

Analysis of forest fires causes and their motivations in northern Algeria: the Delphi method

Ouahiba Meddour-Sahar⁽¹⁾, Rachid Meddour⁽¹⁾, Vittorio Leone⁽²⁾, Raffaella Lovreglio⁽³⁾, Arezki Derridj⁽¹⁾

Forest fires in Algeria are mostly human-caused and result from local social behavior, whether voluntary (arson) or involuntary (negligence). Understanding the reasons why fires start is, therefore, a crucial factor in preventing or reducing their incidence, developing significant prevention efforts and designing specific fire prevention campaigns. The Delphi method is a promising tool for improving knowledge about how fire starts and why, and above all helps reduce the number of fires started by unknown causes, the majority type in Algeria. The Delphi method uses a set of procedures for eliciting and refining the opinions of a panel of experts on a particular subject of interest. This method was used in three case studies, in coastal or inner *wilayas* (provinces) selected from a highly fire-prone area in north-central Algeria. Results showed the traditional use of fire in agriculture and forestry, in situations related to land use changes and in interpersonal conflicts are the major causes of voluntary fires. For involuntary events (negligence), experts unanimously identified the importance of the restart of fire, caused by fire crews who do not ensure the mopping up of controlled fires (91.49%) and the negligent use of agricultural fires, particularly stubble burning (80.14%). For voluntary fires (arson), results highlight the importance of fires set for land use changes (77.30%), pyromania (67.38%) and honey gathering (62.41%). Illegal dumping and burning of garbage was also mentioned by responders in all study-areas.

Keywords: Agricultural Fires, Algeria, Delphi Method, Fire Motivations, Fire Causes, Panel of Fire Experts, *Wilaya*

Introduction

Fire is the main cause of forest destruction in the countries of the Mediterranean Basin. About 50 000 fires sweep through 700 000 to 1 million hectares of Mediterranean forests, wooded lands and other land types each year, causing large economical and ecological damage, as well as loss of human life (Vélez 1999, Dimitrakopoulos & Mitsopoulos 2006). The Mediterranean basin is marked by a prevalence of human-induced fires, *i.e.*, about 95 % (FAO 2007).

The southern rim of the Mediterranean

Basin is characterized by fewer forest fires than the northern one, but its forests are under the growing threat of climatic changes and vigorously increasing human pressure, particularly near the coastal areas where populations concentrate, thus increasing the demand for fuel, meat, food and new lands for urban growth. This translates into higher pressure on degraded wooded lands, coupled with unsustainable overexploitation for fuel wood and overgrazing (FAO 2012) and increased wildfire risk. Fire adds its effects as a factor of degradation and desertification in

those countries, already historically characterized by a progressive loss of forest coverage.

Tab. 1 reports the forest fire situation in Algeria compared to southern Europe countries. The wildfire situation in Algeria results similar to or even worse than Greece's, which has a much more significant forested surface (6 500 000 ha of Greece's surface is wooded, of which 25.4% is occupied by regular forests).

Fires causes in Algeria (1985-2010)

Algeria has a long history of forest fires. National fire statistics cover about 160 years, dating back to 1853. Statistics show a severe depletion of forest resources: for example, from 1876-1962 (87 years), fires have affected 3 506 942 hectares (Meddour-Sahar et al. 2008b). Furthermore, over the period 1853-2001 (148 years), 5 049 777 hectares were affected; a value close to the forested area of the country in the XIX century, about 5 million hectares in 1830, before French colonization (Megreouche 2006). Marc (1916) observes that catastrophic wildfire seasons (more than 140 000 hectares per year) have a decadal frequency; he hypothesizes a relationship between after-fire vegetation re-growth and burning by shepherds to reopen it to herds. Between 1853-2001 the average decadal area burned was 38 500 ha. Only two exceptions occurred: the 1912-1921 decade when average was 64 746 ha, and the even higher 1956-1961 decade when average was 66 042 ha. This latter period includes the Algerian war of independence (1956-1962). Data confirm the exacerbation of the fire phenomenon in periods of political turbulence and troubles (Marc 1916). During the Algerian war, many wildfires were actually voluntarily started as scorched earth policy, the military strategy of destroying anything useful to the enemy. Napalm bombing was also occasionally used by the French Air Army to force out revolutionary groups who sought shelter in the forests in an attempt to deprive them of food and cover (Cooper 2003). Bombing was directed at Algerian guerilla units and used to destroy large numbers of villages, causing tremendous demoralizing effects. Such fires destroyed more than 70% of forest in Bou Taleb (Hodna mountains) by the end of the 1950s (Madoui 2000, 2002), and 220 000 ha in the Aures forests (Sari 1976). Meddour-Sahar et al. (2008a) estimates that about 645 414 ha of forest burned during the independence war period. The use of fire as a weapon has continued in recent years (starting in 1992) in counter-terrorism operations. For example, the Algerian government was implicated in the 2008 forest fires in eastern Algeria (CBS News 2008, Bekdouche 2010). By virtue of its long fire statistic history, Boudy

