

Characterization of the Large Fire Regime in SE France

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Introduction

Southeastern France is the most wildfire prone region of the country, covering 14.7 percent of its land area. The country, is the region most affected by wildfires, with 55 percent of the total number of fires recorded in the whole country from 2006 to 2008. It is a typical Mediterranean climate with hot and dry summers, often with strong NW wind, and includes plant communities well adapted to these drastic climate conditions. These combined fuels and weather conditions significantly increase the fire risk in this regions. Regionally, large fires (≥ 100 ha) may be up to 11 580 ha although they generally are not as big as in other Mediterranean countries. However, because of the high proportion of Wildland-Urban Interface in the region, these large fires are a major concern, especially in the most populated parts (départements Var and Bouches du Rhône) which also concentrate most fires.

Accordingly, it is important to characterize these large fires to improve regional fire prevention. This work intends to answer the following questions:

- What is the distribution of large fires in the study area?
- Is there a correlation between number of large fires and burned area?
- Is there a correlation between large fire metrics and the climate conditions?
- What are the fire return intervals of these large fires?
- Does the past fire regime impact the current fire size and the recent land cover?

Material and Methods

Study area

SE France is composed of 15 geographical districts called “départements”. In this region there is spatial variation both in terms of burned area and fire occurrence and the départements Bouches du Rhône & Var are among the most impacted (Ganteaume and Jappiot 2013). This work will focus on these two areas of SE France.

Fire data

Using the geo-referenced wildfires database of the French Forest Office (1960-2010), the fire history focusing

on large fires (size ≥ 100 ha) was studied for the 1960-2010 period in the study area. The total number of fires geo-referenced (size ≥ 1 ha) was 2710 and the large fires represented only 12 percent of the total number of fires but accounted for 90 percent of the total burned area.

We used spatial analysis (Arc GIS 10) to define the large fire regime in terms of the time interval since the last fire and of the fire recurrence (number of large fires that had occurred on a same spot and time interval between two large fires). Statistics on large fire occurrence, size and cause were used to highlight a possible spatial variation of these parameters in the study area.

Climate data

For this analysis, we selected total precipitation, summer precipitation and maximum temperature (monthly and yearly data). These parameters were recorded since 1960 in the 107 weather stations distributed in the study area.

Linear regressions were used to highlight correlations between large fire occurrence/size and climate conditions (yearly total precipitation and yearly maximum summer temperature).

Land Cover data

Six classes of the Corine Land Cover 2006 were taken into account in the analyses: coniferous stands, broadleaf stands, mixed stands, transitional woodland-shrubland, shrubland and grassland. The relationships between large fire regime and land use classes were investigated by spatial analysis and multivariate analyses.

Results and Discussion

Spatial variation of the large fires

In total, 338 georeferenced large fire ignitions were recorded in the study area between 1960 and 2010 (190 in Bouches du Rhône and 148 in Var) but the distribution of the number of large fires during the period studied did not significantly vary between the two départements contrary to the fire size (on average 583 ha/year burned in Bouches du Rhône and 2 217 ha/year burned in Var). This could be explained by the variation of landscape fragmentation between these two areas. Indeed, the département Bouches du Rhône presents a mosaïc of wildlands interspersed with agricultural areas, large fires being concentrated in natural spaces. In the department Var, large fires mainly occurred in the large wildland areas located on the coast. In the study area, the cause of large fires was known for

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only 23 percent of them, being 50 percent of these due to negligence. However, the knowledge of large fire causes is far better in Var (68 percent of known causes) than in Bouches du Rhône (only 6 percent of known causes), according to the National Forest Office's fire database. There is no spatial variation on the causes of large fires and the main cause is negligence in both areas; however, arson may be strongly underestimated in the département Bouches du Rhône as many arson fires may be recorded as fires of unknown causes (Fig. 1).

Temporal variation of the large fires and of the climate conditions

The analysis of the large fire history in the study area (Fig. 2) between 1960 and 2010, showed that there was a positive correlation between the size of large fires and the number of large fires (linear regression $p < 0.0001$; $R^2 = 0.30$). During this period, the fire history showed a slight decreasing trend in both parameters which was not significant, while the climate parameters showed a significant increasing trend in maximum temperature with time ($R^2 = 0.45$) and a non significant decreasing trend in total precipitation. This latter parameter did not vary spatially in the study area contrary to the maximum temperature which was significantly higher in the département Bouches du Rhône than in Var ($p < 0.0001$).

