, namely territorial managers or planners who nevertheless are still waiting for answers.

It is particularly important to monitor the transfer of this knowledge. This is, in fact a «weak link» often highlighted, namely at the inaugural seminar of the FOR CLIMADAPT project, organised by the *Forêt Méditerranéenne* association in Marseille [13].

This transfer causes many institutional problems. In fact, researchers are lead to believe that their function stop when their results are published in an international scientific magazine (which is what they must do to develop their career). Nevertheless, these articles, moreover often in the English language, are almost never accessible to the field managers (See chapter on projects' methodology, pages 5 to 8).

In France, some engineers from the IDF (Institute for Forest Development) or from the CRPF (Regional Centres of Forest Property) are in charge of scientific monitoring and popularisation but there are only a few of them.

In Catalonia, the CTFC (Forest Science Center of Catalonia) is extremely well organized, grouping applied researchers but also technique popularisers and trainers who convey the information to the forest owners.

Photo 2.18: In Portugal, the experimental area of Monte do Vento is a tool for the transfer of techniques to the forest and agricultural sectors.

13 - See Progress Book No 1 pages 26 to 28.

4.2. Inform and raise awareness of the populations in the exposed territories

A specific and well-targeted pedagogy must be implemented for the local populations of sensitive territories in order to raise their awareness and for them to be able to adapt to the expected changes. The progressive climate change is the most obvious message to communicate but people are usually most interested in its consequences, such as the increase of wildfire risks. This is what they really understood well in Umbria. The organisation of public meetings with participatory surveys and discussions to stimulate the inhabitants' reflections can change opinions and get messages through, such as «live with fire», «save water» or even «use the renewable energy of the fuel wood» instead of fossil energies responsible for the increase of CO^2 content in the atmosphere. Here, we address the concept of climate change «mitigation», which is not the main object of FOR CLIMADAPT that is focused on «adaptation».

The planning structures of natural parks, national ones (Vesuvius) as well as regional ones (Valle do Guadiana) are often positive tools to convey these messages to the general public.

4.3. Encourage decision makers to consult specialists

This is common sense, but many decision makers believe they have no need for the forest owners or ecologists' competences when they deal with natural environments issues. Many failures could be avoided and public or private funds saved if competent experts were consulted before some projects are launched.

Photo 2.19 : Nies Kidonies pilot site (North Aegean Region, Greece), where a typical reforestation operation took place after the «natural» reforestation failure with clay balls including seeds.

The case of the Kidoniès pilot site [14], in the north of the Mytilini city (North Aegean Region, Greece), has been particularly significant in this sense. With minimum precautions, a better location could have been chosen for a pedagogic plantation that brought together inhabitants and school children. In fact, the ecological and paedological conditions of the site do not allow tree planting. It is true that the small range of this plantation does not bring huge financial consequences but the communication operation is hindered by the complete failure of the operation, and good intentions might be discouraged…

4.4. Reach policies and institutional decision makers

FOR CLIMADAPT's aim is not, of course, to advocate/lobby, but many local elected individuals or territorial authorities' collaborators participated in the seminars organised by the partners in their respective countries and carefully listened to the technical recommendations.

Within the project framework, a survey was done by the Peer group members on the forest policies of each country regarding the adaptation of forests to climate change [15]. It seems like many initiatives or measures could be reproduced in other countries within the European Union but also beyond it [16].

On the other hand, a new «capitalisation» European project named MEDLAND 2020 has just began (July 2013-Decembre 2014). Its aim is to extend and promote the actions conducted within the several MED project frameworks related to the natural resources management (in particular the forest ones), in which FOR CLIMADAPT is represented, focusing namely on the communication, at macro regional scale, of the conclusions and recommendations from these projects to the stakeholders of these sectors as well as to major international institutions (European Parliament, FAO…).

Such actions as knowledge transfer, public awareness, raising consciouness of decision makers, etc. are grouped under the generic term of **governance.** This need to improve governance had already been diagnosed and addressed within the framework of the QUALIGOUV [17] project « Improve governance and quality of forest management within the Mediterranean protected areas ». It is a fundamental factor for the success of territorial planning and the harmonious cohabitation between Man and nature. The integration of climate change should also strengthen this need.

14- See Progress Book No 3, pages 41 et 48.

15 - The syntheses produced by the Peer groups members are available in the DVD of deliverables attached to this Book.

16- At the 3rd technical seminar, in Torre del Greco (Italy), representatives from the eastern shore (Liban, Turkey) and the southern shore (Tunisia) were associated to the partners' and Peer group's exchanges. This was an enriching enlargment for the project as well as for all those interested. See Progress Book n° 2, page 25.

17 - See http://www.aifm.org/nos-activites/projets-de-cooperation/qualigouv.

Conclusion

This synthesis is, obviously, a somewhat simplified one. The issues addressed within the FOR CLIMADAPT project are numerous and complementary. They are structured and organised but they cannot be detailed here. For more detailed information, please see the project progress books and the reports of the seminars available on the project website **www.forclimadapt.eu**, under « Publications »), as well as the DVD attached to the present Book, gathering all the deliverables produced by the partners, the Peer group and the AIFM.

Within a set of very diverse pilot operations, we endeavoured to look for the common reflection and transferable technical acquired knowledge that could contribute to support a common Mediterranean vision of climate change, shared by as many concerned stakeholders as possible. For European and national decision makers, it will constitute a very useful technical basis allowing them to consider successful and non-successful experiences from the FOR CLIMADAPT partners as references, within their own action programs related to forests and climate change. For us, the Peer group's members, this is one of the most satisfying points of the project.

PART 3 Details of the activities undertaken within the FOR CLIMADAPT project

This part presents the detail of each partner's activities within the project. The Peer group's members had the responsibility to elaborate, in collaboration with the partners, a balance with a critical vision of the actions undertaken, or possibly unfinished, as well as those not executed. This chapter highlights what was achieved focusing on the input of the FOR CLIMADAPT project, on what is transferable to other contexts, and what did not work, explaining as well as possible the success factors and the reasons for the malfunctions.

Partner's activity balance: NATIONAL PARK OF VESUVIUS (PNV) – ITALY

WEBSITE: : www.parconazionaledelvesuvio.it

1. Objectives and context

Partner's presentation

The Vesuvius National Park, Project leader, was founded in 1991 to safeguard the ecology and heritage values of the territory, allow a harmonious integration between Man and the environment and promote environmental education and scientific research activities. The park covers 8 482 ha in the Province of Naples around the Vesuvius, a typical example of a volcano made up of a truncated cone, still active. The territory, rich in unique elements in historical and natural terms, counts on a quality agricultural production marked by the diversity and originality of its local flavours.

General objective

The general objectives of the FOR CLIMADAPT project the PNV was working on were the following:

- Adaptive forestry (axis 2).
- Restoration and management of the damaged areas (axis 3).
- Improvement of governance (axis 4).

Specific objectives

More precisely, the following were the objectives to achieve:

- To record the risk perception.
- To identify the foreseen solutions.
- To share the on-going experiments.
- To share the experiments on forest management and restoration of damaged lands.
- To choose the best experiments.
- To define the best management and planning solutions for the Mediterranean forests of the Vesuvius.

General description of the context

The Campania region has a surface of 1 359 354 ha and a forest surface of 445 274 ha (33% of the total). Around 792 ha of the region's territory (6% of the total) are classified as volcanic complexes. The Somma-Vesuvius system is the most important active volcanic system, not only at a regional level but in the entire continental Europe.

The Vesuvius itself is characterised by the volcanic cone, which has been active for the past two millennia. The soils are pyroclastic deposits not very evolved and the forest vegetation is characterised by pine forests *(Pinus pinea and mostly Pinus pinaster)* from anthropic origin and by formations of *Spartium junceum* and *Genista aetnensis* also resulting from reforestation activities. The Olm oak *(Quercus ilex),* partly from an anthropic origin and partly from a natural origin, is the tree species that shows the best capacity to colonise forest lands.

The oldest part of the volcanic system is represented by the mount Somma, positioned in the north part of the Park. Here the soils are much older and therefore more evolved and the forest vegetation is represented by aban-

PILOT SITE IDENTITY FILE	
Particular status and available regulation and planning tools	National Park and Natura 2000
Pilot site area	8 482 ha (PNV)
Population	35 2180 inhabitants (42 / km^2)
Main cities and municipalities	Napoli, Portici, Ercolano, Torre del greco, Boscoreale, San Giuseppe Vesuviano, Ottaviano, Somma Vesuviana, Sant'Anastasia, Pollena, San Sebastiano
Forested area in the pilot site	3 775 ha (44%)
Organism locally responsible for forest management	Vesuvius National Park, Campinia Region
Main forest tree species	Prevailing artificial forests *(Pinus sp., Genista aetnensis, Robinia pseudacacia, Castanea sativa)* Pure and mix stands *(Quercus ilex, Q. pubescens)*. Natural forest near the summit *(Betula pendula, Alnus cordata, Populus tremula)*
Stand productivity	1400 trees / ha
	Yearly volume extracted: 4 m^3/ha
Main role of the forest	Conservation and recreational uses
	No grazing
Other land uses category on the pilot site (non-forested area)	Agriculture
Annual amount of precipitations	950 mm
Mean lower temperatures of the coldest month	8.2°C
Mean higher temperatures of the warmest month	26.5°C
Global geological conditions	Volcanic rocks: Vitric- Eutric Leptosols, Lepti- Vitric Andosols, Vitric Andosols- Calcari-Vitric Andosols, Calcari-Vitric Cambiosols, Molli Vitric Andosols, Tephric Regosols
Main natural risks threatening the pilot site	Forest fires, landslides
Main potential climate change related impacts in the region	Erosion, desertification and worsening of the forest fire
Existing initiatives regarding the adaptation to the climate change in the region	None

doned chestnut groves *(Castanea sativa)* in coppice and deciduous formations with mostly *Quercus pubescens, Fraxinus ornus, Alnus glutinosa* and *Ulmus campestre.*

The entire forest surface of the Park is taken by an invasion dynamic of invasive species, among these the *Robinia pseudoacacia,* whose development is considered problematic by the forest services.

Within the FOR CLIMADAPT project, the PNV has taken on two problematics considered as important for the management of the National Park territory:

- The important presence of unstable pyroclastic deposits, at the origin of the initiatives based on the principles of biological engineering.
- The important presence of invasive plants in the major forest stands of the Park.

All the interventions foreseen were framed within the context of the issues related to the climate changes.

2. Description of undertaken actions

Action 1

Standardisation and application of the biological engineering procedures and transfer to the Forest Service.

Action 2

Fight against the invasive exotic species (implementation of 22 monitoring plots), namely of *Robinia pseudoacacia.* This action took place in the extension of other European projects (namely DESERNET and RECOFORME).

Balance of the actions undertaken at the end of the project

The results obtained within the project are in line with the activities planned at the beginning.

Action 1

The pilot sites were chosen to intervene in this action taking into account the restoration and the execution of ecological engineering works on the field.
An intervention protocol for the biological engineering works was established.

A list of the species used in the biological engineering works and their characteristics was elaborated. This list was in particular focusing on the autochthonous species of the Park's territory.

Action 2

The objective was to determine the forest management forms that allow decreasing the expansion of the *Robinia pseudacacia* and improving the expansion of the *Quercus ilex* and other autochthonous trees. The pilot sites were chosen within the «Tirone-Alto Vesuvio» Reserve among the

Photo 3.1: Pine forest of Pinus pinea before the cut.

Photo 3.2: Pine forest of Pinus pinea after the cut.

Photo 3.3: Experimental plot of Pinus pinaster with regeneration of Quercus ilex and Robinia pseudoacacia before the cut.

Photo 3.4: Wooden box with double living wall (Vesuvius type).

experimental plots implemented within the RECOFORME project.

The experiment results showed that the forest intervention that better addresses the invasion problem of the *Robinia pseudoacacia* are the following:

- Thinning of the pine forests (10 to 20% for *Pinus pinea* and *Pinus pinaster*).
- No cutting in *Robinia pseudoacacia* stands.
- No cutting in *Quercus ilex* stands.
- No cutting for the *Robinia pseudacacia* trees in mixt deciduous forest.
- Seeding (S1) of autochtonous species (*ex. Alnus cordata, Quercus pubescens, Castanea sativa, Fraxinus ornus* and *Quercus ilex)* in the pure stands of *Robinia peudoacacia.*

Next phases and future opportunities

Action 1

At mid-term, structural analysis of the plants roots used in the biological engineering works.

Action 2

Data use and conclusions resulting from the project to improve the forest management of the Park.

In order to better understand the role of the climate with the dynamic of the invasive species, a meteorological station was installed at an altitude of 1055 m on the slope of the volcano, with the aim of linking the climatic data and the colonisation dynamic of the *Genista aetnensis.*

3. Main deliverables

Action 1

The main products of the PNV are the intervention protocols for the biological engineering works. The management recommendation present in these documents can be applied in other contexts with Mediterranean forest environment:

- L32_P1_2A: Operation sheet – Brush and hedge layer
- L32_P1_2B: Operation sheet – Slope grid, vegetated wooden grating
- L32_P1_2C: Operation sheet – vegetated log cribwall
- L32_P1_2D: Plant species recommended in bio-engineering works in the National Park of Vesuvius

Action 2

Guidelines for forest management to control exotic species.

Communication documents

- L25_P1_1A: Synthesis of the geographical data of the pilot site
- L32_P1_1: Book with the synthesis of the activities of the Vesuvius National Park
- L32_P1_2E: Presentation of the FOR CLIMADAPT project

Remind: All the deliverables are available in the project's DVD and website.

4. Difficulties and possible improvements

Actions 1

Difficulties

It was not so easy to transfer the knowledge acquired within the project to the technical staff regarding the biological engineering works.

Possible improvements

More flexible information exchanges should allow an improvement in managing the coherence between the field activities and the timeline.

Actions 2

Difficulties

One of the main difficulties was the transfer, on the field, of the activities planned within the project by the technical staff of the Park.

Moreover, the location of some experimental plots caused problems due to the strong growth of the vegetation since their implantation.

