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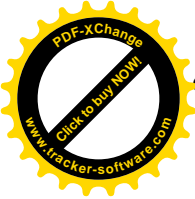
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A Study of the Socioeconomic Factors Influencing Wildfire Occurrence in Mediterranean Basin Countries¹

Panagiotis Koulelis² and Ioannis Mitsopoulos²

Abstract

Forest fires in Mediterranean basin are a complex phenomenon due to the existing socioeconomic factors. The objective of this study was to examine the effects of socioeconomic factors (population density, Gross Domestic Product (GDP) and livestock density) on the number of forest fires and burnt areas during the decade 1995–2004, in most of the Mediterranean basin countries. The analysis was carried out by the method of stepwise multiple linear regression. The variables found significant, for the number of forest fires, were: the Gross Domestic Product (Spain), the livestock density (Greece and Italy) and the population density (Portugal, Israel, Cyprus, France and Turkey) for the period 1995–2004. The variables found significant, for the burnt areas, were: the Gross Domestic Product (Turkey, Spain and Greece), the livestock density (Italy, Cyprus, France and Portugal) and the population density (Israel and Cyprus) for the period 1995–2004. The results of the research show that the socioeconomic factors in Mediterranean basin have a moderate effect in forest fires with different degrees of correlation per country. The national planning of prevention of forest fires should take into account socioeconomic factors as well.

Keywords: Forest fires, socioeconomic factors, burnt areas, stepwise multiple linear regression, Mediterranean Basin.

Introduction

In the Mediterranean Basin, many countries with severe human pressure resulting in burning, cutting and grazing on non-arable lands and clearing, terracing, cultivating, and later abandoning arable portions, have created a strongly human-influenced landscape. The cultivation of marginal areas under increasing population pressure has been common in Southern Europe since the 16th century. It is not possible to understand current vegetation partners in the

¹ An abbreviated version of this paper was presented at the Third International Symposium on Fire Economics, Planning, and Policy: Common Problems and Approaches, April 29 – May 2, 2008; Carolina, Puerto Rico.

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Mediterranean Basin without taking into account past anthropogenic activities and land uses. Human intervention has been so strong that it is still making a significant impact on current and future vegetation patterns (Alexandrian et al. 1992)

The changes in fire occurrence during the last decades closely reflect the recent socio-economic changes underway in the European Mediterranean countries. With industrial development, European Mediterranean countries have experienced: depopulation of rural areas, increases in agricultural mechanization, decreases in grazing pressure and wood gathering and increases in the urbanization of rural areas. These changes in traditional land use and lifestyles have implied the abandonment of large areas of farm land, which has led to the recovery of vegetation and an increase in accumulated fuel (Moreno and Oechel 1994). In Southern Europe, human activity has dramatically increased fire frequency as a consequence of land abandonment and tourist pressure. Land-use changes produced during the present century in Southern Europe are parallel to the changes in the fire regime, from being few in number and affecting small areas, to becoming very numerous and affecting large extensions every year. This trend is not observed in the Southern Mediterranean Basin where traditional land uses remain the major socio-economic system. (Velez 1993).

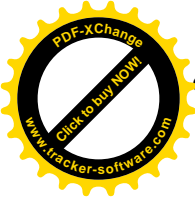
Jennings (1999) presented an extensive literature review on the socioeconomic characteristics and their influence on forest fire incidence. He suggests that fire frequency is affected by community characteristics, while the correlation between fire loss and invested resources is weak.

Cardille et al. (2001) examined the influence of environmental and social factors on fire occurrence using spatial data of natural areas in the USA. They reported that spatial distribution of forest fires are both related to a combination of abiotic, biotic and social factors. Sturtevant and Cleland (2007) claimed that while human factors dominate the probability of fire ignition, ecological factors constrain the fire spread ability. Vadrevu et al. (2006) pointed out that population density is one of the main factors that explain the variation of fire occurrence in India.

