EUROPEAN FOREST INSTITUTE
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Forest-Based Sector
Technology Platform

A Mediterranean forest research agenda – MFRA 2009-2020

A draft proposal for consultation
established by EFIMED

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Preface- Mediterranean forests, an overlooked issue ?

Since the beginning of the nineties, forests and forestry have become key topics on the international political agenda as demonstrated by the United Nations Conference on Environment and Development (UNCED) Conference in Rio in 1992 or the Ministerial Conferences for the Protection of Forests in Europe (MCPFE), which started in Strasbourg in 1991. Since then, international conferences and political processes have constantly emphasized the need for preserving and conserving boreal, temperate and tropical forest ecosystems. However, it has to be recognized that, apart from the FAO initiative of drawing up a Mediterranean forests action programme (approved at the March 1992 session of *Silva Mediterranea* in Faro, Portugal) little attention has been put on Mediterranean forests at the international level, if we do not consider the recurrent issue of forest fires. No comprehensive joint International research agenda has been developed that might address simultaneously the economic, ecological, and social challenges to sustainable Mediterranean forest management.

Although the total area of Mediterranean forests (even including ecologically analogous areas such as those in California, Chile, South-Africa, Australia) is below the order of magnitude of the above mentioned forest types, they have specific features which make them a unique world natural heritage. Moreover, it is expected that predicted climate and socio-economic changes will, on one hand, increase the already existing threats on Mediterranean forests, and on the other hand will contribute to the expansion of Mediterranean conditions to new areas. Therefore, time has come for raising the awareness of the forestry and scientific community as well as of the general public about the complex challenges and research needs for ensuring the sustainability of Mediterranean forests.

The present document presents a common vision on the challenges of Mediterranean forests as well as a **Mediterranean Forest Research Agenda (MFRA)** that describes the main research priorities for forestry in the region in the period 2009-2020. This draft document has been coordinated by the Mediterranean Regional Office of the European Forest Institute – **EFIMED** within the framework of the European Forest-Based Sector Technology Platform (FTP) Strategic Research Agenda. This document has been elaborated in cooperation with the institutions listed in Annex 2.

We would like to thank all those who have contributed to the development of the MFRA. We specially acknowledge the contribution made by the members of the EFIMED advisory group; Jose G. Borges (Portugal), Felipe Bravo (Spain), Davide Pettenella (Italy), Mohamed Sabir (Morocco), Hamed Daly (Tunisia), Zuheir Shater (Syria), Emin Baskent (Turkey), Vassiliki Kazana (Greece); the EFI Scientific Advisory Board member Americo C. Mendes, the EFI Phoenix project center manager Francisco Moreira (Portugal), the Chairman of the Scientific Council of the FTP Giuseppe Scarascia-Mugnozza (Italy) and the FTP Manager Andreas Kleinschmit von Lengefeld.

We also wish to acknowledge the numerous comments and contributions received from the EFIMED network members, who represent different forestry realities and disciplines.

We believe that achieving the MFRA will require an open and flexible approach. We invite all interested parties to contribute to the development of the MFRA.

Barcelona, 12th of December 2008

Yves Birot
Chairman of the Advisory Group of EFIMED

Marc Palahí
Head of EFIMED

Executive Summary

Mediterranean forest ecosystems provide multiple goods and services (specially remarkable is the importance of non-market values), including an exceptional richness in terms of biodiversity, which are crucial for the socio-economic development of rural areas as well as for the welfare of the urban populations of the Mediterranean region. Several challenges have emerged in a context of global change that needs to be addressed to ensure the sustainability of Mediterranean forests:

How will climate change impact Mediterranean forest ecosystems?
How to address forest and fire management concerns in a context of climate and land use changes?
How may governance, policies and economic instruments ensure the provision of valuable forest goods and services?
How to manage multifunctional forests and woodlands in multiple-use landscapes?

Meeting these challenges calls for sound management practices based on improved and enlarged knowledge as well as targeted education and capacity building that might abridge the knowledge and expertise gap between countries and institutions.

Forest research in the Mediterranean region is handicapped by its fragmentation, its limited means, and occasional outdating and isolation. In addition, the low benefits, as compare to other European forests, that Mediterranean forests provide to the forest-based industries make it difficult to attract interest and funds from the private sectors. Therefore new ways to overcome this situation have to be implemented through: research partnerships, networking, capacity building, higher education programmes, knowledge transfer and long-life learning.

The European Forest-Based Sector Technology Platform (FTP) has provided the framework for the Mediterranean forest research community to develop the Mediterranean Forest Research Agenda (MFRA) as part of the Strategic Research Agenda (SRA) in order to highlight the main Pan-Mediterranean scientific challenges as well as the scientific priorities, objectives and outcomes to address them.

The MFRA looks at networking and coordinating research at a Mediterranean level, and will require a coordinated effort by the research community and related stakeholders (forest owners, NGO's, companies, public administration, etc) to utilize in an efficient and effective way the international and national research funding resources available.

The MFRA, based on a shared and common vision on these challenges, is aimed at ensuring the sustainability of Mediterranean forests and the goods and services they provide by advancing and sharing knowledge on forest ecosystems functioning, and by developing new tools for management and governance in a context of global change. In this respect, the most innovative development of sciences (climatology, economics, decision science, biology, ecology, information technology, geomatics, etc.) should be adopted and adapted by forest science. Education and knowledge sharing through a strengthened capacity building are seen as major components of the MFRA.

The MFRA has been structured around four strategic research priorities that have been selected on the basis of their intrinsic importance, for providing a scientific framework to

meet the important challenges ahead, but also of their significance for policy decision-making.

Figure 1. A Mediterranean Forestry knowledge triangle.

The implementation of the MFRA will allow creating a *Mediterranean forestry knowledge triangle* of research, education and innovation but also a geographic triangle with vertices in Mediterranean Europe-North Africa-Middle East that will play a key role in a knowledge-based sustainable Mediterranean society.

1. The need for a Mediterranean Forest Research Agenda

Mediterranean forest and woodlands cover only 73 Mha, or about 8.5% of the region's area. They are one of the most vulnerable forest ecosystems on earth due to their traditional fragility and instability as caused by harsh climatic conditions, long-lasting pressure by humans, recurrent fires, etc. In addition, they are exposed o increased risks related to drastic land use changes (while forest cover increases in Europe, deforestation occurs at a rate of around 1.1%, higher than in tropical countries, in southern and eastern Mediterranean) and climate change (global temperature increase from 1850-1899 to 2001-2005 is about 0.76 degrees Celsius, while in Spain, a Mediterranean country, temperature has increased about 1.5 degrees from 1971 to 2000) in the region.

Mediterranean forests and woodlands host around 25.000 species of vascular plants, (50% are endemic species) and a high degree of tree richness and endemism (290 indigenous tree species with 201 endemics) with extraordinary genetic diversity. Northern and Central Europe with a four times greater surface only accounts for 6.000 plant species. In addition, Mediterranean forests provide multiple non-wood forest goods (cork, pine kernels, aromatic plants, mushrooms and truffles, nuts etc) and services (carbon sequestration, soil protection, recreation and tourism possibilities, water purification, etc.), which are crucial for the socio-economic development of rural areas as well as for the welfare of the urban populations of the Mediterranean region.

In the Northern part, the socio-economic changes of the last decades, triggered by the urbanization of our society and better living standards, have increased the demand for the environmental and social functions of Mediterranean forests. However, most of goods and services derived by these functions do not provide revenues to their forest owners as they are currently non-market services. By contrast, traditional forestry is lacking both manpower (due to rural depopulation) and profitability (high exploitation costs). This situation has resulted in forest abandonment, which in turn has lead to an increase in the risk of forest fires, pests and diseases, etc. On the other hand, forest lands located in highly tourist coastal areas are suffering an increasing pressure for recreational uses and by the tourist sector.

In the Eastern and Southern part, the rapid population growth (around 2% as an average), the low income per capita, the marked rural density and the limited diversification of activities makes forests and the goods they generate (firewood, fodder, aromatic and medicinal plants, etc) relevant primary resources for the subsistence of the local communities. In addition, forest protective functions (fight against desertification, soil protection, regulating water resources, etc) are crucial for the sustainable development of these societies. The main threats to forest sustainability in the Southern and Eastern sub-regions are over exploitation of forests for fuelwood, clearing for agriculture and overgrazing.

Mediterranean forests require special attention because:

(i)	They play a key role in the welfare of urban and rural Mediterranean societies, by providing highly appreciated marketed goods (e.g., firewood, cork, pine kernels, mushrooms, etc) as well as high value but non-market services (e.g., landscape quality, soil protection, water regulation, recreation possibilities, etc.).
(ii)	They constitute a unique world natural heritage in terms of biological diversity, but this patrimony is seriously endangered.

(iii) Their conservation and management affects the availability of soil and water resources, this last one being a key strategic resource for Mediterranean societies.

(iv) Their future is seriously endangered by climate and land use changes, which add to long-lasting problems related to forest fires, forest over-exploitation and the advance of desertification in the region.

In order to avoid an irreversible situation for Mediterranean forests, there is an urgency to tackle all these issues through joint efforts around the Mediterranean basin, as all concerned countries are nowadays interdependent. This implies that countries share a common vision on the future of Mediterranean forests in the context of rapidly evolving social, environmental and economic conditions. In the framework of the *Barcelona convention*, the *United Nations Environment Programme Mediterranean Action Plan* and the high level political process started by the Barcelona process in 1995 which has crystallized in the *Union for the Mediterranean in 2008*, developing such a common vision within the umbrella of the FTP is an important step forward.