Both, the size of large fires and their occurrence were negatively correlated with total precipitation (respectively $R^2 = 0.09$, $p = 0.03$ and $R^2 = 0.11$, $p = 0.017$) and only the number of fires was correlated with summer precipitation ($R^2 = 0.19$, $p = 0.0015$). Maximum temperature was not a significant variable for the prediction of these variables.

Defining the fire regime

Between 1960 and 2010, the fire return interval (recurrence) in the two départements was up to five fires that had burned on a same spot but both were mainly affected by only one large fire event (46 percent of the total recurrence) or a recurrence of two fires (42.5 percent). In areas where the recurrence was high, large fires regularly occurred during the 50 year period, especially around cities and on the coast. In contrast, areas where the recurrence was low were mainly affected by old fires, especially inland (Fig. 3).

Large fire recurrence was mostly low (52 percent of the time intervals were longer than 16 years) with no spatial variation in the study area.

In the East of the study area (Var), the old fires were concentrated in the more fragmented plain area, which is located inland. In contrast, the most recent fires (time since the last fire shorter than six years) were located in the coastal wildland (Maures forest massif). No such trends were

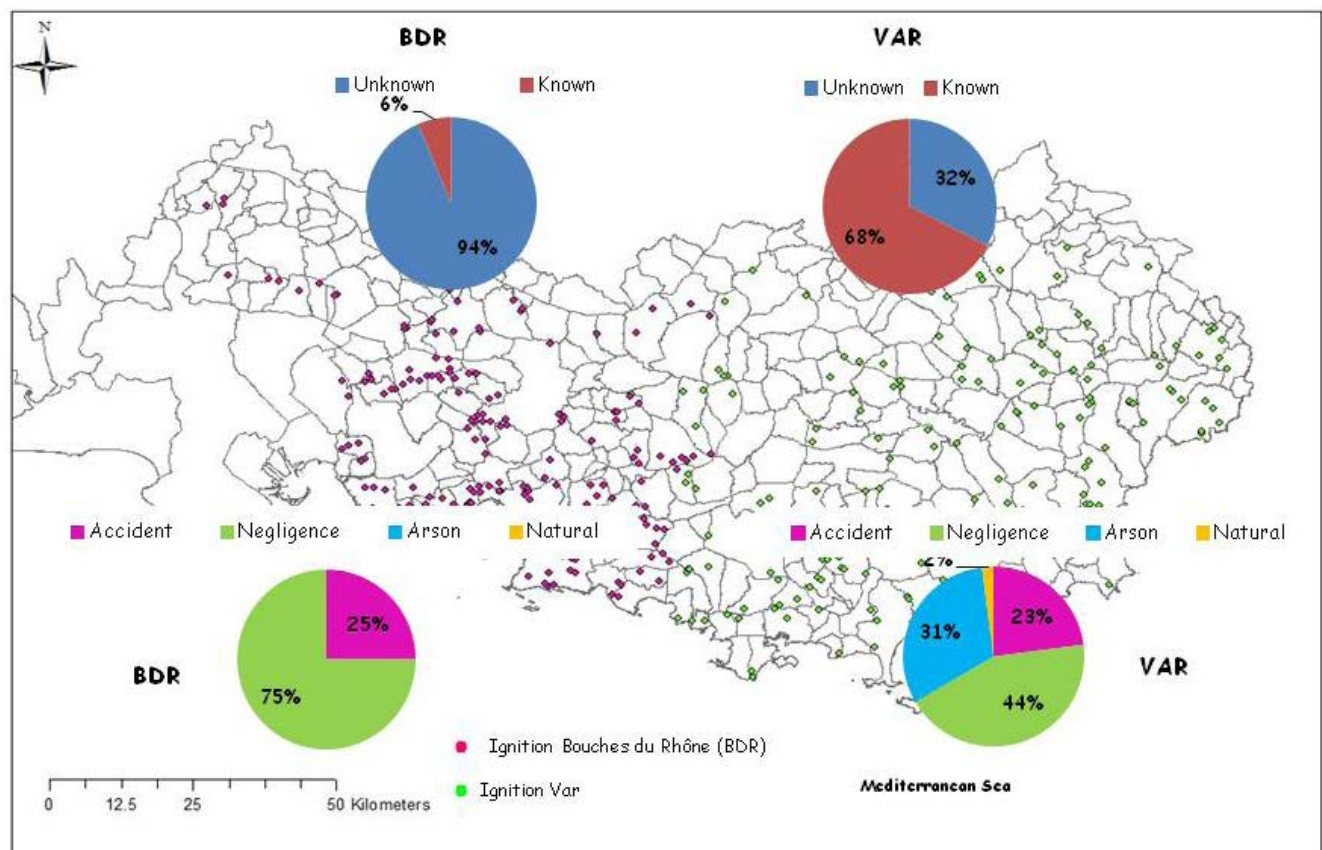


Figure 1—Large fire causes and their knowledge in the study area

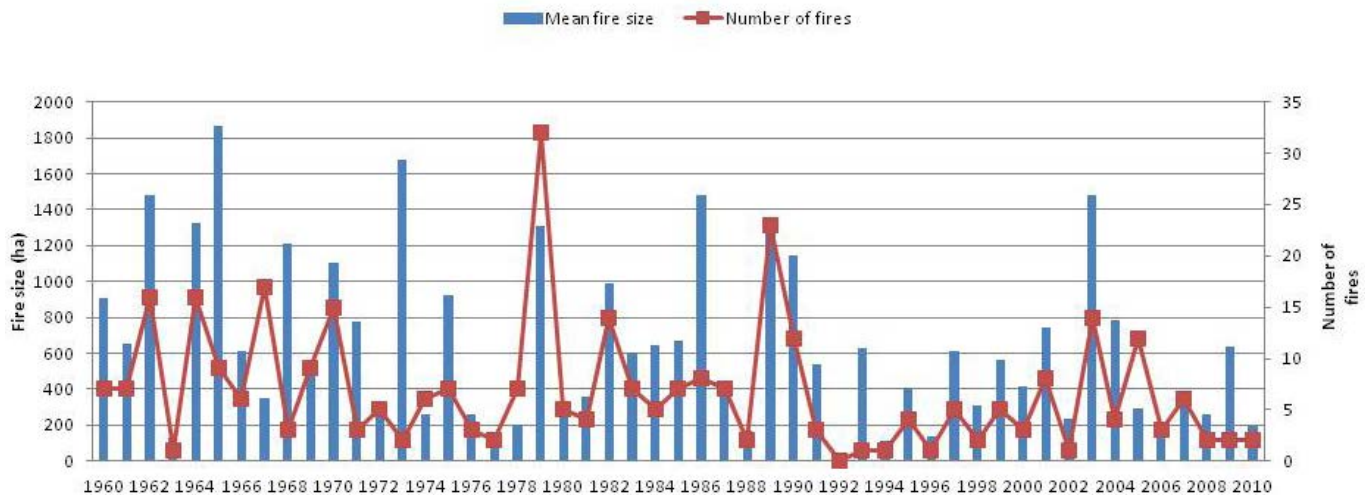


Figure 2—Large fire occurrence and size in the study area between 1960 and 2010

highlighted in the West of the study area where the distribution of old and recent fires was homogeneous.

