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Forest-Based Sector
Technology Platform

EUROPEAN FOREST INSTITUTE
MEDITERRANEAN REGIONAL OFFICE – EFIMED

A Mediterranean Forest Research Agenda – MFRA

2010–2020

Contents

Preface – Mediterranean forests require more research

Since the beginning of the 1990s, forests and forestry have become key topics on the international political agenda as demonstrated by the United Nations Conference on Environment and Development (UNCED) in Rio in 1992 and the Ministerial Conferences on the Protection of Forests in Europe (MCPFE), which started in Strasbourg in 1991. Since then, international conferences and political processes have constantly emphasised the need to preserve and conserve boreal, temperate and tropical forest ecosystems. However, it has to be recognised 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 paid to Mediterranean forests at the international level, apart from the recurrent issue of forest fires. No comprehensive, joint international research agenda has been developed to simultaneously address the economic, ecological, and social challenges of sustainable Mediterranean forest management.

Although the total area of Mediterranean forests (even including ecologically analogous areas such as those in California, Chile, South-Africa and Australia) are significantly smaller than 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 increase the already existing threats on Mediterranean forests on one hand and contribute to the expansion of Mediterranean conditions to new areas on the other. Therefore, the time has come to raise the awareness of both the forestry and scientific communities as well as the general public about the complex challenges and research needs to ensure 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 during 2010–2020. This 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. The consultation process has involved a large number of institutions (research and academic, forest owners, NGOs, and international organisations such as FAO and CIHEAM) in 15 Mediterranean countries. The participating institutions are listed in Annex 2.

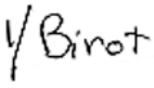
We would like to thank all those who have contributed to the development of the MFRA. In particular, we acknowledge the contribution made by the members of the EFIMED Advisory Group: Jose G. Borges (Portugal), Felipe Bravo (Spain), Davide Pettenella (Italy), Mohamed Sabir (Morocco), Hamed Daly (Tunisia),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

We would also like to acknowledge the numerous comments and contributions received from EFIMED's network members who represent different forestry realities and disciplines.

We invite all interested parties to contribute to the implementation of MFRA.

Barcelona, 14 September 2009

Marc Palahí
Head of EFIMED



Yves Birot
Chairman of the EFIMED Advisory Group

Executive Summary

Mediterranean forest ecosystems provide multiple goods and services (especially noteworthy 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 need to be addressed to ensure the sustainability of Mediterranean forests:

- *How will climate and land use changes impact Mediterranean forest ecosystems?*
- *How to address forest and fire management concerns in a global change context?*
- *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, targeted education and capacity building in order to bridge the knowledge and expertise gap between countries, institutions and science and society in general.

Forest research in the Mediterranean region is handicapped by its fragmentation, its limited means, and occasional outdating and isolation. In addition, the low benefits that Mediterranean forests provide to forest-based industries - compared to other European forests - make it difficult to attract interest and funds from the private sector. For this reason, new ways to overcome this situation must implemented through: research partnerships, networking, capacity building, higher education programmes, knowledge transfer and long-life learning. In this context, research cooperation with other Mediterranean Climate Regions (MCR) should be enhanced to share knowledge in order to address common scientific challenges and needs.

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 forestry challenges as well as the scientific priorities, objectives and outcomes to address them.

MFRA aims at networking and coordinating research at Mediterranean level, requiring a coordinated effort by the research community and related stakeholders (forest owners, NGOs, companies, public administration, etc) to utilise in an efficient and effective way the available international and national research funding resources.

Figure 1. The Mediterranean forestry knowledge triangle.

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 and geomatics, etc.) should be adopted and adapted by forest science. Education and knowledge sharing through strengthened capacity building are seen as major components of MFRA.

MFRA is structured around four strategic research priorities – selected on the basis of their intrinsic importance and significance for policy decision-making – to provide a scientific framework with which to meet the important challenges ahead.

The implementation of MFRA will allow the creation of a Mediterranean forestry knowledge triangle of research, education and innovation as well as a geographic triangle with its vertices in Mediterranean Europe, North Africa and the Middle East. Both concepts 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 mill. ha or about 8.5% of the region's area. They are one of the most vulnerable forest ecosystems on earth due to their marked fragility and instability due to, for example, the harsh climatic conditions, long-lasting pressure by humans and recurrent fires. In addition, they are exposed to increased risks related to drastic land use changes (while forest cover increases in Mediterranean Europe, deforestation occurs at a rate of around 1.1% in southern and eastern Mediterranean – higher than in tropical countries) and climate change in the region (the global temperature increase from 1850–1899 to 2001–2005 is about 0.76°C; while in Spain, a Mediterranean country, the temperature has increased by some 1.5°C from 1971 to 2000).

> "Addressing the numerous issues of Mediterranean Forests through research, requires concerted, joint and increased efforts under the umbrella of an Europe-wide instrument: the FTP

Mediterranean forests and woodlands host some 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. In comparison, northern and central Europe – with its four times greater surface area – only accounts for some 6000 plant species. In addition to wood, Mediterranean forests provide various 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 in the Mediterranean region.

In the northern part, the socio-economic changes of the last decades, triggered by the urbanisation of our society and better living standards, have increased the demand for the environmental and social functions of Mediterranean forests. However, most 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, for instance. On the other hand, coastal forest lands in high tourist areas are under increasing pressure by the tourist sector to be used for recreational purposes.

In the eastern and southern parts, rapid population growth (around 2% on average), 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 (e.g. fight against desertification, soil protection and regulating water resources) are crucial for the sustainable development of these societies. The main threats to forest sustainability in the southern and eastern subregions are the over exploitation of forests for fuel wood, 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 and mushrooms) as well as high-value but non-market services (e.g. landscape quality, soil protection, water regulation and recreation possibilities).*

(ii) *They constitute a unique world natural heritage in terms of biological diversity; however, this patrimony is seriously endangered.*

(iii) *Their conservation and management affects the availability of soil and water resources - key strategic resources 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 crystallised 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 believed that advancing science should be the backbone of a more structured knowledge-based society as it is a prerequisite for creating the basis of innovation and providing the scientific expertise with which to develop more efficient policies aimed at reaching the objectives of the common vision. This implies joint research efforts in order to develop a Mediterranean Forest Research Agenda (MFRA) that is based on commonly agreed priorities and valid for all countries around the Mediterranean basin. MFRA has been designed to fit within the Strategic Research Agenda (SRA) developed by the FTP (see Annex 1) and is endorsed by the FTP Steering body.

