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Forest fires occurrences and burned area in mainland Portugal: preliminary assessment to a fifteen years period

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Keywords

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Abstract

Portugal, as well as the Mediterranean basin, is favorable to the occurrence of forest fires. In this work a statistical analysis was carried out based on the official information, considering the forest fires occurrences and the corresponding burned area for each of the districts of the mainland Portugal, between 1996 and 2010. Concerning to the forest fires occurrence it was possible to identify three main regions in mainland Portugal, while the burned area can be characterized in two main regions. Associations between districts and years are different in the two approaches. The results obtained provide a synthetic analysis of the phenomenon of forest fires in continental Portugal, based on all the official information available to date.

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1 INTRODUCTION

As in other Mediterranean countries, Portugal is characterized by natural conditions that are favorable to the occurrence of forest fires. Relief is irregular and steep slopes are common, the natural vegetation is typically evergreen, resistant to the drought and fire-prone. The alternation between a rainy season and a hot and dry period allows a high production of biomass, increasing the risk of wildfires during the summer months. The drought periods and heat waves create ideal conditions for fires and their propagation, especially in a context of profound social changes that began to be felt in the population residing in the forest areas, especially in the Portuguese inland, since the second half of the twentieth century (Lourenço et al., 2012).

Accordingly, the temporal trend followed by these two variables - i.e., number of occurrences and burned areas - is completely different. The number of occurrences is closely associated with human causes (either intentional or negligent), which results from different behaviors and attitudes that have long been identified and that need changing. Conversely, burned areas are directly related with the different weather conditions throughout the years, the lack of forest management, and, finally, to some inefficiencies in fire fighting operations (Lourenço et al., 2012).

In Portugal, as for the majority of the countries from the Mediterranean basin, more than 95% of the forest fires are due to human actions and/or activity (Collin et al., 2001).

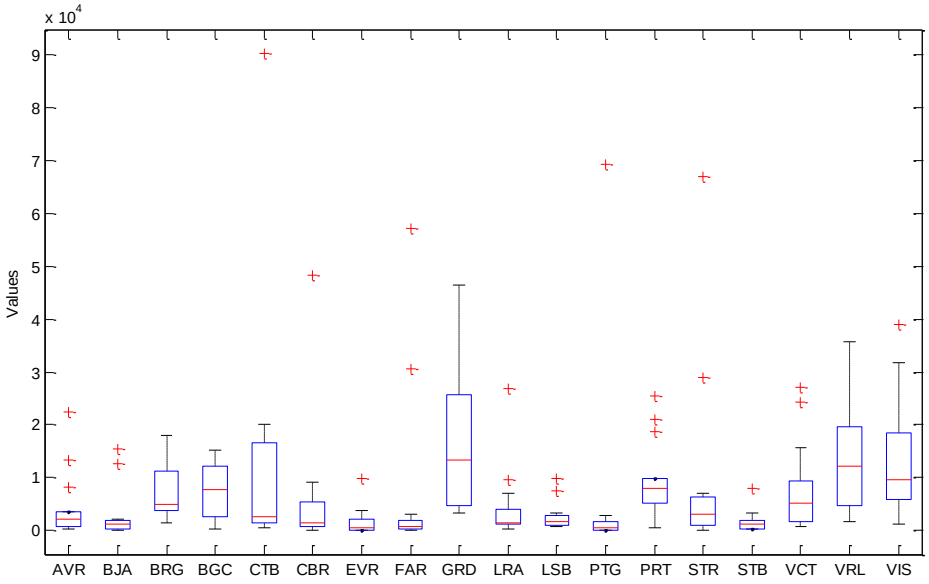

Figure 1. Box-plot of the eighteen districts studied – data related to forest fire occurrences in continental Portugal (codification: AVR-Aveiro, BJA-Beja, BRG-Braga, BGC-Bragança, CTB-Castelo Branco, CBR-Coimbra, EVR-Évora, FAR-Faro, GRD-Guarda, LRA-Leiria, LSB-Lisboa, PTG-Portalegre, PRT-Porto, STR- Santarém, STB-Setúbal, VCT-Viana Castelo, VRL-Vila Real, VIS-Viseu. The red lines represent the median values (Q2) of fire occurrence in each district, blue boxes represent the middle half of the data - they go from the 25thpercentile (lower quartile Q1) to the 75th percentile (upper quartile Q3) - and the black lines or whiskers represent the minimum and the maximum unless there are outliers. Those are represented as red crosses outside the whiskers and are defined as data points that are either more than 1.5 times the interquartile range (the length of the rectangle) from Q3 or 1.5 times the interquartile range less than Q1).