Impact of the large fire regime on the size of the most recent fires and on the recent land cover

Statistical analyses showed that there was no effect of the time interval between two fires on the size of the most recent fire as well as there was no significant difference in size between two consecutive fires (for a fire return interval of at least 2 fires), even if the areas were reburned.

Multiple Component Analysis showed that there was an increase in the maturation of the vegetation (increase in forest land covers) with the decreasing number of fires and the increasing interval since the last fire. Moreover, the number of recurrent large fires had a significant effect on the recent land cover ($\text{Chi}^2=32.4$; $p=0.006$) as well as the time interval since the last fire ($\text{Chi}^2=169.5$; $p<0.0001$) but the time interval between two fires was not a significant variable.

Conclusions

A better knowledge of the large fire regime is necessary to strengthen fire prevention by providing valuable information on priority areas with high large fire hazard, especially in those areas where recurrent large fires are more likely to occur.

Large fires are spread homogeneously in the study area but their size is smaller when the landscape is more fragmented, especially in the West (Bouches du Rhône). Generally, these

fires are due to negligence; however arson may be strongly underestimated in the western part of the study area where the knowledge of the large fire causes is very bad.

During the period studied (1960-2010), large fire occurrence and size presented a slight decreasing trend and large fire occurrence and size were positively correlated. Both large fire occurrence and fire size were negatively correlated with precipitation.