The implementation of MFRA at the pan-Mediterranean level requires that research capacities are of a sufficient level (critical mass) in the partner countries. At the same time, it is important to promote 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 and land-use changes will have a significant impact on forest ecosystems (e.g. by the increase of degradation, deforestation and forest fires) and the functions they fulfil (water regulation, soil protection, etc) to such a critical level that they could be seriously endangered. Expected climate changes will also result in the expansion 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, while taking into account wider rural development policies.*
- *Silviculture and the multifunctional management of Mediterranean forests and woodlands in the context of the management of multiple-use and multi-scale landscapes require the development of new decision-support models, systems and processes.*

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

The Mediterranean area is especially sensitive to any climate change because it represents a transition zone between the arid and humid regions of the world. This makes this region an interesting model system with which 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 pathogen outbreaks and forest fires. Such changes (Figures 2 and 3) will drastically impact forest dynamics and forest health. The level of these impacts and the adaptive capacity of forest ecosystems will affect the provision of relevant forest ecosystems, goods and services.

> **“Climate and societal changes raise new issues and concerns regarding the future of Mediterranean Forests and adjacent areas**

Changes in the region are not only of climatic origin. A series of complex and abrupt socio-economic changes are currently taking place in the Mediterranean region. In the northern part, rural abandonment has resulted in an increase of unmanaged and large continuous forest areas (with higher risk of forest fires and important impacts on the water yield), while new urban and tourism development infrastructures, especially in coastal areas, have increased the risks (fragmentation, biodiversity loss, etc) related to a widespread wildland-urban interface. In the southern and eastern parts, the degradation and conversion of many forests into grazing and agriculture land to supply basic primary resources such as food, for example, have resulted in land degradation and an increase in desertification which are affecting the soil and water resources.

In a situation of an increasing population in the Mediterranean countries, which will have important effects in increasing the demand for water resources and soil availability for agriculture, the impacts of global change on forest ecosystems should also be analysed in connection with water and soil resources.

Finally, it is important to note that not only trees will be affected by climate and land-use changes – all plant and animal communities and populations that partake in ecosystem processes will also be affected. The current rate of environmental change affecting Mediterranean forests is jeopardising biodiversity in the sense that radical changes in the composition of communities and in the extinction of local populations are observed. One main question is

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

Although world temperature-change scenarios vary regionally, they show a clear trend towards warming. The temperature increment from 1850–1899 to 2001–2005 has been 0.76ºC on a global scale; in some Mediterranean countries, however, the increment from 1971 to 2000 was 1.53ºC – 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 a temperature increase higher than the global average value, further reduce precipitation (of up to 20%) and increase the interannual variability of both temperature and precipitation (floods, droughts and heat waves).

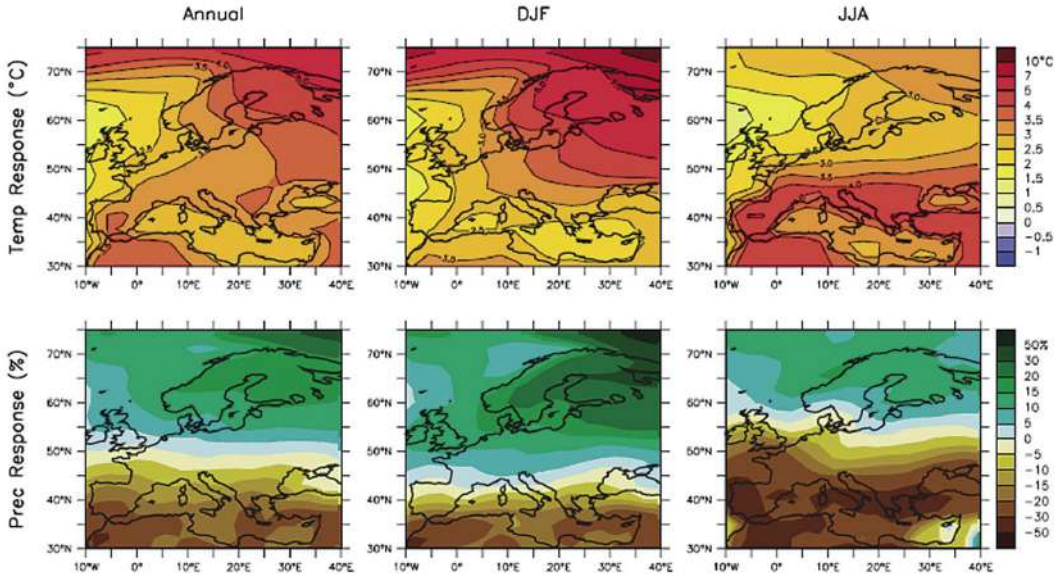


Figure 2. Simulated temperature and precipitation changes over Europe for the A1B scenario. Top row: annual mean; winter (DJF); summer (JJA); temperature change between 1980 to 1999 and 2080 to 2099 averaged over 21 models. Bottom row: same as top, but for fractional change in precipitation. Source: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

to determine whether the natural mechanisms involved in evolutionary processes will be able to cope with the intensity and speed of environmental changes.

Key challenges:

- *To improve our knowledge on the impacts of climate and land-use changes on forest ecosystem processes – from leaf to landscape – including forest biodiversity.*
- *To improve our understanding of the role of forests in the yield and quality of water resources, and in the prevention soil erosion.*
- *To understand the adaptive response of species and their migration capacity with regard to environmental changes and various forest management strategies.*
- *To improve our understanding of how climate change will affect forest susceptibility to existing and new pests, and diseases.*

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 millennia by many natural environmental factors including fire. However, since man has started to interact with his environment, the causes of wildfire have progressively become anthropogenic accounting for 90–95% of recorded fires today. One of the most serious problems in some areas is the frequent recurrence of wildfires which jeopardise the natural resilience of Mediterranean forest ecosystems and leads to their inevitable degradation.

Box 2. Climate change affecting water budgets, plant phenology and tree-growth.

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 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.

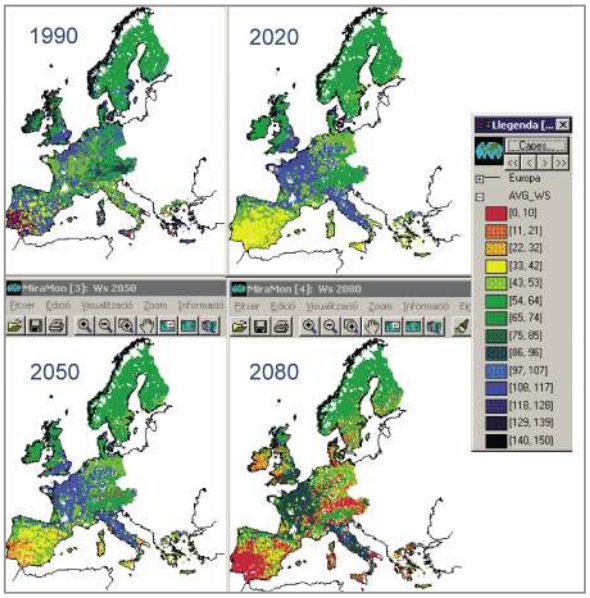


Figure 3. Soil water content in European forest soils simulated with the forest growth process based model Gotilwa+. Simulations use a pixel of 10'x10' combined with climate predictions of HadCM3 model under a socioeconomic scenario A2. Source: Gracia et al 2002

