# Forest Fuels Management in Europe

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***Abstract***—*Current fuel management practices vary considerably between European countries. Topography, forest and forest fuel characteristics, size and compartmentalization of forests, forest management practices, land uses, land ownership, size of properties, legislation, and, of course, tradition, are reasons for these differences.*

*Firebreak construction, although not as clearly favored as in the past, is still a prominent fuel management technique. Fuelbreak construction has been adopted quite extensively in the last decades. Fuel treatments along the sides of roads are common. Use of prescribed burning is generally very limited. However, in most countries, shepherds use fire quite extensively, but illegally. Furthermore, stubble burning is a very common type of fire use, which often becomes source of wildfires. Grazing of cattle, sheep and goats is a traditional practice in the wildlands of Mediterranean countries. In spite of many recent social changes, it is still prevalent. Although its effect is often negative, when the carrying capacity of the land is exceeded, it does offer a significant contribution toward controlling fuel accumulation. In some cases animal herds are actively used as means for controlling vegetation re-growth in areas of fuel treatment. This paper is an effort to provide an overview of current fuel management activities in the European countries, mainly those with Mediterranean climate.*

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## Introduction

Europe is a diverse continent with a large number of nations and countries that differ significantly from each other. Their differences range from the characteristics of their people to the prevailing environmental conditions, and from their culture and heritage to their social and economic structure. The European forest cover is characterized by a great diversity of forest types, extent, ownership structure and socio-economic conditions. However, in regard to forest fires, things are much simpler: the countries in northern Europe are not really concerned with fires. On the other hand, the southern European countries (Portugal, Spain, the south departments of France, Italy, Greece and Cyprus), most of them lying next to the Mediterranean Sea, face a profound forest fire problem. The Mediterranean countries contribute 94% of the total burned area in Europe, according to an analysis of the 1975-2000 statistics by the European Forest Institute. Fire is the most important natural threat to forests in Southern Europe.

The countries of Southern Europe have seen their fire problem getting worse in the second part of the 20$^{th}$ century. Abandonment of rural areas, prolonged protection of forest lands, and expansion of fast growing species that are highly flammable (mostly pines and eucalypts) have aggravated fire

hazards. Tourism growth and development of extensive wildland-urban interface areas have sharply increased fire incidence and disaster potential. The annually burned area has more than doubled since the 1970s.

Realizing they had a problem but not fully understanding the reasons behind it, all south European countries responded by increasing their fire suppression capacity, especially through the 1990s, necessarily increasing their firefighting budgets. The outcome of this effort is a reduction in total annually burned area in relatively easy fire seasons. However, the potential for major disasters is still there. As more fuels accumulate, in difficult fire seasons, the burned area climbs again to high levels. Furthermore, the damages are very high as fires often originate or easily reach the extensive wildland-urban interface areas that have emerged in all these countries, mainly close to the coastline. This has been demonstrated very clearly in the last three catastrophic fire seasons in Portugal (2003-2005), with the occurrence of extremely large (over 10,000 ha) and destructive fires. Currently, the need for reducing fire hazard through active fuel management is becoming more and more obvious, but, to this day, the funding that is diverted from suppression to fuel treatment and general fire prevention is limited.

Fuel occupies one of the three sides of the fire triangle. Heat and oxygen form the other two sides. In the forest, fuel can be manipulated effectively before the start of a fire, influencing the probability of fire ignition and potential fire behavior. The other two contributing factors to fire behavior (weather and topography) cannot be altered by fire managers. Thus, forest fuel management is one of the cornerstones of successful fire management.

There are many definitions of fuel management in literature, most of them quite similar to each other. According to the one adopted by the Food and Agriculture Organization of the United Nations, fuel management is the "act or practice of controlling flammability and reducing resistance to control of wildland fuels through mechanical, chemical, biological, or manual means, or by fire, in support of land management objectives."

Managers can modify the load and the arrangement of both live and dead fuels. Available options are quite well known. They include horizontal isolation of fuel through firebreaks, fuelbreaks and greenbelts, fuel reduction through physical removal, prescribed burning and intensive utilization, change of fuel bed compactness by methods such as lopping and scattering (manually or by tractor crushing) and chipping, breaking vertical continuity through pruning and surface fuel reduction, and change of fuel moisture content through dead fuel removal and even local irrigation (Chandler and others 1983). Fire-aware silviculture is yet another broad option. The choice of which methods are used varies depending on factors such as vegetation type and characteristics, seriousness of the fire problem, available funds, available experience and expertise, tradition, social concerns, etc. How these factors weigh in the final decision has a direct effect on the selection of fuel management methods and the scale of their application. This is where differences exist between Europe and the other continents, as well as within Europe.

Most of the above mentioned methods of fuel treatment are used somewhere in Europe. This paper provides an overview of current fuel management practices in European countries, mainly those with Mediterranean climate, based on literature and on the personal knowledge of the contributing authors. In doing so, we tried to explain the reasons that have led to the current practices.

