



The relationship between fire number and burned area in Antalya, Izmir and Muğla regions in Turkey

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Publication Info

Paper received:
26 February 2013

Revised received:
25 November 2013

Re-revised received:
22 January 2014

Accepted:
17 May 2014

Abstract

This study focuses on Antalya, Izmir and Muğla regions, where the highest number of fires were experienced within Turkey. The number and area relationship between the fires were examined together with large fires. Within whole Turkey, these three regions incorporated 55.24% of the area burned in large fires, in which over 300 ha of land was burned. In terms of the number of fires, Muğla ranked first among these regions and was followed by Izmir. Apart from the number of fires, Antalya, however, had the highest burned area, both in all fires and in large fires. No significant relationship was found between the number and area of fires in all working areas. The fact that most fires were small and that the large fires burnt extremely big areas compared the area per fire, relationship between the number of fires and the area burned. However, when the fires burning an area of over 300 ha in Turkey were considered, there was a strong relationship between the number of fires and the area burned.

Key words

Box-plot, Forest fire, Large fires, Number of fires, rSpearman test

Introduction

Mediterranean and Aegean regions in Turkey, which are both fire-sensitive regions, are high-risk areas due to typical Mediterranean region vegetation and climate. In terms of forest fires, Izmir, Muğla and Antalya regional directorates rank among the first three, concerning the number of fires and the area burned. The big forest fires in Turkey are mainly seen within the borders of these three regional directorates.

The biggest danger for the forests in the whole Mediterranean zone is forest fires. The characteristics of this zone in all countries of Europe bordering the Mediterranean are high summer temperatures and drought as well as shrub, pine and oak forests. In addition to the existing natural conditions, the crowded population and intense human activity jeopardize this natural environment. Over thousands of years, fires have been a natural constituent in Mediterranean and its environs. Fires in this region are vital elements for the sustainability of the ecosystem and for regeneration of many plants. During the second half of the 20th century, because of global climate change, which occurred particularly because of human activities, rapid population growth,

and direct or indirect practices of humans that impacted the nature, there have been changes in forest areas. Fire fighting policy that focuses on removing allfires away from forests has also a big share in these changes. Díaz-Delgado *et al.* (2004) reported that the fire fighting policies implemented until the present day did not drop the ratio of large fire area in the amount of area burned, although they dropped the number of fires.

Forest fires are an inseparable constituent of the Mediterranean region. In recent years, however, it is identified that there was rise in temperature and significant fall in rainfall. Almost 60.000 fires occur annually in the Mediterranean zone in Europe and these fires burn almost half a million hectare area (San-Miguel-Ayanz *et al.*, 2009). According to a research carried out Dimitrakopoulos *et al.* (2011) there was a positive correlation between the annual drought and fire activity between 1961 - 1997.

Similar results are obtained in climate researches done for Turkey. As a result of analyses made in the past (1961–1990) and future (2071–2100) scenario of HadAMP3 climate model, high increase of about 6-7°C in summer temperature in the

western regions of Turkey – even 8 °C in some parts- are observed. And an increase of 5-6 °C is predicted in the maximum temperatures. Moving from east to west, a fall up to 40% has been observed in the rainfall (Demir *et al.*, 2008).

Similarly, the annual average rainfall in Turkey was 640 mm between 1971- 2000 and a fall trend rate, which will be 29 mm in 100 years, was determined (Şensoy *et al.*, 2008).

Along with climate, the vegetation also causes the occurrence and spread of fires in this region. Several studies have been carried out to identify the inflammability of plants in the Mediterranean region. Among the trees in the region, *Pinus halepensis*, *Pinus brutia*, *Quercus ilex* were highly flammable and *Quercus coccifera*, *Pistacia lentiscus*, *Arbutus unedo*, *Phlomis fruticosa*, *Cistus salvaefolius* were found to be moderately flammable. Valette (1990) classified *Pinus halepensis*, *Quercus ilex* as extremely flammable; *Arbutus unedo*, *Quercus coccifera*, *Pistacia lentiscus* as highly flammable and *Cistus salvaefolius* as moderately flammable. There are times during the year when *Arbutus unedo*, *Quercus coccifera* and *Cistus salvaefolius* are moderately and weakly flammable, while *Pinus halepensis* and *Quercus ilex* are highly flammable during the whole year (Valette, 1990; Velez, 1990; Dimitrakopoulos, 2001).