□ (1) Department of Agricultural Sciences, University Mouloud Mammeri, Box 17 RP, 15000 Tizi Ouzou (Algeria); (2) Department of Crop Systems, Forestry and Environmental Sciences, University of Basilicata, v.le dell' Ateneo Lucano 10, I-85100 Potenza (Italy); (3) Department of Agriculture, University of Sassari, v. Cristoforo Colombo 1, I-08100 Nuoro (Italy)

@ Ouahiba Meddour-Sahar (o.sahar@hotmail.fr)

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Tab. 1 - Forest fires in Southern Europe and Algeria (1985-2010). Source: European Commission (2010).

Country	Burnt surface per yr (ha)	Number of fires per yr
Algeria	35 025	1 637
France	21 323	3 771
Greece	32 856	1 308
Italy	77 262	7 867
Portugal	101 166	16 578
Spain	132 305	13 740

(1952) identifies Algeria as the country where the first research on fire causes was developed. According to the National Forest Inventory of 2003 (FAO 2010), the current situation of forest and other wooded land (OWL) in Algeria is dramatic. Forest and OWL cover a total of 4 177 000 hectares (1 492 000 and 2 685 000 respectively). This represents only 1.76 % of the country's total surface area (238 174 000 ha); whereas range area is 33 970 000 ha and desert, unproductive areas account for more than 80 % (about 190 million ha are occupied by the Sahara region - Nedjraoui 2003). Only the northern, mountainous part of the country has a rather significant forestry coverage (about 16.4 %). Climatic conditions are a significant contributory factor to the forest fire situation in Algeria. Prolonged summers (June to October) with nearly no rain and average daytime temperatures well above 30° C with daily peaks as high as 50° C like in Salah (2005), reduce the moisture content of forest litter to less than 5%. Under these conditions, even a small addition of heat (lightning, a spark, a match, a cigarette butt) can be enough to start a violent conflagration. However, fires are rarely ignited by natural causes. For example, in Algeria, not a single fire has ever been reported as caused by lightning, the only possible natural fire cause. Human activities, either directly or indirectly, are exclusively the causes of wildfires. Our knowledge of fire is rather satisfactory regarding how, when and where fire occurs, but we have scarce knowledge of its origin. We still do not know enough about who starts wildfires and why: on the subject we have mainly lists of credible (and sometimes obvious) motives for starting fires (Leone et al. 2003, Lovreglio et al. 2010). A feature of the phenomenon in Algeria is the relative predominance of causes classified as unknown. The statistical data for the 26-year period 1985 to 2010, for which we have almost complete information, show that unknown caused fires represent 79.79 % of all fires ("Unknown" fires are the fires for which no known cause could be determined and/or supposed - see Tab. 2).

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 secu-

rity 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 under 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. A useful tool for improving the knowledge of causes and fire motivations is the Delphi method. This paper reports the findings of the implementation of Delphi sessions in the northern part of the country, demonstrating how it can help to produce enough precise and reliable statistics to help identify unreported fire causes.