In the study area, the large fire regime is characterized by a fire return interval up to five fires on a same spot between 1960 and 2010, especially around the cities (in the West) and on the coast (in the East), mainly with a long time interval between two recurrent fires. The older fires are located mainly in the most fragmented areas, whereas the most recent ones mainly occur in the wildland areas where the recurrence is the highest. Only the number of recurrent large fires and the interval since the last fire have a significant effect on the recent land cover (maturation of the vegetation), although these parameters do not impact the fire size

Reference

- Ganteaume, A.; Jappiot, M. 2013. What causes large fires in Southern France. *Forest Ecology and Management*. 294: 76-85. DOI 10.1016/j.foreco.2012.06.055

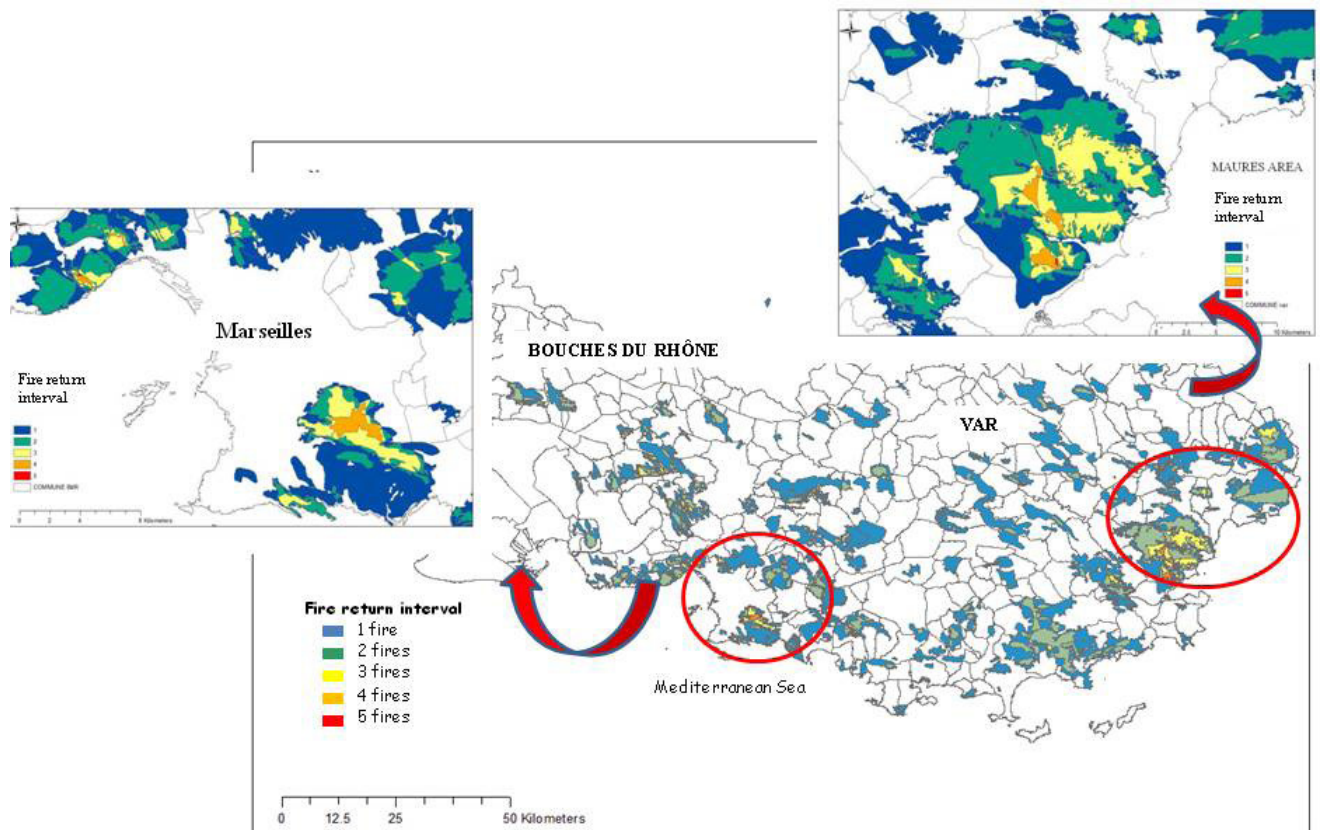


Figure 3—Map of the large fire scars according to fire return interval (number of fires) with focus on the most impacted areas