It is also felt that advancing science should be the backbone of a more structured knowledge-based society as advancing science is necessary both, for creating the bases of innovation, and for providing scientific expertise for developing more efficient policies, aimed at reaching the objectives related to the common vision. This implies to join research efforts to develop a common Research Agenda**: a Mediterranean Forest Research Agenda (MFRA)** valid for all countries around the Mediterranean basin and based on commonly agreed priorities. Such a MRFA fits within the *Strategic Research Agenda* (SRA) developed by the FTP.

The implementation of the MFRA at a Pan-Mediterranean level will require that research capacities have a sufficient level (critical mass) in the partner countries; therefore it is important to promote at the same time capacity building and research networking activities to overcome the traditional fragmentation of the Mediterranean forest research community as well as the weaknesses in certain research areas.

2. A common vision on the future of Mediterranean forests; challenges for their sustainability

The vision on the future of Mediterranean forests is based on four major elements:

- Climate change and land use changes will markedly impact forest ecosystems (forest degradation, deforestation and desertification) and the functions they fulfill (water regulation, soil protection, etc), to such a critical level that they are seriously endangered; it will also result in the extension of Mediterranean-like conditions to new areas.
- Living with recurrent wildfires requires a change of paradigm, by shifting from a predominant short term driven fire control policy, towards longer term policies aimed at acting on the structural causes of fires and integrating fire and forest management strategies.
- Mediterranean forests can provide a large diversity of goods and services to human societies, subject to the design and implementation of new and improved economic, policy and governance instruments, taking into account wider rural development policies.

- Silviculture and multifunctional management of Mediterranean forests and woodlands in the context of the management of multiple-use land multi-scale landscapes require the development of new decision-support instruments and practices.

2.1. Climate and land use changes will impact dramatically Mediterranean forests and their role in providing services related to key resources like soil and water

The Mediterranean area is especially sensitive to any climate change because it represents a transition zone between arid and humid regions of the world, which make this region an interesting model system to study the effects of global change on terrestrial ecosystems.

Climate change in the Mediterranean region is revealing itself by temperature increase, change in precipitation regimes, and more frequent extreme events, such as drought, heat waves and storms, which in turn increase the frequency and intensity of forest fires. Such changes are and will affect drastically forest growth and health, the capacity of forests to sequester carbon as well as the diversity of forest ecosystems either directly or indirectly. Therefore, improving the knowledge about the effects of such environmental changes to forest regeneration, growth and mortality needs to be improved for predicting forest responses from the gene to the community level. Without such knowledge it is impossible to develop adequate adaptive management models for Mediterranean forest.

Box 1. Actual and predicted climate change trends in the Mediterranean region

World temperature-change scenarios vary regionally, but show a clear trend towards warming. The temperature increment from 1850-1899 to 2001-2005 has been of 0.76ºC at a global scale, while in some Mediterranean countries, the increment from 1971 to 2000 was of 1.53ºC, which is a much higher value than the 1.2ºC predicted by the climate models. In addition, simulations of future climate scenarios tend to agree that higher emission levels could produce temperature increase larger that the global average value, further reduce precipitation (of up to 20 per cent) and increase interannual variability of both temperature and precipitation (floods, droughts and heat waves).

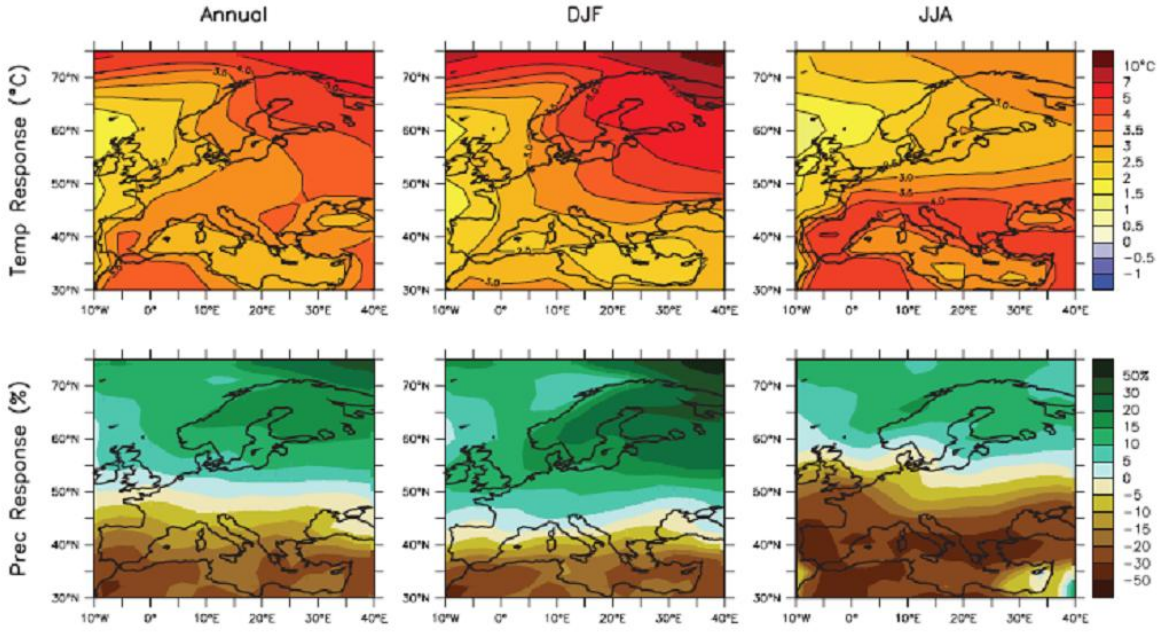

Figure 2. Simulated temperature and precipitation changes over Europe for the A1B scenario. Top row: annual mean, winter (DJF), summer (JJA) temperature change between 1980 to 1999 and 2080 to 2099, averaged over 21 models. Bottom row: same as top, but for fractional change in precipitation. Source: IPCC 4AR 2007. Source: IPCC 4th assessment report 2007

The climate change trends predicted will influence two crucial and interrelated variables; *water budgets* and *phenology*, which will have effects on the physiological processes, adaptability and diversity of Mediterranean forests. Furthermore, such trends will be coupled by a higher demand of water resources by the increasing population in Mediterranean countries, which might have catastrophic consequences for the natural resources and the overall sustainability of the region. In such context the trade-offs between water used by forests, and the impacts of forests and forest management on water quantity and quality, as well as the role of forests in land erosion control are of utmost importance.

Changes in the region are not likely to be only of climatic origin only. A series of complex and abrupt land-use changes have been and are taking place in the Mediterranean region with large scale and dramatic consequences for Mediterranean forests.

In the northern part, rural abandonment has resulted in an increase of unmanaged forest and marginal land, which has significantly extended the surface of continuous and sometimes extremely dense wooded lands. This *extensification* process has occurred in parallel to *intensification* processes related to new urban and tourism development infrastructures, especially in coastal areas with high tourist interest, which have increased the risks (fire, fragmentation, biodiversity loss, etc) related to an already complex and widespread wildland-urban interface.

Box 2. Climate change affecting water budgets and plant phenology.

While simulation models like GOTILWA+ predict a dramatic decrease of soil water content in Mediterranean areas, recent studies predict an enlargement of the length of the growth period by the year 2080 of 50 days for the Mediterranean region. This situation will lead to an increased demand for water parallel to a decrease of the water resources available for forest ecosystems.

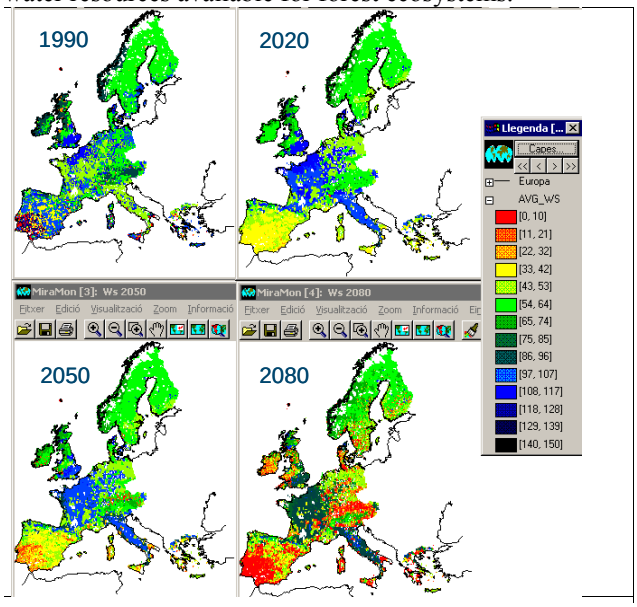

Figure 3. Soil water content in European forest soils simulated with the forest growth process based model Gotilwa+. Simulations use a pixel of 10'x10' combined with climate predictions of HadCM3 model under a socioeconomic scenario A2 (IPCC, 2003). Source: Gracia

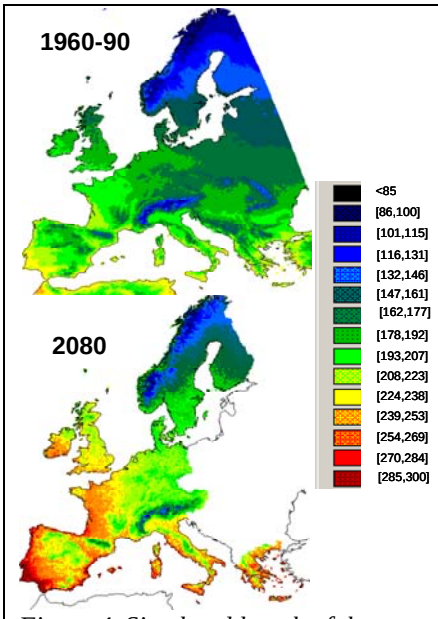

Figure 4. Simulated length of the growth period (days).
Source: C. Gracia

In addition, higher temperatures will induce an exponential increase in the respiration rates of living tissues of trees, while photosynthetic response to temperature are not expected to increase. This may result in a depletion of the reserves of mobile carbohydrates, which are used by Mediterranean trees to overcome the dry summer periods. Most of the dieback episodes observed in Mediterranean forests in recent years, are associated to the exhaustion of carbohydrates reserves, which can be consumed in periods of three to four consecutive dry years. Most pest attacks are the consequence of this weakening of the trees and not the origin of the dieback.

