

Fire and People in Three Rural Communities in Kabylia (Algeria): Results of a Survey

Ouahiba Meddour-Sahar¹, Raffaella Lovreglio², Rachid Meddour¹, Vittorio Leone³,
Arezki Derridj¹

¹Facultés Sciences Agronomiques et Biologiques, Department of Sciences Agronomiques B.P., Université
Mouloud Mammeri de Tizi-Ouzou, Tizi-Ouzou, Algeria

²Department of Agriculture, University of Sassari, Sassari, Italy

³Department of Crop Systems, Forestry and Environmental Sciences, University of Basilicata, Potenza, Italy
Email: o.sahar@yahoo.fr

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This research was conducted to investigate about the causes of wildfires in three municipalities of the Tizi Ouzou and Bouira provinces, in Kabylia. Unknown forest fire causes account for 80% of total in Algeria, with a peak of about 99% in Kabylia, the most forested region in the country but also the most severely affected by wildfires. The three study areas exhibit a rather high forestry ratio (40% on average) but also a very high population density, up to 300 people per km², living in a multitude of small hamlets, near or inside the domanian forests and exerting an enormous pressure on them. Survey was carried out on people (N = 300) randomly selected in nine hamlets (*thaddarth*) through ad hoc questionnaires (134 possible replies) filled with face-to-face interviews. Factorial Correspondence Analysis was used to process data (300 × 134 replies in total). Fires result mainly voluntary (52.95%): pastoral fires to renew pastures (11.30%), political fires as security counter-terrorism measure (11.24%), uncontrolled garbage burning (6.83%). Negligent fires account for 41.79%: carelessly tossed cigarette butts (9.13%), agricultural works (burning of cut bush, stubble burning, 7.03%), restart of fire (6.83%) and forest activities in the forest (6.31%). Results depict a common core of fires due to the pressure on the domanian forests, on which traditional use of fire (pastoralism) and national security needs (counter-terrorism) dominate.

Keywords: Fire Motivations; Folk Crime; FCA; Kabylia; Pastoralism; Political Fire

Introduction

In the Mediterranean region more than 50,000 fires burn an estimated 600,000 - 800,000 hectares annually, about 1.5% of total Mediterranean woodlands (Rowell & Moore, 2000; WWF-IUCN, 2007; Cemagref, 2009). Fires are particularly abundant in the northern rim of the Mediterranean, where France, Greece, Italy, Portugal and Spain contribute with a yearly average of 49,838 fires and 471,644 burned hectares (1980-2010) (JRC, 2010).

In the southern rim fires are less abundant in terms of numbers and burned surfaces, certainly due to different socio-economic conditions (Velez, 1991), where the forest is a resource, for food, for fuel wood but mainly for grazing. Wildfires rarely naturally occur in the Mediterranean region where the only relevant natural cause of forest fires is lightning. Wildfires caused by lightning have a local character and are highly dependent on mesoscale atmospheric conditions (Petersen & Rutledge, 1998; Garcia-Ortega et al., 2011). Apart from those possible, but minimally important causes, fires reveal a strong impact of human actions.

Mediterranean region accounts the larger proportion of human caused fires in the world (95%) followed by South Asia (90%), South America (85%) and Northeast Asia (80%) (Leone et al., 2009).

Forest fire statistics are usually compiled by processing individual wild land fire reports collected after each event by the

national Forest Services, Fire Departments or other similar governmental Agencies. Assessment of cause merely reflects the opinion of the reporting officer filling the fire report; secure determinations are therefore possible only when culprits are brought to justice (Leone et al., 2009). In the list of countries of southern Mediterranean rim affected by wildfires Algeria is the first best, with more than 1300 fires per year and 39,000 hectares burned (respectively 2.34% and 6.5% of the values for the whole Mediterranean; Meddour-Sahar, 2008). Algeria has one of the longest history of fire recording, together with Cyprus (Harris, 2007), since both coming from colonial experiences.

Changes in fire occurrence are evident throughout history of colonization, confiscation of communal land and the application of modern agricultural techniques that increased the amount of arable land (Davis, 2004; Bensaid et al., 2006; FAO, 2010).

The state-owned regime for forest and pasturelands and the settlement policies imposed by the colonial period, for instance, have brought extensive conflicts between pastoral groups and the public administration (Davis, op.cit). Rural incendarism as protest against curtailing traditional use of common lands marked the second half of XIX century (Kuhlken, 1999), when collective fines, set against communities that continued to practice fire-driven agriculture despite a ban from French colonial authorities, were met with non-compliance and an increase in malicious fire raising (Holmes, 2007).

During the long and merciless independence war (1954-1962) fire was widely used in the scorch earth strategy by the French Army; more recently during the decade of severe political troubles of the Algerian Civil War, marked by terroristic activity, fire was among counter-terrorism measures and some forests have been destroyed to avoid giving refuge to armed groups (Bainem forest by Algiers, for example; Dridi, 2002). “*The situation in this area of the Mediterranean basin is particularly alarming and should be a priority for attention of the international community*” (Bariteau in: Baskaran et al., 2001).

Causes of fire in Algeria are the result of high density of rural population (ranging from 40 to over 600 inhabitants per km² in the North Central region of the country), of growing demography, of rural exodus and countryside abandonment, of urban sprawl and increasing demand of building areas along the coast, of increasing production of home waste and of traditional forms of land use dominated by pastoralism.