Despite all these negative effects of fires, the scrubs and oak forests in the Mediterranean region have developed a quite strong flexibility against recurrent fires. However, among them the most fire-sensitive ecosystems are the pine forests. Particularly, because of frequent fires, bushes replace pine forests as they burn in time periods which are too short for their seeds to be formed (Baeza *et al.*, 2007; Pausas *et al.*, 2008).

Forest fire regime in the 20th century changed in Europe due to various new factors. When the abandoning of agricultural

lands, urbanization and developments in industry in Spain was combined with human factor, a high risk of fires emerged (Martinez *et al.*, 2009). In another study, Lloret *et al.* (2002) found that abandoning agricultural lands and human activities, fires and pressures led to increased shrublands in the Tivissa in the Catalonia region of Spain.

Not only abandoning agricultural lands and human-caused fires and pressure, but also increased number of settlement areas in the Mediterranean and its environment play an important role in the change of fire regime. Throughout the Mediterranean region wildland-urban interface areas showed increase and these regions have a particular importance in terms of small and large fires (Galana-Martin *et al.*, 2011). The present study aimed to identify the relationship between number of fires and burned area within the last ten years and the fires spreading to an area over 300 ha between 1973-2010, in these three regional directorates.

Materials and Methods

Forest areas of Izmir, Muğla and Antalya General Directorate of Forest were chosen as the study area (Fig. 1). These three regional directorates incorporate the forest areas where highest number of fires and burned area have occurred. Again with regards to large fires, these three regional directorates are placed on top. Large fires spreading over 300 ha during 37 years between 1973 and 2010 was analyzed and it was found that these fires burned an area of 171911 ha of land. Among these burned land, 45431 ha was within the borders of Muğla; 29317 ha is within the borders of Antalya and 20.218 ha was within the borders of Izmir. The total burned area in these three regional directorates, was 94966 ha, made up 54.24% of the total area burned in large fires.

In the present study, box-plot and rSpearman methods were used (Oliveras and Pinol, 2006). rSpearman test, a non-parametric, measures statistical dependence between two variables. It is used when the distribution of variables is far from normality. Box plots indicate 25th and 75th percentiles and bars indicate 10th and 90th percentiles (Fig. 2). Median values were indicated with a line inside the box. Outliers were indicated by circles.

It is believed that increase in number of fires will cause expansion of burning lands. Recently, such an inclination has been seen in Turkey as observed in Spain and Portugal (Oliveras and Pinol, 2006).

Fires burning an area larger than 1 ha only were considered. The relation between annual average number of fires and average area burned for each region were identified. As the data obtained did not comply with normality test, rSpearman test was applied.