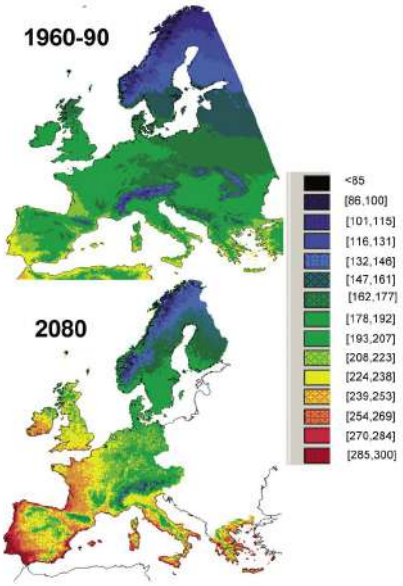


Figure 4. Simulated length of the growth period (days). Source: Gracia et al. 2002

In addition, higher temperatures will induce an exponential increase in the respiration rates of living tissues of trees, while photosynthetic responses 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 with 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.

Today, the causes of wildfires are rather well understood and documented. Among them, four have to be emphasised:

(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 behaviour of the public still reflects a lack of awareness about fire risk; and*
(iv) *the effects of climate change (temperature increase, decreased rainfall and the 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

Box 3. 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 this 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 were used to model both the probability of occurrence and damage of fires related to stand characteristics (e.g. species composition, tree size and stand structure) and topogeographical variables such as elevation and slope.

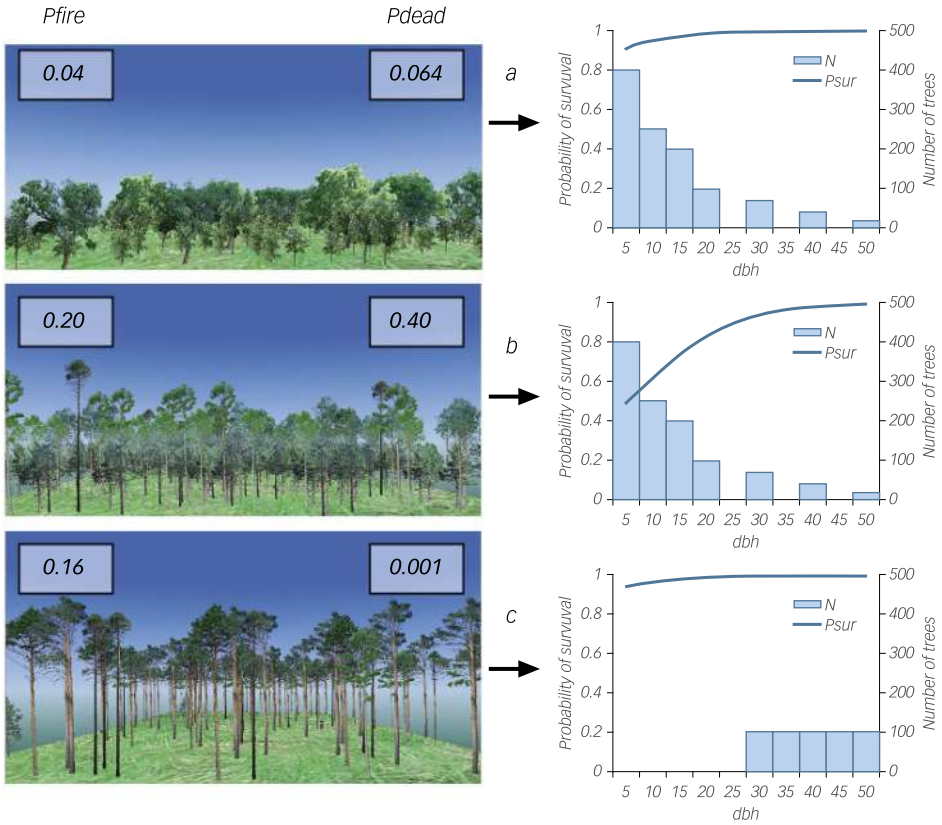


Figure 5. Fire risk depending on the stand structure and composition (altitude 700 meters and slope 12%) as predicted using the models in Gonzalez et al. 2007. The images on the left represent different forest stands and their predicted probability of fire occurrence (Pfire) and damage in proportion 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).

areas still continue to burn an average area of 600 000 ha/year, resulting in significant environmental, social and economic impacts (estimated at € 1 billion/year). Large forest fires (less than 3% of the total number of fires) account for 75% of the total burnt area. In spite of the availability of more sophisticated fire suppression means, this figure has remained stable over time. This is a consequence of implementing suppression policies that have not been properly accompanied by vegetation management, silviculture and integrated landscape-level forest management. Paradoxically, effective fire protection without proper vegetation management leads to fuel (vegetation) accumulation and ultimately to an increased risk of forest fires.

> "increased and extended risk of wildfire calls for new approaches and policies in fire management

This situation requires new fire fighting and prevention policies together with efficient counteracting and preventive strategies such as integrated fire and forest management planning. What is at stake is to set up territorial policies which allow us to live with fires but keep them at an 'acceptable' level. This new approach definitely calls for a profound rethink of these strategies and policies at national and European levels, by tackling the problem in all dimensions including the clear identification of civil protection and forest protection objectives. Finally, there is a need to shift from short-term driven fire control policies, mainly based on huge technological investments, to the longer-term policies of removing the structural causes of wildfires.

Although wildfires have been mainly affecting 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 the expansion of fire-threatened areas (e.g. Syria, Lebanon and Algeria). Climate change projections clearly show an increased fire risk in the current Mediterranean area and that fires will also affect new areas. In France, for example, the area under the Mediterranean climate could triple before the end of the 21st century. This, in turn, raises the question of how to anticipate these changes and adapt forest management to a new climate and fire regime context.

Key challenges:

- *Assess the risk of forest fires in time and space.*
- *Plan forests and landscapes to be more resistant and resilient to fire.*
- *Develop integrated strategies and policies that provide 'reasonable' trade-offs between environmental, social and economic elements, and allow us to 'live' with wildfire risk.*
- *Identify future forest responses to changed regimes as well as new areas subject to forest fires.*
- *Define appropriate post-fire management strategies and practices*

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) is especially pronounced in the Mediterranean context (Box 3). The economic nature of these types of goods and services (characterised in many cases by improperly or ill-defined property rights and lack of markets) causes important market failures that prevent producers (forest owners who bear the cost of forest management) from internalising their full value. As a consequence, some forest owners do not have incentives to manage their forests in a way that ensures the sustainable and socially optimal provision of the relevant non-marketed goods and services. In addition, forest owners' motivation, preferences and objectives have also changed during the last decades; this has had clear changes in the benefits that they have obtained from different forest goods and services.

