Wildfire Management Policies in Algeria: Present and Future Needs[1,2]

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Abstract

Algerian forest lands cover 4,115,908 hectares (ha), of which 2,413,090 (58%) ha are bush or *maquis*. Recent work has shown that forest fires are the main factor explaining (90%) degradation of Algeria forest lands at an annual rate of 45,000 to 50,000 ha. From 1985 to 2010 in 40 provinces of northern Algeria, 42,555 forest fires have burned a total of 910,640 ha. On average, 1,636 fires burn 35,024 ha of forest lands annually. The 1985 to 2010 period saw a general increasing trend in annual fire frequency for the area. As in the entire Mediterranean basin, forest fires in Algeria are mostly human-caused, whether by negligence or voluntary. Unfortunately, the majority of fires are of unknown origin (80%), making it difficult to establish an appropriate preventive approach. The current forest fire prevention strategy in Algeria is based on the principle of "minimum damage", reflecting the technical limits of and lack of firefighting resource capability for protecting the entire forest lands from wildfires. Within the constraints of the existing wildfire management programs, it is necessary to improve the alert system, communication, and to intensify preventive silviculture in high-risk areas to reduce forest vulnerability to fire. Similarly, developing wildfire risk maps and providing adequate maintenance to existing infrastructure would help improve the organizational response to the wildfire season, potentially leading to better prevention programs and more efficient wildfire management programs in Algeria.

Keywords: *Fire causes, fire history, fire management*, *prevention strategy.*

Introduction

Fire is the main cause of forest destruction in the countries of the Mediterranean Basin. Annually, about 50,000 fires sweep through anywhere between 700,000 to 1

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[2] Survey instrument used in this work was designed and implemented by the senior author in Algeria; no US Federal Government money or employee's time was used in such efforts.
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million ha of Mediterranean forest, other wooded land and other land, causing large economic and ecological damage, as well as loss of human life (Dimitrakopoulos and Mitsopoulos 2006).

Algeria is a Mediterranean country strongly conditioned by the physical, biological, climatic and environmental characteristics of the area. Wildfires can be so explosive, due to harsh climatic conditions (extreme temperatures and prolonged drought) that in a few hours they can annihilate wide surfaces (Madoui 2000).

According to the 2009 National Forest Inventory (Bneder 2009) the current situation of forests and other wooded lands (OWL) is of concern. Their combined total area is only 4,115,908 ha (1,702,818 ha forests and 2,413,090 OWL), representing only 1.72% of the country's 238,174,000 ha. Furthermore, 84% or 200 million ha of the total surface area is located in the Sahara region. Only the northern mountainous part of the country has a significant forestry cover of about 16.4%.

Climatic conditions are a significant predisposing factor for the forest fire situation in Algeria. Prolonged summers (June to October), with nearly no rain and average daytime temperatures well in excess of 30°C, and with daily peaks reaching up to 50°C (e.g., at In Salah in 2005), reduces forest litter moisture content way below 5%. Under these conditions, even a small addition of heat from natural (lightning) or human sources (a spark, a match, a cigarette butt) can be enough to start a violent wildfire.

In the context of the Mediterranean basin, Algeria is one of the countries with a significant forest fire problem whose impact requires consideration. Managers are facing upward trends in fire frequencies, area burned, fire intensity and severity, and increases in fire season length and risk resulting from changes in climatic conditions.

The objective of this research is to establish an inventory of existing public policies related to wildfires and understand their context in relation to forest fire management in Algeria.

Study Area

Algeria is the largest country in Africa and the Arab world, with a total surface area of 2,381,714 km². It borders with the Mediterranean Sea to the north (1200 km of shoreline), Morocco to the west, Tunisia and Libya to the east, Mauritania and Western Sahara to the south-west and finally Mali and Niger to the south (Figure 1). Algeria is divided into 48 provinces (*wilayas*), 553 districts (*daïras*) and 1,541 municipalities (*baladiyahs*). As of a January 2010 estimate, Algeria's population was 34.9 million. About 90 percent of Algerians live in the northern, coastal area. More than 25 percent of Algerians are under the age of 15.