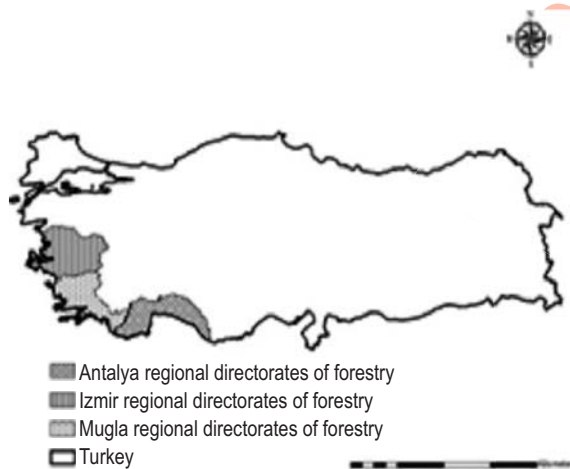


Fig.1: Study area

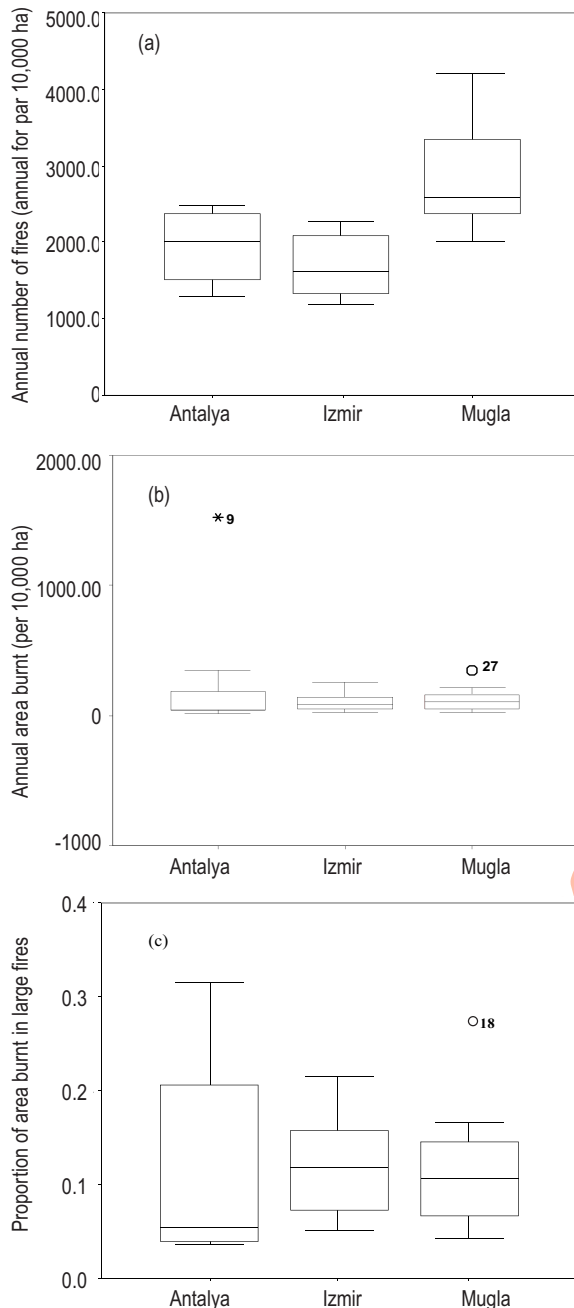


Fig. 2 : (a) Annual number of fires; (b) Annual area burnt and (c) Proportion of fires burnt by large fires in Antalya, İzmir and Muğla region

Results and Discussion

Different results were obtained in this study where relationship between the number of fires, area burned and large fires in different study areas were examined. Among the three regional directorates in the study and Muğla had the highest

number of fires. The highest number of fires per 10000 hectares is in Muğla region 240 fires. Muğla regional directorate of forest in Turkey not only stands out with the highest number of fires per 10,000 ha area but also with its forest land of 56%. Muğla is followed by Izmir in the number of fires per 10,000 ha with 200 fires per 10,000 ha. When all the three regions were examined, it was found that the number of fires in all regions were close to one another. However, looking into recent fires, it was found that there were more big fires in Muğla region. On the other experimented, although Antalya region experienced almost half of the large fires that Muğla had, the land burned in fires in Antalya in large fires was 1.7 times more than the land burned in Muğla.

When the burned area per 10,000 ha forest land was examined, the similarity in the number of fires did not exist between the regions (GFD, 2010). The annual land burned per 10,000 ha in Antalya was twice the land in Izmir with 2300 ha. And on comparing Antalya region with Muğla, a similar ratio, as compared to Izmir was observed. The annual land burned in Antalya per 10,000 ha is 2.14 times higher than the land burned in Izmir.

In the study concerning the fire activities that broke out in different vegetation types in Greece, it was found that although the number of fires in all forest formations except Ostraya Carpinifolia increased recently, there has been a continuous decrease in the land that burned between the years 1985-2004 (Xystrakis and Koutsias, 2013). In a different study carried out in South France, it is found that although large fires (≥ 100 ha) that broke out between the years 1997-2010 made up 78% of the total area burned, these fires made up 1% of the fires in terms of number (Ganteaume and Jappiot, 2013).