Materials and methods

The Delphi method

The Delphi method was originally developed in the 1950s for a US sponsored military project (Dalkey & Helmer 1963, Linstone & Turoff 2002). The method is based on the perception and informed judgment of experts, *i.e.*, on the principle that "a group of experts usually performs better than any one expert because the group possesses at least as much knowledge as its most knowledgeable member" (Henderson 2008). This statement rationally explains the saying "*two heads are better than one or...n heads are better than one*" used by Dalkey (1972), one of the developers of Delphi method. Another attempt of transforming the saying in a more scientific statement is *Group versus individual performance: are N+1 heads better than one* (Hill 1982).

The Delphi method is an iterative process used to collect and distill the informed judgments of experts (Baughman 1989) using a series of questionnaires interspersed with feedback. The questionnaires are designed to

focus on problems, opportunities, solutions or forecasts. Rowe & Wright (1999) characterize the classical Delphi method by four key features:

- Anonymity of Delphi participants: allows participants to freely express their opinions without undue social pressures to conform to others in the group. Decisions are evaluated on their merit, rather than on who has proposed the idea.
- Iteration: allows participants to refine their views in light of the progress of the group's work from round to round.
- Controlled feedback: informs participants of the other participant's perspectives and provides the opportunity for Delphi participants to clarify or change their views.
- Statistical aggregation of group response: allows for a quantitative analysis and interpretation of data.

The Delphi method has four distinct phases (Henderson 2008):

- Phase 1 explores the issue under discussion, with each individual contributing pertinent information and opinions;
- Phase 2 involves obtaining feedback on the issue and reaching an understanding of how the group views it - where the panel members agree or disagree;
- Phase 3 deals with disagreements and the underlying reasons for differences;
- Phase 4 the information is analyzed and there is a convergence of opinion.

In the field of forest fires, the Delphi method has been used to explore the current state of wild land fire communication (Clute 2000), in surveys of arson fires (ICONA 1995, APAS 2003, Dolz Reuss 2005), and in wildfire cause analysis in Italy (Leone & Lovreglio 2003, De Las Heras et al. 2007, Lovreglio et al. 2006, 2008, 2010). The Italian State Forestry Service has recently carried out surveys in the most fire-prone provinces utilizing the Delphi method with rather satisfactory results (Lovreglio et al. 2012).

Study area

The study area consists of three north-central Algeria *wilayas* (provinces) with more or less severe fire events: Tizi Ouzou, Bouira, and Boumerdes (Fig. 1).

At the national level, Tizi Ouzou is among the three most affected *wilayas*, together with Skikda and Bejaia (Meddour-Sahar 2008). The *wilayas* areas vary in size from

Tab. 2 - Forest fire causes through time in Algeria (in %). (n/a): not available.

Causes/Reference	1866-1915 Marc (1916)	1886-1945 Boudy (1952)	1979-1982 Rebai (1982)
Natural	n/a	n/a	n/a
Accidental	8	n/a	n/a
Negligence	32	50	27
Voluntary	23	20	16
Unknown	37	30	57

about 150 000 to 450 000 ha and are described by the geographic indicators in Tab. 3.

All study areas are mountainous territories with a typical Mediterranean climate pattern, where hot and dry summers are a predisposing fire factor. The physical conditions are favorable to forest and/or agro-sylvo-pastoral suitability in a balanced framework. Forest types range from the wide forested complexes of Aleppo pine high forest of Bouira to the small surfaces of decimated forests of Boumerdes, represented mainly by Mediterranean maquis and some Aleppo pine forests, to some wide cork oak high forests in Tizi Ouzou. In many cases, degradation of such areas reflects a population accustomed to using forest as a “free-for-all”, with little concern for forest preservation (Thirgood 1981). Most fires occur during the summer months (39.63 % in August, 28.31 % in July, 20.31% in September, 7.61 % in October and 4.14 % in June). In the study areas, 8 124 fires burned 118 965 ha of forest land during the period 1985-2010. This represents 325 fires per 4 758 ha annually, with an average area burned of 15 ha per fire (Fig. 2).