# Fuel Management Practices in European Countries

## *Horizontal Continuity Disruption*

**Firebreaks**—Firebreak construction was the most widely applied fuel treatment in the past. It still is to a large extent but it is not as clearly favored anymore. The preference for creating firebreaks can be explained by the obviousness of their objective (to stop the fire through fuel continuity disruption) that is visible to laymen and politicians alike. However, through time, a number of disadvantages became evident: high construction cost, high maintenance cost (need for annual clearing), poor aesthetics and significant potential for erosion when built on medium to steep slopes. Furthermore, their effectiveness proved to be quite limited. They may help to stop small fires with little firefighting support under mild weather conditions, but they are easily breached through spotting under strong winds and low relative humidity. The relatively small extent of forests in Europe, presence of villages and agricultural properties, and concerns about aesthetics and erosion, practically preclude construction of very wide firebreaks. The width (30-40 m) is often inadequate for averting breaching by direct flame contact when crown fires are fanned by strong winds.

Currently firebreak construction is a regular practice in Portugal, Spain, France, Greece and Cyprus. In Italy it exists as a practice but its use is not as regular. It should be pointed out that in some of these countries, especially in Spain (where the regions are largely autonomous) and in Italy, there are significant differences in the natural environment (colder north vs. warmer south, elevation influence, maritime influence, vegetation composition), in the societal structure and in the overall political management practices, including budgeting. This is reflected to a large extent in the decisions made on fuel management in general and in firebreak construction in particular.

Building firebreaks is only a start. Maintaining them is much more difficult as budget shortages often make it impossible to keep them free of low vegetation (mainly grasses and shrubs) on a short period (usually annual) basis. The longer the firebreak network, the more the yearly budget required for maintenance. With poor maintenance firebreaks cannot serve their purpose.

**Fuelbreaks**—Fuelbreak construction has been adopted quite extensively in the last two decades. Sometimes fuelbreaks are built "by the book" trying to permanently convert vegetation to a cover of low fuel volume and/or low flammability (Chandler and others 1983). In general this is not easy when dealing with Mediterranean shrubs, either in an open shrubland or under the canopy of trees, because most of these shrubs are vigorous resprouters. On the other hand, use of phytocides has been tried experimentally in various situations with interesting results but their costs and the associated risks make this practice difficult to accept in both ecological and economical terms (Rego 1997).

In the European countries road networks are quite dense. Clearing vegetation on the sides of forest and rural roads, either manually or mechanically, results in fuelbreak-like belts of reduced fire hazard from which firefighters can try to stop a fire, for example, by lighting a backfire. Also, when understory vegetation is removed along the sides of the roads, usually up to a

distance of 30 m on each side, the spread of a fire that starts by the road is slowed down. Crown fire initiation is also delayed increasing the probability of successful initial attack.

Regular fuelbreak construction is common in Spain, France and Italy, while it is less common in Portugal and quite uncommon in Greece.

**Greenbelts**—Chandler and others (1983) referred to greenbelts as "the next logical progression after the fuelbreak." They defined greenbelt as "a strip that has been converted to a nonflammable cover type and is maintained in that state by irrigation and mechanical treatment." They suggested a golf course as an example of a greenbelt, but admitted that greenbelts are prohibitively expensive for a forestry organization.

In Southern Europe, however, some agricultural cultivations play the role of breaking horizontal fuel continuity by providing a strip of nonflammable cover type. The abundance of such fields around villages is one of the reasons for reduced fire damages in the past. Vineyards are one of the commonly encountered cultivations that can function as a greenbelt. Orange and lemon orchards are another. Even olive groves, when properly cultivated, with grass and other surface fuels removed, can stop a fire effectively. However, as much of the rural population abandons agriculture and leaves for the cities, the effectiveness of these greenbelts is greatly reduced. Their size decreases and without the usual treatment of grasses under the cultivated woody plants the fire can easily breach them. Olive groves are the most pronounced example of this change: when left with grasses in the understory they become a major problem for firefighting because the olive trees, once ignited, are very hard to extinguish completely.

## *Fuel Reduction*

**Physical fuel reduction**—Fuel reduction by manual or mechanical means is the main method used by fire protection organizations for the creation of firebreaks and fuelbreaks. However, the cost of such treatments is generally very high and the area that can be treated is quite limited.

**Prescribed burning**—Prescribed burning was introduced in Europe—Portugal, Spain and France, in the early 1980s (Botelho and Fernandes 1998). However, after 25 years, its operational use remains very limited. In some cases, as in Greece, it is not possible as there is no provision for it in the existing laws. There is neither long-term experience in the fire management organizations nor much willingness to assume the risks associated with this practice. The existence of towns and villages, agricultural lands and other private property imposes significant restrictions in regard to smoke management, liability issues and safety. Furthermore, since any type of fire in the forest has been described in all fire prevention campaigns as bad in the past, there is concern of the public receiving mixed signals if prescribed burning is not introduced properly.

Currently, the European Union (EU) is trying to improve its knowledge on prescribed fire as applied in European ecosystems, hoping to expand its usage where it could be beneficial and offer practical solutions. An EU funded Integrated Research Project titled "FIRE PARADOX" was started in the beginning of 2006 and will continue until 2010. It involves 31 institutions from 13 countries, including in addition to the European partners, institutions from Northern Africa (Maroc and Tunis). The aim of the project is to study the use of prescribed fire and the application of backfire in Europe