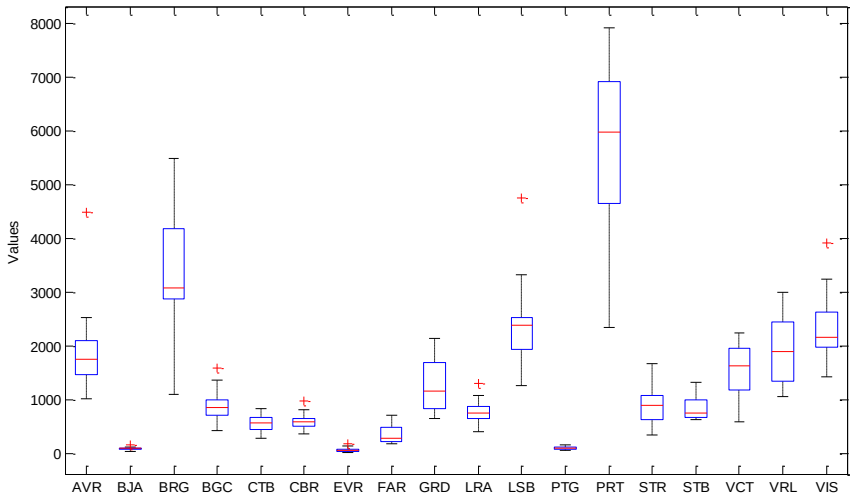

Figure 2. Box-plot of the eighteen districts studied – data related to forest burned area in continental Portugal (Codes as in Figure 1).