Although no statistical relationship was observed between the area burned and the number of fires when three regions were assessed together, however, different results were obtained when these regional directorates were assessed separately. A second order relationship was found between the

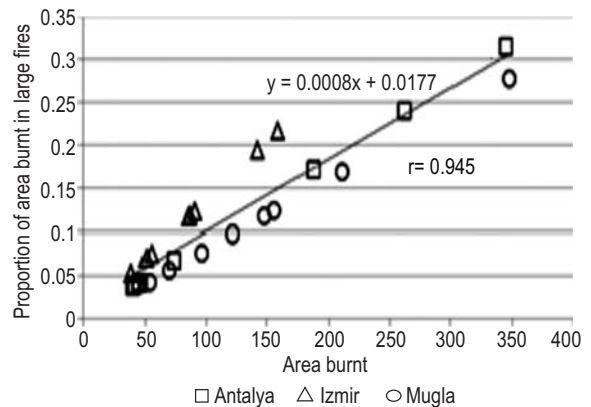


Fig. 3 : Annual number of fires and proportion of area burnt by large fires

area burned and the number of fires in Antalya regional directorate ($r=0.793$; equation $y = 0.0048x^2 - 0.1689x + 1.5112$); and a third order relationship was found in Izmir ($r=0.775$; equation $y = 0.0016x^3 - 0.0819x^2 + 1.3315x - 6.9086$) and Muğla ($r=0.985$; equation $y = -0.0003x^3 + 0.0244x^2 - 0.5634x + 4.2677$) regional directorates of the forestry.

Table 1 and 2 shows the area burned by large fires and the total area burned in the above mentioned three regional directorates over a 10-year-period between 2000-2009. According to that, during the years when large fires burned an area over 1000 ha, the total area burned was found to be significantly higher than other years. And on analyzing total of these 10 years, a positive relationship was found between the area burned by large fires and the total area burned in Antalya, Muğla and Izmir, respectively.

Although Antalya region ranks first among the three regional directorates in the area burned between 2000-2009, it is Muğla region, which ranks the first in the area burned during large fires during 1973-2009. Between 1973-2009 fires that burned an area of over 300 ha destroyed an area of 1,71,911 ha. It was found that 26.43% of this total amount (45,431 ha) belonged to Muğla, while 17.05% belonged to Antalya (29317 ha) and 11.76%

Table 1 : The area burned in fires bigger than 300 hectares in Antalya, Izmir and Mugla Regions between 2000-2009

Year	Antalya	Izmir	Mugla
2000	2977	1184	305
2001	-	-	-
2002	-	-	1775
2003	-	-	902
2004	333	348	-
2005	-	325	450
2006	385	350	3101
2007	1158	-	698
2008	16101	1228	-
2009	-	1090	-
Toplam	20954	4525	7231

Table 2 : The area burned in fires in Antalya, Izmir and Mugla regions between 2000-2009 (GFD, 2010)

Year	Antalya	Izmir	Mugla
2000	3854	2952	1451
2001	183	1020	526
2002	450	308	2072
2003	824	622	1194
2004	509	976	258
2005	404	438	945
2006	515	579	3416
2007	2093	963	1531
2008	17026	1790	665
2009	469	1603	260
Toplam	26327	11252	12318

belonged to Izmir (20,218), respectively. It was noted that the area burned in fires that occurred between these dates and that were bigger than 300 ha, made up the 55.24% of the total area burned in fires, in the existing 20 regional directorates in Turkey.

Contrary to Oliveras and Pinol (2006), a high level of relationship was not found between the number of fires and the area burned in the study area. Most of the fires destroyed small areas and spoil the relationship between the number of fires and the area burned. Only a second-order statistical relationship and a third-order statistical relationship, in terms of number of fires and the area burned, were found in Antalya and Muğla region, respectively. On the other hand, large fires that destroyed an area of over 300 ha in Turkey were examined, a strong relationship was found between the number of fires and the area burned. On analyzing Table 1 and 2 it was found that during the years when there were large fires, the area burned was high as well. Based on this, it is possible to conclude that the total area burned in Turkey was not higher during the years when there were more fires but during the years when there were large fires or the number of large fires were high. It is big forest fires that cause to burning of large forest areas in Turkey. Even fire fighting organization is successful against fires, extreme weather and appropriate fuel conditions, fires may burn large areas. Here, the point to consider is the amount and condition of inflammable material in the forest and extreme weather conditions. When these conditions occur, large fires are seen that lead to an increase in the area burned in Turkey.

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