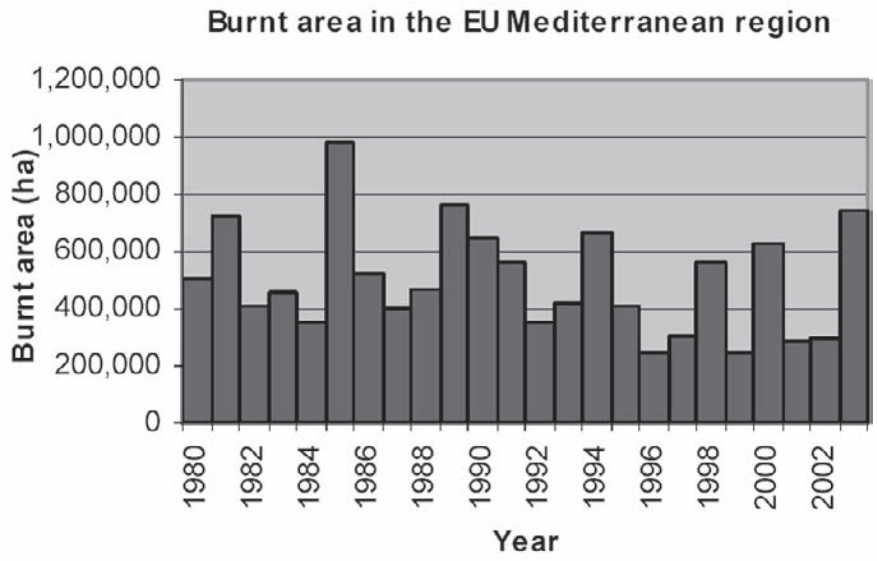


**Figure 1**—Burnt area in the EU Mediterranean region in the 1980-2003 period (European Communities 2004).

in four main domains: Prevention, ignitions, spread and suppression (www.fireparadox.org).

Shepherds often do what is not done by fire management organizations in regard to fuel reduction by fire. It is a long-standing tradition for them to set small fires at times of low fire danger that burn patches of land, stimulating new succulent growth of grasses and (mainly resprouting) shrubs for their animals. This procedure could be considered as a management scheme under certain conditions as it is profitable for the shepherds and also reduces fuel hazard. However, in recent years it has become a problem, often leading to desertification. The reason for this is an increase of the number of animals to levels far beyond the carrying capacity of the available land. EU subsidies to shepherds, in the 1985-2000 period, were based on the number of animals they had, becoming a motive for increasing the size of their flocks. This policy has been changed nowadays after its detrimental effects became evident. The large number of animals quickly reduced available forage, making shepherds reburn the land every 1-4 years. Such a frequency, combined with immediate overgrazing of the young vegetation, quickly denuded many sites leaving them covered with non-palatable, mostly thorny, plants, and having a significant soil erosion problem.

Although "effective" for fuel reduction, this method also has a side effect. As firefighting organizations easily manage to stop shepherd fires in the low fire danger season, it has been observed that the shepherds turn to new lands where they start fires on high danger days.

**Biomass utilization**—Fuels accumulate in forests when biomass production through photosynthesis is higher than the rate of decay. This is common in most ecosystems but the rate at which such accumulation occurs, varies depending on the characteristics of the ecosystem and its environment. When fuels accumulate beyond a certain point fire becomes the alternative that

breaks down the biomass and initiates a new circle of life. Biomass utilization is a third alternative that can maintain balance and reduce the probability of fire.

In the Northern European countries active forest management with good timber utilization that leaves relatively little slash behind is key to keeping the potential for fire disasters low. Timber production is one of the main products fueling the economy of the Scandinavian countries. With such practices, fires like those in the boreal forests of Alaska, Canada, and Siberia are highly unlikely in Sweden or Finland.

On the other hand, in Mediterranean ecosystems fuels accumulate quite fast as biomass production is quick and decay is slow. Active forest management for timber production with appropriate silvicultural practices is mostly carried out where there is financial incentive: the forest products have a higher value than the cost for managing the forest. Examples are the eucalypt plantations in Portugal, the *Pinus nigra* forests in Greece and the *Pinus pinaster* and *Pinus sylvestris* forests in Spain. In many cases, however, as with the forests of *Pinus halepensis* and *Pinus brutia* in Greece, the active management of forests is not economically viable. Without biomass utilization these forests are expected to burn with relatively high frequency. Traditionally, much of the biomass produced by these forests and the evergreen Mediterranean shrublands was harvested and used as an energy source for cooking and heating by the rural populations living close to the forests. Also, resin collectors managed these pine forests in a traditional way, guarding them, maintaining access trails and removing old and non-productive trees to be used as fuel wood, in an effort to create open spaces for regeneration of new clubs of trees. In this way, a balance was maintained, at least close to the numerous villages, where approaching fires were easy to control. The migration of these populations toward the cities and the substitution of other energy sources (electricity, oil, gas) for wood upset this "natural" balance and led to the current worsening condition and the need for fuel management for fire hazard reduction.

Currently, grazing in the shrublands is the most common form of biomass utilization in the non-timber producing forest lands in the Mediterranean. When this practice is planned and controlled at appropriate levels it functions as a very effective and productive method of fuel management.

# A Short Summary for Each Country

## *France*

France is the most active southern European country in regard to fuel management. The French approach is that firefighting implies strategy, and good strategy means preparing wildlands for firefighting to achieve efficiency of suppression operations and safety of fire crews. In this respect, the core of French strategy in fire management is "wildland partitioning" (Figure 2).

The "tools" for achieving wildland partitioning are fuelbreaks and fire fighting areas. Furthermore, as part of the overall strategy, protection of human assets is a priority. A "let it burn" policy is applied on a very limited scale. It is very difficult to apply such a policy in France, because human assets are too many and interspersed in most forests.