In many cases the degradation of forested areas reflects a population accustomed to using forest as a free-for-all with scarce concern for forest preservation (Thirgood, 1981), and for this in strong contrast with Forestry Administration (Berchiche, n.d.). This adds to an adverse climate, with recurring droughts and long, increasingly hot summers with prolonged, severe heat waves, such as in 2012. This scenario is rather similar to other M.E.N.A. countries’ with similar climatic and productive features, where rural populations maintain excessively high pressure on wooded lands, overexploiting firewood and over-grazing (FAO, 2012).

In Mediterranean countries a large fraction of the total number of forest fires remains unexplained. Algeria holds the record of unknown causes with nearly 80%, followed by Tunisia, 65%, Morocco, 55% and Turkey, 48%. The high percentage of unknown causes as in Algeria, makes it difficult the implementation of a prevention policy targeted to specific social groups or activities or behaviours (Meddour-Sahar & Derridj, 2012). Fire causes in Algeria were object of researches in the past (Gravius, 1866; Thibault, 1866; Marc, 1916; IIA, 1933; Boudy, 1952), but more recent information about them is very scarce and dramatically reflects the extremely high incidence of unknown fires which, in some provinces in Kabylia, such as Tizi-Ouzou, is close to 99% (Meddour-Sahar & Derridj, 2010).

Methodology

In this paper we report the result of a survey on fire causes, carried out through interviews to people living in three fire prone areas in Kabylia (Algeria); they represent the powerless who usually have no voice and whose perspective or interpretation of the phenomenon could be different from foresters’. The 26 years time series analyzed (1985-2010), includes the “black decade” (1990-2000) of political instability which raged in the country.

Study Area

Survey was carried out in three different rural *baladiyah*¹ (Mizrana, Ain Zaouia, Haizer), in the *wilaya* (province) of Tizi Ouzou and Bouira in Kabylia (Figure 1), all of them marked by more or less severe fire history.

Kabylia communities live in the forest, which provides

¹*Baladiyah* is the equivalent of municipality.

them with multiple resources: foodstuffs from poaching and gathering, honey, mushrooms, fodder, firewood, timber, cork, etc. (FAO, 2012), but rural populations maintain excessively high pressure on wooded lands. Official data from the Algerian Forest Administration of the two provinces (Tizi Ouzou and Bouira) permit to measure this high pressure: from 1999 to 2009, a total of 347 offenses were officially registered, even not always sanctioned to punish non compliant behavior.

Selected *baladiyah* are representative of different situations (littoral, North part of Djurdjura massif, South face of Djurdjura massif). Each *baladiyah* is formed by different *douar* or *thaddarth* (village) (21 to 28), sometimes at the edge of forested areas, in many cases inside the forest. The *douar* under study are mountain and forest hamlets, all of them in territories having a forestry ratio >40%, thus among the most forested ones in the region.

Forests are highly degraded by fires and by the anthropic activities (illegal cutting and constructions, overgrazing, overexploitation, pollarding for fodder etc.).

Each *baladiyah* covers a surface roughly ranging from 5000 to 9000 hectares and is synthesized, in terms of geographic indicators, in Tables 1 and 2.

Data and Methods

Survey was conducted in a traditional method (self-administered survey; Leones, 1998) by distributing the purposely prepared questionnaires. Surveyor filled every questionnaire with a face-to-face interview, directly contacting each one of the household components. The questionnaire used simple, familiar, and unambiguous words. It is a closed-ended or fixed-item type; questions are multiple-choice with unordered response choices. The questionnaire includes 37 questions allowing 134 responses and is structured in four sections:

- Demographic information (status, gender, residence and level of education, labor condition);
- Agro-forestry activities (type of activities, type and size of husbandry, livestock feeding);
- Knowledge about fires (size, damages, causes);
- Anthropic pressure on the forest (forests’ condition, occupancy, garbage burning, needs for firewood, wood cutting, constructions, forest activities).



Figure 1. Map of the study areas in Kabylia, North Central Algeria.

Table 1
The most relevant socio-economic indicators for the study areas.

Indicator/Baladiyah	Mizrana	Ain Zaouia	Haizer
Position	Littoral	North part of Djurdjura massif	South part of Djurdjura massif
Geographic coordinates	36°20' to 36°30'N 4°05' to 4°07'E		36°20' to 36°30'N 3°55' to 4°10'E
Surface (ha)	5784	5677	8900
Number of villages	28	29	21
Population	9488	17,372	18,371
Population density per km ²	168	305	206
Forest land (ha)	3595	2577	4827
Forestry ratio in %	72	48	56
Agricultural land (ha)	959	2211	3628
Pasture and rangelands (ha)	270	200	30
Unproductive land (ha)	200	400	80
Total agricultural land (ha)	5024	5388	8565
Sheep number	3128	2834	1632
Goats number	2395	1562	146
Cows number	326	345	993
Total livestock	8783	4741	2771
Livestock per km ²	151.80	83.33	31.13
Land-use	Agro-sylvo-pastoral	Agro-sylvo-pastoral	Agro-sylvo-pastoral

Table 2.
The most relevant forestry indicators for the study areas.