In the southern and eastern part, the socio-economic conditions, basically the need for food and economic alternatives, have resulted in the degradation and conversion of many forests into grazing and agriculture land, with dramatic consequences in terms of land degradation and increase desertification.

Finally, it is important to remark that not only trees will be affected by climate and land use changes, but also all plant and animal communities and populations that are partaking in ecosystem processes. The current rate of environmental change affecting Mediterranean forests is jeopardizing biodiversity in the sense that radical changes in communities' composition and in extinction of local populations are observed. A main question is to know whether the natural mechanisms involved in evolutionary processes, will be able to cope with the intensity and speed of environmental changes.

Key challenges:

Developing the capacity of monitoring the forest conditions and ecosystems dynamics in their various components; monitoring should become an integral part of management

A better understanding of the mechanisms underlying the physiological and ecological responses of different Mediterranean tree species (in terms of nutrient uptake, growth, biotic stress factors, etc.) to climate change and water availability is needed to define new adaptive management regimes for reducing water use and ensuring the long-term soil preservation.

Improving the understanding of the role of forests in regulating water flows and influencing the yield and quality of water resources as well as quantifying the trade-offs between soil

erosion prevention and impacts on water resources by the forest cover and other vegetation types..

Understanding the adaptive response of species and their migration capacity, in regard to environmental changes and various forest management scenarios.

Anticipating the effects of interactions between different components of future environmental changes.

2.2. Living with increased wild-fire risk; acting on the structural causes and integrating fire and forest management

Mediterranean forest ecosystems have been shaped over the millenaries by many natural environmental factors including fire. However, since man has started historically to interact with his environment, the causes of wildfire haves progressively become anthropogenic, so that hey reach today 90-95% of recorded fires. One of the most serious problems in some areas is the frequent recurrence of wildfires, which jeopardize the natural resilience of Mediterranean forest ecosystems and leads to their inevitable degradation.

Today, the causes of wildfires are rather well understood and documented. Among them, four have to be emphasized: (i) the rural abandonment in the northern rim of the Mediterranean basin has resulted in vast and continuous vegetation areas very susceptible to wildfires; (ii) the development of the wildland-urban interface, due to a lack of control on housing, has led to a dramatic increase of fire risk; (iii) the behavior of the public still reflects a lack of awareness about fire risk; and (iv) the effects of climate change (increase temperature, decreased rainfall and increase of extreme events) have intensified and extensified the problem of forest fires.

In spite of a dramatic increase of technological means devoted to fire suppression, woodlands, rangelands, *maquis* and *garrigues* in rural areas or at the interface with urban areas still continue to burn (600.000 ha/year on average) with significant environmental, social and economic (estimated at 1 billion euro/year) impacts. Large forest fires (less than 3% of total number of fires) account for 75% of the total burnt area, being this figure stable over time, in spite of the availability of more sophisticated fire suppression means. This is a consequence of implementing suppression policies not properly accompanied by vegetation and landscape management. Paradoxically, effective fire protection without proper vegetation management lead to fuel (vegetation) accumulation, and increased risks.

Such situation calls for improved policies (affecting land use planning, building permits allocation, etc) and integrated fire and forest management planning. In this context, adopting spatially explicit planning by compartmentalising the landscape (fuel-breaks, vineyards, orchards, etc.) in order to prevent large scale fires should be encouraged. In addition, environmental friendly vegetation management techniques, able to reduce the fuel load, such as prescribed burning, could be applied on larger scale. New opportunities of using the biomass extracted from vegetation/fuel reduction operations for energy purposes should also be considered.

Box 5. Modelling the risk of forest fires

Risk has been defined as the expected loss due to a particular hazard for a given area and a reference period. The expected loss may be calculated as the product of the *damage* and its *probability*. Therefore, if fire risk is to be included in forest management planning, models for assessing the probability of fire occurrence, and expected fire damage are required. As stands are regarded as the basic and indivisible forest management units, it is logical to develop stand-level models as the first step of including fire risk considerations in forest planning. These models must be based on stand variables, which are known with reasonable accuracy. If a model is to be used for forest planning purposes, it also has to consider variables that are under the control of the manager. In that way the manager will have the possibility of minimising the expected losses due to fire as a management objective in numerical planning calculations. Such models have been developed in different Mediterranean countries. In Catalonia (North-East Spain), for instance, data from the Spanish national forest inventory and perimeters of fires that occurred in Catalonia was used to model both the probability of occurrence and damage of fires as related to stand characteristics such as species composition, tree size, stand structure, and to topogeographical variables such as elevation and slope.

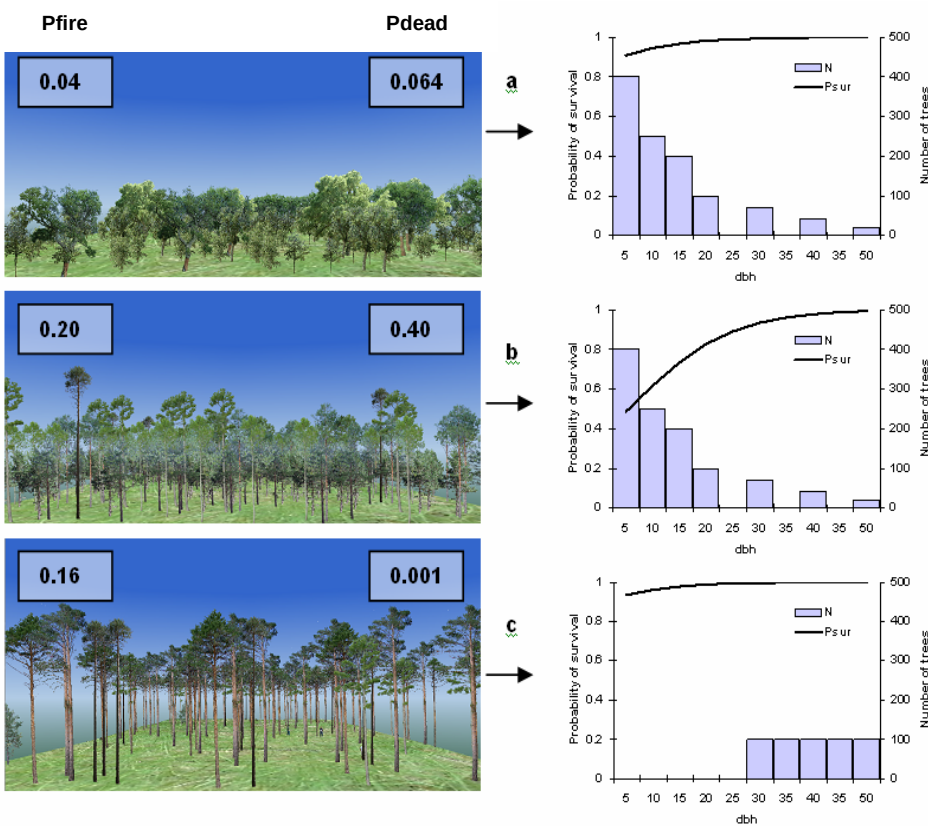

Figure 5. Fire risk depending on the stand structure and composition (altitude 700 meters and slope 12%) as predicted using the models in Gonzalez et al. 2007. The images on the left represent different forest stands and their predicted probability of fire occurrence (Pfire) and damage in proportion of dead trees (Pdead). On the right, the same stands are represented by their diametric distribution (N, number of trees per diameter class) and the survival probability for the trees represented in each diameter class (Psur).

Although, wildfires have been affecting mainly the northern rim of the Mediterranean Basin, some significant changes in climate and land use, are already taking place and will most likely result in an expansion of fire threatened areas (e.g.: Syria, Lebanon and Algeria). Climate change projections show clearly increased fire risk in the current Mediterranean area, but also that fires will affect new areas. For example, in France, the area under Mediterranean climate, could be tripled before the end of the 21st century. Therefore, new areas in the North will be

concerned in relation to a shift of Mediterranean like ecological conditions. This in turn raises the question: how to anticipate these changes and adapt forest management to a new climate and fire regime context ?

These facts call for a profound change in fire fighting and prevention policies as well as in efficient counteracting and preventive strategies. What is at stake is to set up territorial policies which allow to live with fires, but kept at an « acceptable » level. This new approach definitely calls for a *profound rethink* of these strategies and policies at national and European level, by tackling the problem in all dimensions, including a clear identification of civil protection and forest protection objectives. There is a need for moving from short term driven policies of fire control, mainly based on huge technological investments, to longer term policies of removing the structural causes of wildfires.