A "fuelbreak working group" has been established in France. The Group works on:

- Building fuelbreaks

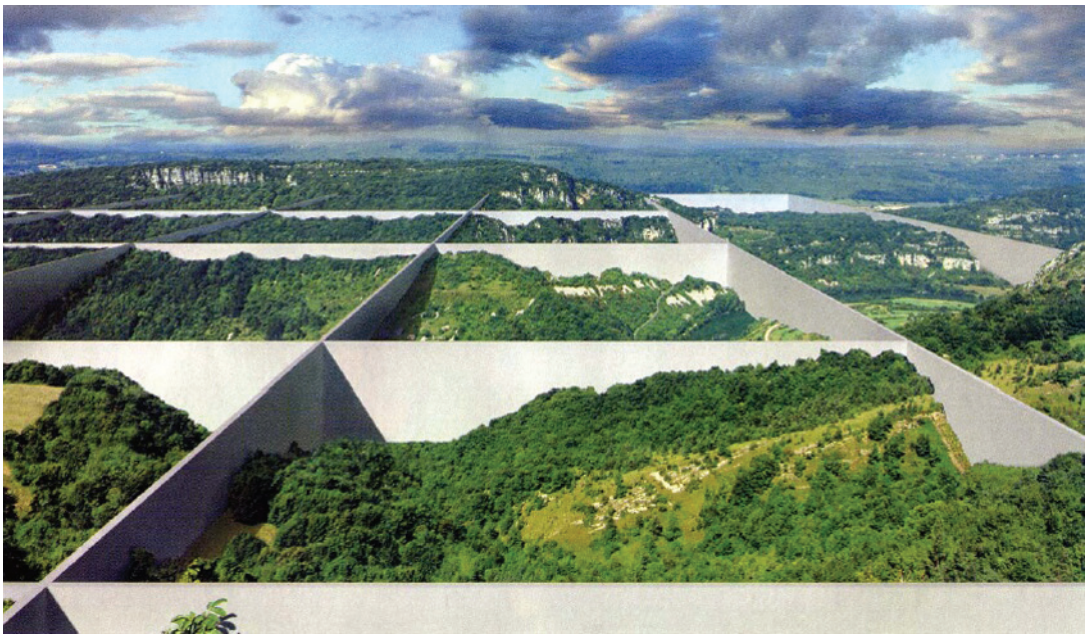

**Figure 2**—The concept of "wildland partitioning" in France.

- Fuelbreak maintenance
- Real study cases analysis
- Economic assessment of fuelbreaks
- Preparing national standards for the "tools" of fuel management (such as firebreaks) that are applied in the field

In France, fuelbreaks are categorized in three types according to their objective:

- Type 1: The objective is to limit fire ignitions: fuel management aims to decrease ignition hazard and to increase success of early fire fighting operations. It is mostly applied in or around Wildland Urban Interface areas.
- Type 2: The objective is to limit fire effects on assets: fuel management focuses on making the circulation of firefighting crews and the public easier and safer (safer escape routes). It is mostly applied in or around Wildland Urban Interface areas. Fuel management for forest autoprotection (i.e. to avoid stand replacement fires) is included in this type of fuelbreak.
- Type 3: The objective is to limit the size of burned areas by breaking forest continuity. These are fuelbreaks built at strategic locations to help firefighters control the head or the flanks of probable fires. They are generally built between 2 non-burning (usually agriculture) areas. In building type 3 fuelbreaks two objectives are:
    - To provide at least a safety zone for fire crews.
    - To enable efficient fire suppression actions.

Scenarios that must be taken into account include the case of a large fire and fires under severe fire weather conditions (Figure 3).

Fuelbreaks are built by forest authorities but in cooperation with the firefighters (Civil Protection) in order to take their requirements into