The aim of this study was to investigate the effects of socioeconomic factors (population density, gross domestic product (GDP) and livestock density) on the number of forest fires and burnt areas during the decade 1995–2004, in most of the Mediterranean basin countries.

Methods

The data set used in this study concerning the number of fires and burnt area that



occurred in eight Mediterranean countries (Spain, Portugal, France, Italy, Greece, Turkey, Cyprus and Israel) during the period 1995-2004, was obtained from the 'Fire Records' of the Food Agriculture Organization (F.A.O.) (Dimitrakopoulos and Mitsopoulos 2005). The socioeconomic factors (population density, Gross Domestic Product (GDP) and livestock density) values of each country were taken from the F.A.O. statistics division (2004) and the United Nations statistics division (2004)

Stepwise multiple linear regression was applied in order to investigate the statistically significant socioeconomic factors that influence the number of fires and burnt area in the studied Mediterranean countries. Stepwise multiple linear regression has proved to be an extremely useful computational technique in data analysis problems. This procedure overcomes the acute problem that often exists with the classical computational methods of multiple linear regression. In stepwise linear regression the variable with the largest probability of F is removed and the equation is recomputed without the variable and the process is repeated until no more independent variables can be removed (Draper and Smith 1981).

The statistical analysis was carried out by the SPSS ver.14 statistical package (Norusis 1997).

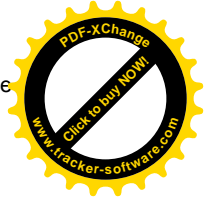
Results and Discussion

Table 1 presents the statistically significant ($p=0.05$) factors according to Pearson correlation coefficient, the coefficient of determination (R^2) and the regression equation parameters for the number of fires in each studied country, during the period 1995-2004.

Population density was the variable that statistically significant correlated with the numbers of fire in Portugal, France, Turkey, Israel and Cyprus. The Pearson correlation coefficient varied from 0.33 to 0.77. Population density, explained the fire occurrence variation in these countries, ranged from 11% in Turkey to 60% in Cyprus.

Livestock density was the variable that statistically significant correlated with the numbers of fire in Italy and Greece. The Pearson correlation coefficient varied from 0.38 to 0.85. Livestock density, explained the fire occurrence variation in these countries, ranged from 15% in Italy to 71% in Greece.

GDP was the variable that statistically significant correlated with the numbers of fire in Spain. The Pearson correlation coefficient was 0.57. GDP explained the fire occurrence variation in Spain with a value of 33%.

**Table 1** — *Stepwise multiple linear regression results for the number of fires and the socioeconomic factors in each studied Mediterranean country during the period 1995–2004¹*

Country	Portugal	Spain	France	Italy	Greece	Turkey	Israel	Cyprus
Socioeconomic factor	Population density	GDP	Population density	Livestock density	Livestock density	Population density	Population density	Population density
Pearson correlation coefficient	0.65	0.57	0.64	0.38	0.84	0.33	0.49	0.77
Coefficient of determination (R²)	0.42	0.33	0.41	0.15	0.71	0.11	0.24	0.60
Model parameters	a) 284162 b) 2.5	a) 28309 b) 1.15	a) 102909 b) 1.61	a) -9236 b) 470.7	a) -40083 b) 2088.8	a) -817.7 b) 4.04	a) 2358.3 b) 2.25	a) -2882.7 b) 4.40

¹ Equation form: $Y=a+bX$

Table 2 presents the statistically significant ($p=0.05$) factors according to Pearson correlation coefficient, the coefficient of determination (R^2) and the regression equation parameters for the burnt area in each studied country, during the period 1995-2004.

Population was the variable that statistically significant correlated with the burnt area in Israel and Cyprus. The Pearson correlation coefficient varied from 0.35 to 0.70. Population density, explained the burnt area variation in these countries, ranged from 12% in Cyprus to 49% in Israel.