Experts’ panel

The selection of Delphi participants directly influences the quality of the final results. Participants (or experts) in a Delphi study must have the background and experience concerning the target issue, be capable of helpful inputs, and be ready to revise their judgments (Hsu & Sandford 2007). In addition, they must correctly and seriously give their contribution. The following four requirements for “expertise” are key features of participants involved in Delphi studies (Adler & Ziglio 1996):

- knowledge and experience with the issues under investigation;
- capacity and willingness to participate;
- time to participate;
- communication skills.

The experts involved in our forest fires Delphi survey are the non commissioned forest fire officers of the State Forestry Service working for the country General Directorate of Forests (DGF), an agency of the Ministry of Agriculture and Rural Development. These professionals are trained and competent within the specialized area of knowledge under investigation. They are actually involved in compiling yearly forest fire statistics, which have been produced since the mid 1980s (Law 84 of 23/06/1984). Based on those statistics, funds for forest fire fighting are allocated to the most affected wilayas, and specific budgets are made available for defense infrastructures construction and maintenance (fire-breaks, water points, look-out towers etc.). The number of experts for each study area is given in Tab. 4.



Fig. 1 - Map of the studied areas.

Tab. 3 - The most relevant indicators for the study areas. (*): Only 10 municipalities on the South exhibit desertification risk.

Indicator/Wilaya	Bouira	Boumerdes	Tizi Ouzou
Position	Inner area	Coastal area	Coastal area
Surface (ha)	446 745	145 616	295 793
Forested area (ha)	94 049	26 614	65 680
Forest (ha)	74 608 (79.3 %)	4 144 (15.57 %)	48 635 (76 %)
Mediterranean maquis (ha)	18 042 (19.2 %)	21 659 (81.38 %)	13 957 (22 %)
Plantations (ha)	1 399 (1.5 %)	811 (3.05 %)	1 501 (2 %)
Forestry ratio	12 %	18%	22 %
Forest fires (average nr per year 1985-2010)	97	70	145
Burned surface (average ha per year)	991	629	2 956
Burned surface in % of forested area (1985-2010)	1.5	2.36	4.5
Sheep number	235 000	60 430	164 695
Goats number	26 000	7 554	51 789
Cows number (Bovins)	67 500	29 555	90 908
Total livestock	328 500	97 539	307 392
Livestock per km ²	74	72	86
Nr. of <i>baladiyah</i> (municipalities)	45	32	67
Population	728 290	801 068	1 133 349
Urban population	236 501	458 745	490 610
Rural population	491 789	342 323	643 188
Population density (people per km ²)	163.02	551.36	381.22
Land-use	Agriculture, forestry, pastoralism	Agriculture, forestry	Forestry, pastoralism
Relief	Rugged and rough territory	Coastal plane 60%, mountain 40%	Mountain 70%, coastal plane 30%
Erosion risk	Medium stability	Medium stability	Medium stability
Desertification risk	partial *	absent	absent

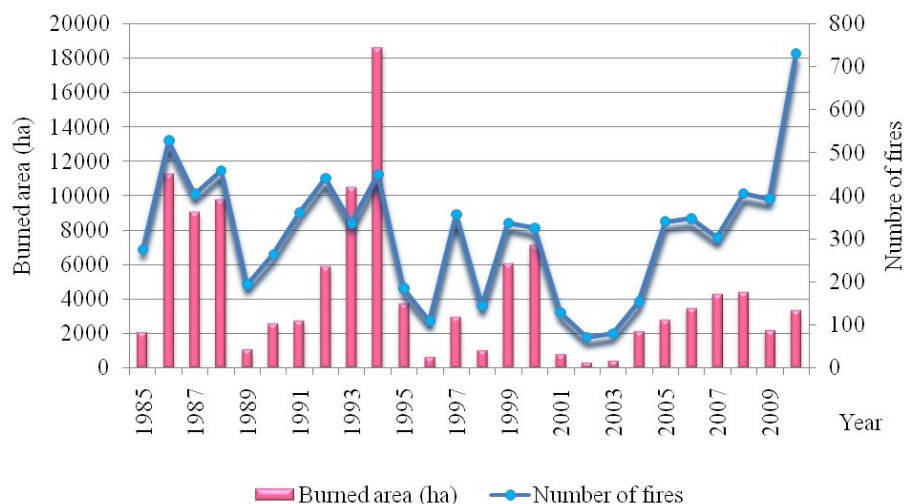


Fig. 2 - Number of fires and burned area in north-central Algeria (1985-2010).