Forest	Domanial forest of Mizrana	Domanial forest of Boumahni	Domanial forest of Haizer
Forest description	Open forest	Mediterranean scrubland	Open degraded and fragmented forest
Vegetation	Cork oak, Zeen oak	Cork oak, Wild olive, Aleppo pine	Aleppo pine, Holm oak, Cedrus atlantica
Climate	Pluviometry: 800 to 1200 mm/yr Subhumid	Pluviometry: 800 to 1000 mm/yr Subhumid	Pluviometry: 700 to 1000 mm/yr Subhumid
Middle mountain terrain (400 - 800 m)	76.31%	53.21%	62.95%
Class of dominant slope (>25%)	60%	69%	47%
Forest fires number (1985-2010)	182	78	208
Burned surface (1985-2010) ha	286	143	104
Burned surface in % of forested area (1985-2010)	3.06	2.13	0.83

Survey was carried out in March-May 2010 in three villages for each *baladiyah*, where we found the support of local authorities, including the transport on the field and presentation to the village chiefs (**Table 3**). Surveyor (O.M.S. and her team) was always accompanied by a local key-informant, usually a member of the village committee who helped the surveyor to get in touch with the relevant villagers and above all to establish a relationship of trust.

Table 3.
Number of sampled villages.

Wilaya (Province)	Baladiyah (Town)	Thaddarth (Village)	Total household	Sample household
Tizi Ouzou	Mizrana	Azroubar	151	43
		Ouatouba	106	30
		Tamazirt Ourabah	96	27
		Total baladiyah of Mizrana	353	100
		Adbagh	29	18
	Ain Zaouia	Ait Amar Moh	48	29
		Igharviyen	80	53
		Total baladiyah of Ain Zaouia	157	100
		Guentour	190	56
		El Mahsar	46	13
Bouira	Haizer	Slim	105	31
		Total baladiyah of Haizer	341	100
		Total	851	300

At first some difficulties in contacting households arose and made necessary the intervention of village leaders to explain that surveyors were not sent by the government to investigate about offences in the forest, but emphasizing that their interest was directed to protect forest against fires.

The target population for the survey consists of 100 individuals aged 15 and older of both sexes, for each *baladiyah*. The unit of observation is a household in the selected villages. Sampling plan and size for each village is reported in **Table 3**. At the household level, the sample of the interviewees was large enough in size in relation to the defined target population. The three *baladiyah* encompass a total of 78 villages; the choice of three villages for *baladiyah* (9 villages in total) therefore gave a sampling rate of 11.53%. Given the security constraints in the area (terrorism), the expected results and the specificities of the Kabylia village residents, a sample of nearly 300 individuals was decided, thus representing a sampling rate of 35.25 % (300 out of 851 households). Not having the availability of lists of inhabitants, a systematic sampling on the field was then applied in agreement with village leaders, by taking a household out of three for Mizrana and Haizer, and one out of two in Ain Zaouia. Sampling was very difficult in the absence of listing, and even on the field; contact also was difficult, since some families refused to participate in the investigation or were not at home. On the contrary, an open willingness came from University students, thus explaining the relatively high percentage of them among respondents (18.7%). A research whatever has never been carried out in those villages and their forests have no management plan.

Results

Data were processed using Sphinx plus V5 survey and statistics software (www.lesphinx-developpement.fr/).

Sample is mainly composed of male (81.7%), rather young individuals (65.7% under 39 years), mainly living in the forest (48.7%) or near it (19%). This is specific for Kabylia but not for Maghreb, since in Tunisia and Morocco the similar percentage is no more than 10% (Colin & Jappiot, 2001).

Labor status is strongly characterized by unemployment (51%), followed by employment in Government (16%) and work in agriculture (14%), be it self-employment or wage work; the number of retired (8%) and students (8%) is low. In general, all people, even in official status of unemployed or employed, work their land, as it is usual in rural societies. People under observation have a rather low education level (illiterate account for 25.3%; primary and college school level for 37%, secondary school for 19%, University level for 18.7%). The latter percentage, however, marks the interest for high levels of education also in small rural communities and, in addition, the relevant attractive power by University in the backcountry.

Main activities (more than 50%) are olive growing and husbandry, followed by growing fruit trees and vegetables. Bee-keeping is rather important (14.7%) based on a reduced number of beehives (the modal value 46.7% is less than 4 beehives). Independently from species (cattle, sheep, goats) number of stock units is low: the modal class is 0 - 5 stock units. Products are mainly for self-consumption (78.7%). Livestock is mainly fed in the forest (27.2%) or fed with a mixed regime (fodder and grazing in forest (42.6%). Replies on occupancy of forest by local residents were bivalent, balanced ones: beneficial for 41.7%, detrimental for 39.3%, no opinion for 19%.

Heating and cooking is mainly based on LPG (89.7%), followed by wood (76.7%) and electricity (27%). Wood is mainly harvested (illegally too) in the forest (71.7%) or purchased (19.3%). A large majority of respondents (88%) complains about scarce effort by Forest Administration in providing them with firewood. Domestic garbage is destroyed on site, arguably by fire (51.7%), abandoned in the forest (50%) and thrown into landfills 9.3%.