Key challenges:

Assessing in time and space fire vulnerability, occurrence, propagation and damage based on (i) weather conditions, (ii) vegetation structure and composition, and its interactions with human infrastructures (wildland/urban interface) and human behaviour

Plan forests and landscapes more resistant and resilient to fire by optimizing silvicultural prescriptions and vegetation management (in particular prescribed burning), to minimize the stand-level risk of fires, and spatially explicit landscape planning to prevent large scale fires.

Developing integrated strategies and policies that provide «reasonable» trade-offs between environmental, social and economic elements, and allow to «live with wildfire risk.

Identification of future new areas subject to forest fire.

Understanding and predicting species and forest ecosystems responses to changed regimes.

Conducting foresight studies as support to new wildfire policies.

2.3. Governance, policies and economic instruments can ensure the provision of valuable forest goods and services in the context of rural development

Mediterranean forests contribute substantially to the welfare of Mediterranean societies by providing highly demanded and valuable goods and services. The relative importance of non-market forest goods and services (mainly public goods and externalities connected with the active protection and management of forest resources) should be highlighted in a Mediterranean context. The economic nature of this type of services (characterised by undefined property rights and lack of markets) causes important market failures that prevent the producers of those goods (forest owners who bear the cost of forest management) from internalising their value. As a consequence, some forest owners do not receive the financial incentives to manage their forests in a way that ensures the sustainable and socially optimal provision of those relevant non-marketed goods and services.

Box 3. The real values of Mediterranean forests

Non-wood forest products (NWP), such as, cork, fodder, mushrooms, fruits, medicinal and aromatic plants, and non-market services like soil protection, watershed management, water quality, biodiversity enhancement and climate change mitigation or micro-climate amelioration contribute significantly to the local or national economies of the Mediterranean region. For example, for the southern Mediterranean area[1] it is estimated, that grazing gives almost three times as much benefit, per hectare, as wood forest products. Another example is cork, which in Portugal accounts for 35% of the estimated total benefits obtained from forests.

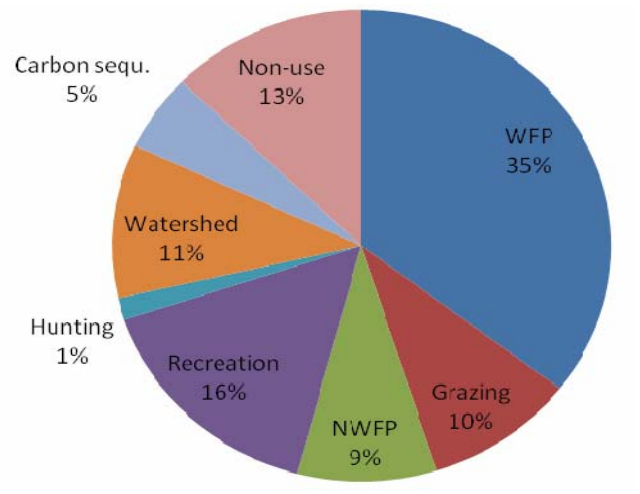

Figure 6. Composition of the Total Economic Value of Mediterranean Forests (source: Merlo & Croitoru 2005). NWP: non wood products; WFP: wood forest products; non-use: bequest and existence value.

Even if non-market forest services can not be valued through market prices, they without doubts contribute to the welfare of the populations benefiting from them. Merlo & Croitoru (2005) reported that approximately 40% of the total economic value of Italian forests can be ascribed to watershed protection. Recreation, tourism and landscape aesthetics are further services offered by Mediterranean forests. With the increasing demand for recreational activities and tourism[2] these services are getting more important. There have been several studies conducted for valuing forest recreation. Such studies reported estimated values ranging from 2.5 – 11€/visit.

The estimated values of different Mediterranean forest goods and services by Merlo & Croitoru (2005) presented an average total economic value of Mediterranean forests of about 133€ per hectare of forests (at 2001 prizes) or in other words almost 50€ per year and capita. Only some 35% of this value can be ascribed to wood forest products (see Fig. 4). The estimate should not be taken as fixed value, since it can vary significantly in magnitude and composition between different countries. It should be acknowledged that due to lack of consistent and reliable data, this value might be an underestimation of the true economic value of Mediterranean forests. In a Spanish study, in which the value of different non-market benefits from afforestation of marginal agricultural land were estimated using rather advance valuation methods, the results indicated that the annual economic value would vary between 464€ and 4100€ per hectare of additional forests. It is clear that harmonized valuation methods as well as benefit transfer functions are required to value non-market services in a consistent and comparable way in different regions and countries.

In the northern Mediterranean sub-region, this situation, together with the lack of profitability of timber management has led, to the abandonment of forestry.

In the southern and eastern Mediterranean sub-regions, the difficult socio-economic conditions, the land tenure systems (mainly public forests with some right access for grazing and forest products collection), the competition by other land uses (agriculture, urbanizations, etc) and again the initiatives for the payment of environmental and social services (soil

[1] According to Merlo & Croitoru (2005) this area includes Morocco, Algeria, Tunisia and Egypt.

[2] Plan Blue (2008) reports, that the number of tourists, visiting the Mediterranean region, increased from 153 million in 1990 to 228 million in 2002.

protection, biodiversity protection, carbon sequestration, etc) prevent to manage forests in a sustainable way or to protect them from being converted to other land uses.

Mediterranean forests have been traditionally managed under a strict command and control system defined by public authorities with the objective of maintaining some public functions of the forests. However, nowadays innovative approaches for developing financing mechanisms are required since a policy predominantly based on command and control system has numerous drawback:

- the strict system of management rules is reducing the profitability of traditional forest management activities, inducing the abandonment of forest resources and increased social and private costs in fire and pest attacks prevention and fighting: a clear case of policy failure;
- public authorities are mainly identified as external controllers and forest owners' and other stakeholders' active participation in forest policy is limited; as a consequence the development of new income generating activities in the fields of tourism, recreation, environmental education, NWFPs, sport and cultural events, etc., requiring a strong and active partnership among private and public actors, is constrained;
- the traditional system of constraints in the use of forest resources is not associated to adequate compensation measures for the forest owners or managers; as proved in Europe by the recent implementation of the 3rd phase of the Rural Development Programmes in the EU Mediterranean countries, the permanence of non compensated management restrictions is creating problems for introducing new systems of payment for environmental services.

The process of decentralisation of forest policy and the increased dependence of the forest resources from other related sector policies (biodiversity protection, renewable resources, tourism development, climate, etc.) is not favoring the process of knowledge sharing of all the positive and negative experiences gained in dealing with the above-mentioned problems.

Key challenges:

Improving the economic information regarding the value and the profitability of Mediterranean forests, with a special focus on non-market forest products and services.

Designing innovative financing instruments at different scales to correct the existing market failures related to the provision and payment of non-market forest services.

Integrate forest policies within the framework of wider rural development strategies and policies since a joint territorial approach between all concerned parties is required.

Proposing appropriate modes of governance and institutional reforms to allow policy instruments to be effectively implemented since poor and weak administration services might prevent their correct application).

2.4. Managing multifunctional forests and woodlands in multiple-use landscapes: the need for new silviculture systems and decision support tools

Despite the acknowledged multifunctionality of Mediterranean forests in providing multiple and valuable goods and services to society, traditional silviculture and forest planning approaches in the Mediterranean region have been wood based (with the exception of cork

and agro-silvo-forestry systems like *dehesa* or *montado*). However, in a Mediterranean context, it is very seldom that wood supply is the only objective or even the most important. The production of non-wood products (mushrooms, pine kernels, acorns, etc), fodder (in silvopastoral systems), the protection against fire, the provision of services such as recreation and aesthetics, the conservation of biodiversity, of the soil and water resources or the contribution to climate change mitigation may often be the most important objectives. Thus they need to be explicitly considered in silviculture and forest planning both at strategic and operational levels.

Box 4. New models and tools for Mediterranean forest management and planning

A key step in forest management planning is the generation of alternative plans. This encompasses a land classification strategy and the simulation and assessment of alternative silviculture paths in each stand in the forested landscape. Such task requires the development of advanced models to both project the stand structure and define the functional relation between structure and different objectives (recreation, risk of fires, mushrooms, pinecones, grazing, carbon sequestration, water yield, etc) (see Fig. 5).

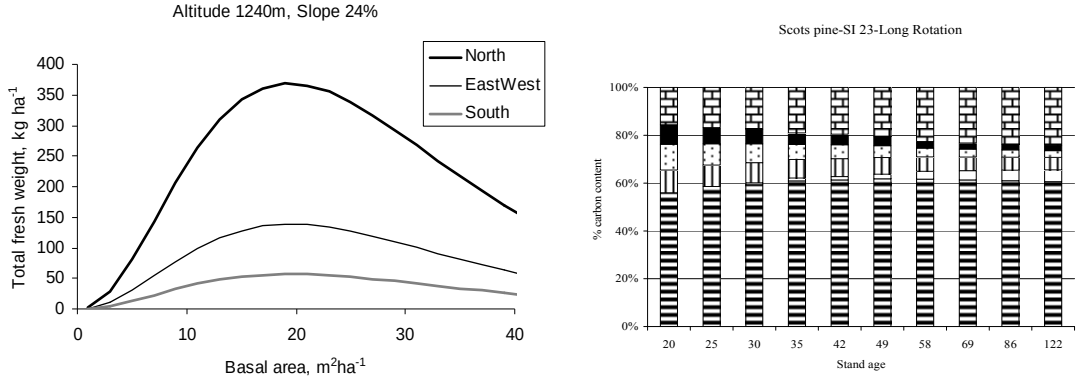

Fig. 7a). Wild mushroom production for different basal areas and expositions in Scots pine forests in Catalonia (Spain) as predicted by an empirical mushroom model. Source: Bonet et al. 2008
and 7b) Carbon content in different tree compartment of Scots pine (Pinus sylvestris L.) stands in northern Spain under long rotation. Stem and roots increase its relative importance as rotation is longer. Regarding carbon sequestration, a high stem proportion (over 60% at 100 year old) has important implications as wood products obtained under longer rotations have a longer life cycle while a high roots proportion (over 20% at 100 years old) means that the role of coarse woody debris after harvest will be important. Source: Bravo et al. 2008.