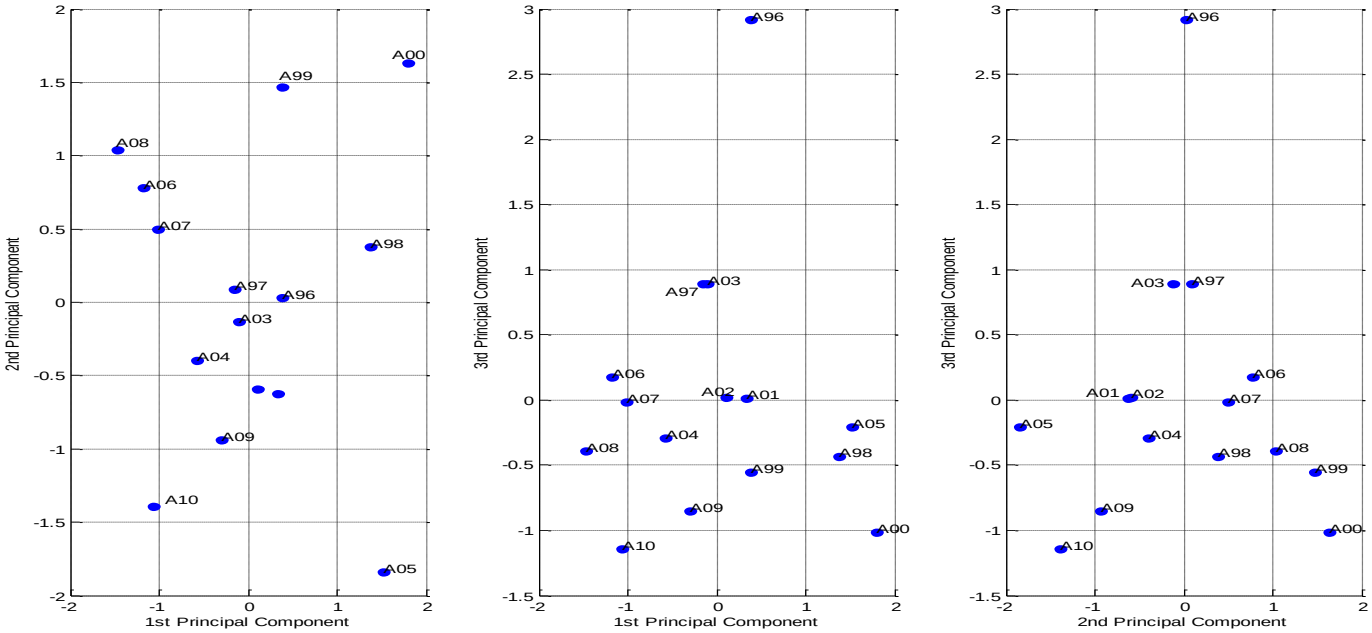

Figure 3. Representation of the PCA scores in PC1-PC2 factorial plan (left), in PC1-PC3 factorial plan (middle) and in PC2-PC3 factorial plan (right), in respect to fire occurrences.

2 MATERIALS AND METHODS

The database used in this study consists of a matrix containing official information on the number of forest fires occurrences and the corresponding burned area in the eighteen districts of mainland Portugal during the period between 1996 and 2010 (http://www.afn.min-agricultura.pt/portal/dudf/estatisticas).

Statistical analyses were conducted in MatLab R2012a environment. Firstly, it was performed an exploratory analysis of the data focused on the key measures of location and dispersion and corresponding graphical representation of its variability. Next to this descriptive analysis multivariate statistical method Principal Component Analysis (PCA) was applied for organizing and synthesizing information.

3 RESULTS AND DISCUSSION

Figures 1 and 2 showed a great variability of forest fires occurrences and burned area in the eighteen districts of Portugal. With regard to the number of fire occurrences, Braga and Porto districts show the highest variance, in a clear contrast with Beja, Évora and Portalegre that recorded the lowest values of variance. Some of the districts present outliers, highlighting Aveiro and Lisboa with the most extreme values (Figure 1). In addition, and in relation to the number of fire occurrences, Santarém and Lisbon districts show a notably high positive correlation (90 %). Regarding to the burned area, Castelo Branco district stands out with the highest value of variance in contrast to Setúbal district that possesses the lowest variance value (Figure 2). Good correlations between districts can be also pointed out, with emphasis on the correlation between i) Faro and Beja (97%), ii) Faro and Évora (93%), iii) Portalegre and Castelo Branco (95%), iv) Castelo Branco and Santarem (96%), v) Setúbal and Évora (90%) and vi) Setúbal and Portalegre (90%).

Principal Components Analysis was performed on a data matrix previously standardized (zero mean and variance equal to one), since the variables have different measurement scales.

The PCA analysis for fire occurrences points out that 70% of the data variability can be described by three components (PC1, associated to Braga, Bragança, Castelo Branco, Guarda, Leiria, Lisboa, Porto, Santarem, Vila Real,