Geographically, the country is divided from north to south into four natural zones: 1) the Tellian Atlas (or the Tell) is made up of the northernmost steep relief flanked by rich coastal plains such as the Mitidja in the centre, the Chelif to the west and the Seybouse plains in the east; 2) the High plateaus, where the vegetation is steppeSummers are generally dry and winters coldThe main cities are Bordj Bou Arreridj, Serif, Tiaret, Dejelfa, M'sila; 3) . . the Saharan Atlas as a succession of NE-SW oriented reliefs spreading from the Moroccan border to Tunisia; and 4) the Sahara desert, composed of large sand dunes (East and West Erg) and gravel plains (regs) with dispersed oases such as El-Oued, Ghardaia and Djanet.

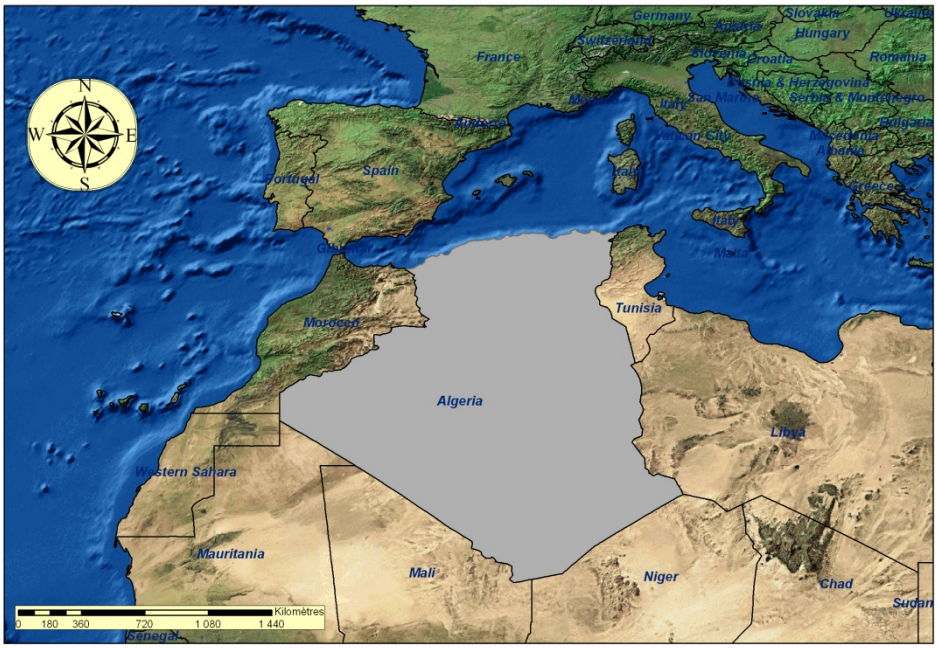

Figure 1—Map of Algeria

Methods

The research reported here was conducted during the spring 2011. Our initial working phase consisted of a review of all existing documents, reports, and legislation dealing with forest fires in the country at the national, regional and local levels. To complement this information we conducted a qualitative survey (structured qualitative interviews) administered to a sample of 35 fire managers in Algeria Central Directorate of Civil Protection and National and Regional Forest Administration. In addition, 70 in-person interviews were conducted at the regional level with forest managers (N=20), firefighters (N=17), and local authorities (N=33) involved in forest fire protection.

Results

Forest fire statistics

Forest fires are a recurring phenomenon, and have always had a pervasive influence on Algerian forests. In the period 1985-2010, a total of 42,555 wildfires burned 910,640 ha of forest land. This represents 1,637 fires and 35,025 ha annually for an average area burned of 21.39 ha per fire (Meddour-Sahar and Derridj 2012b). As shown in Figure 1, the yearly variability in these two statistics is very high. This is corroborated by the large coefficient of variation (40.30%) for number of fires and 143% for area burned. The large number of fires and area burned in 1993, 1994, 2000, and 2007 is of particular note here. A possible explanation for the relationship is the high correlation between area burned and seasonal meteorological conditions.