Possible improvements

In the future, the communication and training methods for the technical staff should be improved.

5. Elements transferable/replicable on a large scale

The main replicable elements on a large scale are the following:

- Intervention protocol for the biological engineering works.
- List of species used in the biological engineering works.
- Methods to contain the development of *Robinia pseudoacacia*.

6. Benefits derived from FOR CLIMADAPT project

Among others, the project provided the following benefits:

Action 1 and 2

- Improvement of the general scientific and technical knowledge.
- Improvement of the procedures of forest planning.
- General improvement of the knowledge of the Park territory and its problematics.

Action 2

- Exchange of experiences with experts who operate in different Mediterranean environments.
- Awareness about several issues related to climate change and forest planning in the Mediterranean region.

Partner's activity balance: UMBRIA REGION – ITALY

WEBSITE : www.regione.umbria.it/

1. Objectives and context

Partner's presentation

In Italy, the regions have the exclusive competence in terms of forests. As a result, the administration of the Umbria Region exercises the functions of programming, orientation and implementation of EU regulations in this sector, particularly through the Regional Plan (AIB) for forest fires regulation.

In addition, the regional government develops activities related to the knowledge of the forests and is responsible for the promotion of research, experimentation and implementation of demonstration projects in forestry.

Objectif principal

The main issue is the awareness raising and involvement of the population and local organizations for the de-

fence of biodiversity and forest resources as a fundamental factor in the water cycle and wildfire prevention.

The Umbria Region conducts studies to raise awareness and actively involve the public and local agencies in the development of systems for the prevention of forest fires. The aim is to involve key stakeholders and implement actions to preserve forest heritage and biodiversity in a context of climate and social changes.

The activities of the Umbria Region within the project are structured around the following topics:

- Analysis of the territorial context (environment, socioeconomic situation...) in order to highlight the current (and potentially future) difficulties for fire prevention and fighting.
- Establishment of an initiation workshop, to define a model of local organization focused towards the wildfires prevention in a changing context.
- Forest fire prevention plans, local fire fighting plans and Energy biomass supply plans.
- Communication through leaflets, articles, website, seminars and other meetings.
- Evaluation and exchange of experiences with partners.

Description of general context

In Umbria, the constantly growing forests cover 371,574 ha, representing 44% of the territory (29% average in Italy). Almost a third part is constituted of public properties, and 87% are coppices (42% average in Italy), particularly Oak coppice. More than 90% of production is valorised as firewood. Approximately 40% of households use wood for domestic heating.

Pilot site

The pilot site, covering an area of 13,000 ha, is located in the administrative territory of the Mountain Community of «Valnerina» (municipalities of Terni, Ferentillo, Arrone, Montefranco and Polino). This is a chain of hills with limestone massifs in the south of the Umbria Region, along the lower valley of the Nera River. The territory is characterized by rugged terrain and extensive forest cover predominantly consisting of coppice of *Quercus ilex* and P*inus halepensis stands*. (Photo 3.5)

The Mountain Community of Valnerina includes 15 municipalities and covers an area of approximately 113,000 ha. It is located in a largely mountainous region, marked by deep and narrow valleys with steep slopes and peaks often exceeding 1,000 meters altitude.

Forests cover about 57% of the territory (compared to only 44% across the Umbria Region) and are characterized by a high density of Beech. The main management system used is coppice (more than 90% of the forest area). Semi-natural grasslands cover higher mountain areas. The most important rivers are the Nera (main tributary of the Tiber) and the Corno. A large part of the flow of these two watersheds is taken up to feed the hydroelectric system in the area of the Marmore waterfall.

PILOT SITE IDENTITY FILE	LOW VALNERINA – TERNI
Particular status and available regulation and planning tools	Public Forest Forest management plan Natura 2000
Forest management plan	35 208 ha
Natura 2000	119 815 habitants. (340 hab/km^2)
Pilot site area	35 208 ha
Population	119 815 inhabitants. (340 inhab/km2)
Main cities and municipalities	Terni, Arrone, Ferentillo, Montefranco, Polino
Forested area in the pilot site*	18 979 ha (54%)
Including private forests	10 254 ha (54%)
Organism locally responsible for forest management	«Valnerina» Mountain Community
Main forest tree species	*Quercus ilex, Pinus halepensis*
Stand productivity	Mature coppices : 156 m^3 ha
Main role of the forest	Protection and production
Other land uses category on the pilot site (non-forested area)	Agricultural areas 33%, urban areas 8%, grazing 4%, rivers and lakes 1%
Annual amount of precipitations (millimetres)	963 mm
Mean lower temperatures of the coldest month (°C.)	3,0 °C
Mean higher temperatures of the warmest month (°C.)	32,1 °C
Global geological conditions	Calcareous massifs
Main natural risks threatening the pilot site	Wildfires
Main potential climate change related impacts in the region	Increase of the number of fires, water stress, forest stands dieback.
Existing initiatives regarding the adaptation to the climate change in the region	SECLI « Siccità e Cambiamenti Climatici » http://secli.unipg.it/secli/frontend.jsp?script=intro_smb.jsp&id=56 (Droughts and climate changes) POR-FESR 2007/2013 - Axis II, Activity a1), action 4

The difficulties of the karst relief led to a strong depopulation during the second half of the 20th century, accompanied by a marked aging of the population. Economic activities are mainly farms, forestry and pastoral, often in a familial structure. The tourism sector is also significant, especially in localities with an important religious heritage and others hosting major sporting events, sometimes international.

Justification of local needs

As well as in other Mediterranean regions, one of the most serious consequences of climate change is the increasing risk of forest fires. Indeed, the data show a significant correlation between the number of fires and increasing temperatures and droughts, and climatic data show that Umbria switched from humid to sub-humid in the latest 30 years (See climagram page 13).

Data provided by the Regional Plan AIB, show that in the period 1992-2006, the average forest area burned annually is approximately 370 hectares.

In 2011, in Umbria, 123 fires were reported, 108 occurred in forest areas, and in total 217.26 hectares of forest area were affected by fire. On average, that year, each fire burned a wooded area of 2,01 hectares. In 73% of cases, the forest area burned by fire was less than 1 ha and the forest area burned did not exceed 30 hectares in any case. In 2012 (preliminary data), were reported 186 fires, for a total of 2447 hectares affected. Wooded burnt area represent 1632 hectares, which means that each fire burned an average wooded area of 8.8 hectares.

To fight against this calamity, each year, there are many activities, such as cleaning of slopes and the creation of fire belts. The forest fires prevention activity is organized by a regional plan (Regional Council deliberation n°865/2009) and an annual programming document. The most sensitive forest type are *Quercus ilex* stands (Holm oak) and Mediterranean conifers forest.

2. Description of undertaken actions within the project

The most important actions of the project were the following:

Action 2: Field Activities

- 2.1 Diagnosis and comments
- 2.2 Adaptive forestry
- 2.3 Education, training and governance

Action 3: Communication component

- 3.1 Local promotion of undertaken actions

The phase 2.1 consists of:

- Analysis of climate data, use of land and resources, forest fires, economic and social data, cartographic data, preliminary valuations
- List of local stakeholders
- Scenery processing
- Analyses of economic benefits

Only the analyses of economic benefits are still in progress.

The phase 2.2 was completed as scheduled:

- Conceptualisation of demonstrative project
- Demonstrative project implementation

Demonstrative forestry interventions aim to identify management methods that reduce the vulnerability of forest stands to face forest fire risks. Modular fire belt and coppice with cluster-standards took place on plots of public property (8,000 hectares including the Arone municipality forest) under forest management plans (Photo 3.6)

The phase 2.3 was completed as scheduled:

- Participation process
- Local plan for forest fire prevention and fighting
- Energy biomass supply plan

The Umbria Region considered that in order to develop a more effective Local plan for forest fire prevention and fighting, it was necessary to obtain the support and participation of stakeholders from the municipalities involved in the FOR CLIMADAPT project (Photo 3.7). According to

Photo 3.5: Valnerina pilot area view (Source: Umbria Region archives).

Photo 3.6: Valnerina demonstrative interventions: the modular fire belt (Source: Umbria Region archives).

Photo 3.7: Participation process: the last meeting in March 2013 (Source: Umbria Region archives).

Figure 3.1: Logo of Participation process: «Decide together for the Italy's green heart forests» (Graphics by Compagnia delle Foreste, Arezzo).

this approach, four participatory meetings took place in February, May and October 2012, and March 2013[1].

The phase 3.1 is still in progress. Targets of the local promotion actions are:

- to involve local stakeholders in the monitoring and prevention of forest fires
- to better understand:
  - their relationship with the forest
  - their perception of the territory,

…and then:

- identify critical points in the Local plan for fire prevention and fighting.

3. Main deliverables

- Local plan for forest fire prevention and fighting is a pilot project aimed to evaluate the effectiveness and the method of the actions. It may in the future be included in the Regional Forest Plan and carried out on other Umbria's districts. To download the Local plant (Italian version only) please follow this link: http://www.foreste.regione.umbria.it/mediacenter/FE/articoli/progetto-for-climadapt-piano-antincendio-locale-pa.html

Remind: All the deliverables are available in the project's DVD and website.

4. Difficulties and possible improvements

With the FOR CLIMADAPT project, the Umbria Region strives to conduct activities based on the close relationship between forests and climate change, taking into account the social and environmental characteristics of the region. So the question of data quality and sources are not yet fully solved.

Another complementary objective could be to develop a system of training programs for farmers, breeders and foresters to improve the understanding about what to do and not do in woodlands.

5. Elements transferable/replicable on a large scale

The Umbria Region, where the majority of fires are caused by people, has established a forest fire prevention and fighting local plan (PAL) in the lower Valnerina area. This plan will be based on a participatory process, which means educating and involving people and stakeholders into a program for prevention and fight against forest fires. This is why continuous prevention and awareness raising can be an even more valuable tool against fire.

These models are applicable in any other country or region that faces similar situation.

6. Benefits derived from FOR CLIMADAPT project

Linkage to the local community and participatory process are an important innovation in regional policy. An improvement of governance is expected because this process is supposed to promote a comprehensive vision of the territory by policy makers.

To share our projects with international partners with similar situations was clearly a good support to have a better view of the problem.

1 - One more than planned at the beginning (Fig.3.1).

Partner's activity balance: FOREST TECHNOLOGY CENTRE OF CATALONIA (CTFC) – SPAIN

WEBSITE: www.ctfc.cat

Partner's presentation

The CTFC's main action is to contribute to the modernization and competitiveness of the forestry sector, rural development and sustainable management of natural environment, resource development, education, technology and knowledge transfer to society.

In the current context of global change, the activity is focused towards solving environmental problems of ecosystem management and interactions between natural resources and society, and improving the wealth and well-being while preserving sustainability of the natural environment. The results of operations are for the benefit of the whole society.

The content of the activities of the CTFC is based on the three following lines of work:

- Functioning of agroforestry ecosystems.
- Multi-function management of natural environment.
- Governance and socio-economy of rural areas.

Pilot action 1: Enrichment plantations in monospecific Pine stands

1. Objectives and context

General objective

The main objective is to establish different resprouting species (and provenances) under the canopy of monospecific Pine stands oriented to increase the adaptability of these forests to climate change and its resilience in a context of increased natural disturbances.

Description

The sites are located in three different forests dominated by Pine, in Catalan Pre-Pyrenees (North-East of Spain). In each forest, two enrichment plantations (of about 140 m^2) were established at three different altitudes (between 1 000 and 1 600 m). Soils were mainly calcareous and Sub-Mediterranean climate dominates the area. The plantations were established under two different conditions of light:

- under the canopy of a close stand,
- in natural gaps.

2. Description of undertaken actions

Actions performed

The main steps of the activity were the following ones:

- 1. Analysis of the current bibliography.
- 2. Design of the plantations (species choice, treatments).
- 3. Selection of pilot sites (in accordance with forest owners).
- 4. Establishment of the plantations (and the fencing).
- 5. Monitoring and evaluation of plant survival and growth.
- 6. Implementation of the sowing experiments, using the same protocol for each site and species/provenances (Figure 3.2).
- 7. Monitoring and evaluation of the phenological stages and growth of the established plants (Figure 3.3).
- 8. Spreading of initial results (6th Spanish Forestry National Congress) and education (visits of the pilot site by students, researchers and managers).

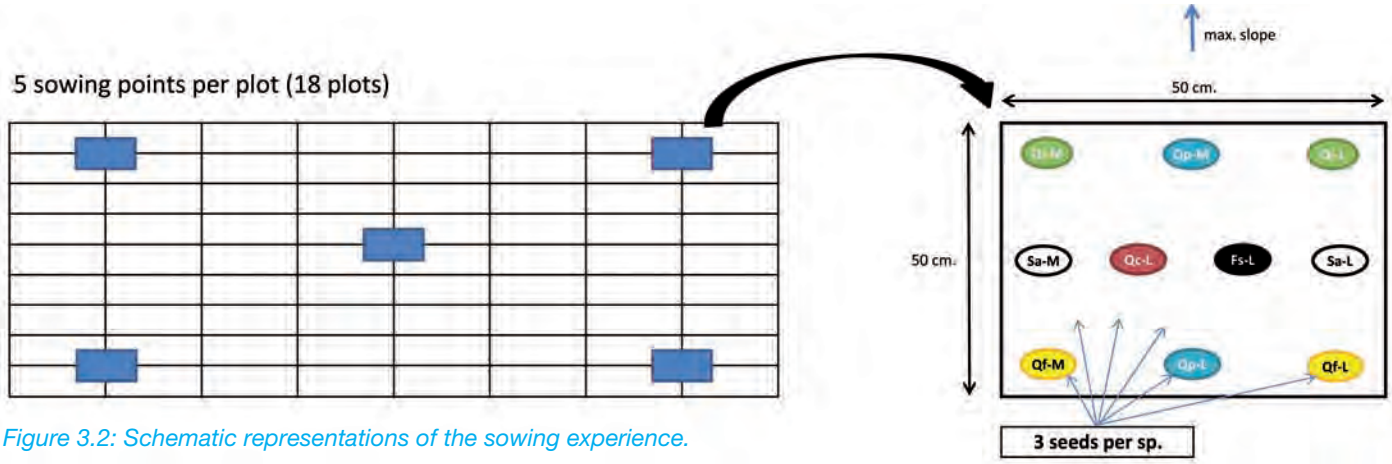


Figure 3.2: Schematic representations of the sowing experience.