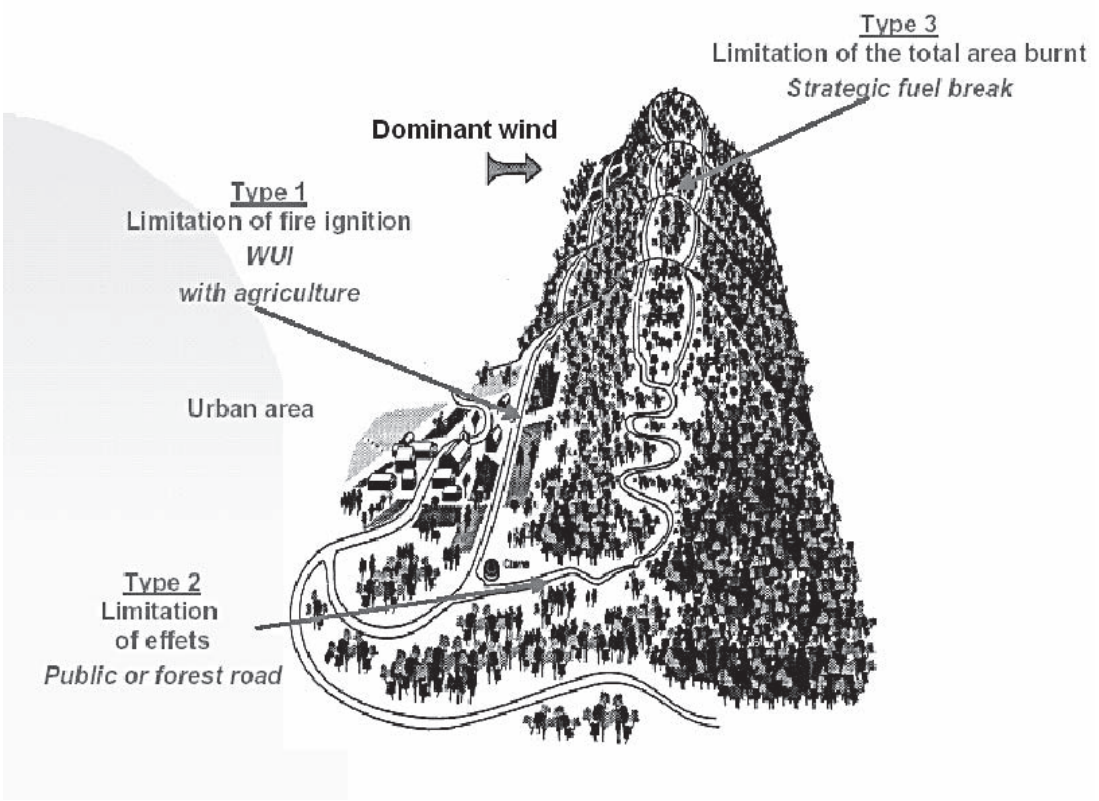


**Figure 3**—The concept of a fuelbreak network in France.

consideration. Their construction takes into account the firefighting strategy. Necessary elements, such as water supply, access (roads), road signs, etc., must be available along a fuelbreak.

The standard approach for fuelbreak maintenance is mechanization. When possible, grazing and agriculture are also used. Prescribed burning is also used to some extent and its application is increasing. Of course, social constraints have to be integrated when choosing to use it.

In a 1999 study of nine fuelbreaks in France, which took into consideration the cost of construction (amortizement), maintenance, outcomes from grazing (production) and external costs, over a 5 to 15 year period, it was found that the annual cost of a 30 to 40 ha fuelbreak is equal to one hour of aircraft flying time delivering three retardant drops.

## *Portugal*

The Portuguese Forest Services structure is based in a Central Office at Lisbon and three regional offices, each with 7 sub-regional offices. These sub-regional offices have the responsibility of promoting the Regional Plans of Forest Management. Recently, a Sub-Directory for Forest Fires Prevention was created under the General-Directorate of Forest Resources, to accomplish the execution of the National Plan for Forest Fire Prevention and Management. The Regional Plans of Forest Management also define the primary and secondary fuels break network planning, to promote rural landscape fragmentation and control the spread of large fires.

There is the assumption that the solution to the forest fire problem relies on the promotion of private forest management, although this is a mid-term solution. Several incentives are now being developed, such as reduction of the Value Added Tax (VAT) for preventive silviculture services and funding support for the installation of "Integrated Forest Zones", that unite, for management purposes, a large number of small size private forest parcels. These zones have a size of at least 1,000 ha, a size that is considered as the minimum needed for professional management of the forest resources and for fire prevention planning at the landscape level.

At the municipal level, Forest Fire Prevention plans include characterization of hazardous areas and set the fuels treatment strategy. Techniques like prescribed fire, grazing and localized mechanical interventions are defined in those plans. Fuel treatments in the forest/urban interface are also planned, as well as pre-suppression infrastructures (water points, lookout towers, forest roads and fuelbreaks).

Firebreaks are the most widely used fuel management technique in Portugal, mostly in the mountainous areas, in the public lands and in the eucalypt plantations of the pulp and paper companies. Directed grazing for cattle at the landscape level is starting to be promoted. Localized manual fuel treatment by hand crews is another technique used in strategic areas. Recently, Portugal puts an emphasis in the reintroduction of prescribed fire and for this purpose has started a broad training program of foresters and support crews. A technical exchange program with the U.S. Forest Service (USFS) is being prepared to support this initiative (Figure 4).

**Figure 4**—One of the first prescribed burns executed in 2006 in Portugal with the cooperation of USFS prescribed fire specialists (Photo: Mike Crook (USFS)).

## Spain

In Spain the responsibility for forest fire prevention belongs to the 17 autonomous regions (Autonomies). Every region has its own regulation and rules for forest fuel management, hence the methods, intensity and allocated budget varies from region to region.

Out of the 26 million hectares classified as forest land, about 18 million are privately owned. Landowners are in charge of the exploitation and maintenance of the ecosystems, and also responsible for the forest fuel treatments. Although specific regulations apply in the regions most affected by forest fires, landowners do not respond in the same way in regards to fuel management. Hence the methods, extension and intensity vary within the regions as well.

Every region, by law, has to provide a forest fire defense plan, including a chapter for preventive measures, which include operations on the forest fuel. However, common objectives are followed, mostly thanks to the yearly CLIF meeting which is hosted by the Ministry of Environment and in which main target priorities are discussed and set among all autonomous regions.

In the last two decades, an important change in fuel structure and load has occurred, mostly caused by the de-population of rural areas. Land use change, in many cases followed by the abandonment of activities in the forested lands, has brought about an increase of burnable biomass in grasses and shrubs, and the modification of the vegetation structure, favoring horizontal and vertical fuel continuity.

Three areas can be considered in terms of fuel structure and load, hence giving an idea of the requirements of forest fuel treatments.