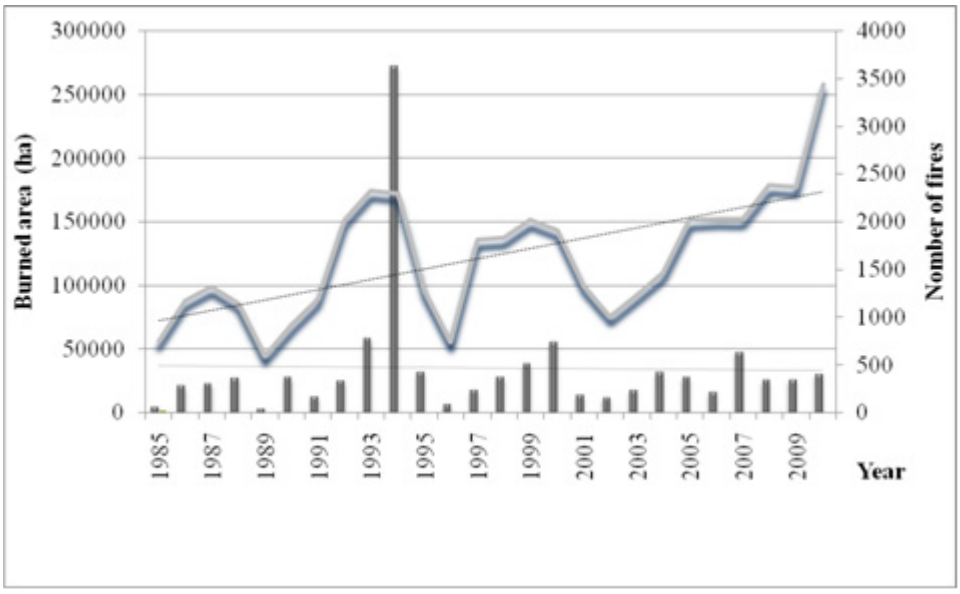

Figure 2—Number of fires and burned area in Algeria, 1985 to 2010

Over the period 1985-2010 the annual average numbers of fires, area burnt, and area burnt per fire are 1,637, 35,027 and 21.39 respectively (Table 1). However, when breaking the full period into two 12-year sub-periods an interesting pattern emerges. While the annual average number of fires increased from 1,348 in the period 1985 to 1997, to 1,925 during 1998 to 2010, the opposite was true for area burnt and burnt area per fire. The area decreased from 41,147 to 28,902 and from 30.52 to 15.01 ha respectively (Table 1). The following factors may have influenced this trend. First, improvements in detection methods (lookout towers, but mainly mobile patrols) have most likely resulted in the detection and reporting of more fires.

Second, the quality of the databases has improved considerably. Third, due to aggressive and effective fire suppression policies, fires are extinguished earlier (after the purchase in 2005 of 4WD pick-up type vehicles equipped with small fire engines (600 liters) and a high pressure pump), which may lead to smaller fires by reducing intervention time.

Table 1—*Forest fires statistics for Algeria.*

Year	Number of fires	Burned area (ha)	Burned area per fire (ha)
Average (1985-2010)	1,637	35,025	21.39
Average (1985-1997)	1,348	41,147	30.52
Average (1998-2010)	1,925	28,902	15.01

As expressed earlier the main cause of wildfires throughout countries in the Mediterranean Basin is anthropogenic. Algeria is marked by a strong prevalence of human induced fires. In some cases, they are purposely started, e.g., for criminal reasons. In many others, they are related to agricultural and forestry activities, e.g., fires for agricultural cleaning that escape control. There are other factors that contribute to fire spreading faster, which makes them more difficult to suppress (Meddour-Sahar *and others,* 2012). Weather conditions are not the cause of fire ignition (except for lightning episodes), but rather have a catalytic effect because they are predisposing factors that make fire propagation easier in a hot and dry environment (typically associated with fuel moisture close to zero).