The three panels of experts included a total of 141 respondents. The number of experts is well balanced among areas and, in addition, their number is well above the minimum of at least 10 (Delbecq et al. 1975). The use of the questionnaire allows for anonymous responses, giving group members the freedom to express their opinions without feeling pressured by the wider group or dominant members. Actually, one of the main problems with people of the strongly hierarchical, military-like organization State Forestry Service, is avoiding negative group dynamics that may emerge; mainly superiority of rank, but also domination by key individuals, prestige of certain participants, and timidity of others. Anonymity partly reduces this problem.

Structured questioning

Structured questioning was achieved through the use of *ad hoc* questionnaires. Following our literature searches on the topic, we identified 29 causes of forest fires for Algeria, divided into three main categories: accidental, negligent, and deliberate (Appendix 1). The causes used for the Delphi sessions

are more or less the same identified by Marc (1916), by Boudy (1952), and specifically for Algeria, in the International Fires Survey (IIA 1933). The only new cause identified is garbage dumping and burning. The persistence of fire causes through time confirms that fires are site and culture specific (Leone et al. 2003). Panel members were contacted *via* mail the first time, receiving the form reporting the list of causes. However, because a problem of non-mail response we successively established a face-to-face contact procedure. Though mail contact is still an accepted form of Delphi session (Skulmoski et al. 2007), it is now less frequently used because the availability of electronic communications. In round one, participants were asked to preliminarily rate each of the 29 causes on a 1 to 5 scale, with 1 being “strongly disagree” and 5 being “strongly agree” (Likert 1932). In round 2, based on their perception and experience, experts were asked to identify the eight most relevant fire causes in their area of activity. These were selected from those in round 1 reaching a value of 5 on the Likert scale at least 60% of the time. We then asked them to rank the eight selec-

ted causes in decreasing order of importance from 1 (most important) to 8 (least important).

Results and discussion

Frequency

As a first interesting result, the frequency of illegal garbage dumping and burning, and the problem of fire restarts are very important in our study areas. Experts mention them as the most important causes 88% and 85% of the time, respectively (Tab. 4).

Garbage burning is related to the high population density of the study areas and is, in general, a cause of general concern for Algeria (Meddour-Sahar & Derridj 2010). Among causes in the voluntary category, the most frequently identified is related to interest in land use changes (77.3 %), followed by causes referring to pasture renewal (67.38 %), wild honey gathering (62.41 %) and pyromaniacs (67.38 % - see Tab. 4, Tab. 5, and Fig. 3). Another interesting finding is that the majority of expert responses converge towards a rather limited number of causes (Fig. 3). More than 60% of experts

Tab. 4 - Study areas and fire causes in order of decreasing frequency. (N): number of experts.

Bouira (N = 41) Main motives	Frequency (%)	Boumerdes (N = 47) Main motives	Frequency (%)	Tizi Ouzou (N = 53) Main motives	Frequency (%)
Restart of fire	97.55	Agricultural works (burning of cut bush, stubble burning)	95.74	Illegal garbage dumping and burning	90.56
Cigarette remains	95.11	Restart of fire	93.62	Restart of fire	84.9
Illegal garbage dumping and burning	92.67	Forest works (burning of cut bush)	82.98	Agricultural works (burning of cut bush, stubble burning)	75.58
Interest in land use changes	92.67	Illegal garbage dumping and burning	80.84	Cigarette remains	75.46
Agricultural works (burning of cut bush, stubble burning)	92.67	Interest in land use changes	80.84	Forest works (burning of cut bush)	73.58
Pasture renewal	87.88	Pasture renewal	78.71	Pyromania	67.38
Wild honey gathering	87.79	Cigarette remains	72.34	Interest in land use changes	62.37
Conflicts related to wildland ownership	82.92	Cigarette remains	72.34	Cigarette remains	62.25

Tab. 5 - Rank-ordering (1 to 8) of most frequent fire causes in study areas.