Figure 3.3 and Photo 3.9: Monitoring of the plant phenology.

Results

We expected to find:

- Important differences between species in their performance along environmental gradients (elevation and light).
- Better performance of the local provenances compared with the Mediterranean ones (in particular in the plantations established at high elevation).
- A significant effect of light exposure in the performance of the species, with a positive effect in the plantations established at higher elevations and a negative effect in the plantations established at the lower ones.
- Important phenological differences between species and provenances all along the environmental gradients.

Acquired results:

- Limited capacity of beech plants to survive in the drier sites (see table below).
- Important mortality of evergreen *Quercus* species at higher elevations.
- Drought-induced senescence in deciduous *Quercus* species (see table below).
- High post-frost and post-drought resprouting ability of *Quercus* spp.
- General better performance of local provenances, although the trend is weak.
- Important phenological differences between species (work in progress).

Future (next steps, opportunities...) and deadlines.

During the next months and years, we are going to follow-on with part of the activities initiated during the project, and in particular:

- Continue monitoring the growth and survival of the established plants (next 3 years).
- Analyzing the results of:
  • the sowing experience
  • the evaluation of the phenological stages of plants (this year)
- Characterizing the main physiological variables of the plants to better understand how plants develop themselves under different climatic and light conditions (next year).
- Excavating some plants to evaluate the repartition of biomass among the different organs and better understand the adaptive mechanisms of the species to different growing conditions (next 3 years).

3. Main deliverables

- Study of the evolution of the vegetation in Catalonia:
  • **Case 1.** The forests of *Pinus uncinata* (L2_P4_1 & L2_P4_2)
  • **Cas 2.** The «Aigüestortes» National Park (*Unavailable. Please contact directly the CTFC*)
- L17_P4_1: Support information for visitors.
- L18_P4_1: Informative panels in the pilot sites.
- L36_P4_1: Report of the main results of the enrichment plantations.
- L28_P4_3 and L28_P4_4: Accepted communication in the 6th Spanish Forestry National Congress: «Martin S., Coll L. 2013. *Plantaciones de enriquecimiento en pinares puros submediterráneos: capacidad adaptativa de las principales especies de frondosas rebrotadoras acompañantes*».

Species	Fs	Qc	Qf		Qh		Qi		Sa		Total
Provenance	Local	Local	Local	Med	Local	Med	Local	Med	Local	Med	
High-elevation	1.6%	0.0%	2.4%	1.6%	1.6%	1.6%	0.8%	1.6%	1.6%	2.4%	1.5%
Mid-elevation	9.6%	0.0%	3.2%	9.5%	0.8%	4.8%	1.6%	0.8%	0.0%	1.6%	3.2%
Low-elevation	20.8%	0.8%	7.1%	8.7%	0.0%	11.1%	0.8%	4.0%	0.0%	0.0%	5.3%
Total	32.0%	0.8%	12.7%	19.8%	2.4%	17.5%	3.2%	6.3%	1.6%	4.0%	10.0%

First-year summer mortality (%) by species and provenances in the different elevation levels
Abbrev: Fs: Fagus sylvatica, Qc: Quercus coccifera, Qf: Quercus faginea, Qh: Quercus humilis, Qi: Quercus ilex, Sa: Sorbus aria

PILOT SITE IDENTITY FILE	Site 1: Bosc de Fontanella (Forest of Fontanella)	Site 2 : Muntanya d'Alinyà (Forest of Alinyà)	Site 3 : Bosc de Senyùs (Forest of Senyùs)
Particular status and available regulation and planning tools	Forest plan; Natura 2000 sites		
Pilot site area	670 ha (0.5 ha occupied by our experience)	ha (0.5 ha occupied by our experience)	ha (0.5 ha occupied by our experience)
Population	0	0	0
Main cities and municipalities	Organya and Figols i Alinyà (nearest villages)	Alinyà (nearest village)	Cabó (nearest village)
Forested area in the pilot site*	100%	100%	100%
Including private forests	0%	100%	100%
Organism locally responsible for forest management	Catalan Ministry of Agriculture, Livestock, Fisheries, Food, and the Environment	Private Foundation (Obra Social Catalunya Caixa)	Private owner (supervised by Forest Ownership Centre)
Main forest tree species	*Pinus nigra* (from 800 to 1200 m a.s.l.) and *Pinus sylvestris* (from 1200 to 1600 m a.s.l.)		
Stand productivity	600 stems/ha	500 stems/ha	750 stems/ha
Main role of the forest	Protection	Protection	Protection
Other land uses category on the pilot site (non-forested area)		Livestock farming, tourism, education, wildlife conservation, etc.	Livestock farming
Annual amount of precipitations	920 mm	900 mm	850 mm
Mean lower temperatures of the coldest month	-4°C	-3,5°C	-3°C
Mean higher temperatures of the warmest month	23°C	24°C	25°C
Global geological conditions	Limestone, in some cases decarbonated. Deep forest soils in low-slope sites and calcareous shallow soils in steeper areas.		
Main natural risks threatening the pilot site	Wildfire, drought, pests and diseases		
Main potential climate change related impacts in the region	Altitudinal migration of species, water stress, forest decline, increasing the magnitude and frequency of disturbances (fires, storms, pests, etc.).		
Existing initiatives regarding the adaptation to the climate change in the region	Some research projects developed by institutions (mainly CTFC and CREAF)		

Remind: All the deliverables are available in the project's DVD and website.

4. Difficulties and possible improvements

We did not found particular difficulties in the development of this pilot action.

5. Elements transferable/replicable on a large scale

The experimental design we have used in this pilot action can be replicated in other areas using different species (and provenances) and different environmental gradients.

The results of this study may allow some progresses in the understanding of the species plasticity to different growing conditions. It will also provide a first evaluation of the existing inter- and intra-specific variability in the performance (i.e. survival and growth) of plants under different climate and light conditions. This information could be of great value for forest managers when deciding the choice of species for reforestation programs and, more generally, for the evaluation of the vulnerability of forest ecosystems to climate change.

Finally the enrichment plantations represent a good example of an action with both an important research and demonstrative component. It constitutes an interesting management alternative for increasing the diversity of forest stands and, at the same time, their resilience in a context of increased natural disturbances.

6. Benefits derived from FOR CLIMADAPT project

The FOR CLIMADAPT project has allowed the establishment and monitoring of the enrichment plantations and the analysis of the first results regarding the performance of the different species and provenances to contrasting growing

conditions. It has also contributed to raise awareness about the benefits and the need of diversifying monospecific forest stands in the current changing context.

Finally it has definitely facilitated the occurrence of interesting exchanges and discussions between researchers, managers and different stakeholders during the 5th seminar held in Solsona.

Pilot action 2: Forest management guidelines and forestry treatments towards more resistant and resilient forest structures

1. Objective and context

General objective

The aim is to implement, and test in the field, forestry guidelines and treatments aimed to increase the resistance and resilience of forest to the natural disturbance of large forest fires.

Place: Municipality of Baronia de Rialb, Noguera county, Catalonia

Description of general context

Pilot site 2 is located in the Pre-Pyrenean range, a highly forested area where the large forest fires are the main natural disturbance during the last decades. Forests are composed by pure stands of Spanish Black pine *(Pinus nigra)* and mixed stands of Pine and Downy oak *(Quercus humilis am.).* Stands are mainly decapitalised due to historical intense exploitation of wood and firewood.

The area is completely private-owned. Forests have been managed mainly with short-term economic objectives, and had also been affected by large forest fires in the past. Furthermore, the wildfire risk is considered as very high nowadays in the area.

2. Description of undertaken actions

Actions performed:

- Study/state of the art of the topic and experimental design. A literature review on related issues was carried out, and the experience protocol was designed.
- Search and description of pilot site. Once the study area was determined, the pilot site was delimitated and described.
- Forest inventories of permanent plots were done previously to treatments execution, including fuel inventories. 6 permanent plots were established and stand parameters were measured. In one of them, parameters concerning shrub, herbaceous and dead fuel were also measured.
- Execution of forest treatments. The pilot area was treated according to the experimental design, in order to increase the resistance and resilience of forest to the natural disturbance of large forest fires.
- Forest inventories after treatments execution, including fuel inventories. Stand parameters were measured again in permanent plots. In one of them, fuel parameters were also measured again.
- Data management, description and economical evaluation of treatments. The pre- and post-treatment characteristics were determined and the changes were recorded. A financial assessment was carried out.

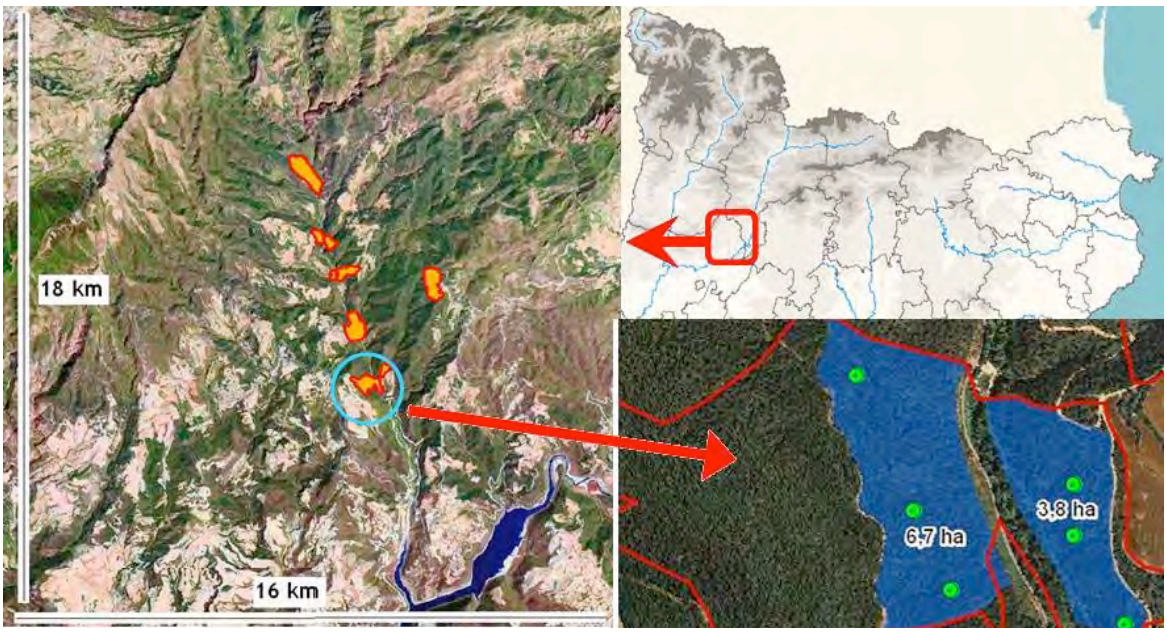


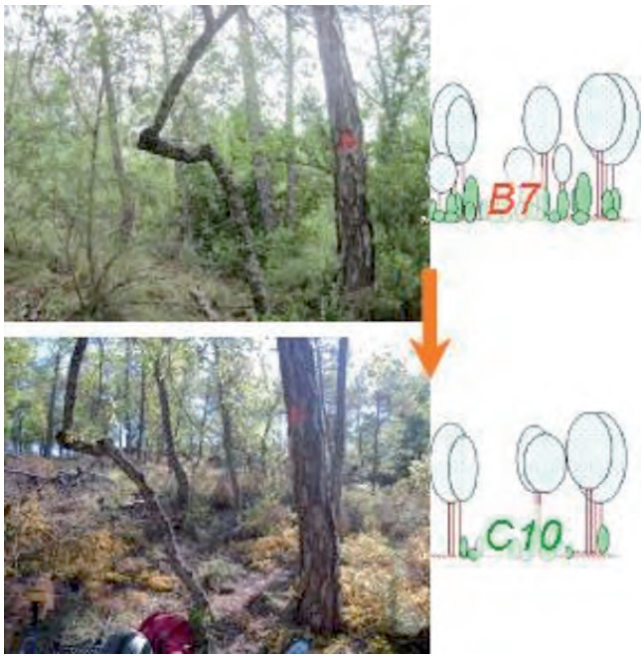
Figure 3.4: Location of the pilot area, treated stands and permanent plots.

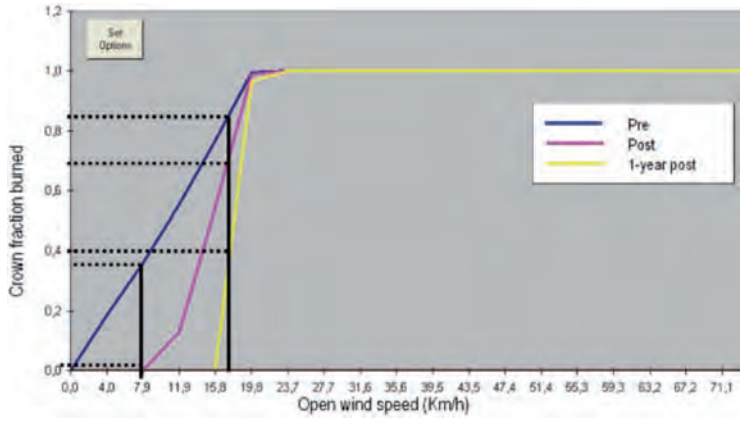
- Monitoring the experimental areas. Permanent plots and inventory protocol have been established to allow regular and accurate measurements.
- Test with NEXUS regarding the effectiveness of treated areas (now classified as « C » structures: forest structures where fire does not propagate to the crowns). The fuel data available allowed a recreation of stand characteristics with the NEXUS fire simulator. Information describes the fire behaviour before treatments, after treatments.