Unfortunately, the investigation of fire causes in Algeria is in its infancy thus limiting understanding of the main causes of fire in the country. For example, for the 1985 to 2010 time series, for which we have almost complete information, the fire cause cannot be identified in 80% of the cases (Table 2). Even for fires that can be assigned to a category, the categories are very broad such as *negligence*, *accidental* or *voluntary*. A more refined categorization is needed that could aid design of fire prevention programs.

Table 2—*Forest fire causes in Algeria for the period 1985-2010*

Causes	Numbers of fires	%
Negligence	1,260	3
Accidental	256	0.6
Voluntary	7,009	16.4
Unknown	34,030	80
Total	42,555	100

The recorded causes in the fire data do not reflect reality. In Algeria, it is commonly accepted that at least half of the fires attributed to unknown causes are either arson or *security fires*, which are purposely set by the Algerian Army as a counter terrorism measure; making it a rather difficult topic to address.

These fires are listed as of unknown causes either because the arsonist was not arrested or because conclusive evidence of arson was not found (Dimitrakopoulos 1995). Again, this points to the urgent need to improve the capability to investigate fire causes.

Forest Fire Policy in Algeria

The national forest fire policy emanates from Algerian forest legislation containing provisions specifically related to the prevention and organization of the response to forest fires. The following four laws and decrees contain specific elements addressing forest fire concerns.

- Law 84/124 of 23 June 1984, which under Articles 19, 20 and 23 requires the involvement of different state organizations in the fight against forest fires. The law establishes the obligations of certain agencies for carrying out fire protection actions;
- Decree 87-44 of 10 February 1987 establishes rules and standards for prevention against forest fires in and near the national forest domain;
- Decree 87-45 of 10 February 1987 establishes the organization and coordination of actions in fighting forest fires in the national forest domain;
- Decree 301-07 of 27 September 2007, amending and supplementing Decree 80-184 of 19 July 1980, establishing coordinating agencies for implementing actions to protect forests.

In addition to this policy related laws, Algeria and the majority of Mediterranean Basin countries, have a variety of legal instruments to punish violators in the case of a forest fire. Punishment ranges from forced work in Morocco (Zitan 1986), Algeria (Grim 1989) and Tunisia (Chandoul 1986), to jail sentences of only a few months in Cyprus, to life imprisonment in France (Alexandrian and others 1999).

The current national forest fire policy is based on the following three guiding principles: **prevention** (including all measures intended to prevent the occurrence of forest fires), **pre-suppression** (covering all provisions intended to improve interventions and safety in the event of fire), and **suppression** (including all possible types of intervention). Below is a description of activities within each of these three fire management program actions.

Prevention

Prior to the wildfire season, the administration starts a number of prevention activities, such as:

Sensitization and education of the public and forest users—
Among the activities in this program are: 1) organizing conferences on wildfires in centrally located meeting places of easy access by the population to explain the precautions to be observed in the event of fire use, to avoid or reduce the probability of fire spreading into the forest; 2) designing and broadcasting television and radio spots, films and posters; 3) preaching in mosques; 4) articles in newspapers highlighting the benefits of forest and nature; and 5) campaigns in schools starting in September to coincide with the beginning of the school year.