Another key step is the selection of the plan that best suits the management objectives. Such task requires the development of approaches that may accommodate multiple objectives and help search for the most suitable plan. Both mathematical programming techniques (e.g. linear programming and goal programming) and heuristic techniques (e.g. genetic algorithms, simulated annealing or tabu search) may be used for that purpose. The use of heuristic optimization has gained popularity in forest planning along with the increasing importance of both operational and ecologically based forest management goals, which are often described spatially through landscape metrics. Effective spatial and multiple criteria optimization to address Mediterranenan forest management will require innovative approaches that may combine benefits from direct approaches and from the heuristic manipulation of simulation models.
Finally, in order to implement advanced simulation models and numerical multi-objective optimization techniques, they need to be programmed, integrated and used within computer-based decision systems (Figure 6). Examples of forest planning decision support systems (DSS) developed in a Mediterranean context, exist in Portugal - the SADfLOR system (Borges et al. 2003; Reynolds et al. 2008) - and Spain - MONTE (Palahi et al. 2008) and BASIFLOR (Bravo et al. 2008) systems. Such systems have demonstrated that the utility of DSS goes beyond their complex problem solving capabilities, since they also provide important insights to the understanding, structuring and effective analysis of options and implications of alternative forest ecosystem management plans.. They further may be very helpful as consensus building support tools when multiple decisionmakers (e.g. forest owners) and stakeholders are involved.

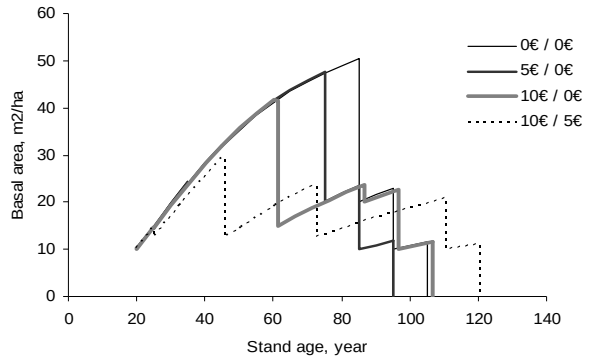

Figure 8. Optimal forest stand development (above) for maximizing the profitability derived form timber and mushrooms for different mushroom prizes in Catalonia. Study conducted using a simulation-optimization system based on forest growth models, mushroom production models and non-linear programming optimization techniques. Source: Palahi et al 2008.

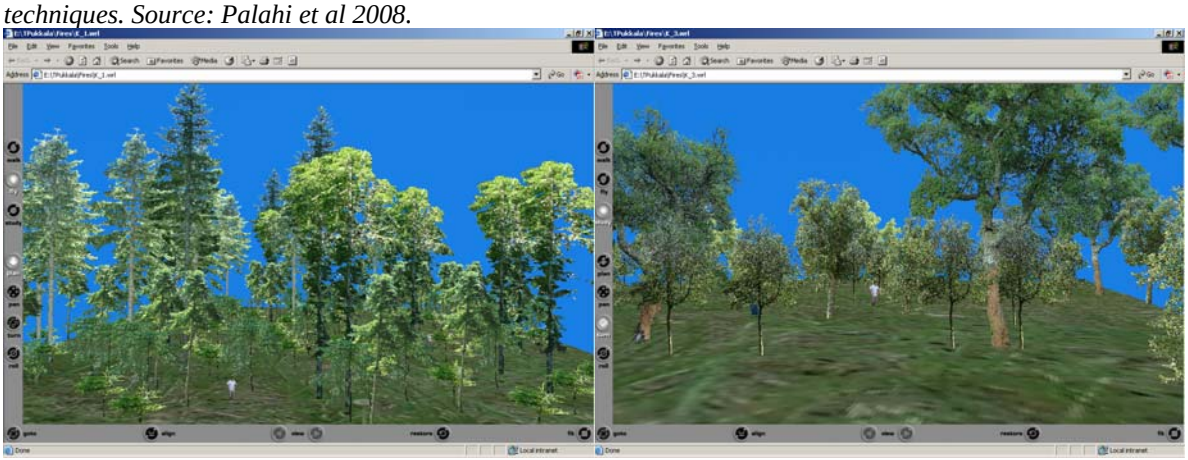

Figure 9. Virtual reality models for two forest stands using the decision support system for Mediterranean forest planning MONTE.

Mediterranean forest owners and managers need adequate scientifically-based decision support tools for the management of forest resources in order to optimize the joint production of multiple goods and services and to maximize the utility of forest owners, and stake holders and society at large. Nowadays, Mediterranean forest management needs to ensure the production of traditional economic goods (e.g. cork, fodder, wood, mushrooms, pine kernels, etc) and socially demanded services (recreation, landscape beauty, etc) while maintaining their protective (soil, watersheds, etc) and environmental (biodiversity, climate amelioration, carbon fixation, etc) functions in a context of integrated land use planning. Forests are usually part of heterogeneous and mosaic-like rural landscapes which need to be planned in an integrated manner and many forest management objectives cannot be evaluated at the stand-level or even at forest holding level. Sound ecological planning, fire prevention, watershed management or improving recreation requires consideration of areas larger than the forest holding, which requires a comprehensive landscape level integrated approach. Landscape planning does not mean replacing the forest holding level by the landscape level because decisions are made by forest owners at holding level and their acceptance and commitment is crucial for the plan implementation. Instead landscape planning should address the integration of stand, forest and landscape-level objectives to design an optimal composition and configuration of the landscape.

Key challenges:

Developing a new generation of forest simulation models to predict the effects of forest management on the multiple goods and services provided by forests and woodlands with specific focus on the effects on water and fodder. These models should take into account adequate indicators and metrics and acknowledge both the global change impact and the new externalities such as climate change mitigation.

Developing goal-based Mediterranean silviculture models and forest-landscape management models based on available technical and decision science tools.

Designing Mediterranean forest landscape decision support systems that may provide insights about the management problem, enhance management planning processes aiming at the provision of different forest-woodlands-rangelands goods and services and promote consensus building.

3. Strategic research priorities

3.1. Impact of climate and land-use change on Mediterranean forest ecosystems functioning: assessing and monitoring main physical and biological processes including biodiversity

a) Rationale

Mediterranean forest ecosystems are particularly sensitive to the following conditions: (i) extreme seasons, in particular exceptionally hot and dry summers, (ii) short-duration events such as heavy rains and (iii) slow, long term changes in climate leading to rising sea level ("coastal squeeze") or general *aridification* or desertification. Aspects of global change impacts include high sensitivity of ecosystem productivity to water availability, important phonological changes, strong nutrient limitations in natural ecosystems of the region, high risk of major land use changes and intense soil erosion, increasing nitrogen deposition and elevated levels of ozone formation.

Therefore, it seems reasonable to identify the following key scientific questions: (i) which will be the effects of increasing concentration of atmospheric CO_2 with nitrogen and water availability on plants and ecosystem physiology and community dynamics; (ii) which interrelations are expected in the water cycle and water availability with ecosystem functions and land use changes; (iii) which alterations in ecological diversity as affecting responses to global change, including carbon sequestration, fire resilience and soil erosion are expected.

b) Research approaches

1. long term ecosystem monitoring and experiments (*sites ateliers*) on the effects of global change and environmental stresses (climate anomalies, salinity and other soil limitations) on natural and planted forest ecosystems, with the use of forest-atmosphere flux stations, instrumented watersheds, water and nutrient cycling; different types (from extensive to intensive) of comparable monitoring sites that cover well the forest typologies, as well as the geographical and climatic diversity of the region should be established;
2. landscape experiments on the impact of land use change and forest ecosystem management on water resources and soil erosion protection.