In the northern Mediterranean sub-region, declining prices for wood forest products, high extraction costs and difficulties in accessing these resources negatively affects the profitability of forest management. This situation, together with the fact that forest owners do not obtain any revenue from the highly demanded non-market forest goods and services, and the sociological changes in the forest owners' motivation often leads to the abandonment of forestry. In this context, the creation of new markets and products to internalise the current non-marketed services, the use of forest resources for biomass as a source of renewable energy, as well as a better mobilisation of forest resources (including non-timber products) can play an important role in improving the profitability of forestry.

Box 4. The real values of Mediterranean forests

Non-wood forest products (NWFP) such as, cork, fodder, mushrooms, fruits, medicinal and aromatic plants, together with 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 it is estimated that grazing gives almost three times as much benefit per hectare than wood forest products. Another example is cork, which in Portugal accounts for 35% of the estimated total benefits obtained from forests.

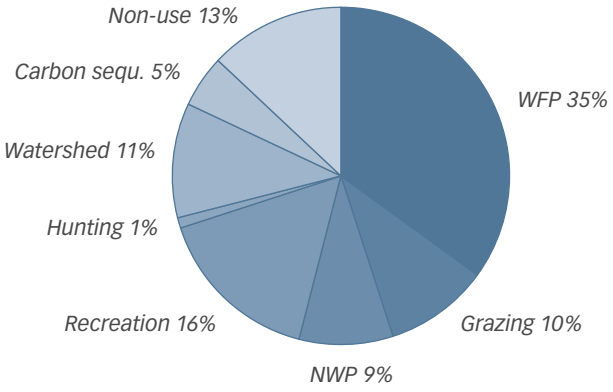


Figure 6. Composition of the Total Economic Value of Mediterranean Forests (source: Merlo & Croitoru 2005). NWFP: non-wood forest products; WFP: wood forest products; non-use: bequest and existence value.

Even if many forest services do not have markets and therefore cannot be valued through market prices, they without doubt contribute to the welfare of the population benefiting from them. Merlo and Croitoru (2005) report that approximately 40% of the total economic value of Italian forests can be ascribed to watershed protection. Other valuable services provided by Mediterranean forests include recreation, tourism and landscape aesthetics. With the increasing demand for recreational activities and tourism , these services are becoming more important. Many studies have been conducted to estimate the value of forest recreation; the estimates range from € 2.5–11 per visit.

The estimated values of different Mediterranean forest goods and services by Merlo and Croitoru (2005) presented an average total economic value of Mediterranean forests of about € 133 per hectare of forests (in 2001 prices) – or almost € 50 per capita/year. On average, only some 35% of this value can be attributed to wood forest products (see Figure 4). This estimate should not be taken as a fixed value since it can vary significantly in magnitude and composition between different countries. It should also be acknowledged that due to a lack of consistent and reliable data, this value is likely to underestimate the true economic value of Mediterranean forests. In a Spanish study, in which the values of different non-market benefits from afforestation of marginal agricultural land were estimated using advanced valuation methods, the results indicated that the annual economic value would vary between € 464 and € 4100 per hectare of additional forests (Mavsar and Riera, 2007). It is clear that harmonised 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 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), competition from other land uses (agriculture, urbanisation, etc), together with the lack of awareness of the value of non-market forest services as well as the lack of well-defined property rights, the absence of markets and compensation measures for non-market forest services (soil protection, biodiversity protection, carbon sequestration, etc) prevent forests from

being managed in a sustainable way and fail to protect them from being converted to other land uses.

> **"Increasing profitability and implementing innovative economic instruments to internalise non-market goods and services are key elements of sustainable forest management**

In this context, the traditional command and control type of policies used in the region were demonstrated to have numerous drawbacks. In addition, the process of decentralising forest policy and the increased dependence of forest resources on other related sector policies (biodiversity protection, renewable resources, tourism development, climate, etc.) does not favour the process of sharing knowledge of all the positive and negative experiences gained in dealing with the above-mentioned problems.

Key challenges:

- *Monetary valuation of Mediterranean forest goods and services.*
- *Fostering the provision of valuable non-market forest goods and services (including the financing of biodiversity conservation and protected areas) by introducing new policies and economic instruments.*
- *Analysing and improving the profitability of Mediterranean forestry, e.g. by new markets, products and uses (e.g. biomass extraction).*
- *Understanding the motivations and perceptions of forest owners and society at large regarding forests and forestry.*
- *New modes of governance, institutional reforms and integration of forest policies within wider rural development policies.*

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

Despite the marked multifunctionality of Mediterranean forests in providing multiple and valuable goods and services to society (see previous section), traditional silviculture and forest planning approaches in the Mediterranean region have been wood-based (and still are in management practice, with the exception of cork and agro-silvo-forestry systems like dehesa or montado). Examples of these approaches are the various forest regulation methods and cutting budget formulas developed in central Europe during the 19th century or the more recent stand-based economy approaches. However, in a Mediterranean context, it is very seldom that wood is the only objective or even the most important. Today, Mediterranean forest management needs to ensure the production of traditional economic goods (e.g. cork, timber, fodder, firewood, mushrooms and pine kernels) and socially demanded services (recreation, landscape beauty, etc) while maintaining their protective (soil, watersheds) and environmental (biodiversity, climate amelioration, carbon fixation) functions in a context of integrated land-use planning. In addition, the increasing risks (e.g. forest fires, droughts, pests and pathogens) and uncertainty involved in Mediterranean forestry decision making due to climate and land-use changes (as it has been presented previous sections) need to be taken into account explicitly in the decision-making process of forest management. Finally, Mediterranean forests are usually part of heterogeneous and mosaic-like rural landscapes which need to be planned in an integrated manner since many forest management objectives cannot be evaluated at the stand level or even at the forest-holding level. For instance, sound ecological planning, fire prevention, watershed management or improving recreation requires considering areas larger than the forest holding which will involve a comprehensive landscape-level integrated approach.

Forest owners and managers thus need adequate scientifically-based decision support tools for the management of Mediterranean forests in order to optimise the joint production of multiple goods and services (water yield, non-timber products, etc) at different temporal and spatial scales in a context of increasing risks.

Key challenges:

- *Develop tools to predict the effects of forest management on multiple forest goods and services, and related resources: water and soil.*
- *Develop a goal-based adaptive silviculture to ensure the provision of relevant goods and services in a changing environment.*
- *Design new forest management models that address the multifunctionality of Mediterranean forests in an integrated stand-to-landscape scale.*
- *Develop user-friendly forest landscape decision support systems to capture the preferences of key stakeholders regarding forest goods and services, and be able to optimise forest management to ensure the provision of these goods and services.*

Box 5. 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 the structure and different objectives (recreation, risk of fires, mushrooms, pinecones, grazing, carbon sequestration, water yield, etc) (see Figure 5).