Illegal wood cutting and illegal constructions are considered important by 11.3%, but of low importance by 60.63% of respondents. Surprisingly, only 36.7% of respondents or their families, though living in the forest or rather close to it, are involved in forestry works: cleaning (21.7%), fire fighting activities (21%), cork harvesting (21.7%). Forest is considered by far an advantage by 87.3% of respondents. Surveyed people express equivalent opinion about fires trend: increasing (45.7%), decreasing (45.3%) constant (only 9%). A great majority of surveyed people has seen a fire (90%), mainly of medium or large size (respectively 43.1% and 36.3%). Their opinion about fire damages mainly refers to crops (75.7%), fruit trees (52.3%), houses (22.3%) livestock (20.7%) and humans (only 2.3%). About forest fire causes, surveyed people were invited to declare presence or absence of the officially accepted causes, as proposed by Forest Administration. No question involved qualitative evaluation of the phenomenon.

Causes of Forest Fires

Percentage of causes results as follows:

- Natural: 0.74%
- Accidental: 4.47%
- Voluntary: 52.95%
- Involuntary: 41.79%

Percentages are well consistent with current literature, which often underlines an excess of emphasis given to voluntary fires (Velez, 2000; Franco Irastorza & Dolz Reus, 2007). The main causes are reported in **Table 4** here following (all *baladiath* merged):

As evident from **Tables 4** and **5**, a few motives have a fre-

Table 4.
Decreasing frequency of forest fires motives.

Main motives	%
Pasture renewal	11.30
Fires set for political reasons (security fires)	11.24
Cigarette remains	9.13
Pyromania	8.67
Agricultural works (burning of cut bush, stubble burning)	7.03
Illegal garbage dumping and burning	6.83
Restart of fire	6.83
Forest works (burning of cut bush)	6.31
All the others	<6

Table 5.
Fire motives in decreasing order of frequency in the three *baladiath*.

	Ain Zaouia	Mizrana	Haizer
Motives	(%)	Motives	(%)
Fires set for political reasons	23.29	Pyromania	19.63
Restart of fire	15.22	Pasture renewal	18.06
Pasture renewal	12.73	Cigarette remains	15.45
Illegal garbage dumping and burning	10.56	Fires set for political reasons	14.40
Forest works	6.21	Agricultural works	11.26
Agricultural works	4.66	Interest in land use changes	6.81
Conflict related to land use	3.42	Conflict related to land use	5.76
Cigarette remains	3.42	Forest works	4.19
Others	20.49	Others	1.57

quency >6%, but they strongly differ from a *baladiath* to another, thus confirming that, at every scale, fire is site and culture specific (Leone et al., 2003).

Factorial Correspondence Analysis

Given the relevant amount of information gathered by the survey (300 × 134), forest fires causes were explored also with the help of FCA (Factorial Correspondence Analysis) a technique which belongs to the family of multidimensional descriptive statistics (Maniatis, 2010). We present only significant results of analysis, and some representative scatter plots.

Municipalities, Villages and Causes

Ain Zaouia is more distant from the average (axes origin), whereas Mizrana and Haizer are symmetrically opposite to it.

In Ain Zaouia, political fires are the more impressive motive, followed by fire restart; the latter motive, as already reminded, is closely related to security reasons which hamper the efficiency of fire fighting crews, thus confirming a sort of feedback with political fires.

Haizer is characterized by garbage burning, honey gathering, children's games, land use conflicts, followed by less important causes (brash burning, agricultural fires, tourists, machinery, power line arching, vehicle's muffling, hunting conflicts).

Mizrana has its distinctive trait in pastoralism, followed by cigarette remains, pyromania, land use change (it is a municipality rather close to coast, where housing boom is a reality).

Exploding the results in the nine villages, the mentioned matching is:

Ain Zaouia villages:

Ait Amar Moh and Igharbiyene are characterized by political fires and hunting interest, Adbagh by fire restart, conflicts with Administration.

Haizer villages:

Guentour stands out for garbage burning and conflict with Forest Administration, El Mahsar for land use conflicts and forest machinery, Slim for honey gathering and hunting conflicts.

Guentour and El Mahsar appear closer, therefore more similar and more involved with bush burning, whereas Slim is characterized by minor causes, such as machinery, hunting conflicts, land use conflict, agriculture and forest work by machinery.

Mizrana villages:

Mizrana, Tizi Ourabah and Outouba are involved with pastoralism and agricultural fires, in some opposition and rather distant from Azroubar which is characterized by pyromania, interest in land use and cigarette discarding.

For pyromania, present only in this context, probably the term was not well understood by respondents and merely mistaken for unknown as Franco Irastorza & Dolz Reus (2007) argue.

Location of Villages

People dwelling villages inside the forest mainly refer to pyromania, but also to cigarette remains, to interest and/or conflicts for land use changes; two main causes dominate: pastoralism, which pertains to their culture and political reasons. People living outside the forest have a less concerned image of problems: they recall rather obvious and banal reasons: children's games, power line arching, tourists, vehicle's mufflers. In a rather intermediate position the replies of people who dwell villages close to the forest or at the edge of it: they mainly refer to forestry works, to restart of fire, to honey gathering, but with strong emphasis on burning of garbage, which is probably part of their familiar scenario.

Educational Level

Municipalities and level of education form a rather compact cloud, rather distant from two causes which represent outliers: lightning, which is a rare event (within Algeria and all Maghreb) and interest in hunting, which is a forbidden activity now practiced only as poaching, therefore a rather risky one. In order of educational level, illiterate refer to restart of fire, tourists, forestry works, vehicles' mufflers, illegal dumping and burning of

domestic waste. Primary and secondary school refer to honey gathering and change of land use. Middle school refers to political reasons and pastoralism and to less important leisure activities, cigarette remains, accident from agriculture and forestry works and machinery.