3. landscape experiments on the impact of land use change and forest ecosystem management on biodiversity and biogeochemical cycles at forest landscape level; special emphasis on bi- and tri-trophic interactions at foodweb level (i.e. plant-pests and plant-animal interactions);
4. large scale infrastructures for whole tree and ecosystem manipulation experiments to simulate responses to changing climatic (temp., precipitation, UV), atmospheric (CO_2 and other GHG, N deposition) and soil conditions;
5. mobile sensors equipment systems to study effects of forest management, logging operations and fire regimes on carbon budget of forest and other wooded ecosystems;
6. ecosystem experiments on forest-atmosphere interactions with special emphasis on organic signalling (i.e. VOC) and particular attention on polluted atmospheric conditions (O_3 and other air pollutants) in sub-urban vs. natural environments;
7. structural and functional genomics at ecosystem level to study adaptive responses to global change in Mediterranean forest ecosystems;
8. networks of long term genetic experiments to analyze responses of plant material (provenances, families, genotypes) to changing environmental conditions;
9. modelling approaches at genotypes, tree, ecosystem and landscape level to climate change and management options; As the speed of expected changes is fast, approaches based on modelling of the demographic, ecological and genetic aspects of the communities' evolution should be developed and implemented.

c) Expected outputs or achievements

1. definition of scenarios of ecosystem responses to climate change in the Mediterranean region;
2. identification of management options for CC mitigation and adaptation;
3. selection of plant material better adapted to climate change;
4. identification of land use options in forest and suburban areas for a sound use of trees and forests for climate change mitigation;
5. identification of forest management options and land use options for optimizing the trade-offs between water quantity and water quality and soil protection.
6. generating information and models for expert systems for land use management and fire prevention.

d) Characteristics

Character of the work: basic and applied research, knowledge management
Major competences needed: biological sciences, silvicultural and other ecosystem management sciences, ecology, hydrology, soil science, atmospheric sciences, modelling, computing sciences, information technologies, geography, etc.
Type of project: Small and large collaborative projects (including third countries)

3.2. Integration of the risk of forest fires in land use and landscape planning and management

a) Rationale

In spite of all efforts devoted to fire prevention and fire fighting, we still do not manage to prevent the occurrence of large wildfires. Thus, further research on forest and landscape management to prevent large wildfires is needed. This research should range from landscape-level planning to stand level silvicultural treatments, and should provide tools to plan effective and cost-efficient fuel management at several spatial (and temporal) scales. In

parallel, more knowledge on the social aspects of fire (causes of ignitions, motivation and consequences) and a better understanding of the relationships between human attitudes, values, and beliefs, and fire and fuel management, is needed.
There is still much uncertainty and variability on the ecosystem and species responses to fire, as well as on the diversity of responses in relation to a changing fire regime. This is because of the regional variability in species traits, as well as the changing fire regimes to which species have to cope with. More research is needed on this topic. Finally,the post-fire management and rehabilitation of burned areas has been given much lesser attention than fire itself, but important questions still need scientific research, e.g. how to evaluate fire damages in economical terms, how to manage burned areas, how to manage burned trees, and how to prevent post-fire soil erosion and water runoff.

b) Research approaches
1. new technologies and methods (including satellite imagery) to ameliorate fire detection efficiency, to improve early warning systems, and to assess spatial and temporal evolution of factors associated to risks (wild-land urban interface, fuel characteristics, erosion, biodiversity loss, human populations and infrastructures, etc.).

2. improved models assessing fire behaviour and validation of existing models, including the use of deterministic physical models, and targeted to various applications: vegetation/fuel management, risk assessment, fire suppression, training forest managers and firefighters, etc.

3. understanding the variability in species/ecosystem traits, resilience and responses to changing fire regimes, in the context of climate change, including the effects of fire and fire regimes on vulnerable/valuable ecosystems.

4. investigatinglandscape-scale patterns and processes related to large fires, and forest stand management in relation to fire hazard, including prescribed burning.

5. understanding temporal and regional variations in the socio-economic and behavioural drivers of fire use and ignition patterns (with a focus on thewildland-urban interface), and assessing the socio-economic impact of fire, on all forest goods and services and the post-fire costs of infrastructure restoration.

6. evaluating the effectiveness and limitations of various post-fire management techniques, and determining the adequate forest/vegetation types to use in forest conversion after fire to promote forests with lower fire risk.

7. foresight studies: the background for policies addressing the structural causes of increased fire risk in current and future exposed areas.

c) Expected outputs or achievements
1. New models allowing more accurate predictions and assessments of vulnerability and risks, and in general of tradeoffs between several factors.
2. Tools and management options at different scales (from stand to landscape level configurations) to minimize the risk of forest fires.
3. Tools and management options for post-fire management.
4. Information on the economic efficiency of different fire prevention and suppression measures.
5. Background for policies based on integrated fire management.

6. Bases of comprehensive and holistic policies addressing the multi-objective management at landscape and territory scale.

d) Research characteristics
Character of the work: basic and applied research, knowledge management
Major competences needed: biological and physical sciences, silvicultural and other ecosystem management sciences, ecology, atmospheric sciences, modelling, computing sciences, information technologies, geography, remote sensing, socio-economics, foresight cience, etc.
Type of project: Small and large collaborative projects (including third countries)

3.3. Policy, economic and institutional aspects for sustainable provision of forest goods and services

a) Rationale
Due to the great relative value of non-market Mediterranean forest services and the importance to ensure their sustainable provision, it is crucial (i) to improve the information regarding all non-market forest benefits, characterizing their economic nature, assigning values and positioning them within a total economic value framework; (ii) to design and implement an appropriate mix of policy instruments (e.g., juridical, financial, market-based or persuasive measures) at different scales (local, regional, national and international) to correct the existing market failures related to non-marketed forest services; (iii) to promote institutional reforms to effectively implement policy and financing instruments, (iv) to design forest policies within the framework of wider rural development strategies and policies as they require a joint territorial approach between all concerned parties: agriculture and rural development, urban societies, tourism, industry, environment, transport, etc.

b) Research approaches:
1. developing valuation methods and benefit transfer methods for valuing in an integrated and comparable manner non-market forest services;
2. development of environmental accounting systems for forest resources at regional and national level, also for the evaluation of the efficiency of defensive expenditure in relation to the value of the stocks and products and services delivered;
3. environmental accounting system should be associated to forecast modeling in order to evaluate the costs of inaction, as well as the cost of active policies;
4. designing innovative forest policies or measures within the framework of wider rural development strategies and using a joint territorial approach between all concerned parties
5. evaluating and developing financing mechanisms to promote the optimal provision of non-market services (e.g., systems for payment for environmental services by the final users, by the forest managers or by public authorities);
6. new marketing instruments for the supply of forest products and services, also based on the horizontal and vertical integration of economic agents in the value chain;
7. developing participatory approaches for stakeholders' involvement and responsibilities sharing in local and regional development programmes based on public-private partnership (see the EU "Leader" approach in rural development policies);

c) Expected outputs or achievements

1. Values (social) and cost of provision for different non-market forest services as well as harmonized methods for benefit transfer, including data and procedures for accounting the non-market dimension of forest products and services;
2. Innovative financing mechanisms for the different types of non-market forest services (e.g. systems of payments for environmental services);
3. Tools for knowledge sharing and participatory decision making that leads to a sustainable forest management and an improvement of the new forest products and services supply.
4. Integrated forest policies and new governance approaches to integrate forestry within wider rural development policies.

d) Characteristics

Character of the work: applied research
Major competences needed: forest and environmental economics and policy, regional planning and economics, marketing, etc.
Type of project: large collaborative project (including third countries)

3.4. Forest and woodlands in the context of integrated management of land resources: models and decision systems for optimising multi-objective and multi-actor problems

a) Rationale

The marked multifunctional characteristics of Mediterranean forests, their mosaic-like structure, the fragmented forest ownership and the intimate interrelation with other land-uses (agriculture, pastures, urban areas, etc) and the foreseen climate change impact on this region requires innovative silviculture models, multi-objective planning models as well as multi-actor and multi-scale (stand- to landscape approach) approaches to effectively support forestry decision making. Such scientific challenges are in principle feasible with the current knowledge, methods and tools (based on recent scientific findings, simulation tools, geographic information systems and optimization techniques) and the computing technology available. However, a multi-disciplinary effort involving biologists, ecologists, foresters, agronomists, economists, geographers, and hydrologists needs to be undertaken to synthesize information from different disciplines and build up integrated decision support systems.

A new paradigm of Mediterranean forest-land planning should take advantage of existing knowledge on simulation tools (based on advanced growth models), multi-criteria decision support methods and multi-objective optimization algorithms to develop new and innovative silviculture models, planning models and decision support systems specially tailored for the Mediterranean context. Traditional forestry strategies should be revisited and included as basis to develop silviculture and management strategies adapted to the region characteristics.

b) Research approaches

1. New forest growth and yield models that can provide predictions on the provision of relevant goods and services (mushrooms, pine cones, fodder, water yield, scenic beauty) and take into account the changing climatic conditions.
2. Goal-based silviculture models and adaptive approaches to optimize the provision of relevant goods and services under global change.
3. New multi-criteria, scenario analysis, and group- decision methods for analyzing stakeholders' preferences on forest management objectives and support consensus building.

4. New multi-objective forest planning models and advanced optimization techniques to solve multiple objective problems considering the economic, social and environmental functions, within a multi-scale stand-to-landscape-level approach.
5. New knowledge on the interactions and trade-offs of different types of land uses and development of integrated approaches for forest-land-use planning in the context of rural development.
6. New presentation techniques such as visualization to show the consequences of alternative management strategies to different stakeholders, thus addressing participatory planning and social sustainability concerns.
7. New decision support systems that integrate the techniques and models (1)-(6) to support Mediterranean forestry decision making in a broader context of land use planning. The use of demonstration forests might be instrumental for developing, testing and disseminating the new tools.

c) Expected outputs or achievements
1. New silviculture models and planning models for addressing multiple objectives and risks.
2.Tools for optimizing multi-objective forest management and analyzing the trade-offs between various forest functions, and conflicting goals (biodiversity, wood production, water and soil protection, etc) as well as between different land-uses.
3. Means for addressing the segregation/integration dilemma in a Mediterranean context and optimizing land use allocation.
4. Tools for participatory and group decision making in the context of forest and land use planning.

d) Characteristics
Character of the work: applied research, knowledge management
Major competences needed: management sciences, modelling, computer sciences, information technologies, forest economics, ecology, hydrology, geography, etc.
Type of project: Large collaborative project (including third countries)

4. Sharing knowledge for capacity building and innovation

The existing gaps in terms of research capacities between countries needs to be addressed by a series of integrated and interrelated activities to (i) share existing scientific knowledge (ii) improve the research capacities where needed and (iii) integrate southern and eastern scientists and institutions in European projects. Such activities should target, both, individuals and institutions, as well as teaching staff and students, through individual mobility grants for young scientists, summer schools and advanced doctoral courses on emerging and methodological research topics and joint graduate and post-graduate courses among different Universities.