Results:

- Specific forestry treatments have been designed following management guidelines to create more resistant and resilient forest structures using information available about stand vulnerability to crown fire.
- A collaborative work was done between forest services, fire-fighters, land-owners and researchers to identify strategic areas inside de basin and to execute a treatment with a large-scale and long-term management objective.
- Forestry treatments result in an immediate improvement of forest structure characteristics to be more resistant to crown fires.
- The monitoring process will determine when a following treatment is needed, according to the management guidelines.
- Other strategic areas inside the basin, as well as other, could be treated in the same way as the pilot areas, getting profit of the experience developed.

PILOT SITE IDENTITY FILE	Site 1: Baronia de Rialb *(Noguera, LLeida)*	Site 2: Castellolí *(Anoia, Barcelona)*
Particular status and available regulation and planning tools	Non-protected area, private forests, forest planning tools (PTGMF)	
Pilot site area	9581 ha (experimental area: 9 ha)	600 ha (experimental area: 2 ha)
Population	261 inhabitants (municipality)	519 inhabitants (municipality)
Main cities and municipalities	Baronia de Rialb (nearest village)	Castellolí, Castellfollit del Boix (nearest villages)
Forested area in the pilot site*	8298 ha, 87 % 44508 ha, 25 % (total county: Noguera)	600 ha, 100 % 27482 ha, 32 % (total county: Anoia)
Including private forests	8260 ha, 99 %	600 ha, 100 %
Organism locally responsible for forest management	*Centre de la Propietat Forestal* (Forest Ownership Centre)	
Main forest tree species	Pure spanish black pine *(Pinus nigra ssp. salzamanni)* stands and mixed with Downy oak (*Quercus pubescens)* and Holm oak (*Quercus ilex)*	*Pinus halepensis* forests, some *Quercus ilex* and *Q. faginea*
Stand productivity	Variable (600-800 stems/ha) Non-commercial extractions Mean annual growth: 2 m^3/ha·year	8000-11000 stems/ha, after prescribed burning (6000-7000 stems/ha) Non-commercial extractions Regeneration stands
Main role of the forest	Soil protection, landscape, biodiversity, recreation, production	Soil protection, landscape, production, biodiversity
Other land uses category on the pilot site (non-forested area)	Agriculture, tourism	Pasture, tourism, agriculture
Annual amount of precipitations	700 mm	580 mm
Mean lower temperatures of the coldest month	0 ºC	0,7 ºC
Mean higher temperatures of the warmest month	28 ºC	29,5 ºC
Global geological conditions	Limestone, in some cases decarbonated. Deep forest soils in low-slope sites and calcareous shallow soils in steeper areas.	
Main natural risks threatening the pilot site	Wildfire, drought, pests and diseases	
Main potential climate change related impacts in the region	Water stress, forest decline, increasing the magnitude and frequency of disturbances (fires, storms, pests, etc.), altitudinal migration of species.	
Existing initiatives related to climate change adaptation in the country/ region	Catalan Government is working in the elaboration of Catalan Forest Policy Plan, Forest Resources Management Plans at province/county level, Sustainable Forest Management Guidelines, taking into account the present context of global/climatic change. Research centers are involved in the study of climate change effects and forest adaptation.	





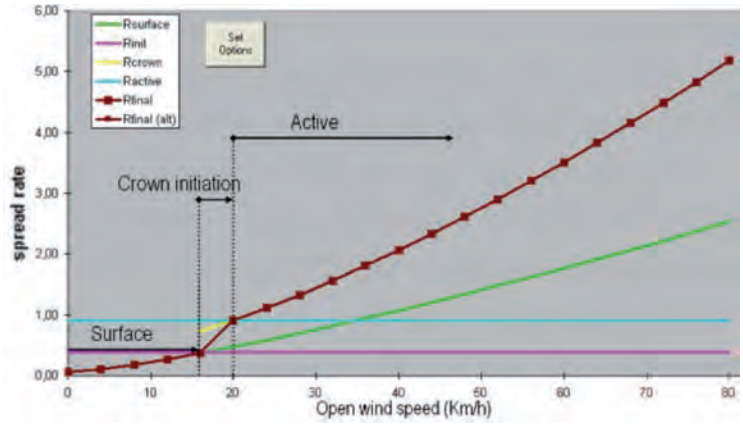


Figure 3.5 a, b and c: Left, structural changes in treated stands. Right up, results of pre- post- and 1 year post-treatment NEXUS simulations about crown fraction burned in relation with open wind speed. Right down, results of 1 year post-treatment NEXUS simulations about crown fire hazard assessment. Author: CTFC.

3. List of « deliverables »

- L36_P4_2: Report about Pilot site 2: « Forestry treatments for forest fire prevention: reducing forest stand vulnerability to crown fires ».
- L7_P4_1: Report « Forestry guidelines for forests adaptation to climate change: making Catalan *Quercus* forests more resistant and resilient to large forest fires ».

Remind: All the deliverables are available in the project's DVD and website.

4. Difficulties and possible improvements

No special difficulties were found during the project development. Nevertheless, some issues related with coordination of private-owners needed a special attention to be properly solved. The land ownership structure has to be taken into account if the replication of the experience is undertaken. There are several private owners within a relative small area, but the planning of forestry treatments is done only with stand criteria. So, the execution of treatments has to be approved by the directly-affected owners, bearing in mind that the action benefits to all, improving the state of the whole stand area.

On the other hand, the forestry criteria of intervention with aim of fire prevention are slightly different from those of wood production. This has to be clearly explained both to the owners and to the managers, in order to realize a suitable execution.

5. Elements transferable/replicable on a large scale

The results obtained with the fire simulations, done with real data, are reinforcing the concept of a forestry specifically designed to improve the resistance and resilience of stands to forest fires. So, the methodology of designing the appropriate forestry techniques may be useful in other areas with similar problems and characteristics.

6. Benefits derived from FOR CLIMADAPT project

The FOR CLIMADAPT project has allowed the establishment and monitoring of the forestry treatments to increase the resistance and resilience of forest to natural disturbance due to large forest fires. It has also contributed to raise awareness about the benefits and need of creating forest structures resistant to crown fires in the present changing context. Finally it has definitely facilitated the occurrence of interesting exchanges and discussions between researchers, managers and different stakeholders.

Pilot action 3: Use of prescribed burning as a forest management tool: improvement of trees resilience and water resources, and fuel reduction with the aim of reducing the risk of large forest fires

1. Objective and context

General objective

The main goal is to evaluate the use of prescribed burning as a forestry tool for adapting *Pinus halepensis* forests to climate change. For this, the effectiveness of using fire to conduct early thinning treatments in a young stand of *Pinus halepensis* was evaluated eight years after the burning. The applied treatment aimed at:

- improving the vitality and growth of remaining trees
- promoting forest fire prevention.

Place: Municipality of Castellolí, Anoia county, Catalonia.

Description of general context

Pilot site 3 is located in Central Catalonia, between Anoia and Bages counties, at the Western part of Montserrat Mountain (an area commonly affected by forest fires during the last decades). Climate in this area is sub-Mediterranean, with a huge annual and seasonal variability, and the main species is *Pinus halepensis* mill (which conforms young stands that regenerated after fire occurrences).

The area is completely private-owned. Forests have been managed mainly with short-term economic objectives, and had also been affected by large forest fires in the past. Furthermore, the wildfire risk is considered as very high nowadays in the area.

2. Description of undertaken actions

Actions performed

- State of the art of the topic and experimental design. A literature review on related issues was carried out, and the experience protocol was designed.
- Search and description of pilot site. Once the study area was determined, the pilot site was delimitated and described.
- Forest inventories eight years after the forestry treatment (prescribed burning). Stand parameters were measured within the permanent plots.
- Monitoring: Permanent plots and their inventory protocol have been established to allow regular measurements.
- Data management and results evaluation. The eight years post-treatment characteristics were determined and the changes were recorded.

Results

- The obtained data indicate that prescribed burning could be used as a fuel management tool for reducing the risk of crown fires in young stands of *Pinus halepensis.*
- Increased knowledge of the prescribed burning technique as an alternative tool for stand management about which data were previously limited.
- There is a need of more experiences to evaluate the

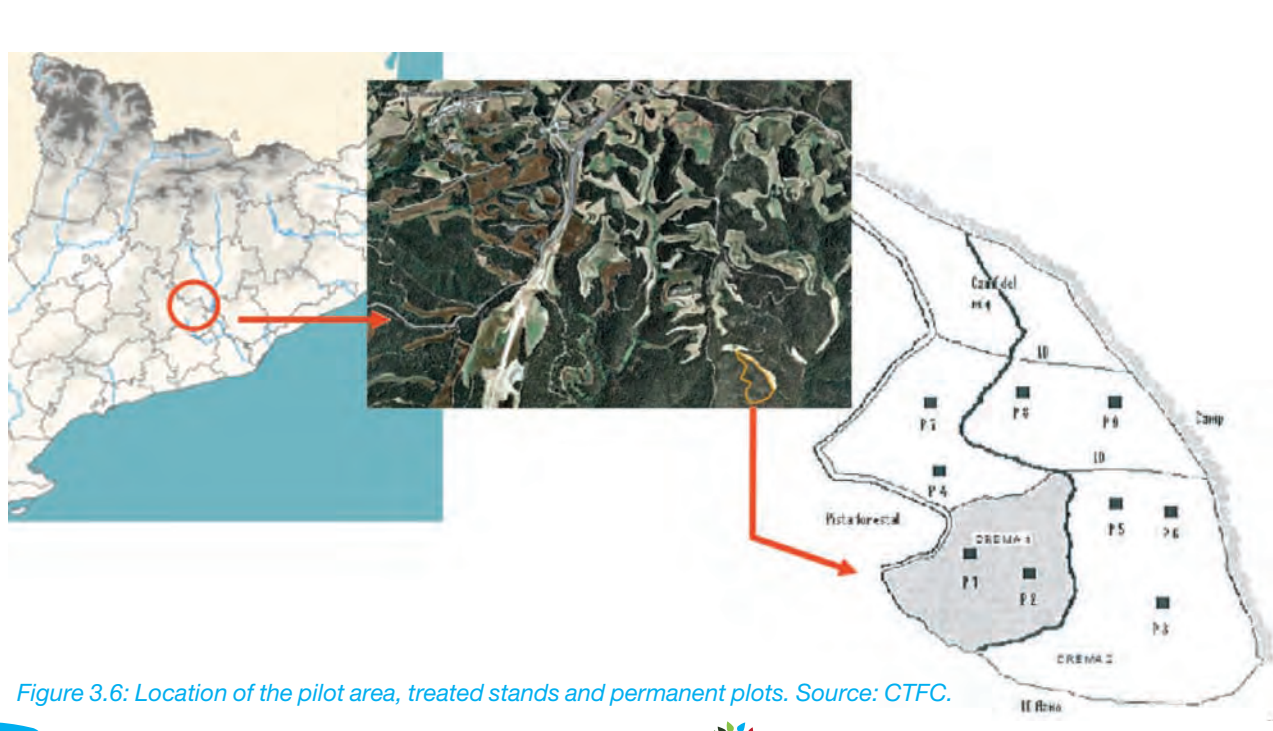


Figure 3.6: Location of the pilot area, treated stands and permanent plots. Source: CTFC.

use of fire for enhancing growth of surviving trees in young stands of *Pinus halepensis.*

- This experience has led into training opportunities for fire fighters.
- This experience established a starting point for modifying factors such as prescribed window and ignition patterns to achieve forest management objectives.
- In the future it would be interesting to test the use of fire in other young stands of *Pinus halepensis* to assess the effect of other factors that may affect mortality.

Photo 3.10: stand image.

3. Main deliverables

- L36_P4_3: Report about Pilot site 3 « Prescribed burning as a forestry tool for adapting *Pinus halepensis* forests to climate change: the effectiveness of using fire for thinning young stands ».

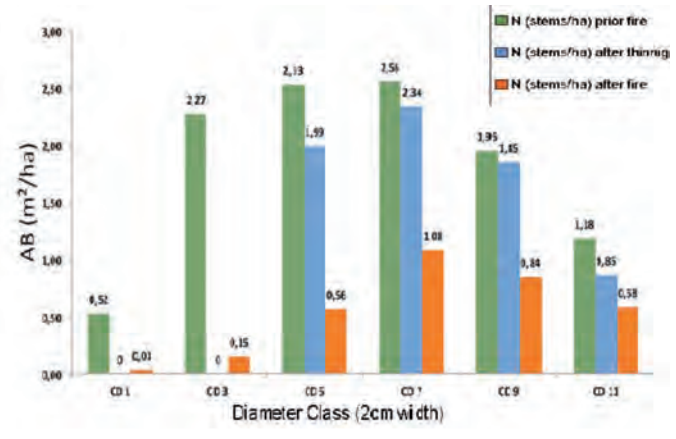


Figure 3.7: Forest structure data prior fire (green), after thinning simulation (blue) and after prescribed fire application (orange).

Remind: All the deliverables are available in the project's DVD and website.

4. Difficulties and possible improvements

Difficulties such as bureaucracy, landowner's acceptance of prescribed fire, availability of competent staff for conducting understory prescribed burns, and also society suspicions about the use of fire were encountered.

Technicians had difficulties in identifying appropriate areas of young stands of *Pinus halepensis* where prescribed burns were realized, because only a limited number of prescribed burns in the past years were conducted. In this sense it was not possible to replicate the experiment, as there were no other available sites with similar stand characteristics ready to be burned.

5. Elements transferable/replicable on a large scale

The results of the use of fire as a forestry tool for reducing tree competition and the risk of high intensity fires are encouraging and may serve as a referent to extrapolate its use in other Mediterranean areas with similar problems. To manage landscape areas vulnerable to crown fires and low productivity forest stands though prescribed fire may increase the value of the forestry product, as the risk of damage to the ecosystem and private goods would be limited and the remaining trees will be well adapted. In addition, potential costs of environmental restoration caused by forest fire occurrences will be reduced.

6. Benefits derived from FOR CLIMADAPT project

The FOR CLIMADAPT project has allowed the establishment and monitoring of experiences regarding the use of prescribed burning as a forestry tool for adapting *Pinus halepensis* forests to climate change. It has also contributed to raise awareness about the effectiveness of using fire to conduct early thinning treatments in young stands with the aim of:

- improving the vitality and growth of remaining trees,
- promoting forest fire prevention.