The University level clearly refers to pastoralism and pyromania, together with power lines arching, interest and conflicts in land use. In such results we can argue that some importance have mass media, since the motives are rather "high" and echo the frequent analysis circulated by them, sometimes containing not acceptable fire cause hypothesis such as glass refraction or magnification (Belgacem, 2012).

In the replies by the University level respondents we cannot also exclude a sort of reactivity in altering their performance, probably to conform to the expectations of the surveyors. At the opposite, the group of illiterate and low education summoned their experience of livelihood and traditional, rural, pastoral culture.

Pastoralism and political fires are quite coincident with axes origin and close to middle age classes, mainly 40 - 49, which in part arguably recalls personal experiences of the black period. Medium age class 30 - 39 seems attracted by land use changes and conflicts. More aged class 50 - 59 and 60 and over, clearly refer to livelihood activities: pastoralism, honey gathering, i.e. the traditional activities of aged rural people.

Age Classes

Analysis of age classes gives interesting result, though some classes are clustered: 30 - 39, 50 - 59, 60 and over are tightly grouped close to the origin of axes but under A1, whereas 20 - 29 and 40 - 49 are over the axe but symmetrically distant from axe A2. Rather distant from the cluster stays the younger class, >20, which appears as an outlier. Younger respondents refer to leisure activities, as expected; aged 20 - 29 are closer to pyromania, rather close to garbage dumping and cigarette remains, arguably under the influence of mass media.

Scatter Plots

Examples of scatter plots issued from FCA are here following (Figures 2 and 3).

Discussion

Survey results about causes are commented in their order of importance as in Table 5 but only when exceeding a frequency of 4%. By far the most serious cause of forest fires attributed to the rural population is deliberate burning for grazing and land improvement.

The Most Relevant Motivations

Pastoralism: Pastoral fires are a traditional practice all over the Mediterranean basin in areas where fire is the cheapest way to regenerate pastures invaded by shrub (Cemagref, 2004; Pyne, 1997). Range burning could be related to the high number of sheep in the country as a whole: in Algeria (with more than 25 millions livestock, 77% of which represented by sheep; FAO, 2012) demand for red meat is high and growing. In the '90s the country imported around 20% of all that it uses (Homewood, 1993). Now sheep meat represents 30% of the total meat production of Algeria (Dutilly-Diane, 2006). In general fire is not

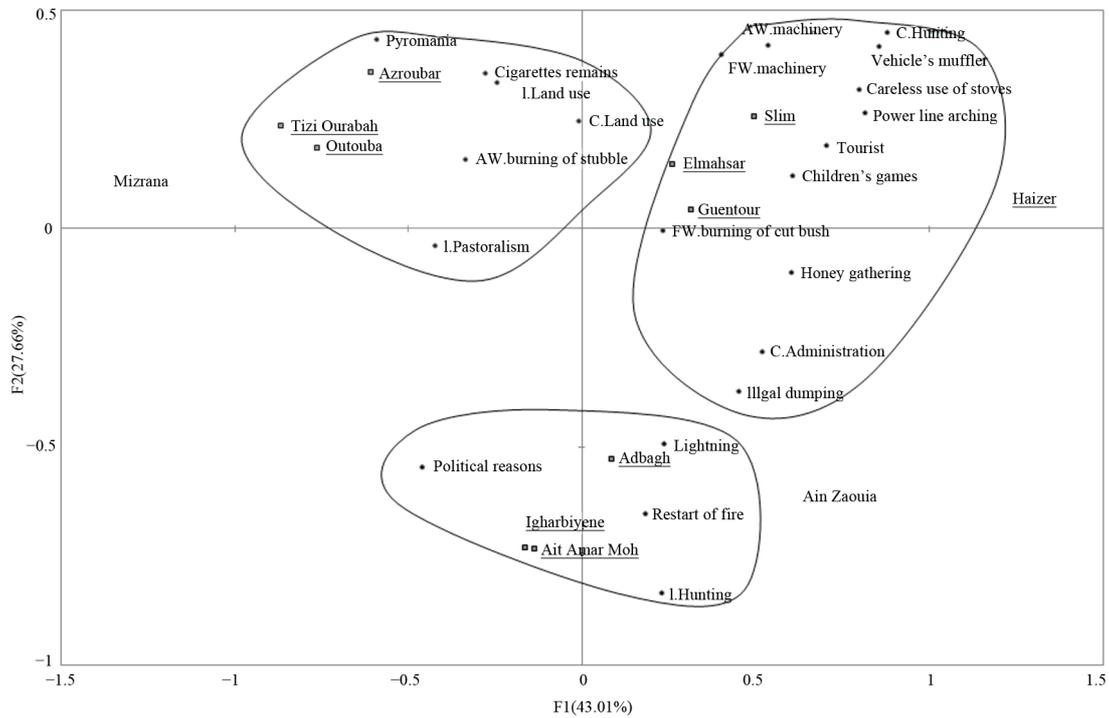


Figure 2. FCA scatter plot related to the nine villages and causes. A1 axe explains 43% of variance, A2 explains 28%.Correspondence of motivation with municipalities is rather evident.