The reinforcement of forest surveillance—
There are three main provisions that regulate the use of fire in forests, or in their vicinity during the period of summer dryness between June 1 and October 31. The intent is to safeguard the population surrounding these areas from potential wildfire occurrence. The provisions are:

1. Establishment of a 50-meters wide buffer zone around villages to ensure their protection. In this zone fruit trees will be maintained, forest trees pruned to a third of their height, brush and dry grass will be systematically removed; all of this in accordance with Article 4 Decree No. 87/44 dated 10 February 1987.
2. Establishment of a 25-meters wide buffer zone devoid of vegetation and other flammable material around schools and socioeconomic units' buildings, yards and other installations; all in accordance with Article 6 of the Decree No. 87/44 dated 10 February 1987.
3. Establishment of a 50-feet wide buffer zone around permitted sanitary landfills; all in accordance with Article 15 of Decree No. 87/44. In addition, those facilities must have a security guard present for safety (to prevent people from entering for salvage activities), burning of materials is prohibited, and fire protection equipment must be present to respond in case of need. Illegal dumps must be eliminated.

Pre-suppression

Fire management protection programs infrastructure and personnel are distributed throughout the country provinces. At present the program consists of a basic pre-suppression force of 2,229 people organized in 456 Forest Mobile Patrols (2 to 5 person crews depending on the province) responsible for initial attack, and 922 employees staffing 375 fire lookout towers. In addition, there are another 6,000

Directorate of Civil Protection employees and 42,088 forest workers available for fire activities when needed. In terms of equipment and infrastructure the program consists of 40, 4WD Medium Tanker (3000 Litres), 800 firefighting trucks provided by the Directorate of Civil Protection when needed, 1,617 water points in or near forests, 32,556 ha of passive firebreaks , and 37,933 Km of forest access roads.

The fire management program is not the only governmental agency with fire protection responsibilities. As such, the program cooperates with other governmental agencies and institutions with fire protection responsibilities. These include:

- The Ministry for Public Works, responsible for weeding along national roads that cross forest lands in accordance with Article 25 of Decree No. 87/44.
- Ministry of Energy and Mining, the Railway Service: SNTF, responsible for weeding along the railway that crosses forest areas in accordance with Article 24 of Decree No. 87/44.
- The Ministry of Interior and Local Governments responsible for weeding 5 meters on each side of communal roads and other access routes located inside and within 500 meters of the national forest domain.
- The National Gas and Electricity Society (SONELGAZ), responsible for weeding the area under power lines crossing forest areas in accordance with Article 21 of Decree No. 87/44.
- The National Meteorological Service, responsible for producing fire weather forecasts during the fire season highlighting potential fire danger. These bulletins are provided to Forest Service managers to strategically place their firefighting resources over areas diagnosed with high fire danger conditions.
- Ministry of Agriculture and Rural Development; responsible for establishing a 5-meters wide vegetation free buffer zone around farms adjacent to forests in accordance with Article 7 and 26 of Decree No. 87/44.

None of the above mentioned institutions uses prescribed fire, which is an unknown practice in the country.

In June, prior to the fire season, Forest Service engineers conduct a series of conferences/workshops targeted at local administrative authorities and fire protection volunteers. The objective of these conferences is to provide a refresher on fire prevention activities, remind local volunteer groups and all community members of their obligation to participate in forest firefighting, and a reminder of the requirements established by the protection provisions of Decree No. 87/44 and 87/45 dated 10 February 1987. A report on the results of this activity has to be sent to Direction of Forestry to ensure accountability of completion.

In each province, the fire management protection organization includes the following agencies: the Provincial Operational Committee (POC), District

Operational Committee (DOC), Municipality Operational Committee (MOC), and the Local Population Operational Committee (LPOC). The following flow chart (fig 3) shows their relationship and the number of agencies within each type in parenthesis.

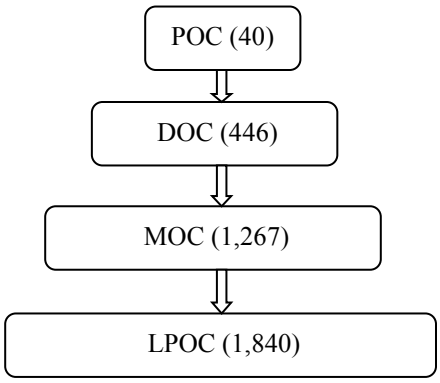

Figure 3—The fire protection organization in Algeria (40 provinces).