Rank-Order	Bouira	Boumerdes	Tizi Ouzou
1	Agricultural works (burning of cut bush, stubble burning)	Agricultural works (burning of cut bush, stubble burning)	Agricultural works (burning of cut bush, stubble burning)
2	Cigarette remains	Restart of fire	Illegal garbage dumping and burning
3	Illegal garbage dumping and burning	Forest works (burning of cut bush)	Interests in land use changes
4	Pastoralism	Illegal garbage dumping and burning	Cigarette remains
5	Interests in land use changes	Cigarette remains	Restart of fire
6	Wild honey gathering	Interests in land use changes	Forest works (burning of cut bush)
7	Restart of fire	Pastoralism	Pyromania
8	Conflicts related to wild land ownership	Wild honey gathering	Conflicts related to forest policy

actually refer to involuntary causes, namely negligent restart of fire, agricultural use of fire, fires caused by smoking activities or accoutrements, including matches (vehicles, walkers). The most frequent causes (frequency > 80 %) are related to the restart of fire followed by illegal garbage dumping and burning, and agricultural works (burning of cut bush). As can be seen in Tab. 4 and Tab. 5, the voluntary and involuntary categories (40% and 50% respectively) of fire causes are responsible for 90% of all fire starts in the country. This result is well coherent with the general opinion of experts, who claim an excess of emphasis attributed to voluntary fires (Vélez 2000).

Rank ordering

Within the category of causes of voluntary fires, defined as “the inner drive, reason or incentive that induces or prompts a specific behavior” (Rider 1980, O’Connor & Red-sicker 1996), there are interesting results when looking at ranked causes (Tab. 5). For example, the panel of experts attribute the

majority of fire ignitions to cultural (traditional) causes (agricultural works: burning of cut bush, stubble burning, pastoralism), followed by revenge (fires set for political reasons, conflicts with Public Administrations), personal interests (e.g., in land use changes) or social and/or interpersonal tensions (conflicts related to wild land ownership or forest policy - Leone et al. 2002). Their answers are rather homogeneous and convergent (a few causes account for 54% of all fire starts), despite the obvious difference of study areas (Tab. 5).

The experts considered only 11 out of 29 possible causes initially presented to them. The remaining 18 causes appear rather scattered, with few cases for each; results confirm the absolute unimportance of natural fires in the Algeria wildfires problem. One possible explanation for the importance of the traditional agricultural use of fire as a source of wildfires is that farmers use it not only to eliminate crop stubble, but more importantly to push back the forest to make room for agricultural expansion. Thus, fires

started in cultivated fields easily spread to nearby forests (Dimitrakopoulos 1995). In spite of the obvious risks, farmers often set fire to agricultural residues even when large out-of-control fires are burning in the same area (Vélez 1999). In the Tizi Ouzou wilaya, the second highest cause reported by experts is illegal garbage dumping and burning. The north-central part of the country is densely populated (on average 356 inhabitants per km²) and is characterized by the proliferation of illegal, uncontrolled dumps along roadsides. Consequently, the burning of waste at legal or illegal garbage dumping sites has increased at an alarming rate in recent years. In Tizi-Ouzou, the presence of more than 30 illegal garbage dumping sites, mainly along roads, has been reported (Meddour-Sahar & Derridj 2010). This cause is ranked third and fourth, respectively, for the Boumerdes and Bouira wilayas. Many garbage dumping sites are located in nearby forest areas. Organic wastes generate methane, which is extremely flammable and can contribute to fire ignition and to the spread of forest fires (Dimitrakopoulos 1995). In these cases, the use of fire to reduce the accumulation of garbage must be interpreted as a tough but inevitable “problem solving” solution by inhabitants, who have no other more sustainable alternative for waste disposal and are, therefore, obliged to eliminate their solid waste accumulation by fire or by directly throwing it in ravines or rivers, which can cause more serious health problems. In the Boumerdes wilaya, the second highest cause of fire ignitions is the restart of fires, caused by firefighters’ incomplete mop-up of controlled fires, leaving hot areas to reignite. A possible explanation for their apparently negligent behavior is the conditions of insecurity in the region, where terroristic groups are known to be rather active. Another possibility could be, as in Tizi Ouzou wilaya, the high number of fires that fire crews must respond to. They are over-extended, and therefore have no possibility or enough time for mopping-up any fire after it has been controlled. In Algeria, forest fire-fighting crews are seasonally paid and are made up of about twenty people from local communities and a foreman. All crews fall under the responsibility of a fire officer on duty in DGF. In general, these crews are not properly equipped. This can also be a contributing factor to the problem of lack of mop-up in controlled fires (Meddour-Sahar & Derridj 2012). Foresters are the first to intervene after a fire alarm; Firemen and Civil Protection officers can also intervene, the latter much better equipped. Negligent disposal of cigarettes (throwing of butts or matches from vehicles and/or by walkers) is a rather transversal cause of fire starts and is the second highest cause in the Bouira province. This negligent, careless behavior of individuals is very frequent and generates