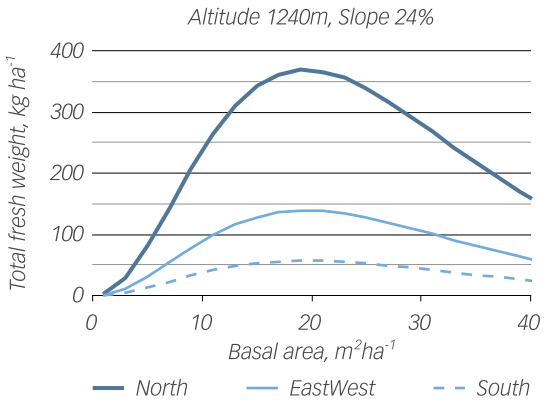


Figure 7a. Wild mushroom production for different basal areas and expositions in Scots pine forests in Catalonia (Spain) as predicted by an empirical mushroom model. Source: Bonet et al. 2008

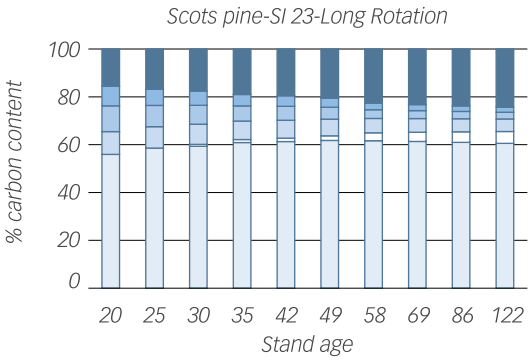


Figure 7b. Carbon content in different tree compartments of Scots pine (Pinus sylvestris L.) stands in northern Spain under long rotation. Stem and roots increase its relative importance as rotation is longer. Regarding carbon sequestration, a high stem proportion (over 60% at 100 years old) has important 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 a task requires developing 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 this purpose. The use of heuristic optimisation 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 optimisation to address Mediterranean forest management will require innovative approaches that may combine the benefits from direct approaches and from the heuristic manipulation of simulation models.

Box 5. Continued

Finally, in order to implement advanced simulation models and numerical multi-objective optimisation 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 in Spain – the MONTE (Palahi et al. 2009) and BASIFOR (Bravo et al. 2004) systems. Such systems have demonstrated that the utility of DSS goes beyond their complex problem solving capabilities, since they also provide important insights into the understanding, structuring and effective analysis of options and implications of alternative forest ecosystem management plans. They may be also very helpful as consensus-building support tools when multiple decision makers (e.g. forest owners) and stakeholders are involved.

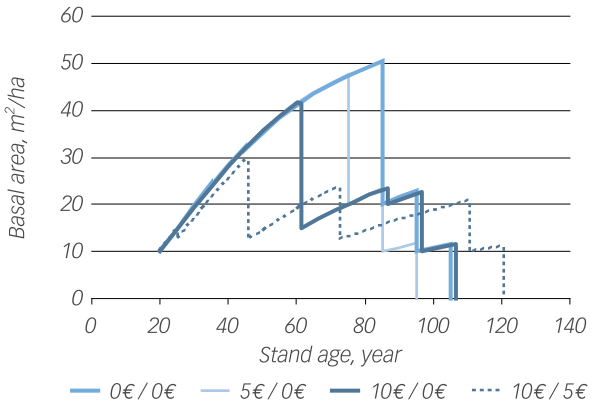


Figure 8. Optimal forest stand development (above) for maximising the profitability derived form timber and mushrooms for different mushroom prizes in Catalonia. The study used a simulation-optimisation system based on forest growth models, mushroom production models and non-linear programming optimisation techniques. Source: Palahi et al 2009.

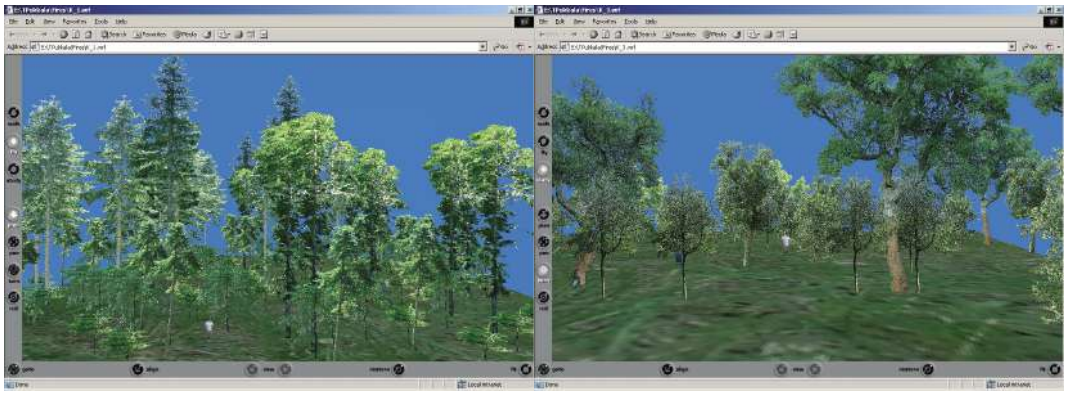


Figure 9. Virtual reality models for two forest stands using the decision support system for Mediterranean forest planning MONTE.

3. Strategic research priorities

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

a) Rationale

The forecasted rapid and intense changes in climate and land-use are expected to induce significant impacts on Mediterranean forest ecosystems and, in turn, to other interrelated key resources like water and soil. For this reason, understanding the mechanisms underlying the physiological and ecological responses of Mediterranean tree species (in terms of nutrient uptake, growth, biodiversity, etc.) to climate change is required. Furthermore, scientific information regarding the susceptibility of forests to current and new biotic and abiotic risks needs to be improved. This knowledge is crucial to predict the impacts of global change in Mediterranean forests and develop the basis for adaptive forest management.