Livestock density was the variable that statistically significant correlated with the burnt area in France, Italy and Portugal. The Pearson correlation coefficient varied from 0.30 to 0.46. Livestock density, explained the burnt area variation in these countries, ranged from 8% in Italy to 22% in Portugal.

GDP was the variable that statistically significant correlated with the numbers of fire in Spain, Greece and Turkey. The Pearson correlation coefficient varied from 0.13 to 0.55. Livestock density, explained the burnt area variation in these countries, ranged from 1.6% in Turkey to 31% in Greece

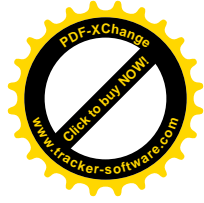


Table 2 — *Stepwise multiple linear regression results for the burnt area and the socioeconomic factors in each studied Mediterranean country during the period 1995-2004¹*

Country	Portugal	Spain	France	Italy	Greece	Turkey	Israel	Cyprus
Socioeconomic factor	Livestock density	GDP	Livestock density	Livestock density	GDP	GDP	Population density	Population density
Pearson correlation coefficient	0.46	0.20	0.43	0.30	0.55	0.13	0.70	0.35
Coefficient of determination (R²)	0.22	0.04	0.18	0.08	0.31	0.016	0.49	0.12
Model parameters	a) 3104699 b) 90329.6	a) 146979 b) 5.5	a) 413622 b) 8224,2	a) -140309 b) 5761.2	a) 103755.3 b) 5.12	a) 13177.8 b) 1.98	a) 30395,9 b) 4.337	a) -74802 b) 0.20

¹Equation form: $Y=a+bX$

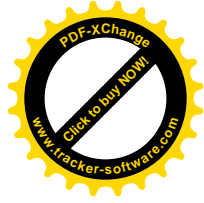
From the statistical analysis revealed that most of the studied countries gave as more important factor that it relates with the phenomenon, the population density. A possible explanation is that despite that statistics on the causes of forest fire in the Mediterranean region are far from complete; it is evident that people set more fires. Natural agents such as lightning also cause fires, but the number of naturally occurring fires is small in comparison with those caused by people.

In Italy and Greece, livestock density it is presented as the most important factor that explains the number of fires. An important source of fires is shepherds in these countries, who ignite the grasslands to promote new flushes of growth for grazing animals. Farmers also use fire to eliminate crop stubble and invasive thorn plants and to push back the forest to make room for agricultural expansion. The central Government likely should give particular importance and focus their efforts limiting the above actions. Spain is the unique country which presents as main variable of correlation of number of fires and of burnt area the GDP. A likely explanation can be given, relating GDP that constitutes a very good economic indicator of growth, with growth of tourism, with changes in the use of land and with internal immigration to the big urban areas. An increasingly important cause of fires is the burning of large quantities of waste by tourists and other recreational users of forest areas. Another important role motivation for destructive fires is an attempt to change land-use classification. It's also important to relate GDP with the migration of population from rural areas to cities. However, this migration increases the forest fuels. The population shift does not imply the total elimination of activities in the forest area. The remaining, often elderly, rural population continues to use fire to eliminate

stubble and renew pastures and fields. Moreover, the sparse rural population makes fire suppression more difficult. The other countries that correlate the burnt area with GDP are Greece and Turkey. Portugal's and Italy's burnt area correlated with livestock density, fact that indicates the important and fast meters that should be taken for the shepherds. Finally Israel's and Cyprus's burnt area correlated with population density strong evidence that people set more fires also.

Summary

Overall, a moderate correlation between forest fires and socioeconomic factors was observed in the studied Mediterranean countries, as indicated by the stepwise multiple linear regression. The results of research show that the socioeconomic factors in Mediterranean countries have a moderate effect in forest fires with different degree of correlation in each country. Further study including the influence of other factors (environmental, etc.) it would probably contribute to the variability explanation on fire occurrence and burnt area in the Mediterranean countries. The rational planning of prevention of forest fires in each country should take into account socioeconomic factors as well.



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