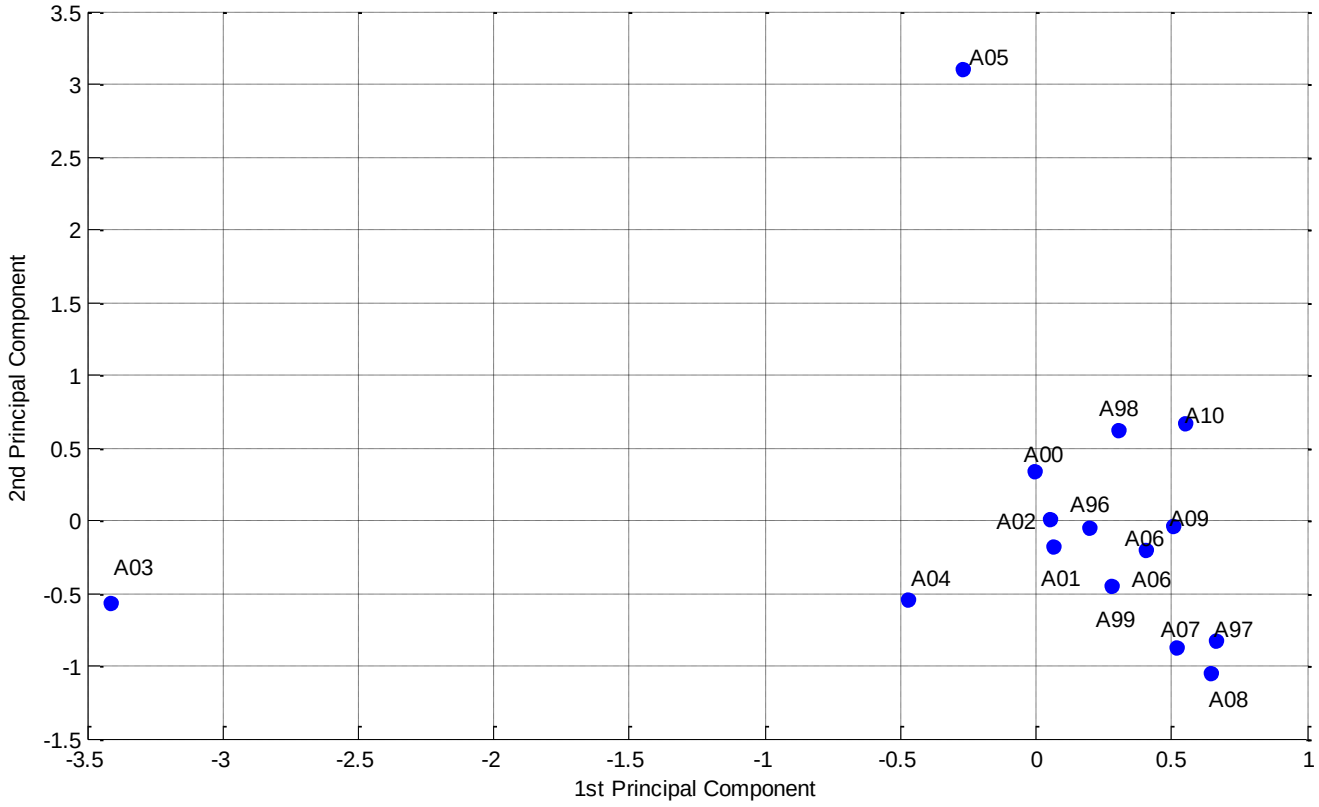

Figure 4. Representation of the PCA scores in PC1-PC2 factorial plan, in respect to fire burned area.

Viseu districts and, in opposition, Faro district, explain 41% of the data variability, PC2, associated to Aveiro and Viana do Castelo districts and, in opposition to Setubal district, explains 15% and PC3, associated to Beja, Évora and Portalegre districts, explains 14%). Based on visual examination of Figure 3, one can say that years 1998, 2000 and 2005 have presented high number of fire occurrences in the districts associated do CP1 in opposition to the years of 2006, 2007, 2008 and 2010. In the districts represented by CP2, the years of 2005 and 2010 have presented high number of fire occurrences, in opposition to years of 1999 and 2000. In the districts represented by CP3, the year 1996 is the one who have presented higher value.

In relation to burned area, the PCA analysis points out that 75% of data variability can be described by two components PC1, 42%, and PC2, 33%. PC1 is related to southern districts and PC2 is related to northern districts. Based on visual examination of Figure 4, one can say that all years, except 2003 and 2005, have presented average burned area levels. Year 2005 shows an expressive representation CP2, presenting high burned area levels in northern districts. In opposition, year 2003 shows an expressive representation CP1, presenting very low burned area levels in southern districts.

4 CONCLUSIONS

In this study it was possible to identify the districts that possess similar behavior in relation to the number of forest fire occurrences and the burned area during the period from 1996 to 2010, as well as the association between some districts and years.

The results obtained provide a synthetic analysis of the phenomenon of forest in continental Portugal, based on all the official information available to date.

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