Key scientific questions emerge in this context:

(i) What will be the effects of the increasing temperature and concentration of atmospheric CO2 coupled with less water availability on plants and ecosystem physiology, and community dynamics, including biodiversity from the gene to landscape level?
(ii) How may climate-forest growth relationships be modified in the future?
(iii) Which impacts are expected in the water cycle and soil processes as result of changes in forest ecosystems, climate and land-use changes?
(iv) What changes in forest health are expected with the forecasted changing conditions?

b) Research approaches

1. *Retrospective studies (including dendrochronolgy, dendro-chemistry and climate studies) covering the whole range of forest typologies and geographical and climatic conditions taking advantage of former long-term experiments: provenance trials, permanent plots, etc.*
2. *Long-term ecosystem monitoring and experiments (sites ateliers) on the effects of global change in natural and planted forest ecosystem processes. The following should be established: forest-atmosphere flux stations; instrumented watersheds; water and nutrient cycling; different types (from extensive to intensive) of comparable monitoring sites that effectively cover the forest typologies as well as the geographical and climatic diversity of the region.*
3. *Landscape experiments on the impact of land-use change and forest ecosystem management on: water resources, soil erosion, biodiversity and biogeochemical cycles at forest landscape level; special emphasis on bi- and tri-trophic interactions at the food-web 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 (temperature, precipitation, UV), atmospheric (CO_2 and other GHG, N deposition) and soil conditions.*
5. *Mobile sensor equipment systems to study the effects of forest management, logging operations and fire regimes on the 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 (O3 and other air pollutants) in sub-urban vs. natural environments.*
7. *Monitoring, understanding and modelling interactions between forests and microorganisms and insects: symbionts, pathogens, pests as related to climate change.*
8. *Structural and functional genomics at ecosystem level to study adaptive responses to a global change in Mediterranean forest ecosystems.*
9. *Networks of long-term genetic experiments to analyse responses of plant material (provenances, families, genotypes) to changing environmental conditions as background for assisted species migration.*
10. *Modelling approaches at genotypes, tree, ecosystem and landscape levels to climate change and management options. As the speed of expected changes is fast, approaches based on the 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. *Understanding management options for CC mitigation and adaptation.*

3. *Selection of plant material that is better adapted to climate change.*
4. *Understanding land-use options in forest and suburban areas for the sound use of trees and forests for climate change adaptation and mitigation as well as protecting water and soil resources.*
5. *Generating information and models for forest management, fire prevention and land-use decision support.*

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 the efforts devoted to fire prevention and fire fighting, the occurrence of large wildfires has not been reduced in the last decades. Such a stagnated situation calls for generating and transferring science-based information for improved policies (affecting land use planning, building permits allocation, etc) as well as new tools and models for integrated fire and forest management planning, including preventive silviculture and vegetation management techniques, such as prescribed burning. Further research is thus needed: on improving the understanding and predictability of the occurrence of forest fires, 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. Such knowledge should be the basis for developing new forest and landscape management strategies, tools and models to design more resistant and resilient landscapes in a cost-effective manner. 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. Finally, the post-fire management and rehabilitation of burned areas has been given much less attention than fire itself; however, important questions still need scientific research, e.g. how to evaluate fire damage in economic terms, how to manage burned areas, how to manage burned trees, and how to prevent post-fire soil erosion and water runoff.

> **"Fire research should develop socio-bio-physical approaches and aim at creating more fire resistant and resilient landscapes**

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 to assess fire behaviour and the 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. *Investigating landscape-scale patterns and processes related to large fires as well as 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 the wild land-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 post-fire forest conversion to promote forests with a 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 on different scales (from stand to landscape level configurations) to minimise 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 science, 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

The benefits of Mediterranean forest services are spread over a wide variety of stakeholders in both the public and private spheres. Due to this mix and in particular, to the relatively high non-market component of the total economic value, improved management and conservation requires:

(i) *Improved information on all Mediterranean forest goods and services, characterising their economic nature, assigning values and positioning them within a total economic value framework.*

(ii) *Design, implementation and evaluation of appropriate combinations of policy instruments (e.g. juridical, financial, market-based, voluntary or persuasive measures) at different scales (local, regional, national and international) that aim at fostering the sustainable and socially optimal provision of both market and non-market forest goods and services, including a better mobilisation of forest resources.*

(iii) *Improved understanding of forest owners' motivation and goals.*

(iv) *Promotion of institutional reforms to effectively implement policy instruments within the framework of comprehensive rural development strategies and policies in order to facilitate a joint regional approach between all concerned parties and sectors, including agriculture and rural development, urban societies, tourism, industry, environment and transport.*

b) Research approaches

1. *Application and/or extension of existing methods of valuation and benefit transfer in order to obtain consistent and comprehensive measures of market and non-marketed forest values;*
2. *Development of environmental accounting systems for forest resources at regional and national levels with the aim of improving the evaluation of changes in forest resources in relation to the value of the stocks, goods and services they deliver.*
3. *Estimating with common economic frameworks the profitability of forest resources and developing recommendations for its improvement, by analysing new markets, products or uses (biomass for bioenergy) and a better mobilisation of existing resources.*
4. *Design, implementation and evaluation of policy instruments (among them, market-based instruments) to promote the optimal provision of market and non-market goods and services (e.g. user pays systems for the use of environmental services, by the forest managers or by public authorities).*
5. *Development of new marketing instruments and channels for the supply of forest goods and services, including those based on the horizontal and vertical integration of economic agents in the value chain and taking into account communities reliant on the forest and related sectors.*
6. *Development of participatory approaches for stakeholders' involvement. This should include sociological research on the motivations of forest owners as well as mapping stakeholders to identify their interests and interactions and sharing of responsibilities in local and regional development programmes based on public-private partnership (see the EU 'Leader' approach in rural development policies).*

7. *Development of innovative forest policies in the context of wider rural and joint territorial development strategies.*
8. *Application of common research frames with a broadly based institutional recognition and acceptance such as the European Environment Agency's DPSIR (Driver-Pressure-State-Response) to describe the complex interactions and causations between society and the physical environment in forest ecosystems.*

c) Expected outputs or achievements

1. *Full range of economic values of forest goods and services and cost of provision for different forest goods and services.*
2. *Harmonisation of valuation and benefit transfer methods, including data and procedures for accounting the non-market dimension.*
2. *Innovative market-based instruments for the different types of market and non-market forest goods and services (e.g. systems of payments for environmental services, auctions).*
3. *Tools for knowledge sharing and participatory decision making that lead to sustainable forest management and an improvement of the supply of new forest products and services.*
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; stakeholder processes, etc.*
- *Type of project: large collaborative project (including third countries) and coordination action.*

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 multifunctionality of Mediterranean forests, the increasing risks related to climate change and the mosaic-like structure and complex interactions of Mediterranean forests with other land-uses (agriculture, pastures, urban areas, etc) call for a new paradigm of multifunctional, adaptive and multi-scale (stand to landscape level) Mediterranean forest management planning. This requires new forest management tools based on scientific approaches and new knowledge in key areas. Research on management-oriented simulation models (based on advanced growth models, risk models, etc) to be able to predict the effects of forest management on the different forest goods and services under different climatic scenarios and levels of risk is crucial in order to provide information on adaptive multi-objective management options. New knowledge on different multi-criteria decision support methods and multi-objective optimisation algorithms able to solve complex silviculture and management planning problems with several objectives and spatial scales is needed for the development of multifunctional and multi-scale forest management plans. New user-friendly computer-based forest management decision systems need to be developed in order to integrate the advanced simulation models, multi-criteria methods and multi-objective optimisation techniques so as to provide the required support for implementing new forest management planning. Such systems will provide important insights into the understanding, structuring and effective analysis of options and implications of alternative management approaches to forest ecosystems and the provision of their multiple goods and services.