In the last decade, in view of the increasing importance of forest related problems, new forest degrees and specialised forestry courses have been developed in most southern and eastern Mediterranean countries. Yet, the lack of critical mass and expertise in crucial disciplines, the lack of standards that might facilitate communication and interdisciplinarity, or the lack of resources to implement modern scientific methods and tools has jeopardized most of these initiatives. In addition, the traditional fragmentation of Higher Forestry Education in the region, the lack of research as linked to education and innovation, as well as the common problems shared by different countries call for a Pan-Mediterranean initiative to bring

together the best expertise, human resources and facilities to develop jointly an International and innovative Master addressing the new paradigm in Mediterranean forest management. Such initiative, an *International Master on Mediterranean forest ecosystems management*, would act as a bridge of knowledge among Mediterranean countries that would put the basis for a strong Mediterranean forestry knowledge triangle. Within the framework of this initiative a solid link with potential forest-related labour markets should be established to address their needs as well as to put the basis for innovative future activities.

Innovation, in addition to research and education, is the third pillar of a knowledge triangle. Innovation in the Mediterranean forestry sector should take place at different levels; (i) at the scientific level, by developing scientific, innovative and useful tools for forest management, (ii) at entrepreneur level by stimulating companies, industries and forest owners to be innovative in supplying new goods and services to address changing societal demands, and (iii) at the political and management level by designing and implementing policies and new financing mechanisms that can ensure the sustainable provision of relevant goods and services, while minimizing increasing risks.

5. Implementing the MFRA

The MFRA represents a bold step forward in networking and coordinating research and will require a coordinated effort by the research community and related stakeholders (forest owners, NGO's, companies, public administration, etc) to utilize in an efficient and effective way the international and national research funding resources available. The MFRA should be implemented through different type of activities: networking, capacity building, higher education programmes, research partnerships, knowledge transfer and long-life learning in order to establish a Mediterranean forestry knowledge triangle of research, education and innovation that will play a key role in a sustainable Mediterranean society.

The Mediterranean regional Office of the European Forest Institute – **EFIMED** will promote the implementation of the MFRA in cooperation with other relevant stakeholders like the European Forest-Based Sector Technology Platform or representatives of Mediterranean research organizations, forest owners, industry, NGO's and national governments (e.g., through the *Silva Mediterranean FAO committee*). EFIMED, involving a network of more than forty Mediterranean forest research organizations from 18 different countries, will act as a facilitator in converting the MFRA into projects and activities, facilitating the creation of research networks and identifying funding opportunities. The EFIMED annual meeting will be an appropriate forum to discuss the progress of the implementation of the MFRA.

The main source of finance will come from public research programmes at national and European level (e.g., ERA-Net, Cost actions, EU Framework programme collaborative programmes, MED programme, Tempus programme, Life+ programme, Joint Research Centre calls, bilateral programmes among Mediterranean countries, etc). In order to avoid duplication of efforts, fluent communication and joint activities will be carried out with the forest-based technology platform.

Education and capacity building are significant elements required to achieve the MFRA objectives.

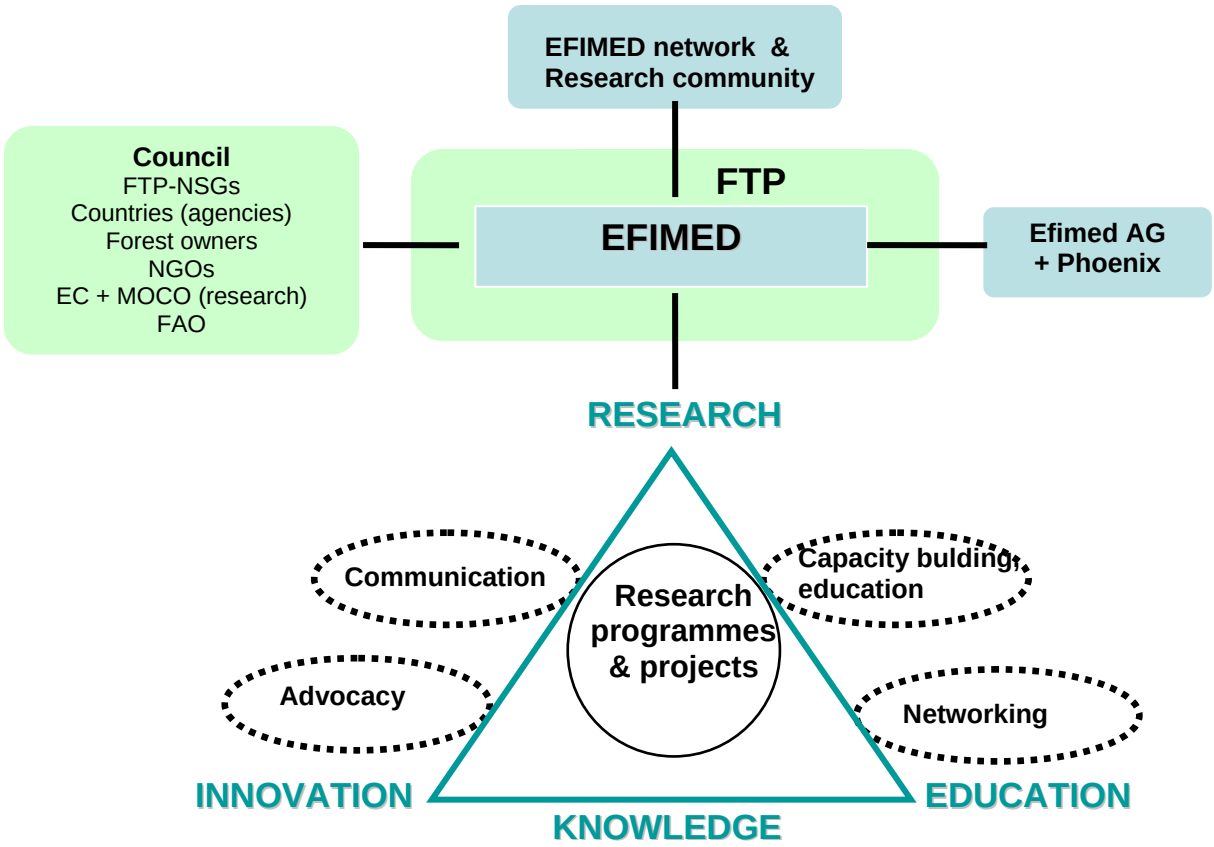

Figure 10. Implementation structure of the MFRA.

Annex I: Integration of the MFRA to the Strategic Research Agenda (SRA) of the European Technology Platform for the Forest-Based Sector (FTP)

The European Forest Based Sector Technology Platform (FTP)

Research and Innovation play an essential role in promoting industrial development and competitiveness, as well as economic growth and employment, both at national and European level. The European Commission and the major stakeholders in the forest-based sector have recognized the primary importance of sharing common strategies for a better use of human and economic resources in the field of research and working together in setting priorities, timeframes and funding for the common goal of economic, social and environmental sustainable development. The concept of "Technology Platform" was established by the European Union to promote an integrated approach to research, based on a private-public partnership involving industry, research institutes and public authorities, aiming at defining common long-term research agendas and at fostering alignment between the Seventh European Research Framework Program (FP7) and the national programs.

The European Technology Platforms, one for each strategic industry sector, are asked to define "Strategic Research Agenda" (SRA), providing medium to long term and fully supported objectives for the technology. Each alliance defines an action plan and provides a favourable socio-economic context for supporting innovation with high societal relevance, while preserving the environment.

The Forest-Based Sector Technology Platform (FTP – Forest Technology Platform), is an initiative of three European Confederations: the European Confederation of woodworking industries (CEI-Bois), the Confederation of European forest owners (CEPF) and the Confederation of European paper industries (CEPI).

Major challenge of the FTP is to promote the growth of research in Europe and the development of emerging technologies. A wide engagement of stakeholder and the interaction with other European Technology Platforms are needed to accelerate the transfer of knowledge and the development of integrated technologies. The production of bio-fuels and/or raw materials based on biomass and on agro-forestry by-products represents an important example of value added that will originate from the substitution of non-renewable resources with forest-based materials in the "green chemicals" and bio-energy sectors. The primary objective of the FTP consists in a coordinated development of emerging sectors, all the while avoiding counterproductive competition (as an example in the availability of raw materials) with the well-established industrial sectors such as paper and wood, and in the meantime guaranteeing the sustainable management of European forestland with special regard to the commercial and social aspects tied to it (as tourism and recreation).

The FTP organization consists of a High Level Group, an Advisory Group, a Scientific Council, the Project Management and the National Support Groups, one for each of the 20 countries participating to the Platform.

FTP-SRA VISION 2030

The European forest-based sector plays a key role in a sustainable society.

It comprises a competitive, knowledge-based industry that fosters the extended use of renewable forest resources.

It strives to ensure its societal contribution in the context of a bio-based, customer-driven and globally competitive European economy.