In the Atlantic zone, which is humid, there are several vegetation structures. The forested areas frequently have an overload of flammable fuels creating explosive situations. This is caused by the low budget invested in the forest stands, and the poor investment of landowners in fuel treatments. The situation is aggravated further by the fact that the shrubs in this zone regenerate quickly, leading to heavy accumulations of very flammable biomass in a short time after fires or fuel treatments. The agricultural lands have mostly been abandoned. Natural vegetation has invaded these lands, mostly in the interior. The situation is made worse by the uncontrolled use of fire in an effort to control the invading vegetation. Removal of forest fuels in the Atlantic zone is costly due to the high rate of biomass production, and is traditionally limited to the removal of fern and grasses. Their biomass is normally burned in piles. Today, a new practice is being explored: it is the mechanical removal of the fast growing shrubs and their use in biomass-energy production plans. In the Atlantic zone, it is normal to apply systemic herbicides on firebreaks and cleared zones built along the perimeter of forest lands to reduce future regeneration of shrubs and tree sprouts. Although very efficient as a vegetation control tool, Administrations are generally reluctant to use prescribed burning, perhaps due to the many agricultural burnings that end-up as large forest fires. As a result, at least in the vicinity of large and/or dense forest stands, prescribed burning is avoided, although is the most efficient and cheap method of forest fuel removal. In the Atlantic zone, grazing is not applied systematically for fuel control.

In the Mediterranean zone, Spain has a mosaic of forest land patterns, including young forest stands and reforested areas, abandoned agricultural lands, and mature forest stands. They are always subject to the pressure of

shrub species. Most forests have a more or less dense shrub understory. In this zone, silvicultural and other treatments of the forest fuel are generally economically unfeasible for widespread application. Hence, hazard reduction efforts are localized and more focused. A combination of silvicultural treatments and livestock grazing is the measure of choice.

In calculating risks in the Mediterranean zone, it is very important to consider soil erosion and other hydrological phenomena, which could take place under sparse vegetation coverage. Large forest stands are infrequent, and when they exist, they are protected by a strip of low combustibility around their perimeter. Networks of firebreaks are combined with other low-load vegetation patterns (i.e. agriculture) to avoid horizontal continuity, while taking into consideration the protection of settlements and housing areas in the increasing wildland-urban interface domain. Planning the extent and location of fuel management takes into consideration the quality and extent of the various ecosystems, regeneration capacity, vegetation coverage and special protection priorities, if any.

In the Southern zone of Spain, the forest structure is very variable and has a direct correlation with the ownership regime. The forest stands belonging and managed by the Administration are subject to periodic silvicultural treatments, such as thinning, pruning and understory removal. In contrast, in privately owned forests the response is quite poor, except for some cases, in which several owners associate and cooperate in managing their forest. In this Southern zone, the most common fuel management practices applied are grass and shrub removal, prescribed burning and grazing. Due to budget restrictions mechanization is still not totally achieved.

Firebreak construction is perhaps the most common fuel control measure in Spain. All fire-prone areas in Spain are criss-crossed by a network of linear firebreaks. The main objective is to fragment the territory into cells to minimize the spread of large fires. Regardless of whether they serve their purpose well, firebreaks are unpopular among citizens in Spain, mostly due to the visual impact on the landscape, although the rural population has accepted them more quickly due to the forest protection benefits they offer. Maintenance of firebreaks, which is required, takes a large part of the fuel treatment budget. Often, budget constraints lead to poor maintenance in certain regions. However, in some regions, such as Valencia, application of intense grazing by goats in firebreaks keeps costs low and helps to maintain the firebreak network.

The standards for building new firebreaks are summarized below:

- Width of firebreak has to be two and a half times the dominant canopy height, with a minimum of 15 m in the vicinity or forest stands.
- Width of firebreak has to be 10 m in the vicinity or inside of shrublands.
- Width of firebreak has to be 5 m in the vicinity or inside grasslands.
- In all cases, firebreak vegetation has to be totally removed to mineral soil.

In areas where lightning is a main cause of forest fires, firebreaks are often built along mountain crests where they serve as an efficient transport corridor for ground forces in addition to hindering fire growth.

Fuelbreaks are becoming more popular in Spain lately. They are favored by many because they have a more natural-looking structure. Their width is normally about 30% more than that required for the firebreaks.

Prescribed burning is not a generalized and accepted practice for forest

fuel reduction. It is regulated and applied in some regions (i.e. Andalusia), it is slowly being accepted in others, such as Catalonia and Castilla Leon, but it is totally banned in several others, such as Madrid. In general, it is a rather unpopular practice, perhaps due to the fact that the use of fire as a tool in agricultural activities has frequently been the cause of large and very destructive fires (Vega and Velez 2000).

The frequency of burning for grazing by shepherds varies between regions but it is more or less general practice in Spain to obtain pasture by burning shrubs. This practice is more prevalent in the Atlantic zone as mentioned above. Grazing of cattle, sheep or goats is a common practice for fuel reduction in Valencia and other provinces of the Mediterranean zone. In Galicia, Castilla Leon and many other regions of the Atlantic zone grazing is used just to contain shrub sprouts. Other fuel management practices include mechanical and manual clearance around heavily traveled roads, and under high-voltage (1,000 to 220,000 V) power lines. Furthermore, silviculture in Spain takes into consideration the need to reduce fire hazard. Treatments include shrub removal, tree thinning, and pruning of lower branches and are often applied at locations of special interest (Figure 5).