Suppression

The initial attack response to a fire alarm is always by the local Forest Mobile Patrol (FMP, CCF in French). This response is by a 5 person crew, with a first strike 4 WD vehicle equipped with a tank with a capacity of up to 600 liters. The goal of this first attack is to arrive within the first 10 minutes of the fire notification. These crews have minimal suppression equipment (shovel, pick, fire swatters, backpack pump and a radio to inform headquarters personnel). These crews will routinely alert Civil Protection and Local Authorities of the fire origins (forest, district, and municipality). The Civil Protection Organization mandate is to respond to all type of emergencies, including forest fires, and to deploy the necessary resources in response to the emergency; and in the case of wildfires, to manage the suppression operations in conjunction with forest fires protection crews. As the fire expands, additional Mobile Forest Patrols are dispatched to reinforce initial attack crews.

Schematically, the intervention in forest fires firefighting is as follows:

- First Response/initial attack by Mobile Forest Patrols (MFP);
- Intervention of Civil Protection with heavy equipment during extended attack;
- Intervention of agencies and other external resources if necessary, including additional MFPs.

Economic Dimension

As in much of the countries of the world the economic dimension of wild land fire management is not well addressed. Algeria is not the exception. Here budget information for a very small segment of the country's areas and estimates of the economic losses associated to wildfires, for the period 1985 to 2006 is provided.

Partial fire management information only for the Tizi Ouzou province for 2009 was obtained. This very limited information concerns the costs for 54 fire protection people, and it is about 9 million Algerian Dinars or about 90,000 Euros. Assuming that all 40 Algerian provinces invest at least the same amount in fire suppression personnel we can estimate a total presuppression expenditure of 3.6 million Euros for the country. However, we do not know if these assumptions are correct.

We also have limited information on the economic impact of wildfires in Algeria. Only Arfa and others (2009) have produced estimates of the economic impact of wildfires in the forestry sector in the country. They estimated that between 1985 and 2006 the forestry sector suffered losses equivalent to 1.11 billion Euros (113 billion Algerian Dinars). These losses include damages to commercial products like timber, cork, and cereals. However, no direct suppression expenditures or losses of homes are included in their estimates. This could be a significant under estimation, because for example, in 2007 alone destruction of 334 houses were directly associated to forest fires. Loss of life is another dimension of the potential impacts that are not considered when evaluating the socioeconomic impacts of fire. For example, before 2007 only 8 fatalities had been directly associated with wildfires, but in 2007 alone 8 civilian fatalities were recorded, and 1 firefighter fatality in 2008. Another significant, but not included, component of losses is the long-term loss of biodiversity and other ecosystem services, such as water production, carbon sequestration or recreation benefits from Algerian forests. However, this limited estimation provides a glimpse of the potential large economic impacts of wildfire.

Discussion and Recommendation

Forest fire prevention must take into account two fundamental factors: treatment of fuels and fire cause. Fuels treatment has to do with the reduction or compartmentalization of existing fuel load in the forest (dead and alive). Knowledge of the causes of fire could help determine the best approach to prevent future fire occurrences. The success depends as well on the integration of the population in some form of fire prevention. Doing this requires at least three types of actions: persuasion, conciliation and sanction (Velez 1999). As discussed by Vélez (1999), *persuasion* intends to modify people's behavior via education and information, by making publics aware of the situational danger. The fire management program devotes a serious effort to this action by engaging the publics in the series of

prevention activities described in the prevention section above. *Conciliation* tries to harmonize communities and agencies interests through forest policy and legislation to remove conflicts, which may lead to fires. The laws and regulations in place in the country, as well as the specific programs engaging the public in prevention and protection activities surrounding their communities shows the agency commitment to conciliation (see, section on reinforcement of forest surveillance above). *Sanctions* are used as a last resort, to punish both negligent and deliberate offenders. Algeria laws provide for punishment of offenders and violators of forest fire codes and regulations.