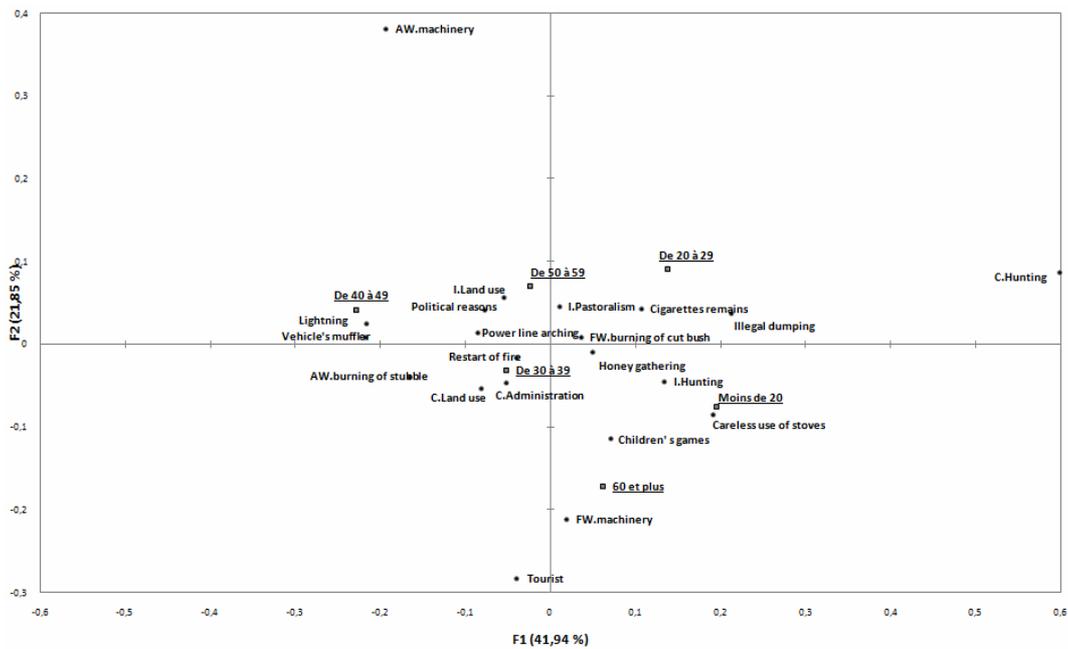


Figure 3. FCA scatter plot related to age classes of surveyed and causes. A1 axe explains 37% of variance, A2 explains 27%.

directly applied to the forests, but rather to marginal rangelands and shrub lands close to them. When vegetation is stressed after a long summer drought, easily fires get out of hand affecting the forest boundary (Meddour & Derridj, 2012).The tendency to increase range areas at the detriment of degraded forest cover is a real problem, observed in other Mediterranean countries

(e.g. in Sardinia, Italy). Shepherds do not refrain from use of fire, even if this means risk for forests (Meddour-Sahar et al., 2012). Fire setting normally follows traditional rules, such as procedures, timing, and time of return on same site; therefore this practice could be defined as a cultural trait of the local populations.

Political fires are the most site specific and disquieting cause of wildfires for Algeria, mainly in Kabylia. The term refers to forest fires as a tool used by the State in its fight against *jihadi* combatants (UNHCR, 2001; Dridi, 2002; Kervin & Gèze, 2004; Rahal, 2012). During the Algerian war (1954-1962) the French Army is reported having burned about 70% of forest in the Massif of Bou-Taleb (Madoui, 2000, 2002) also using napalm to destroy insurgents in Movis forest (Ouarsenis forests; Sari, 1976). Burned forests in Oued Lardjem, Theniet el Had, Ain Antar still exhibit scars of burning by napalm.

Cigarette remains: Carelessly tossed cigarette butts are responsible of roadside fires. Cigarettes, under normal conditions, do not start wild land fires unless the relative humidity is under 22%, it is windy, and a continuous, cured, finely-particulated fuel-bed exists (NWCG, 2005). Lack of roadside maintenance (through slashing or manual brush removal) increases fire hazard in summer, since roadsides are recognized as critical ignition start points (Romero-Calcerrada et al., 2008; Chapman & Balmain, 2004; Cardille et al., 2001) No specific roadside treatments (such as fire safety strips along roads i.e. "anti-cigarette strip"; FAO, 2001) to prevent the occurrence of fires and minimize the danger of fire spread are actually required for roads crossing forests or plantations in the area (Meddour-Sahar & Derridj, 2010).

Pyromania results with high frequency in general, and rather high, first best, in the *baladiyah* of Mizrana. The term is often improperly used as a synonym of arsonist (Instituto Medio Ambiente, 2003; Dolz Reus & Franco Irastorza, 2005; Lovreglio et al., 2010), or just an improper way to express "unknown" (Franco Irastorza & Dolz Reus, 2007). In a recent survey in Sardinia, carried out by Delphi technique, pyromania resulted among the main causes of fires in the province of Cagliari (Lovreglio, unpublished data). It is probable that the number of authentic pyromaniacs, who suffer an addictive behavior, is over-estimated as many fire-raisers if caught "red handed" claim to be suffering from mental trauma in an attempt to escape a custodial sentence (Ashby, 2012).