**Figure 5**—An example of a silvicultural treatment that also aims at crown fire potential reduction on Tenerife Island, Spain.

## *Italy*

The 20 Italian Regions have unique administrative competencies concerning wildland and forest management in their territory. They are also in charge of forest fire protection, supported by the State Forestry Corps through special agreements at regional level.

Law dispositions on wildland fires in Italy are mainly established by the national law 353/2000. This law states that each Region is in charge of setting up a Fire Management Plan for its regional territory. The plan should identify priorities and arrange all fire protection activities, including interventions on woodlands. The national law is inspired by the principle that the best approach to protect forests from wildfires is to promote and provide incentives for prevention activities, instead of just focusing on suppression. In spite of this declared goal, neither the law nor its specific guidelines discuss in detail the subject of fuel treatment and management for wildfire prevention. The law simply states that each regional plan must provide for silvicultural activities to clean and manage woodlands. The greatest investments are still made in fire fighting, with a varying amount destined to prevention activities from Region to Region.

Each Region must plan, realize and maintain fuelbreaks (and other structural and infrastructural interventions), establishing typologies and standards according to its environmental characteristics. To reduce the risk of fires spreading from agricultural areas to forests, within some Regions, plowed or mowed buffers are realized along cultivated and abandoned fields located next to forests (Figure 6).

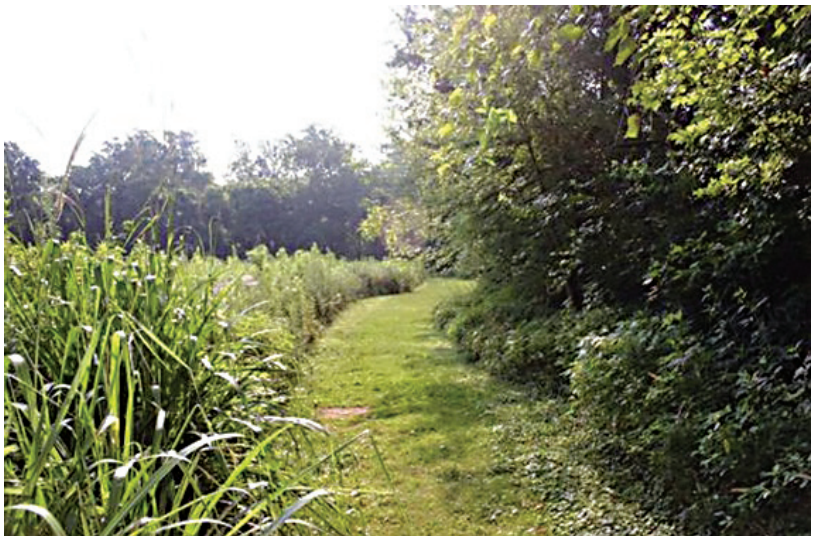

**Figure 6**—Mowed buffer strip separating a forest from agricultural land in Italy.

Each regional plan also has to design all forest cleaning and management interventions for those areas with the greatest wildfire risk. These interventions must specifically aim at:

- Reducing fuel biomass and removing coarse woody debris.
- Creating mixed and well structured stands, with a heterogeneous forest composition.
- Favoring, where possible, coppice conversion to high forest.
- Favoring natural regeneration.
- Thinning old and too dense coniferous plantations.
- Slashing, mowing and cleaning in the proximity of railway lines, forest and ordinary roads and road banks, especially if they are located next to forested areas.

This last treatment is mainly applied in the summer. It is realized by the organizations responsible for the road network and railway management. Along railroads chemical weeding is a common practice, while around roads both manual and mechanical clearance are applied.

In Italy there is clearly lack of experience concerning prescribed burning; moreover there is not a clear set of rules that would define for all the country the use of fire for ecological and management purposes. The national law does not mention the possibility to use prescribed burning; thus, it is up to each Region to adopt the use of prescribed fire in its fire management plan. Only a few Regions currently have plans that allow and regulate the use of the prescribed burning technique. For these reasons and because of a widespread mistrust of fire for ecological and management purposes, in Italy prescribed burning is not applied. Recently some experiments were conducted by the Agroselviter Department of the University of Torino to investigate the use of prescribed burning both for the management of particular biotopes and to reduce fuel load (Ascoli and others 2005).

The practice of burning for grazing by shepherds was more widespread in the past; currently it is quite limited and is exercised mainly in a few areas of the southern regions and in the islands (mostly Sardinia). Stubble and shrub burning is instead a traditional practice adopted by farmers; it is one of the most frequent sources of wildfires.

Grazing of cattle was also more common in the past. Recently some attempts are being conducted to use sheep grazing to reduce fuel biomass within fuelbreaks, instead of mechanical treatments (Antona and others 2003).

## *Greece*

In Greece, the responsibility of firefighting passed from the Forest Service to the Fire Service in 1998 (Xanthopoulos 2004). As a result, prevention and suppression are not seamlessly tied anymore. The cost of firefighting tripled in the years that followed. Funding for prevention decreased. Subsequently, fuel management efforts are relatively limited today.