The Strategic Research Agenda (SRA) of the FTP

24 National Support Groups (NSG), thanks to the participation of enterprises and European researchers of the sector, have been already established and others are close to being established. NGS have defined sector's research priorities for the different value chains: forestry, wood products, pulp & paper, bio-energy, innovative products and new businesses. The result has been a wide-ranging pool of around 700 research proposals which have been condensed in the Strategic Research Agenda of the forest-based sector. This is why the SRA is considered the guideline for European Research in the field of forestry and forest products for the next 30 years, a "living" document that will be able to follow the future developments of research and innovation. For the very first time, all the European research bodies of the forest-based sector – COST Forests their Products and Services (COST-FPS), Eureka Euroforest, European Forest Institute (EFI), Innovawood, EFPRO, Woodwisdom-net (ERA-net) – together with trade associations, entrepreneurs and forest owners, are working to define a common vision to the future and clear strategic objectives, in strict conjunction with the Seventh European Research Framework Program. Ultimate objective is to increase the value of research projects, basing the actions on adequate economic support and on attention to social and occupational aspects.

Table 1. Overall structure of the SRA

	Forest-based value chains				
Strategic Objectives	**Forestry**	**Wood Products**	**Pulp & Paper Products**	**Bio-energy**	**Specialities**
1. Development of innovative products for changing markets and customer needs	**1-6: Commercialising soft forest values***	1-1: *A new generation of functional packaging* 1-4: Living with wood 1-5: Building with wood 1-10: *New generation of composites*	1-1: *A new generation of functional packaging* 1-2: Paper as a partner in communication, education and learning 1-3: Advancing hygiene and health care 1-8: *Pulp, energy and chemicals from wood bio-refinery* 1-10: *New generation of composites*	1-7: Moving Europe with the help of bio-fuels 1-8: *Pulp, energy and chemicals from wood bio-refinery*	1-8: *Pulp, energy and chemicals from wood bio-refinery* 1-9: *"Green" specialty Chemicals* 1-10: *New generation of composites*
2. Development of intelligent and efficient manufacturing processes, including reduced energy consumption		2-4: Advanced technologies for primary wood processing 2-5: New manufacturing technologies for wood products	2-1: Reengineering the fibre-based value chain 2-2: More performance from less inputs in paper products 2-3: *Reducing energy consumption in pulp and paper mills*	2-3: *Reducing energy consumption in pulp and paper mills* 2-6: Technologies to boost heat and power output	
3. Enhancing availability and use of forest biomass for products and energy	**3-1: Trees for the future*** 3-2: *"Tailor-made" wood supply*	3-2: *"Tailor-made" wood supply* 3-4: Recycling wood products - a new material resource	3-2: *"Tailor-made" wood supply* 3-3: Streamlined paper recycling	3-2: *"Tailor-made" wood supply*	3-2: *"Tailor-made" wood supply*
4. Meeting the multifunctional demands on forest resources and their sustainable management	**4-1: Forests for multiple needs*** **4-2: Advancing knowledge on forest ecosystems*** **4-3: Adapting forestry to climate change***				
5. The sector in a societal perspective	5-1: Assessing the overall performance of the sector **5-2: Instruments for good forest-sector governance*** **5-3: Citizens' perceptions***				

** Relevant sub-topics for Mediterranean forestry and addressed in the MFRA*

Table 2. Relationship between the MFRA and the SRA overall structure

	SRA Research Areas	Mediterranean Forest Research Agenda
SRA Strategic Objectives	**Forestry-based value chain**	**Research approaches**
1. Development of innovative products for changing markets and customer needs	1-6: Commercialising soft forest values	- evaluating and developing financing mechanisms to promote the optimal provision of non-market services (e.g., systems for payment for environmental services by the final users, by the forest managers or by public authorities); - new marketing instruments for the supply of forest products and services, also based on the horizontal and vertical integration of economic agents in the value chain;
3. Enhancing availability and use of forest biomass for products and energy	3-1: Trees for the future	- structural and functional genomics at ecosystem level to study adaptive responses to global change in Mediterranean forest ecosystems. - networks of long term genetic experiments to analyze responses of plant material (provenances, families, genotypes) to changing environmental conditions. - modelling approaches at genotypes, tree, ecosystem and landscape level to climate change and management options; As the speed of expected changes is fast, approaches based on modelling of the demographic, ecological and genetic aspects of the communities' evolution should be developed and implemented.
4. Meeting the multifunctional demands on forest resources and their sustainable management	4-1: Forests for multiple needs	- new forest growth and yield models that can provide predictions on the provision of relevant goods and services (mushrooms, pine cones, fodder, water yield, scenic beauty) and take into account the changing climatic conditions. - goal-based silviculture models and adaptive approaches to optimize the provision of relevant goods and services under global change. - new multi-criteria, scenario analysis, and group- decision methods for analyzing stakeholders' preferences on forest management objectives and support consensus building. - new multi-objective forest planning models and advanced optimization techniques to solve multiple objective problems considering the economic, social and environmental functions, within a multi-scale stand-to-landscape-level approach. - new knowledge on the interactions and trade-offs of different types of land uses and development of integrated approaches for forest-land-use planning in the context of rural development. - new presentation techniques such as visualization to show the consequences of alternative management strategies to different stakeholders, thus addressing participatory planning and social sustainability concerns. - new decision support systems to support Mediterranean forestry decision making in a broader context of land use planning. The use of demonstration forests might be instrumental for developing, testing and disseminating the new tools.
	4-2: Advancing knowledge on forest ecosystems	- long term ecosystem monitoring and experiments (*sites ateliers*) on the effects of global change and environmental stresses (climate anomalies, salinity and other soil limitations) on natural and planted forest ecosystems, with the use of forest-atmosphere flux stations, instrumented watersheds, water and nutrient cycling; different types (from extensive to intensive) of comparable monitoring sites that cover well the forest typologies, as well as the geographical and climatic diversity of the region should be established. - mobile sensors equipment systems to study effects of forest management, logging operations and fire regimes on carbon budget of forest and other wooded ecosystems;

	4-3: Adapting forestry to climate change	- ecosystem experiments on forest-atmosphere interactions with special emphasis on organic signalling (i.e. VOC) and particular attention on polluted atmospheric conditions (O_3 and other air pollutants) in sub-urban vs. natural environments; - landscape experiments on the impact of land use change and forest ecosystem management on water resources and soil erosion protection. landscape experiments on the impact of land use change and forest ecosystem management on biodiversity and biogeochemical cycles at forest landscape level; special emphasis on bi- and tri-trophic interactions at foodweb level (i.e. plant-pests and plant-animal interactions); - large scale infrastructures for whole tree and ecosystem manipulation experiments to simulate responses to changing climatic (temp., precipitation, UV), atmospheric (CO_2 and other GHG, N deposition) and soil conditions;
5. The sector in a societal perspective	5-2: Instruments for good forest-sector governance	- development of environmental accounting systems for forest resources at regional and national level, also for the evaluation of the efficiency of defensive expenditure in relation to the value of the stocks and products and services delivered. - environmental accounting system should be associated to forecast modeling in order to evaluate the costs of inaction, as well as the cost of active policies. - designing innovative forest policies or measures within the framework of wider rural development strategies and using a joint territorial approach between all concerned parties. - developing participatory approaches for stakeholders' involvement and responsibilities sharing in local and regional development programmes based on public-private partnership (see the EU "Leader" approach in rural development policies).
	5-3: Citizens' perceptions	- developing valuation methods and benefit transfer methods for valuing in an integrated and comparable manner non-market forest services;

Annex II: Provisional list of organizations participating in the MFRA

Albania
Forest and Pasture Research Institute
Association Awareness for Progress

Bulgaria
University of Forestry, Sofia

Croatia
Forest Research Institute

Cyprus
Department of Forests

France
INRA Nancy
INRA/Montpellier - Unité d'Économie et Sociologie rurales
INRA/Avignon – Ecologie des Forêts Méditerranéennes

Greece
Demokritos University of Thrace
Technological Educational Institute of Kavala
Aristotle University - Laboratory of Rangeland Ecology

Israel
University of Haifa

Italy
Universidad de Padova
Universidad de Tuscia
University of Catania
Inst. Forest & Environmental Biology-CNR

Lebanon
Faculty of Agricultural & Food Sciences, the American University of Beirut
Lebanese University
Ministry of Environment
Ministry of Agriculture

Morocco
ENFI
Forest Service - Service des Eaux et Foręts
Forest Research Centre

Portugal
Escola Superior Agrária de Coimbra
Technical University of Lisbon - Instituto Superior de Agronomia
Portuguese Catholic University - Faculty of Economics and Management
Universidade de Tras-os-Montes e Alto Douro

Romania
University of Suceava – Faculty of Forestry

Slovenia
Slovenia Forestry Institute

Spain
CTFC Forest Technology Centre of Catalonia
CREAF
INIA-CIFOR
Universidad de Valladolid
Universidad Juan Carlos I
Universidad Pablo de Olavide
Universidad Politécnica de Madrid
Universidad Complutense de Madrid
Universidad Politécnica de Valencia
Universitat Rovira i Virgili
Universitat de Lleida
Universidad de Santiago de Compostela
University of Barcelona
Autonomous University of Barcelona
University of Girona

Syria
University of Aleppo
Univeristy of Tishreen

Tunisia
INRGREF
INAT

Turkey
Central Anatolia Forest Research Institute & State Planning Organization
Fatih University
Technical University of Karadeniz

International organizations

IUCN Centre for Mediterranean Cooperation
FAO Forestry
IAMF - International Associations for Mediterranean Forests
Plan Bleu
WWF Mediterranean Programme Office
MAICh-CIHEAM