Translating such scientific capacity into decision support systems requires a multi-disciplinary effort involving biologists, ecologists, foresters, agronomists, economists, geographers and hydrologists.

> **"Developing new tools for multi-objective forest management and planning implies to combine biophysical and socio-economic modeling science with decision science approaches**

b) Research approaches

1. *New inventory methods and long-term modelling plots for acquiring information on non-timber products (mushrooms, pine kernels, aromatic plants, etc).*
   The use and development of new forest growth and yield models that can provide predictions on the provision of goods and services (mushrooms, pine cones, fodder, water yield and scenic beauty) and take into account the changing climatic conditions.

2. *Goal-based dynamic and adaptive silviculture models to optimise the provision of relevant goods and services (including key resources like water and soil) under global change.*
3. *New multi-criteria, scenario analysis, and group-decision methods to analyse stakeholders' preferences on forest management objectives and support consensus building.*
4. *New multi-objective forest planning models to solve multiple objective problems considering economic, social and ecological factors, and adjacent resources (soil and water) within a multi-scale approach.*
5. *Advanced optimisation techniques capable of integrating bio-physisca and socio-economic paradigms in dynamic modelling frameworks.*
6. *New presentation techniques such as visualisation 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 in 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 optimising multi-objective forest management and analysing 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. *Improved understanding of the interface between forest ecology and human systems.*
4. *Means to address the segregation/integration dilemma in a Mediterranean context and optimising land-use allocation to address water and soil resources demands.*
5. *Tools for participatory and group decision making in the context of forest and land-use planning.*
6. *New knowledge on the interactions and trade-offs of different types of land uses and the development of integrated approaches for forest-land-use planning in the context of rural development.*
7. *Identification of forest management options for ensuring the sustainable production of multiple goods and services in a changing environment.*

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) and small to medium collaborative projects highly focused on concrete technical and topical matters.*

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. However, 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 jeopardised 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 jointly develop an international and innovative Master's degree programme 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 the 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 minimising increasing risks.*

The management and exchange of existing knowledge and new insights and information derived from the implementation of MFRA will require a well-functioning system for communication and dissemination. The main objective is to facilitate a strong interaction between scientists and stakeholders. Different instruments are foreseen: electronic journals presenting practical applications or know-how based on research results; science-policy papers and workshops; demonstration projects; and life-long learning, etc.

> "Capacity building requires a double approach: targeting both the individuals and the institutions

5. Implementing MFRA

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, NGOs, companies, public administration, etc) to utilise in an efficient and effective way the international and national research funding resources available. MFRA should be implemented (see Figure 10) through joint research projects involving adjacent and emerging disciplines, and other types of activities related to networking, capacity building, higher education programmes, knowledge transfer and long-life learning. This will be crucial for establishing a Mediterranean forestry knowledge triangle of research, education and innovation that will play a key role in a sustainable Mediterranean society. The implementation of MFRA should also consider developing links with other MCRs through specific instruments (e.g. FP7) like joint research projects, events and involvement in collective scientific assessment.

The Mediterranean regional Office of the European Forest Institute – EFIMED –together with the FTP secretariat will promote the implementation of MFRA as result of ongoing consultations with all relevant stakeholders and research institutions (see Figure 10). EFIMED, involving a network of more than 40 Mediterranean forest research organisations from 18 countries, will act as a facilitator in converting MFRA into projects and activities, facilitating the creation of research networks and identifying funding opportunities. EFIMED's annual meeting, which will involve all relevant partners, will be an appropriate forum to discuss the progress and make decisions on the implementation of MFRA.

The main funding will come from:

a) *National sources which have and will have the major share. In this context, it is important to use MFRA as an argument for increasing the funds and means devoted to Mediterranean forest research.*
b) *EU-related sources (e.g. ERA-Net, COST, EU Framework Programme, MED programme, Tempus programme, Life+ programme, Joint Research Centre calls, etc).*
c) *Bilateral or multilateral agreements and programmes (FAO, Cooperation Agencies, etc).*

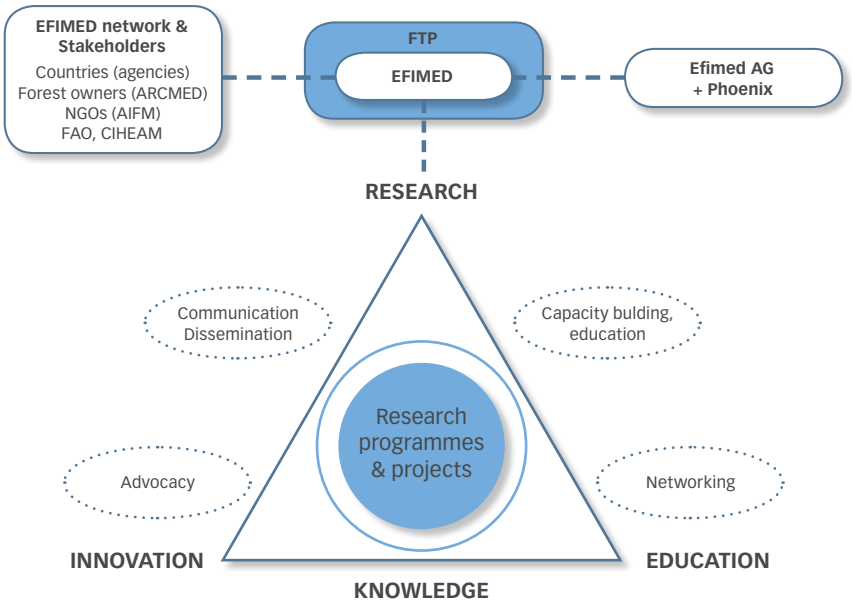


Figure 10. Implementation structure of MFRA.

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Annex I: Integration of MFRA to the Strategic Research Agenda (SRA) of the Forest-Based Sector Technology Platform (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 levels. The European Commission and the major stakeholders in the forest-based sector have recognised 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 a '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. It is aimed at defining common, long-term research agendas and fostering alignment between the Seventh European Research Framework Program (FP7) and the national programmes.

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).

The major challenge of 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 FTP consists of a coordinated development of emerging sectors while avoiding counterproductive competition (e.g. the availability of raw materials) with the well-established industrial sectors such as paper and wood; furthermore, it should guarantee the sustainable management of European forestland with special regard to its related commercial and social aspects (e.g. tourism and recreation).

FTP's organisation comprises 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 in 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 FTP

In total, 24 National Support Groups (NSG), thanks to the participation of enterprises and European researchers of the sector, have already been established and others are close to being established. The NGSs have defined the 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 as 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 for the future and clear strategic objectives in strict conjunction with the Seventh European Research Framework Program. The ultimate objective is to increase the value of research projects by basing the actions on adequate economic support and on attention to social and occupational aspects.