Finally it has definitely facilitated the occurrence of interesting exchanges and discussions between researchers, managers and different stakeholders.

Partner's activity balance
NATIONAL FORESTS OFFICE (ONF) – FRANCE

WEBSITE : www.onf.fr

1. Objectives and context

Partner's presentation

ONF main objective is to manage state forests and other public forests following the Forest Regime, and the achievement of public interest tasks entrusted by the French State. The ONF is also developing various services (management, expertise, forestry works...) to the benefit of all kind of clients in terms of natural areas management, environment, forestry wood and territorial development.

Concisely, some figures:

- Public forests correspond to 27% of the French forest in the metropolis, of which 1.8 million hectares (Mha) of state forests and 2.6 millions hectares of municipal forests.
- The ONF employs approximately 6 800 employees and nearly 3 200 forest workers.
- The ONF annually mobilizes more than 14,5 millions cubic meters of wood.
- 4,5 Mha are PEFC-certified, concerning 100% of the state forests and more than 50% of municipal forests.

The ONF is organized into nine regional branches and five regional offices. Extending from Spanish to Italian borders, from seaside to summits of the Southern Alps (Languedoc-Roussillon and Provence-Alpes-Côte d'Azur regions), the Mediterranean office of the ONF is the regional section involved in the FOR CLIMADAPT project.

In the project, the ONF wants to improve its experimental activities in terms of adaptive forestry to climate change effects, including the replacement of decaying Silver fir stands by the Atlas cedar.

Photo 3.11: Thinning done in February 2012 on the Picaussel pilot site.

Context and justification for the local needs

The «hot» Fir forests, located at low altitude or in *adret* (south side), have shown signs of diebacks at different degrees for more than 30 years. These signs reached alarming proportions after the heat wave of 2003 and the drought period that lasted until 2007. In fact, the climate evolution scenarios applied to the natural area of the Silver fir, converge towards the prediction of a strong regression of this Fir, probably ending with its extinction in the Pre-Alps of the south and in the north Pyrenean piedmont.

Managers have two options to perpetuate these forests that are facing a critical situation due to the climate changes:

- The first is an adaptation of the existing stands thanks to an innovating forestry that saves more water, according to the research results, through a reduction of the leaf area. This is for the adult pine forests that are still in good health.
- For stands that are irreparably dying or close to the renewal stage, the only solution is a transformation of the stands, substituting the Fir for a forest species more resistant to water stress. The species identified as the most interesting one in this context is the Atlas cedar both ecologically and in terms of wood quality.

These management options need to be validated in the Mediterranean mountain context. This is why the ONF initiated three pilot actions within the FOR CLIMADAPT project in order to confirm their efficiency and to specify their implementation in the existing fir forests and in the future Cedar forests.

2. Description of undertaken actions

Pilot site of Picaussel: Relevance of low density forestry for the Silver fir considering the stand adaptation to the climate change

The experimental device was installed at the beginning of 2012. It is spread over two plots that are two repetitions, in the Fir forests with 75 and 55 years respectively.

The homogeneous area chosen for the experiment covers around 1 ha in each plot. The tested modalities are of two density levels: a low density of 200 t/ha for a basal

area of 20 m²/ha after removal of one stem in two, is compared to a strong density of 400 trees for a basal area of 40 m²/ha, without intervention during the project, the latter being the control one (see Photo 3.11).

A monitoring system was established, on one hand at the stand level (production, development of the undergrowth vegetation, natural regeneration of the Fir), on the other hand at the individual level for a sample of objective-trees (growth and health conditions), the health of the objectives-trees being the main assessment criteria.

An assessment of the water balance is also foreseen and it will integrate, namely, measurements of the leaf area index. These observations must allow answering several questions that the manager asks himself regarding the low-density forestry:

- 1. Is it efficient? Considering that we only control the density or the basal area of the main stand, is it possible that the development of undergrowth vegetation, which will be stimulated by the opening of the cover, compensate the benefits of the density reduction in terms of water balance?
- 2. Is it realistic within an extensive management context? The exploitation and commercialisation difficulties impose exploitation of important volumes and spaced in time. A strong decrease of the density reduces the productive capital, and this tends to space the interventions in time at the risk of having again a strong leaf area.
- 3. If the low density triggers the natural regeneration, are we not going towards more irregular stands?

After the end of the project, that is only a year after the installation, we observe a stimulating effect of the strong thinning on the radial growth of the objective-trees but still no meaningful results on their heath.

This device will be monitored at least during 8 years, in order to obtain reliable lessons with the necessary critical distance.

Pilot site of Callong: Transformation of a Fir forest after the failure of the natural regeneration and dieback - plantation of Atlas cedar with comparison of different French provenances

Throughout the project, the set of operations needed to get to the plantation stage were executed: collection of the Cedar seeds in the selected stands, growing of seedlings in an experimental tree nursery, preparation of the land for the plantation and, finally, the plantation at the beginning of 2013 (see Photos 3.12).

The Cedar plantation covers 7 hectares but the experimental part in which the provenances will be compared covers 0,7 ha. Four provenances are used, from four French Cedar forests of the south: Rialsesse, Mont-Ventoux, Saumon and Issole.

Twelve blocs of four times 24 seedlings (4 provenances) are installed on homogenous surfaces. Each seedling is being monitored in terms of growth and health. The set makes up a reliable and precise experiment that will highlight the differences in terms of performance and sensitivity of the tested provenances.

This device for comparing provenances will be monitored for 15 years.

Pilot site of Nans: Relevance of low density forestry for the Atlas cedar considering the adaptation of the stand to the climate changes

This device is equivalent to the one of Picaussel (see before) for the Atlas cedar. The experimental protocol is almost identical, but the experiment plan is different because it was established based on the characteristics of the initial stand.

The experiment was established in the Cedar plantation with 35 years old trees and a mean height of 12 meters. The surface, quite homogenous on the ecological and measurements plan, covers 1.35 ha.

Photo 3.12 a and b: Plantation and young seedlings used on the pilot site of Callong.

Pilot site identity file	Forest of Nans	Administrative Area of Picaussel-Callong
Particular status and available regulation and planning tools	Administrative Forest of Nans, acquired through the RTM	Administrative Forest of Comfroide-Picaussel and Administrative Forest of Callong-Mirailles
Pilot site area	445 ha (Pilot site : 1,8 ha)	Picaussel : 657 ha (Pilot site : 5 ha) Callong: 336 ha (Pilot site : 2 ha)
Population	0	0
Main cities and municipalities	Saint-Vallier de Thiey (3 000 inhabitants) Grasse (50 000 inhabitants)	Espezel (200 habitants), Belvis (200 habitants) Quillan (3 500 habitants)
Forested area in the pilot site*	244 ha (55%)	100%
Including private forests	0%	0%
Organism locally responsible for forest management	ONF, Alps-Maritimes agency, territorial unit of the Pre-Alps of Azur	ONF, Aude-Eastern-Pyrenees agency, territorial unit of the Sault plateau
Main forest tree species	Scots pine (32%) and Downy oak (24%)	
Stand productivity	Around 1000 trees/ha	Around 500 trees/ha
	Around 3 m^3/ha.year	Around 5 m^3/ha.year
Main role of the forest	Wood production, receive the general public	
Other land uses category on the pilot site (non-forested area)	Scrubland and rock	
Annual amount of precipitations (millimetres)	1230 mm (St-Vallier de Thiey)	950 mm (Belcaire)
Mean lower temperatures of the coldest month (°C.)	-0,2 °C	2,4 °C
Mean higher temperatures of the warmest month (°C.)	26,6 °C	17,5 °C
Topography	Altitude : 1000 à 1050 m, South exposure Slope : 45%	Callong : altitude 1000 m., plateau Picaussel : altitude : 850 m., bottom of the valley and mean slope
Global geological conditions	Compact limestone Parent material: scree Type of soil: gravelly calcareous soil of average thickness, from scree	Compact limestone Parent material: limestone alterite and colluvium
Main natural risks threatening the pilot site	Drought, wildfire	Drought
Main potential climate change related impacts in the region	- Droughts and forest diebacks, mainly in sub-Mediterranean mountains - Increase and extension of the risk of fire	
Existing initiatives regarding the adaptation to the climate change in the region	Institutions: Climate plan at national (inter-ministerial) and regional levels (prefecture of the Languedoc-Roussillon Region, Regional Council of PACA) Research: numerous national research programs and projects Management: adaptation of the public and private forest management plans	

Three density levels are compared thanks to the thinning executed at the beginning of 2011 (see Photo 3.13):

- A normal density of 1200 trees per hectare
- A low density of 600 trees per hectare
- A very low density of 300 trees per hectare

The monitoring is done, on the one hand, on the evolution of the stand (production, development of the understorey vegetation, water balance, natural regeneration of the Cedar), on the other hand on a sampling of objective-trees (growth and health conditions), the health of the objective-trees being the main assessment criteria.

After two years, we observe a stimulating effect of the thinning on the radial growth of the objective-trees, particularly strong because competition is weak. It seems that the health of the trees has slightly improved after the thinning, but this trend must be validated in future years. This device will be monitored at least during 8 years, in order to obtain definitive results.

Photo 3.13: Plantation and young seedlings used on the pilot site of Callong.

3. Main deliverables

- L6_P5: State of art of the adaptive forestry in France
- L8_P5: Pilot_Sites
  - Pilot site of Picaussel - Experimental protocol
  - Pilot site of Picaussel - Report of installation and initial measurements
  - Pilot site of Picaussel - Report of the measurements after one year
  - Pilot site of Callong - Experimental protocol
  - Pilot site of Callong - Report of installation
  - Pilot site of Nans - Report of installation
  - Pilot site of Nans - Report of installation and initial measurements
  - Pilot site of Nans - Report of the measurements after two years
- L17_P5: A page dedicated to the project on the Internet site of the ONF (www.onf.fr)
- L25_P5: Press releases and articles
- L28_P5: Documents regarding the two days of visit organised on the pilot sites, the 2nd December 2010 and 18th October 2012 for seminars 1 and 5
- L20_P5: Information panels (5)
  - Pilot site of Picaussel - 2 information panels
  - Pilot site of Callong - 1 information panel
  - Pilot site of Nans - 2 information panels

Remind: All the deliverables are available in the project's DVD and website.

4. Difficulties and possible improvements

The difficulties met are namely related to the heavy nature of the works executed within the pilot actions, and to the quite slow natural evolutions regarding forestry, implying that the results observed at the end of the project do not allow drawing definitive conclusions.

On the other hand, there has been a delay regarding the experimental plantation of Cedar on the Callong site because of several technical issues: the unavailability of the plants at the beginning of the project, poor germination of several plots of seeds and very poor weather conditions at the moment of plantation.

By the end of the project, the pilot actions started providing concrete results, but still partial and provisional. This is the reason why the monitoring protocols tend to be extended for 8 to 15 years according to the sites in order to learn as much as possible from the situation.

5. Elements transferable/replicable on a large scale

The expected results affect the set of French south Fir forests, which cover a total of more than 20 000 hectares and, beyond it, a huge part of the Mediterranean hinterland forests. They relate, namely, to two aspects:

- The adaptive forestry: First lessons on the implementation of a reduction of the leaf area index in Mediterranean mountain and on its efficiency for the adaptation of the forests.
- The use of the Atlas cedar as a substitution tree species for the Silver fir: identification of the most adapted French provenances.

6. Benefits derived from FOR CLIMADAPT project

The FOR CLIMADAPT project allowed the ONF to start innovating experiments to adapt the existing Fir forests of the south to the effects of the climate changes. These operations were stimulated by the European funding and improved within their conception thanks to the exchanges between partners during the visits to the pilot sites of each partner and to the expertise of the Peer group.

Partner's activity balance: NORTH AEGEAN REGION – GREECE

WEBSITE : www.northaegean.gr

Partner's presentation

The North-Aegean Region is composed of several islands. Each one has unique and distinct natural features. In addition, the socio-economic activities of the population of the island differently affect the natural landscape.

These distinctions lead to a variety of climate change consequences that each island will have to face. For example, the island of Lesbos is under constant threat of large forest fires, while the islands of Lemnos and Ikaria undergo intensive grazing of thousands of livestock (sheep and goats in particular) highly destructive to the few remaining forest areas and preventing natural stands regeneration.

Pilot action 1: Studies on the structure, dynamics and vegetation management

1. Objective and context

General objective

The overall objective is to conduct research and information - awareness raising activities allowing the understanding of climate change on the structure and dynamics of vegetation and propose management actions to reduce the risk of fires.

Pilot site

The pilot sites are located on the Lesvos Island and the Amali Peninsula, which suffered frequent and severe fires over the past three decades.

2. Description of undertaken actions

2.1 Study of the evolution of vegetation facing climate change

The vegetation is analyzed and a projection of future vegetation is considered according to climate change, which is expected to bring drier conditions.

Thus, an apparent extension of Mediterranean vegetation type (phryganas, maquis and pine stands of *Pinus brutia*) is expected at a higher altitude, pushing out the deciduous oak forest (*Quercus pubescens*) or sub-humid pine (*Pinus nigra*). In addition, in the Mediterranean enlarged area, there will be a dominance of low shrubby formations of phrygana to the detriment of maquis and pine forests, mainly as a result of drier climate and more frequent fires.

2.2 Method of reducing the risk of fire

In order to deal with the future risk of frequent fire, a document was written, including the management of forest and shrublands to reduce the risk of fire.

The measures to be considered include mainly:

- Information and awareness campaign to reduce the number of fires caused inadvertently.
- Adequate monitoring network, possibly supported by cameras, to reduce the time of the first intervention.
- Network of firewalls using a scientific method following the correct proportions and locations.
- Network of roads with areas allowing vehicles to return in the opposite direction.
- Network of rainwater tanks.
- Measures around isolated infrastructure and escape routes around the villages.