Agricultural works refers to burning of cut bush or stubble burning, i.e. traditional systematic burning of stubble, for the preparation of the agricultural land for new sowing-purposes and the elimination of residues that restrict exploitation. Forest works are a rather common case of negligence, quite often related to old age of responsible, or imprudence; more rarely related to an overconfidence and boldness in manipulating fire.

Restart of fire can be caused by fire-fighters who do not ensure that the fire is completely out; the alarming conditions of insecurity in Kabylia, where terroristic groups are reported still active, could justify this apparently negligent behavior. Another reason could be the high number of fires which the fire crews must intervene on, therefore having no time enough for mopping-up any fire after it has been controlled (Meddour-Sahar et al., 2012).

Garbage burning is a direct consequence of extreme population density and type of settlements, which make garbage collecting rather difficult. The production of domestic waste in Algeria is estimated in 657,000 tons/year; (Benouar, n.d.), i.e. 0.50 Kg/hab/day (Dorbane, 2007). In the town of Tizi Ouzou the daily amount of domestic waste is estimated about 68.38 tons, corresponding to 0.81 kg/hab./day. In the wilaya of Tizi Ouzou a proliferation of illegal, uncontrolled dumps along roadside is reported, with the presence of only 30 controlled garbage dumping sites v. 1236 illegal ones (Meddour-Sahar &

Derridj, 2010; DPAT, 2011), i.e. an average of 18 sites per municipality. Dump sites are preferential points of fire start in forests (Djema & Messaoudene, 2009)

Interest in land use change mainly refers to fire used to change land use: from forested area to agricultural area or, more frequently, to building area. The latter is more evident in Mizrana, where demand of space for urbanization is very high. Such changes have no relevant obstacles given the lack of Land Cadastre and negligible fines for illegal behaviors. An increasing demand for housing can induce forest fires as an illegal means to increase the supply of available land (Gonzalez, 2007).

Children's games (with lighters, matches, small fireworks such as firecrackers or small amount of explosives) are currently reported in all countries, not therefore having any local character. Children cause fires out of curiosity or mischief; in the study area, fire is more probably a possible occasion to spend time together and relieve boredom, lacking other opportunities for free time.

Other fire causes exhibiting a frequency <4% are just listed, without a commentary: Tourists (3.09%), Honey gathering and related use of smoke (2.83%), Vehicle's muffler (2.76%), Barbecue fires (2.04%), Power line arching (1.71%), Conflicts with Administration (1.31%), Hunting conflicts (0.85%), Interest in hunting (1.25%), Lightning (0.79%).

Just some comments for conflicts with Foresters and Forest Administration seem useful. Conflicts related to forest policy could be interpreted as a kind of reaction, for example, when reforestation is carried out at the expense of traditional extensive grazing lands, against the lack of negotiation with the population (Meddour-Sahar et al., 2012). Similar reactions by local populations against national programs of reforestation (the so called *Green Belt* of the '70s) were already reported (Vallejo, 2005).

Conflicts with foresters. The policy adopted by the Forest Administration often tends to further marginalize rural populations, which manifest themselves in the firing of forests against the application of a criminal jurisdiction and a colonial-style behaviour (Berchiche, n.d.). In those cases, though limited in frequency, fire can have a subtle but strong symbolism, because a patch of fire is a very visible and powerful claim.

Rural incendiarism is an expressive form of resistance, allowing a powerful statement to be expressed, with some livelihood benefits through freshly cleared land or regenerated pasture, while having fewer constraints than other forms of protest because of its anonymity and difficulty to be identified (Holmes, 2007).

Causes Classification

For a classification of voluntary fires we adopted the classification by Douglas et al., (1992), which proposes six possible motives for arson: Vandalism, Excitement, Revenge or Protest, Crime Concealment, Profit, and Extremist. Douglas' classification was mainly conceived for urban fires but it well fits also with wild land fires (Leone & Lovreglio, 2003).

In the study case, ten possible motives after Douglas can be retrieved: Extremist: for political fires; Revenge or protest: for conflict related to land use, conflicts with foresters and Administration, hunting conflicts; Profit: for interest in land use and change in land use, for pastoral fires, for illegal garbage burning, for hunting.

For all the others, mainly involuntary fires, excluding pyromania classified as a mental addictive disorder (APA, 2000) a possible unifying category is folk crime (Bankston & Jenkins, 1982). Many law violations in rural communities such as the violation of gambling, hunting and game laws, and woods burning fall in such category. Woods burning, like poaching, is deeply rooted in some rural cultures (Bankston & Jenkins, 1982; Forsyth & Marckese, 1993; Forsyth et al., 1998).

As a result these violations became accepted as normal behavior in some cultural settings. Setting fire on woods is a "...*custom* (emphasis added by Authors) that has been predicated upon the assumption that timber is either an undesirable barrier to land use or, at best, an expendable commodity secondary in importance to other land uses. In the course of time...it has become accepted as normal behavior... Although fire setters may be few in number, they can practice fire setting with the assurance or at least the toleration of their activities because community members subscribe in some degree the beliefs and/or attitudes that motivate the fire setter" (Bertrand & Baird, 1975: pp. 6 and 11).

All this explained, behind the majority of motives for setting fire on woods in Kabylia some subsistence reasons exist (Emery & Pierce, 2005). Of course, the Penal Code of Algeria (Grim, 1989), is rather severe with fire setters, who are sentenced to hard labour jobs.