Table 1. Overall structure of 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	- Application and/or extension of existing methods of valuation and benefit transfer in order to obtain consistent and comprehensive measures of market and non-marketed forest values. - Design, implementation and evaluation of policy instruments (among them, market-based instruments) to promote the optimal provision of market and non-market goods and services (e.g., user pays systems for the use of environmental services, by the forest managers or by public authorities). - Development of new marketing instruments and channels for the supply of forest goods and services, including those based on the horizontal and vertical integration of economic agents in the value chain and taking into account communities reliant on the forest and related sectors.
3. Enhancing the 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 analyse responses of plant material (provenances, families, genotypes) to changing environmental conditions as a background for assisted migration. - 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 inventory methods and long-term modelling plots for acquiring information on non-timber products (mushrooms, pine kernels, aromatic plants, etc). - The use and development of new forest growth and yield models that can provide predictions on the provision of goods and services (mushrooms, pine cones, fodder, water yield, scenic beauty) and take into account the changing climatic conditions. - Goal-based dynamic and adaptive silviculture models to optimise the provision of relevant goods and services (including key resources like water and soil) under global change. - New multi-criteria, scenario analysis, and group- decision methods for analysing stakeholders' preferences on forest management objectives and support consensus building. - New multi-objective forest planning models to solve multiple objective problems considering economic, social and ecological factors and adjacent resources (soil and water) within a multi-scale approach. - Advanced optimisation techniques capable of integrating bio-physisca and socio-economic paradigms, in dynamic modelling frameworks. - New presentation techniques such as visualisation to show the consequences of alternative management strategies to different stakeholders, thus addressing participatory planning and social sustainability concerns. - 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.

	4-2: Advancing knowledge on forest ecosystems	- Long term ecosystem monitoring and experiments (sites ateliers) on the effects of global change in natural and planted forest ecosystem processes. 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. - Landscape experiments on the impact of land use change and forest ecosystem management on: water resources, soil erosion, 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 (CO2 and other GHG, N deposition) and soil conditions. - Mobile sensor equipment systems to study effects of forest management, logging operations and fire regimes on carbon budget of forest and other wooded ecosystems. - Ecosystem experiments on forest-atmosphere interactions with special emphasis on organic signalling (i.e. VOC) and particular attention on polluted atmospheric conditions (O3 and other air pollutants) in sub-urban vs. natural environments. - Monitoring and understanding and modelling interactions between forests and microorganisms and insects: symbionts, pathogens, pests as related to climate change. - Retrospective studies (including dendrochronolgy, dendro-chemistry and climate studies) covering the whole range of forest typologies and geographical and climatic conditions taking advantage of former long-term experiments: provenance trials, permanent plots, etc. - 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.
	4-3: Adapting forestry to climate change	- The use and development of new forest growth and yield models that can provide predictions on the provision of goods and services (mushrooms, pine cones, fodder, water yield, scenic beauty) and take into account the changing climatic conditions. - Goal-based dynamic and adaptive silviculture models to optimise the provision of relevant goods and services (including key resources like water and soil) under global change. - 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.
5. The sector in a societal perspective	5-2: Instruments for good forest-sector governance	- Development of participatory approaches for stakeholders' involvement. - Development of innovative forest policies in the context of wider rural and joint territorial development strategies. - Application of common research frames with a broadly-based institutional recognition and acceptance like the European Environment Agency's DPSIR (Driver-Pressure-State-Response) to describe the complex interactions and causations between society and the physical environment in forest ecosystems.
	5-3: Citizens' perceptions	- Understanding temporal and regional variations in the socio-economic and behavioural drivers of fire use and ignition patterns (with a focus on the wild land-urban interface), and assessing the socio-economic impact of fire on all forest goods and services and the post-fire costs of infrastructure restoration. - Sociological research on the motivations of forest owners as well as mapping stakeholders to identify their interests and interactions.

Annex II: List of organisations participating in the MFRA

Albania

Forest and Pasture Research Institute

Association Awareness for Progress

Bulgaria

University of Forestry, Sofia

Croatia

Forest Research Institute

Cyprus

Ministry of Agriculture, Department of Forests

France

INRA Nancy

INRA/Montpellier – Unité d'Économie et Sociologie rurales

INRA/Avignon – Ecologie des Forêts Méditerranéennes

French Forest Owners Association

Greece

Demokritos University of Thrace

Technological Educational Institute of Kavala

Aristotle University - Laboratory of Rangeland Ecology

Greek Forest Owners Association

Israel

University of Haifa

Tel Aviv University, Department of Plant Sciences

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

Portuguese Forest Owners Association (CAP)

Romania

University of Suceava – Faculty of Forestry

Slovenia

Slovenia Forestry Institute

University of Ljubljana, Biotechnical Faculty, Slovenia

Department of Wood Science & Technology

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

Universidad de Zaragoza, Departamento de Geografía

Spanish Forest Owners Association (COSE)

Catalonian Forest Owners Association (CFC)

Syria

University of Aleppo

Univeristy of Tishreen

Tunisia

INRGREF

INAT

Turkey

Central Anatolia Forest Research Institute & State Planning Organization

Fatih University

Southeast Anatolian Forest Research Institute, Elazığ

Eastern Black sea Forest Research Institute, Trabzon

East Anatolian Forest Research Institute, Erzurum

Central Anatolia Forest Research Institute, Eskişehir

Aegean Forest Research Institute, Izmir

Poplar and Fast Groving Forest Trees Research Institute, Izmit

Western Black sea Forest Research Institute, Bolu

Forest Tree seeds and Tree Breeding Research Institute, Ankara

İstanbul University, Forestry Faculty

Artvin Çoruh University, Forestry Faculty

Zonduldak Karaelmas University, Forestry Faculty

İstanbul University, Bartın Forestry Faculty

Kastamonu University, Forestry Faculty

Karadeniz Teknik University, Forestry Faculty

Kahramanmaraş Sütçüimam University, Forestry Faculty

Düzce University, Forestry Faculty

Isparta Süleyman Demirel University, Forestry Faculty

Center of Research on Rural Environment and Forestry Problems

Foundation of Fight Against Erosion, Afforestation and Protection of Natural Assets of Turkey-TEMA

Ministry of Environment and Forestry, General Directorate of Forestry

Ministry of Environment and Forestry, General Directorate of Erosion control and afforestation

Ministry of Environment and Forestry, General Directorate Nature Protection and National Parks

Ministry of Environment and Forestry, General Directorate of Forest villager Affairs

Foundation of Import & Export of Forest Products of Turkey

International organisations

IUCN Centre for Mediterranean Cooperation

FAO Forestry

IAMF - International Associations for Mediterranean Forests

Plan Bleu

WWF Mediterranean Programme Office

CIHEAM

Foresters Association from the Mediterranean Arc (ARCMED)

Confederation of European Forest Owners (CEPF)

For further information and detailed contact data, please visit our homepage

www.forestplatform.org