As shown in Figure 2 and Table 1, the number of fires has significantly increased in the last two decades. In contrast, area burnt has shown some stabilization. At the same time, there has been a significant increase in the availability and allocation of firefighting resources for surveillance and suppression actions. However, Vélez (1999, p 93) warn us that although "*the problem of forest fires can be seen in the context of simple cyclical measures, or merely improving techniques used to combat them, but it requires a set of policies affecting their causes*". That is, not only do we need to have better equipment and trained personnel for fire suppression, but we must also attack the root causes of human-caused fire. Understanding of the fundamental causes of anthropogenic fire would lead to better prevention programs to help in the reduction of wildfire occurrence.

A comprehensive analysis of current fire management policies could help us in identifying potential limitations that can reduce their effectiveness in addressing the present wildfire problem in Algeria.

Based on our work, we list below a series of difficulties affecting fire management programs (prevention and suppression) in Algeria and propose recommendations for their resolution.

In terms of prevention

Difficulties	Recommendations
Lack of computerized databases on forest fires.	Create national and standardized fires database within Mediterranean countries.
Increased number of fires as a consequence of the general lack of prevention.	Development of a coordinated prevention policy across all jurisdictions to reduce forest fires. Integration of population programs in forestry.
Insufficient awareness of residents about the risk of forest fires.	Increase awareness campaigns among local residents based on mass communication.
Increase in fires following the careless burning of stubble and weeds by farmers and ranchers.	Authorization of prescribed fire in Algeria by an appropriate regulatory authority.
Inadequate monitoring of preventive and dissuasive actions in wooded areas because of lack of personnel and	Recruitment of forest protection personnel, increase mobile surveillance in areas at highest risk, with a minimum density of 5000 ha per

equipment.	supervisor.
Lack of specific weather stations in forest areas to identify factors influencing fire in real time.	Installation of an automatic weather stations network in forest areas by the National Meteorology Service to facilitate calculation of fire risk indices and help firefighting actions.

In terms of fire suppression

Difficulties	Recommendations
Inadequacy of the first intervention or initial attack.	Increase amount of available initial attack resources and reduce response and intervention times.
Lack of personnel in relation to the country's forest territory; problem of simultaneity of fires and the inaccessibility of some forest.	Increase staffing and budget levels of the Directorate General of Forests to offset the additional operational deficits in agencies with fire suppression responsibilities.
Lack of aerial resources.	Staffing Civil Protection airlift for ferrying personnel and firefighting in rugged terrain.

In terms of restoring forest burned areas

Difficulties	Recommendations
Absence of silvicultural operation over large areas with large accumulation of fine fuels.	Conduct silvicultural operations to remove accumulation of fine fuels (removal of dead wood, suppression of shrub layer, cleaning, etc.).
Repeated fires in some province (coastal province).	Research leading to actions targeted to specific high risk areas for reconsideration of forest policy.

Conclusion

Algeria has ~~a~~ serious wildfire problem. The effort devoted to dealing with it is significant in terms of personnel, material, and financial resources. However, results of the last few years not only on number of fires and area burnt, but in loss of life and property clearly indicate that there is need for improvement, especially in regard to the knowledge and organization of the whole fire management program effort.

The lack of an institutionalized program of investigations of fire causes is a contributing factor in reducing the potential effectiveness of prevention programs. Improving the collection of fire statistics and maintenance of fire databases would provide basic information to fire managers to help guide their decision making process. Limited budgets results in underfunded fire management programs. Increases in fire prevention and presuppression programs at the national and provincial levels would help improve the response capability of the Fire Service. A closer working relationship between the Forest Service and other national agencies

and the Fire Service is necessary to reduce potential duplicity of responsibilities and maximize program efficiencies. A continuous reevaluation and updating of their fire management program planning process would help the Fire Service to account for technological improvements in equipment and personnel to maximize the effectiveness of its forces.

Implementation of these minimum actions would further the effectiveness of the Fire Service in responding to the present and near future wildfire problems in Algeria.

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