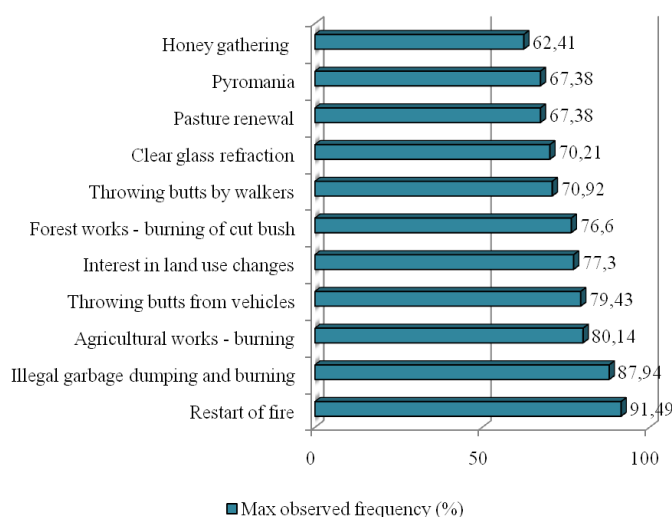


Fig. 3 - Increasing frequency of most relevant motives (all areas included).

fire outbreaks, especially along the tourist routes in Algeria. This cause could be in some way reduced by regular campaigns, aimed to increase awareness of the problem by rural and urban population. Forest fire as a means to change land use patterns in Algeria is aggravated by the absence of a national Cadastre (maps showing a land ownership and use), the high percentage of public land which is more prone to invasions, the lack of regional planning, the lack of severe punishment to arsonists, and most likely also fostered by increasing demand of space to build. In the study area, an important source of forest fires is the traditional and deliberate burning of forest lands by the rural population for improving ranges for grazing animals. When this coincides with high climatic risks, forest fires are practically unavoidable (Vélez 1999). Range burning is a very traditional practice all over the Mediterranean basin, and most recently in Algeria is related to the high number of sheep in the country as a whole: 77% of more than 25 million live-stock (FAO 2012). The tendency to increase range areas at the expense of degraded forest coverage is a real problem; the same is observed in other Mediterranean countries (e.g., island of Sardinia, Italy). Shepherds do not refrain from the use of fire to reach their goals, even if this means risking forests, which are overgrazed and degraded. Other concerns also contribute to this problem. For example, in Sardinia, the European Union (EU) subsidy allocation provides an incentive to increase the number of animals, without considering the biological capacity of the grazing areas used (Bassi & Kettunen 2007) or the potential of aggravating the wildland fire problem. The Tizi Ouzou *wilaya* is the only study area in which the cause over conflicts related to forest policy is observed; though present at a low level, it has local importance. This could be interpreted as a reaction to reforestation projects carried out at the expense of traditional, extensive grazing lands, especially when considering the lack of negotiation with the local population at the beginning of the project. This kind of behavior was previously reported in the 1970s when local populations protested against wide national programs of reforestation known as the “Green Belt”, which were considered an obstruction to pastoral activities and a destruction to natural “alpha” pastures (Vallejo 2005). Local reactions were appeased when the program was revised and reshaped, providing employment to people during its implementation. Similarly, from the 1860s until as late as 1956, *Imazighen* (the historical indigenous inhabitants of Maghreb area, “Berber” is a more common label for the group) and Arab residents of Algeria utilized incendiarism to protest colonial expropriation of communal lands, setting fire to state-controlled forestland, which