Conclusion and Final Remarks

Survey carried out in the three representative municipalities had the main scope to uncover motivations and drivers that lie behind wildfire in Kabylia. Of course we describe causes as perceived by local inhabitants and not by professionals of Forest Administration, since their statistics admit that the totality of fires is of unknown origin (99% in Tizi Ouzou wilaya).

We decided to give voice to the inhabitants, therefore admit-

ting and accepting that their responses are frank and truthful. Our results therefore concern truth-as-observed, not exact science (Jollands et al., 2011).

It is the first time that a similar survey is carried out in Algeria; at our knowledge, this procedure is not so common also in more advanced countries, where statistic are always compiled on the basis of the subjective knowledge of professionals charged of this task. The fire scenario of our survey depicts relationship among people, land and fire rather different from the rhetoric image reported in some classical books on forest fires in Algeria, for instance Gravius (1866) and Thibault (1866).

In our results forested areas are degraded by human overuse and impact, swarming with a myriad of people using fire in a more or less legal way. The forest is a place where to use fire for getting fodder to animals; to illegally extract stones, accelerating the operations by burning used tires; to use fire to relieve boredom; to dispose garbage and wastes and burning them; in short, gradually consuming the forest or eroding it.

Results highlight a complex reality, issued from a new style of life where people live in the backcountry but work (if they do so..) in towns and are therefore in some way obliged to find new ways of problems solving, where time saving is an imperative, and fire is the privileged tool.

We can synthesize as follows: the causes, as perceived by dwellers (we insist that they are perceived but not real) can be distinguished in a "common core", represented by a cluster of negligent behaviors and scarcely important folk crimes; two more evident causes, represented by political fires and pastoralism, clearly dominate on them, whichever the criterion of analysis.

The negligent behaviors recall the anarchistic activities practiced in the Algerian forests (Djema & Messaoudene, 2009), results of the release of the rules of a former rural culture based on traditional behaviors, now no more consistent with changed style of life and age and/or education contrasts.

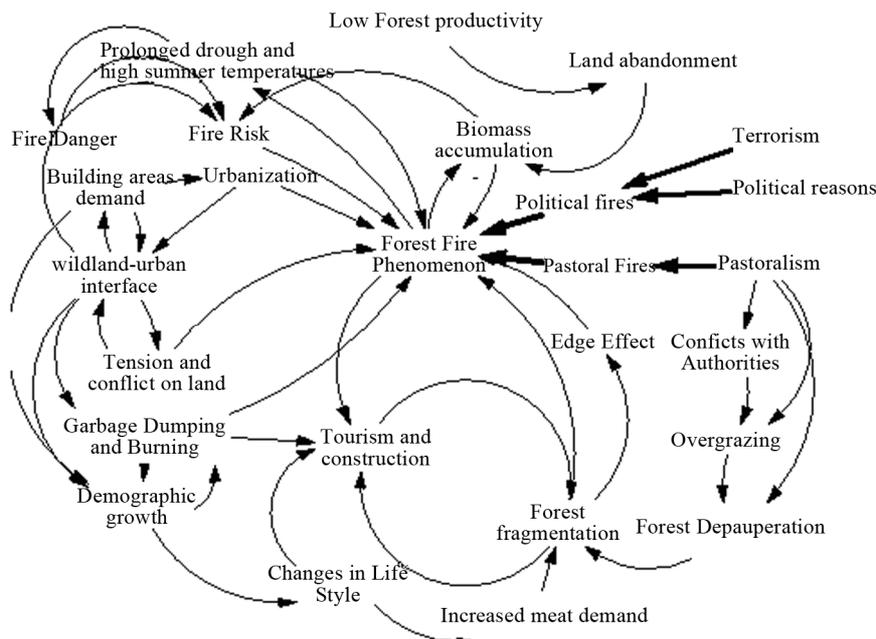


Figure 4. CLD of forest fires and causative agents (factors) for Kabylia and Algeria: the number of arrows visualizes the multiplicity and complexity of interrelated factors.

We propose here as a conclusion (**Figure 4**) a CLD (Causal Loop Diagram; Richardson & Pugh, 1981; Kim, 1992), to visualize relationships of the most important variables which are behind causes in Algeria and in Kabylia.²

Though related to only three municipalities (i.e. 2.67% of the 67 municipalities of Tizi Ouzou and 45 municipalities of Bouira; 0.0019% of the 1541 municipalities of Algeria), our result is well representative of Kabylia.

We underline the importance of our survey, which for the first time measured the unknown causes, accounting for 99% in official statistics. Their importance must be considered in the scope of a new approach to fire fighting: from fire suppression, mainly oriented to emergency measures, therefore a “reactive” process, to a longer term policy of removing the structural causes (Biro, 2009; Velez, 2008), then a more “pro-active” approach.

But if wildfires are to be tackled conclusively, then there is a need (Jollands et al., 2011) to address the root causes which lead to fire setting, properly targeting the social groups and concentrating efforts consistently with fire risks.

Contribution

All authors contributed extensively to the work presented in this paper. O.M.S designed the study, collected and analyzed data; O.M.S. and V.L. wrote the manuscript; R.M., R.L., A.D. gave technical support and conceptual advice. All authors discussed the results and implications and commented on the manuscript at all stages.

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²A causal loop diagram consists of variables connected by arrows, denoting the causal influences among the variables. Diagram was drawn using *Vensim plus* software (www.vensim.com/software.html).

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