The General Secretariat for Civil Protection which was established in the late 1990s tries to organize cooperation of all organizations involved in fire management. It organizes public education and fire prevention campaigns every summer, co-ordinates general planning and, in regard to fire hazard reduction, it distributes some prevention funds to local authorities for fuel management work, mainly in the vicinity of settlements and along roads.

Firebreaks are the most common fuel management measure taken by the Forest Service. Forestry officers struggle to keep them clear of vegetation re-growth before every fire season with the limited funding they get.

In Greece, few fuelbreaks are built "by the book" (i.e. trying to permanently convert vegetation to a cover of low fuel volume and/or low flammability). The road network in the forests is quite dense. Clearing vegetation on the sides of forest and rural roads, either manually or mechanically, results in fuelbreak-like belts of reduced fire hazard from which firefighters can try to stop a fire (Figure 7). The cost of this work, when performed manually, has been studied in Greece by Xanthopoulos (2002).

Grazing of sheep and goats is very common in the wildlands of Greece. In all regions of the country, the number of animals exceeds the carrying capacity of the available grazing land. This high grazing pressure has obvious negative ecological effects but also keeps fuels under control. On the other hand, fires lighted by shepherds to rejuvenate vegetation in the overgrazed shrublands are a significant problem as they constitute more than 10%, probably close to 20% if fires listed as "of unknown cause" are considered, of all wildfires in the country (Figure 8).

**Figure 7**—An example from mount Parnis, near Athens, of shrub understory removal around heavily used forest roads, chipping the resulting biomass.

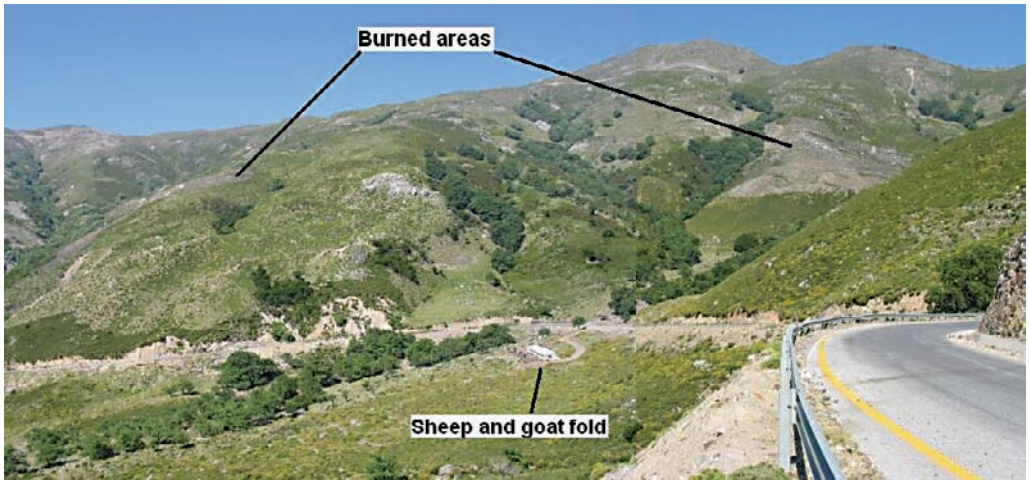


**Figure 8**—Two small burned areas near a sheep and goat fold in western Crete, Greece.

# Conclusions

Table 1 summarizes the fuel management methods in the southern European countries. In spite of the differences between them, there are many similarities worth noting here:

- Firebreak construction, although not as clearly favored as in the past, is still a prominent fuel management technique.
- Fuelbreak construction has been adopted quite extensively in the last decades. Fuel treatments along the sides of roads are common.
- Use of prescribed burning is generally very limited. The existence of villages and other infrastructures within and around forests is one of the reasons discouraging its adoption. It can be concluded that efforts to expand its use are underway.
- In most countries, fire is used quite extensively, but illegally, by shepherds.
- Stubble burning is a very common type of fire use, which often becomes source of wildfires.
- Grazing of cattle, sheep and goats is very common in the wildlands of Mediterranean countries. In spite of many recent social changes, it is still prevalent. Although its effect is often negative, when the carrying capacity of the land is exceeded, it does offer a significant contribution toward controlling fuel accumulation. In some cases animal herds are actively used as means for controlling vegetation re-growth in areas of fuel treatment.

In general, efforts are concentrated mainly close to inhabited areas and focus on protecting humans and infrastructures. Firebreaks and fuelbreaks mainly aim to aid in limiting the spread of large fires but their density in areas where there is little population and low forest value is generally limited. Preventive silviculture, including prompt timber harvesting and development of mixed forests rather than monocultures are often solutions in seeking fire resistance in productive forests.

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**Table 1**—A summary of current fuel management practices in southern Europe.

| Country | Firebreak construction | Fuelbreak construction | Manual clearance around roads | Mechanical clearance around roads | Grazing of cattle, sheep or goats | Prescribed burning for fuel reduction | Burning for grazing by shepherds | Silvicultural treatments | Clearance under powerlines |
|---|---|---|---|---|---|---|---|---|---|
| France | R | R | R | R | I | I | I | I | R |
| Greece | R | I | R | I | R | N | R | E | R |
| Italy | I | R | R | R | N | N – E | N | R - I | R |
| Portugal | R | I | I | R | R | E | R | I | R |
| Spain | R | R | R | R | R | I | R | I | R |

Where: R : Regular operation
I : Applied but not on a regular basis
E : Applied in small scale or experimentally
N : Not applied

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