was a major resource for the colonial cork industry (Lauermaann 2009). Gathering honey from wild bee colonies (honey hunting) is usually done by disorientating and subduing the bees with smoke, obtained from dry cow dung slowly burning at the base of trees (Delacre & Tarrier 2000). Honey gathering may be considered part of the lives of the world’s last remaining hunter/gatherers, often on the outskirts of the farming world (Bradbear 2009). Such use of fire can produce an uncontrolled propagation and consequent wildfires. Special reference must be made to pyromaniacs (frequency 67.38%), which received a relatively high frequency, but ranked low in terms of importance in only one of the study areas. The term “pyromaniac” is commonly misused everywhere as a synonym of arsonist, not only in Algeria, but also in other countries (APAS 2003, Dolz Reuss 2005, Lovreglio et al. 2010). No work has been done in the country about the social conditions or any particular event that trigger pyromaniac activities affecting the incidence of pyromaniac-caused fire starts.

Conclusions and final remarks

We must preface this section by stating that the results of the study represent only the collective, informed opinion of the experts participating in the Delphi Panel, but that, at this time, there is no alternative mean to produce better information. Forest fire in itself is not a problem, but an intrinsic factor of ecosystem disturbances when it develops within its natural regime. However, it is also a cultural tool used in all traditional rural societies for multiple purposes, including land management. Its improper use is the most conditioning factor for Mediterranean forest management and a symptom of serious social and territorial problems of the forest system in many cases. Considering that human action is the main cause of fires in Algeria, knowing the causes of fires is a crucial factor in designing policies and programs for wild-fire prevention. Prevention requires a shift in the approach to fire fighting from fire suppression, based mainly on investments for emergency measures, to a long-term policy of removing the structural causes of fire starts (Biro 2009). The high percentage of fires reported under unknown causes in Algeria (79.97%), is a serious obstacle for the development of any policy/program aimed at reducing the number of fire events by targeting specific social groups, activities or behaviors. In this study we applied a Delphi method in three sites of northern-central Algeria to identify the most relevant fire causes. Study results confirm that the causes of forest fires in the northern-central region of the country are substantially invariable through time, because they are mainly related to local culture and traditions (Lovreglio et al. 2010). From the study findings we

can confidently conclude that the majority of fire occurrences in the northern-central region is principally due to unsuitable and negligent use of fire in agriculture, conflictive behaviors, and/or social tensions. Additionally, in all three study sites illegal garbage dumping and burning is considered a frequent and important cause of fires. In synthesis, the Delphi method results depict fire setting in the context of a very traditional, rural society characterized by a poor “problem solving” ability similar to other cases observed by the authors in Italy (Lovreglio et al. 2010). Typically, interpersonal problem solving ability is significantly related to the socio-cultural level of the subjects. From our results, fire represents a preferential solution that resolves problems such as grass renewal, land for cultivation or space for urban growth etc. immediately, but are deemed inadequate by modern cultural and social standards. Ranking the causes of fire starts in order of importance and relevance in Algeria permits us to establish priorities when designing policies or programs of actions to address them. For each of the causes, a series of prevention measures can be imagined, discussed and verified.

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Supplementary Material

Appendix 1 - List of forest fire causes identified for Algeria, divided into three main categories: accidental, negligent, and deliberate.

Link: [Meddour_Sahar_098@suppl001.pdf](http://www.sisef.it/forest/Meddour_Sahar_098@suppl001.pdf)