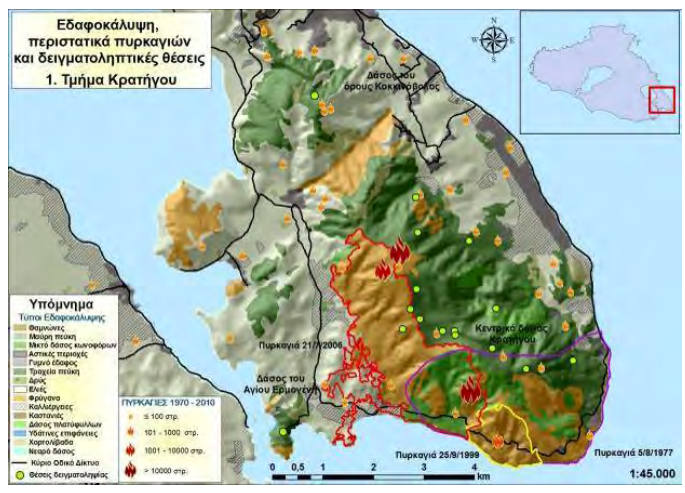


Figure 3.8: Map of incident fires / area (Amali Peninsula, Lesvos Island). [Source: Prof. K. Kalabokidis, University of Aegean, Geography of Natural Disasters Laboratory]

- Fuel management around the roads and infrastructure by clearing.

A study was conducted for the Amali Peninsula, which examines how forest fuels can be processed to reduce the threat of wildfires.

2.3 Modelling fire behaviour

Modelling of fire behaviour has been carried out for the Amali Peninsula, using the algorithm Minimum Travel Time (MTT) of the system FlamMap and also the software BehavePlus. Localizing the site of origin of fires and inserting in the program environmental surrounding data (vegetation, wind speeds, fuel types, topography), and other data (network of roads, water tanks, urban areas...), maps were produced, presenting the spread and the intensity of fire in time and space.

2.4 Automatic Weather Station

Installation of a Remote Automatic Weather Station. It collects data automatically, remotely and in real time to a central system, from sensors on various parameters such as temperature, relative humidity, wind speed and direction, soil moisture and fuels, precipitation, solar radiation, etc.

2.5 Training «prescribed burning»

Training of technical staff to the technique of «prescribed burning» to reduce the risk of fire.

2.6 Training

Training of students and forest service personnel in the use of modelling forest fires software.

Photo 3.17: Presentation of the project during a conference with the North Aegean Region

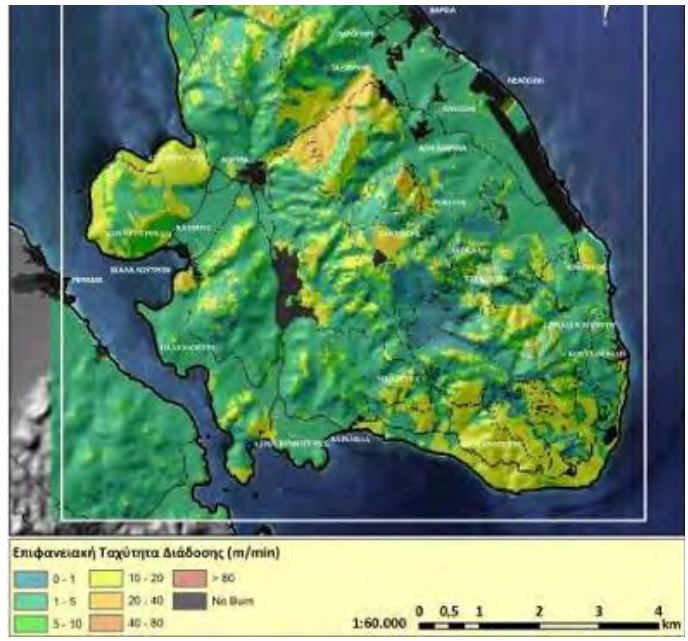


Figure 3.9: Map of simulation of fire spreading (Amali Peninsula, Lesvos Island).
[Source: Prof. K. Kalabokidis, University of Aegean, Geography of Natural Disasters Laboratory]

2.7 Information – awareness raising

Organization of information –awareness raising seminars in the five major islands of North Aegean Region. These seminars include the presentation of the FOR CLIMADAPT project, elements of climate change, the dynamics of forest ecosystems, risks of inadvertent fires, etc.

3. Main deliverables

- L2_P6: « Recommendation Guide for the adaptation of vegetation to climate change at a regional level »
- L7-8_P6: « Study on the past and future vegetation dynamics in the study area »

Actions 2.1, 2.2 and 2.3 are included in reports - deliverables. The North Aegean Region intends to distribute the document - deliverable 2.2 to all the services involved in the prevention of forest fires (forest services, municipalities, fire brigade, volunteers, etc.). Other actions are trainings and seminars.

Remind: All the deliverables are available in the project's DVD and website.

4. Difficulties and possible improvement

Despite the efforts of our staff, the fact that the «prescribed burning» is totally prohibited in Greece made it impossible to receive the authorization of the fire brigade to implement it. Thus the action 2.5 has not been achieved.

The weather station was operational only towards the end of the project, because of the difficulties in ordering the devices and the apprehensions on the location of installation (due to the data transmission mode).

5. Elements transferable/replicable on a large scale

The techniques proposed in the actions 2.2 « Method of reducing the risk of fire » and 2.3 « Modelling fire behaviour » could be adapted all over Greece and beyond.

6. Benefits derived from FOR CLIMADAPT project

The FOR CLIMADAPT project has generated to the North Aegean Region the necessity to address the problem of climate change and its impact on the forest environment. By the contribution, although quite late, of external experts and the University of the Aegean, an important work, both qualitatively and quantitatively, has been achieved. The elements collected are considered very important for the regional services and all other services involved in the prevention and fight against forest fires.

Pilot action 2 : Restoration - rehabilitation of burnt – degraded ecosystems

1. Objectives and context

General objective

The general objective is the pilot implementation of restoration - rehabilitation methods of burnt – degraded ecosystems:

Site 1. Testing *in situ* different reforestation methods by planting and by direct seeding of *Pinus brutia* a new application in Greece.

Site 2. Mobilization of the local population for a test of «natural» type reforestation of forest and shrub species by seeds in balls of clay.

Place

Both sites are located on the Lesbos Island.

Site 1: In the South-East of the island, the Amali Peninsula has been suffering frequent and severe fires over the past three decades, which has led to extensive degradation of *Pinus brutia* forests and the loss of their intrinsic ability to regenerate naturally.

Site 2: In the North of Mytilini in a small area near the village of Nees Kidonies.

Description

Site 1: Amali Peninsula covers an area of about 1500 ha. The vegetation consists of:

- A pine forest of *Pinus brutia,* covering about 650 ha, which occupies the central part of the peninsula.
- Open/degraded pine forest around this main forest.
- High shrubby formations such as maquis (with *Quercus coccifera, Arbutus spp., Pistacia lentiscus*) or low as phrygana (kind of garrigue, Tomillares, with *Sarcopoterium spinosum, Cistus spp.*).
- Olive groves.
- Plant formations have a primary role in the soil protection and biodiversity. The production function is not a priority for the Forest Direction of Lesvos.
- The peninsula is sparsely populated and has relatively little tourist infrastructure.

Site 2: The experimental site consists of an area of 1 ha without any forest vegetation, and characterised by an outcropping rocky layer.

2. Description of undertaken actions

The experimentation began in autumn 2012, after the first rains.

Site 1: Testing *in situ* different reforestation methods by planting and by direct seeding of *Pinus brutia* a new application in Greece.

The reforestation on terraces done in the last decade in the peninsula created good results for the establishment of pine forests, but their ecological structure is poor (absence of shrubs).

Thus, in the frame of the project, the North Aegean Region tested different methods of reforestation in a shrubby area.

The aim is to try different methods involving minimal or more drastic interventions to achieve the restoration of a pine forest.

The experimental protocol has two main types of reforestation material of *Pinus brutia:* Application of direct seeding and plantation of young plants.

Two ways of implantation where experimented:

Seedling: using 15 to 20 seeds on small plots of about 0.25 m to 0.25 m, each one separated of 3 m from the others, in a very shallow depth more or less 2 cm. Half of the seeds

Pilot site identity file	Site 1 : Peninsule d'Amali	Site 2 : Nees Kidonies
Pilot site area	1 500 ha	1 ha
Population	2 500	
Main cities and municipalities	Loutra, Ano Charamida, Charamida, Skala Loutron, Taxiarxai, Neapoli, Ag, Marina, Ag. Paraskeyi, Agrilia Kratigou	Nees Kidonies, Mitilène
Forested area in the pilot site	650 ha (43 %)	
Including private forests	325 ha (50 %)	
Organism locally responsible for forest management	Forest administration of Lesbos	Municipality of Nees Kidonies
Main forest tree species	*Pinus brutia (small trees: Quercus coccifera, Arbutus spp., Pistacia lentiscus, Cistus spp., Sarcopoterium spinosum).*	
Stand productivity	800/ha	
Main role of the forest	protection of the soils, biodiversity	
Other land uses category on the pilot site (non-forested area)	horticulture (olive groves), tourism	
Annual amount of precipitations (millimetres)	565 mm	566 mm
Mean lower temperatures of the coldest month (°C.)	9,0 °C	9,0 °C
Mean higher temperatures of the warmest month (°C.)	26 °C	27 °C
Global geological conditions	Hard and marly limestone, peridotites, schist, phyllite, etc. Mean or low fertility	Volcanic rocks. Superficial soil with low fertility
Main natural risks threatening the pilot site	Wildfires	Erosion
Main potential climate change related impacts in the region	Aggravation of the fires, desertification	

are planted without any treatment, while the other half is made with seeds swollen by immersion in water during 48 h.

Plantation: plants are two years old with roots of about 30 cm. They are planted in the trenches or conical holes of 30 to 40 cm deep. A belt of soil of 5 to 10 cm keeps water in a sort of basin, at least for the first year.

Three different field treatments are applied for each type of planting (6 different areas in total):

- Use of a ripper with one knife, which opens parallel trenches of about 30 cm deep, each one separated of 3 m from the other. The ripper works the ground and uproots everything on its path.

Advantage: the technique combines a relatively light mechanical intervention, and so a limited perturbation of the vegetation in place, and prepares the ground to improve roots implantation.

Disadvantage: presence of shrubs that will eventually be in competition with the young plants.

- 2. The second treatment includes a complete clearing of shrubs in surface thanks to a bulldozer, added to the use of a ripper in the same way as in the first case.

Advantage: the removal of shrubs in surface is comparable to the passage of fire, without the negative effect of heat. The effect of shrub competition disappears at least for the first seasons, which is crucial for the success of the reforestation.

Disadvantage: it momentarily destroys any vegetation. Although it is not a forest, this destruction will have an undeniable ecological impact.

- 3. The third treatment is the gentlest intervention possible. It consists in a small clearing with manual tools only and locally around the plots where the seeds or plants are implanted.

Advantage: a minimal disturbance of the vegetation that continues to operate its ecological functions.

Disadvantage: seeds and plants have to face a constant competition from the other existent species.

First results and next Steps

The comparison on the same site with similar ecological conditions of the three treatment methods on two types of implantation, will give us elements, totally unknown in Greece at the date, on the most appropriate methods for Pine forest restoration.

Obviously, if the results are equivalent or present a small difference, we will choose, for a large-scale refores-

Photo 3.18: General view of the experimental site. In the centre, we can clearly see the area totally cleared of shrubs (treatment 2).

Photo 3.19: Young plants of Pinus brutia proceeding from direct seedlings (Charamida, Amali Peninsula, island of Lesbos).

tation, the method with the minor degree of intervention on the ecosystem.

Otherwise, direct seeding could reduce the cost of reforestation and their application to a larger scale.

The action was carried out in autumn 2012. The first results are very satisfactory for both applications. The new action of direct seedling has given impressive results.

It is necessary to monitor the experiment during the next seasons and years and to analyse and compare the results. We must take care to help some plants to survive during the first summer by applying some watering if necessary. Other plants will be left such as facing the natural selection and adaptation.

Site 2: Clay balls containing seeds of forest and shrub species were laid directly on bare soil. The objective was to use a technique of natural selection to get a reforestation of the most adapted to the environment species.

The soil environment was too hostile for such activity; the winter rains certainly dissolved the balls of clay and asphyxiated the seeds. The results were very disappointing, considering the mobilization of the population.

To remedy this situation, we conducted a classic reforestation plantation of conifers (*pines, Pinus brutia* and *P. pinea* and *cypresses Cupressus sempervirens*), which we expect to have fairly satisfactory results.

3. Main deliverables

The main deliverable which will be distributed to the services involved (Forest Directory, Region, Municipalities) is a guide including the techniques used, the comparison of results and conclusions with the choice of the type of treatment to use in a large-scale reforestation.

- L4_P6: « Forest Fire behaviour modelling in the study area using suitable software »
- L30-31_P6: « Proposal of methodology for the reduction of the risk of forest fire »

Remind: All the deliverables are available in the project's DVD and website.

4. Difficulties and possible improvement

The good will of all the services involved contributed to achieve the activity without difficulty. An improvable point could be to have conducted a larger pilot activity at the beginning of the project, which would have allowed having the final results already.

5. Elements transferable/replicable on a large scale

If the initial results are confirmed, the techniques used could be reproduced on a larger scale in the region, Greece and possibly in other countries.

6. Benefits derived from FOR CLIMADAPT project

The FOR CLIMADAPT project has been the source of a self-questionning for the Services of the Region, which has stimulated this scientific experimental activity that could be used on a large scale, with environmental benefits and undeniable costs of reforestation.

Partner's activity balance: ASSOCIATION FOR THE DEFENCE OF MÉRTOLA'S HERITAGE (ADPM) – PORTUGAL

WEBSITE : www.adpm.pt/adpm.html

1. Objectives and context

Partner's presentation

Since its establishment in 1980, the Association for the Defence of Mertola's Heritage (ADPM) has developed a strategic action based on the relationship between nature conservation and socio-economic development.

Priority action is ranging from sustainable local economy to the restoration of degraded lands and fight against desertification through public awareness and environmental education.

To deal with local issues, it was necessary to form an interdisciplinary team of technicians able to work together in a cross-cutting project for Mértola, in which the participation of local stakeholders was a key factor.

Photo 3.14: General view of Monte do vento, Mértola, Portugal.

Photo 3.15: Erosion data collection from «GERLACH» collector in Monte do Vento.

The ADPM is notably responsible for the establishment of the Vale do Guadiana Natural Park, contributing to its administration. It has also initiated various projects such as FAJA III on rivers ecological restoration, and implemented various training programs, in particular a Master «Regional Economics and Local Development», in partnership with the University of the Algarve, the Polytechnic Institute of Beja and the Archaeology centre of Mértola.

General context and justification of local needs

The Region of Alentejo is severely affected by climate change, which, combined with increasing human pressure (including silvopastoral activities) and mismanagement of the ecosystems, is seriously exacerbating the desertification risk (increased aridity, lack of regeneration in *montados,* erosion and soil leaching...).

Pilot site

In 1993, ADPM has acquired a property of 200 ha with the aim of establishing a demonstrative experiment of good management practices that could be adapted by other owners and managers in their own fields. The aim is to combine agriculture, forestry and nature conservation in a sustainable development approach. Various ecological slopes restoration project (reforestation, firebreaks...) and actions preventing erosion in rivers were conducted.

The pilot site is located inside of the Natural Park of Vale de Guadiana, in an ADPM property called Monte do Vento. It is located in the North of Mértola municipality, near Pulo do Lobo. It is more or less plan, with low altitude.

2. Description of undertaken actions

Actions performed

Action 1 « Diagnosis and observation »

- 1.1 Diagnosis and observation of the territory of Vale do Guadiana Natural Park

Diagnosis of the actual agro-forestry management done in the Park area and impacts in terms of soil conservation, water conservation and carbon fixation. Related to the main management activities we produce a list of impacts (negative, neutral or positive) related to water, soil and carbon. When the impacts are negative we suggest measures to mitigate them and to act in order to turn them into positive impacts.

PILOT SITE IDENTITY FILE	Natural Park of Vale de Guadiana
Particular status and available regulation and planning tools	Natural Park, Natura 2000, Baixo Alentejo Forest Plan
Pilot site area	69 773 ha
Population	7500 (11/km^2)
Main cities and municipalities	Mértola.
Forested area in the pilot site*	13954ha (20%)
Including private forests	13500ha
Organism locally responsible for forest management	Ministry of Agriculture, Sea, Environment and Territory Planning - Directorate-General of Preservation of Nature and forests
Main forest tree species	*Quercus ilex, Quercus suber, Olea europea, Fraxinus angustifolia, Populus alba, Salix sp. Eucalyptus globulus*
Stand productivity	New projects (600 trees/ha), *Montado* (90 trees/ha)
	Main production is cork (2Ton/ha) and acorns for cattle (20 sheep/ha) or (3 cows/ha), firewood and charcoal
Main role of the forest	Protection, grazing, Tourism Grazing activities
Other land uses category on the pilot site (non-forested area)	Agriculture, livestock, tourism, grazing
Annual amount of precipitations (millimetres)	450 mm
Mean lower temperatures of the coldest month	4,7 °C
Mean higher temperatures of the warmest month	33,8 °C
Global geological conditions	Acid very thin schist soils with a very low productivity
Main natural risks threatening the pilot site	Drought, wildfire, desertification and high risk of erosion
Global tendencies of the forest policy usually implemented in the region	Low intervention degree. Priority given to protection and tourism.
Main potential climate change related impacts in the region	Die-back of *Quercus ilex* and *Suber,* increased risks of wildfires, erosion and desertification

- 1.2 Monitoring of fauna and flora in CESAMV
  List of fauna and flora species present in Monte do Vento
- 1.3 Survey on the perception of the impact of climate change
  Survey on farmers and owners in the park area that allowed making the diagnosis. The survey covers around 12% of the Park area (about 8000 hectares) and concerns 12 properties.

Action 2 «Adaptive forestry»

- 2.1 Evaluation of techniques and species used in reforestation project
  Study regarding the techniques used in the forest plantation in Monte do Vento. Studies are related to mycorrhization, facilitation and trench and mount. This study allows understanding better the good results we have related to trees mortality.

Action 3 « Techniques of ecological restoration and reforestation of damaged areas»

- 3.1 Course of ecological restoration techniques.
  A course, related to conservative agriculture focusing on new techniques used in Australia related to soil and water conservation, was organized.
- 3.2 Monitoring of an ecological restoration project
  Study of geomorphological, sediment and vegetation aspects.

Action 4 « Awareness, training and governance for a social adaptation»

- 4.1 Realization of two Workshops to make know the example of restoration projects.
- 4.2 Realization of two workshops focuses on agriculture activity and climate change scenarios.
- 4.3 Awareness campaign towards local community, about the impact of climate change.

Results…

…expected

- Increase knowledge about the perception of Climate Change effects in general public.
- Increase knowledge about restoration measures to fight against desertification process in Monte do Vento.
- Develop measures that can be undertaken by forest owners and farmers regarding adaptation to climate changes effects in Mediterranean region.

…acquired at the end of the project

- Better understanding of the impacts, at Mediterranean level, of the climate change effects.
- Better understanding of the different strategies used in each country.
- Better understanding of the perception that forest owners and farmers have about climate change.
- List of measures that can be taken by forest owners and farmers to better adapt to climate change effects.

Perspectives (next steps, future opportunities...) and deadlines

After the end of the project, some actions still will be conducted:

- Monitoring the adoption by owners and farmers of the proposed measures[2] related to climate change adaptation.
- Developing new studies about adaptability of trees (actual and new species) to climate change.
- Developing new models for forest management in *« Montado »*.

3. List of deliverables

- L2_P7: Monitoring of fauna in Monte do Vento
- L2_P7: Monitoring of flora in Monte do Vento
- L7_P7: Diagnosis and observation of the territory of Vale do Guadiana Natural Park
- L9_P7: Course of Ecological restoration, realized on 22-24 April
- L11_P7: Workshop «Agriculture and climate change» (19 September 2012 and 9 May 2013)
- L12_P7: Workshop «Ecological restoration» (22 May)
- L13_P7: Game for children related to climate change and forests in Portuguese and English
- L16_P7: Leaflets with information about the project
- L17_P7: Presentations in project seminars of Mértola (2011) and Naples (2013)
- L20_P7: Poster participation in the 3rd Mediterranean Forest Week.

Remind: All the deliverables are available in the project's DVD and website.

4. Difficulties and possible improvements

The main difficulties are related to the uncertainty of the real impacts of climate change over territories. In the Alentejo's forest areas, the main problems are related to mortality of Holm and Cork oak and there is still no consensus in the scientific and academic levels about the causes of this mortality. This uncertainty means that public opinion still does not have these issues very much in mind, despite knowing the concept and the general causes and effects. More studies and particularly more pilot actions are essential to clarify these doubts.

5. Elements transferable/replicable on a large scale

The main transferable elements are the techniques of management of woodland in semi-arid areas. The results obtained through the experiences of Monte do Vento allow that management measures may be transferable to similar climate areas that are confronted to the same problem of desertification process.

The methodologies of public awareness raising and environmental education can also be transferable.

6. Avantages retirés du projet FOR CLIMADAPT

Through the European networking and the development of knowledge on these subjects, the project strengthened our relations with different international institutions in the area of climate change and forest management.

It also allowed an increased perception of the degree of climate change impacts in Mediterranean areas and in the different countries, in particular on forests (forest fires, droughts and die-back, pests' attacks…).

Finally, it gave to the ADPM a major role, at national and regional level, as an actor in the area of climate change adaptation in forested areas.

Photo 3.16: Restoration of « Montado », a traditional agro-silvo-pastoral system that allows fighting efficiently against erosion and desertification processes in the context of climate change

2 - Some recommended measures:
- Land mobilization according to the contour line avoiding soil erosion
- Encourage natural regeneration;
- Keep the soil covered with vegetation;
- Shrubland control should pass by a set of integrated techniques: mechanical control, chipping, harrowing, fertilizing (with phosphorus to favor legume herbs species), grazing;
- In new agro-forest stands, keep some lines without ploughing and alternate them over the years;
- Make a correct management of shrubland, renewing plans every 10 years;
- Ensure the protection of soil, prevent mobilizations and ensuring the soil cover;
- Avoid constant shrub clearing as accelerate the decomposition of organic matter;
- Ensure *montado* sanity, reducing tree mortality and favoring regeneration;
- In most deforested areas, increase trees density;
- Adopt techniques that minimize the risk of erosion;
- Promote forests fires prevention through fuel management by cattle grazing.

ASSOCIATION INTERNATIONALE FORETS MEDITERRANEENNES

Partner's activity balance:
INTERNATIONAL ASSOCIATION FOR MEDITERRANEAN FORESTS

WEBSITE : www.aifm.org

1. Objectives and context

Partner's presentation

Every issue related to Mediterranean forests interests and/or concerns, more or less directly, many different social and professional groups. Therefore, to address this diversity of stakeholders and sensitivities associated to the Mediterranean forest, the International Association for Mediterranean Forests (AIFM), founded in 1996, has the mission of facilitating the exchange of knowledge, experiences or ideas about this theme, in a cross-disciplinary way between all persons concerned by Mediterranean forests.

The AIFM has developed a network of organizations and individuals made up of approximately 3 000 international contacts including experts with varied skills (foresters, environmentalists, scientists, decision-makers, civil security…) and multiple stakeholders. Among other network driving activities, it publishes a quarterly newsletter («Latest on Mediterranean Forests») in French and in English, moderates a website (www.aifm.org) and participates and organizes events related to Mediterranean forests.

But one of the main current activities of the AIFM is to take part and initiate cooperation projects among which, FOR CLIMADAPT.

Role of AIFM in the FOR CLIMADAPT project

The functions of the AIFM within the project were namely to facilitate the communication and capitalisation activities, but also to energise the project by developing synergies with other similar initiatives. See more detailed information hereafter.

2. Description of undertaken actions

The AIFM had a major role in the emergence of the project and played an active coordinating role during the preparation phase. AIFM was responsible for leading technical exchanges and disseminating the main achievements resulting from these actions (capitalization). Throughout the implementation of the project, it was responsible for the work of technic animation. As such, in collaboration with the Lead partner and under the control of the steering committee, it guranteed the general methodology of the project (developed during the projects it has led previously).

In addition, the AIFM was in change of the organisation and the Presidency of the Peer group and the secretariat in terms of capitalisation. It was in charge of drafting the Progress books and the present Final capitalisation book of the project.

The AIFM promoted the project through its Mediterranean network of contacts and communication tools. In order to achieve this, it carried out various media such as the website www.forclimadapt.eu and the biannual Newsletter. It also worked to transmit the information and recommendations to the major institutions (European Union in particular).

AIFM also participates in events such as the third Mediterranean Forest Week in Tlemcen (Algeria), where FOR CLIMADAPT was represented. It also contributed to the preparation of the MED capitalisation project called MEDLAND 2020[3] Programme events. AIFM is also involved in external events to establish a link with similar initiatives (RMT AFORCE, EFIMED, FAO/SilvaMediterranea, GIP Ecofor…). Finally, it tried to involve stakeholders in order to promote exchanges of ideas throughout the project.

3. List of deliverables

The main products and deliverables are the following:

- L1_P2 and L34_P2: Reports of the technical seminars 1 (Marseille), 2 (Mértola), 3 (Vesuvius), 4 (Umbria), 5 (Solsona) et 6 (Mytilene).
- L17_P2: Presentation of the project in at least 6 events of international scope (100 people and more).
- L21_P2: Progress Book No. 1 (on seminars 1 and 2), No. 2 (on seminars 3 and 4) and No. 3 (on seminars 5 and 6). French and English versions.
- L22_P2: 6 Biannual newsletters of the project (French and English versions). About 1200 direct recipients.
- Initial state of the pilot sites of the project and of the programmed activities completed (online at the www.forclimadapt.eu site and partially transcribed to the progress books).

3 - This project has just began in July 2013. The main objective is to promote jointly the outputs of MED standards projects related to the management of natural resources, in particular forests, such as FOR CLIMADAPT, QUALIGOUV, Model Forest, Sylvamed or PROFORBIOMED. More information about the project on the website: http://www.aifm.org/nos-activites/projets-de-cooperation/medland-2020

Photo 3.20: The organisation of the Peer group meetings was at the heart of the AIFM's missions.

Figure 3.10: Although quite late in the project, the Internet site www.forclimadapt.eu was very successful with more than 6000 visits per month towards the end of the project.

- L23_P2: Website of the project (French and English versions). In average 6000 monthly visits.
- L24_P2: Logo and graphic charter of the Project.
- L25_P2: External promotion of the project
  - Synthetic leaflet of presentation and promotion of the project (French and English versions).
  - Presentation poster of the project.
  - Press articles.
- Technical synthesis of the project presented at the restitution seminar of Herculanum.
- L35_P2: Final capitalisation Book (this final Book + DVD of the deliverables), establishing the project balance at the and.
- L37_P2: Reinforcement of the relations with other close projects and initiatives and in particular: Presentation of the project at the 3rd Mediterranean Forest Week (Tlemcen, 03/2013), *Cluster* of project «Integrated and sustainable management of the natural resources in the Mediterranean territories» and representation of the project within the capitalisation MEDLAND 2020 project.

Remind: All the deliverables are available in the project's DVD and website.

4. Difficulties and possible improvements

- Internal restructuration of the association during the implementation period of the project.
- Cash-flow problems due to the ERDF reimbursement delay.
- The structural difficulties that the partners faced directly affected the capitalisation work (delays in answering to the information requests, absence of some members of the Peer group in several meetings…).

Despite all of that, the activities executed are online with the initial projections.

5. Elements transferable/replicable on a large scale

The method used within the FOR CLIMADAPT project (see Part 1) was developed by the AIFM during previous projects (RECOFORME, QUALIGOUV…). It is replicable in many other similar initiatives and it constitutes the main element that the AIFM wishes to make available to future projects' leaders.

6. Benefits derived from FOR CLIMADAPT project

The project allowed a mutual enrichment of the partnership and of the AIFM. Indeed, the latter provided a methodological support, a visibility and a macro-regional opening to the partners, via a thorough work in terms of capitalisation, a global vision of the project in order to promote it, and the development of synergies with other close initiatives and institutions involved. In return, the project allowed AIFM to broaden a little bit more its network by meeting new partners, and to widen its knowledge of the Mediterranean forest issues, namely via the field visits during the technical seminars. These new experiences will help the association to progress towards its fundamental objective set out more than 15 years ago: to contribute to the development of a « shared vision » of the Mediterranean people on their forests.

Partner's activity balance: FORÊT MÉDITERRANÉENNE ASSOCIATION – FRANCE

WEBSITE : www.foret-mediterraneenne.org

1. Objectives and context

Partner's presentation

Forêt Méditerranéenne is a French association, created in 1978. It is a place of exchange and meeting for all people interested in the forest and natural areas of French Mediterranean regions.

Today, *Forêt Méditerranéenne* has a network of nearly 4 200 individuals and partner organizations, nearly 330 members and 450 subscribers to its magazine *« Forêt Méditerranéenne ».* Its network consists of institutional stakeholders, socio-professionals, associations... of the Mediterranean forest management and protection sectors.

P3.21: Field visit during the opening seminar organised by Forêt méditerranéenne and the ONF.

Role of the association « Forêt Méditerranéenne » in the FOR CLIMADAPT project

The main contributions of the Association *Forêt Méditerranéenne* to the project were:

- The organization of an international conference as a shared initial state of knowledge at the beginning of the project,
- The constitution of a platform for knowledge exchange validated in French Mediterranean region (institutions, communities, organizations research, associations ...) and initiate this associative process in other partners' countries (the writing of a methodological guide was for this purpose).

2. Description of undertaken actions

Actions performed

- 1 - *Forêt Méditerranéenne* organised a two days symposium, as an opening seminar for the FOR CLIMADAPT project on the subject «Observe and adapt to climate change in the Mediterranean forest» followed by a reflection workshop on the knowledge transfer issues. These seminars joined 200 participants and the balance is extremely positive.
- 2 - A database with the information of different contacts: researchers and managers from different countries, who executed research and experiments' programmes regarding the adaptive management of the Mediterranean forests was elaborated. Today, it has 428 contacts from 18 different countries.
- 3 - *Forêt Méditerranéenne* elaborated the Methodological Manual «implement a multi-stakeholder network on forest adaptation to climate change» and proposed the diagram of a prototype web platform « adaptation of the Mediterranean forests to climate changes ».

Results…

- Regarding the *Forêt Méditerranéenne* partner, the results expected at the beginning of the project were achieved. All the actions were executed and the deliverables were delivered.
- The *Forêt Méditerranéenne* wishes to publish and distribute the technical reports of the works of the other project partners within its network, via its usual means (magazine, newsletter).

3. List of deliverables

- L15_P8: Database of the stakeholders who work on forests adaptation to the climate change (format FileMaker or Excel).
- L17_P8: dossier of participants's booklet of the symposium, with the summaries of all the interventions and the press releases. The presentations slides are downloadable from the Association's website: www.foret-mediterraneenne.org.

- L26_P8: Methodological Manual «implement a multi-stakeholder network on forest adaptation to climate change» including:

• L14_P8: Prototype of the web platform «adaptation of the Mediterranean forests to climate changes», available in PDF format and downloadable at the association website: www.foret-mediterraneenne.org. At this link, there is also the issue of the magazine « *La feuille et l'aiguille* » with articles on the FOR CLIMADAPT project

• L27_P8: Reports from the symposium, published in the special edition of the magazine *Forêt Méditerranéenne* (PDF format of the magazine available upon request).

- L28_P8: Presentation of the workshop «The methods of transfer and communication of knowledge» organised at the symposium (see below).
- L25_P8_1: Article published in the magazine *« Forêt Entreprise ».*
- L29_P8: Organisation of the symposium « Observe and adapt to climate change in the Mediterranean forest » (opening seminar of the project).

Remind: All the deliverables are available in the project's DVD and website.

4. Difficulties and possible improvements

The actions and the deliverables were executed without particular difficulties. The difficulties arose mainly from the part related to the administrative and financial management of the project (largely underestimated).

5. Elements transferable/replicable on a large scale

- Method of organisation of the symposium and of the knowledge transfer workshop
- Method of network implementation
- Prototype of website useful to the elaboration of an information capitalisation website.

6. Benefits derived from FOR CLIMADAPT project

- Productive relationships with the other partners.
- Improved knowledge of what is done in the other Mediterranean countries regarding the adaptation to climate changes.
- Collection of the useful data (knowledge, articles, contacts) for the association's objectives of information communication and dissemination.

CONCLUSION AND RECOMMENDATIONS

Beyond the positive collective dynamic of which it is an integrating part, the FOR CLIMADAPT project has allowed reinforcing techniques for the observation of an evolving Mediterranean climate, as well as the development of tools or the implementation of methods for the adaptation of the forests to these changes according to three major axes:

- Development of an « adaptive forestry »,
- Anticipation of crises and restoration of degraded reas,
- Public awareness raising and improvement of governance.

1 - FACTS SPEAK FOR THEMSELVES

Climate change causes concrete mutations, already observed on the pilot sites of the project's partners, even if sometimes difficult to distinguish from the usual variations of the Mediterranean climates. They are observable namely on the statistics, thanks to the Emberger's climagram (see page 13).

The major impacts are the following:

- Temperature increase (the year 2012 was the hottest year ever recorded).
- Decreased rainfall during the summer and periods of intense droughts.
- Increased frequency of extreme meteorological events (floods, storms, heat waves…).

We also observe that the exposed areas are broadening, and that the risk of wildfires in the already sensitive areas is higher with, for example, the outbreak of huge wildfires, the so-called «convection» fires (see Page 21).

Moreover, the major changes in practices should not be neglected (rural exodus, agriculture modernisation, population ageing, urbanisation and peri-urban « sprawl », development of outdoor recreational activities, environmental policies…), which interfere with the climate variations. The expression « global change » should therefore be used.

No matter what we do, the process is on progress. The Mediterranean climate of tomorrow will be different from the one of today. On the light of this reality, the partners of the FOR CLIMADAPT project have chosen to steer their actions towards the anticipation of these changes, in order to better prepare their forest lands. As such, the project took place within an important worldwide dynamic for the study of this phenomenon, and has contributed to the evolution of knowledge on these subjects and allowed possible answers to be given.

2 - OVERVIEW OF THE MAJOR TECHNICAL RECOMMENDATIONS

By their respective experimental activities, the partners, through the capitalisation body that the Peer group represents, are now able to address the following recommendations to all the decision makers and managers of the Mediterranean wooded lands who wish to integrate the issue of the climate change in their way of managing territories [1] :

Adapt forest management to the expected changes, at Stand scale, at Massif scale, as well as, at Regional Scale

Improve the stands resistance and resilience to climate change (2.2) :

- Playing on stands' density
- Making forestry rotation shorter
- Favouring irregular stands' structure
- Promoting tree species' combination

Enhancing genetic adaptation of local tree species (2.3) :

- Stimulate the natural regeneration through seeding
- Plant adapted local tree species
- Look for more «southern» provenances of local tree species

Replace declining species by exotic species, which causes a vigorous debate between forest owners and environmentalists (2.4)

Adapt the techniques of reforestation (2.5):

- Loosen the soil to favour root growth
- Use plantation accessories (soil mulching, shade nettings and green houses, irrigation…). These actions imply high costs.

1 - Note that each recommendation corresponds to a specific context and allows answering specific issues. The details of their implementation are explained in the Part 2 - « Mediterranean forest and climate change: time to adapt » (technical synthesis from the Peer group). The figures in brackets indicate the corresponding section.

Anticipate diebacks, prevent fires, fight erosion and rehabilitate deteriorated lands

Monitor and manage stands diebacks, which requires (3.1):

- To learn how to observe diebacks
- To follow-up the most affected massifs thanks to mapping
- To make the right decisions in the very short term

Observe accurately the vegetal dynamics (3.2):

Address the increasing risk of wildfire (3.3):

- Learn how to «live with fire»
- Better know the vulnerability of territories
- Create and maintain equipments for prevention and facilitation of fire fighting: prescribed burning, forestry interventions allowing for example to avoid crown fires…
- Develop synergies with breeders, in order to enhance grazing by cattle, which contributes to maintain « clean » understorey and to control organic fuels accumulation.

Prevent soil erosion and desertification (3.4)

Contain localised erosion processes (3.5)

Transfer knowledge, raise society's awareness and improve participative governance in territories

Improve knowledge transfer from specialists to the managers (4.1)

Inform and raise awareness of the populations in the territories more exposed to climate change impacts (4.2)

Encourage decision makers to consult specialists (4.3)

Reach policies and institutional decision makers (4.4)

PROSPECTS...

It is obvious that all these recommendations cannot be followed to the letter, overnight and regardless of the circumstances. Firstly, because the costs and the technical barriers related to the local conditions can sometimes become overwhelming and restrict the good intentions of the managers. Then, because rushed decisions making often leads to mistakes, the impacts of which are sometimes noticed years later. A serious thought, underpinned by experts from all concerned subjects, is therefore crucial prior to any large scale initiative.

But the main satisfaction of FOR CLIMADAPT partners is in the background work done these past three years to drive forward the reflection and the experience in these areas. It is a modest step forward but a sure one towards an increasing consideration of the issues related to climate changes in the policies and methods of management in the Mediterranean forests. In the long run, they should enable us to limit their impacts and to prevent huge crises. This requires highlighting the project's conclusions to the field stakeholders and to the international, national and regional important institutions.

This is one of the objectives of the « Declaration of Herculaneum » (see pages 59, 60), signed during the project's final conference. This motion displays the will of the partners to perpetuate their collaboration in order to give some continuity to the actions undertaken within the project.

Moreover, the capitalisation project MEDLAND 2020 « Design of a future common integrated land management scheme to protect natural resources in synergy with their social and economic valorisation » [2] (2013-2014) also constitutes an important perspective of large scale valorisation of the FOR CLIMADAPT acquired knowledge, via a network of numerous institutions concerned with the natural resources management, namely forest resources in the Mediterranean region.

2 - See note n°3 of the Part 3 (page 52)

Finally, we must remind everyone that to work on the questions of adaptation to the new climate conditions should not undermine the importance of fighting, in parallel, the factors that are at the origin of the changes. In particular, the limitation of greenhouse gases emissions by saving energy and by transitioning towards renewable energy sources [3] is a global challenge to which each stakeholder concerned must contribute within its possibilities. This has a direct consequence on the Mediterranean woodlands whose values, in terms of biodiversity, as well as economic production, are based on a fragile natural balance. Each one of us is responsible for doing everything possible to preserve this heritage.

3 - It is one of the major objectives of the PROFORBIOMED project « Promotion of residual forest biomass in the Mediterranean Basin » (2011-2014), in which AIFM and CTFC are also partners. See.www.proforbiomed.eu.

Declaration of Herculaneum

We, representatives of FOR CLIMDAPT project's partners:
- Vesuvius National Park (Italy),
- International Association for Mediterranean Forests,
- Umbria Region (Italy),
- Forest Research Centre of Catalonia (Spain),
- National Forestry Office (France),
- North-Aegean Region (Greece),
- Association for the Defence of Mertola's Heritage (Portugal),
- *Forêt Méditerranéenne* Association (France);

Considering that the FOR CLIMADAPT project allowed us to take into account the first manifestations of climate change on Mediterranean forest areas (particularly affected by climatic evolutions) that we are managing;

Considering that the project has allowed us to capitalize and promote these improvements in terms of knowledge, observation, adaptation, restoration and governance in the context of climate change practices;

According to the lessons that we have learned from each other's activities during the discussions we had on the subject and significant progress they brought us in terms of knowledge of issues related to forests adaptation to climate change, not only for the partners, but also for the whole Mediterranean forest community;

Considering the cooperation dynamic and the results obtained by the different partners during former projects (QUALIGOUV, RECOFORME...) that allowed to reach a better knowledge of Mediterranean forests and its diffusion towards all stakeholders and institutions concerned;

Declare our wish of prolonging and maintaining our partnership, while opening it to all stakeholders interested by these issues, and demand that
- International institutions, European Union and United Nations supply for agriculture (FAO), United Nations for Education, Scientific and Cultural

Organization (UNESCO), the United Nations Programme for the Environment Facility (UNEP-MAP-Blue Plan), the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM), the International Union for Conservation of Nature (IUCN),
- The States concerned by the development of the Mediterranean regions and their respective cooperation tools (GTZ, AFD, FGEF...),
- The territorial administrations, regions, departments, provinces, deputations, *willayas*, municipalities and inter-municipal agencies of the countries bordering the Mediterranean,
- National and regional parks, natural reserves management organizations and other protected areas,

1 - Commit more strongly in active policies to influence the management of natural Mediterranean forest areas and in the direction of climate change adaptation;

2 - Join Forces whenever possible to design and promote cooperation actions for this adaptation, in particular to promote transfer of knowledge and know-how between research, conception and concrete implementation in the field;

3 - Facilitate scientific works in this perspective, as well as the integration of management organisms and their work, not only by their diffusion, but also through pilot and demonstrative experimentations;

4 – Try to promote interregional cooperation programs, focusing on the management of Mediterranean forests and natural areas in the context of global change, not only within the European Union but also in other countries bordering the Mediterranea;

5 - Involve institutions who have worked in this direction in the design of these new cooperation programs.

Done in Herculaneum on 16 of May 2013

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Annex 2 : Cartography of the pilot sites

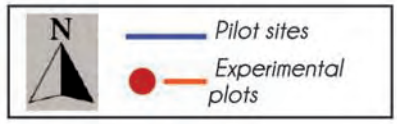
Umbria Region, Municipality of Arone

Catalan Pyrenea, forests of Fontanella, Alinyà and Senyùs

Localisation of pilot sites within the Mediterranean bassin

Catalan Pyrenea, Baronia de Rialb

Aude, Plateau de Sault



Alpes-Maritimes, Préalpes de Grasse

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