STUDY OF FIRES IN THE FRENCH MEDITERRANEAN AREA

(Provence-Alpes-Côte d'Azur)

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1. INTRODUCTION

1.1 PURPOSE OF STUDY

In France, the National Observatory of Natural Risks (ONRN) defines forest fires as any ***"fire covering a minimum area of 0.5 hectare in one piece and that at least part of the shrub and/or tree layers is destroyed***". According to Turner and Bratton (1987), forest fires are disturbances of abiotic origin whose source is external to the ecosystem, they originate from a point, and can then spread through the landscape.

Globally, forest fires are becoming an increasing source of concern to many governments, in recent times, climate change has been thought to be a major contributor to this increase in forest fires. 2020 statistics from Prométhée (national database dedicated to housing of forest fires data in France) show that the south-eastern part of France recorded some of the highest number of forest fires in the Mediterranean region. These fires of human origin are part of traditional agricultural practices, subject to multiple controls and prohibitions (Régis DARQUES, 2013).

The Mediterranean landscapes have undergone many transformations due to human action over the last millennia, however, for some authors these forest fires are caused by the excess of the Mediterranean climate and the fragility of the forest. In essence, the Mediterranean nature would carry within it the seeds of its own destruction: the recurrent summer drought and the flammability of the vegetation.

The objective of this study is to focus on the phenomenon of forest fires by putting the problem in the geographical context of south-eastern France (Provence-Alpes-Côte d'Azur). While it is true that there has been an increase in the understanding of the behaviour of forest fires, their impact on the environment, and control measures used in preventing and extinguishing them, it is however, quite important for us to study and understand the various factors that contribute to and influence the emergence of forest fires in this zone.

1.2 PRESENTATION OF THE STUDY AREA

The study area (Provence-Alpes-Côte d'Azur) covers about 31,400 km^2 and is made up of six department (Alpes-De-Haute-Provence, Alpes-Maritimes, Hautes-Alpes, Var, Vaucluse, and Bouches-du-Rhône) in the southern part of France. These departments are part of the Mediterranean ecoregion which is a set of low-lying and mid-mountain areas characterized by a Mediterranean climate. The region is bordered in the south by the Mediterranean Sea, to the east the Italian regions of Liguria and Piedmont and is bordered to the north by Auvergne-Rhône-Alpes region and to the west by the Occitanie region. Provence-Alpes-Côte d'Azur has 5,081,101 inhabitants in 2019, making it the seventh most populous French region. The economy and society of Provence-Alpes-Côte d'Azur are marked by immigration from both other regions and other countries: 47% of the region's inhabitants were not born on its territory and the proportion of immigrants is 10.2% (source Wikipedia).

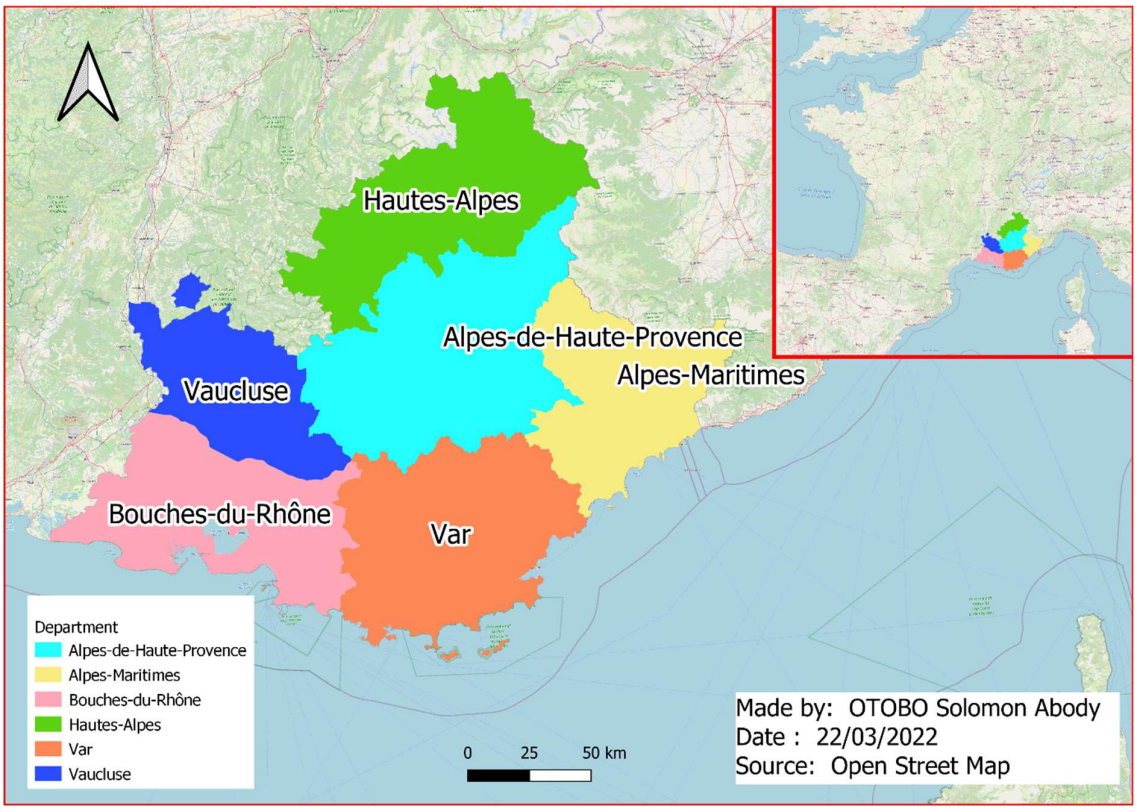

Figure 1: Geographical location of the Provence-Alpes-Côte d'Azur

2. METHODOLOGY

To effectively study occurrence of forest fires and their relationship with agriculture, climate, forest types and urban areas, a methodology to analyse and visualize data obtained from various sources (forest fire data between 1973 and 2022 from Prométhée, Land Use Land Cover maps, Climate maps) was applied by employing advanced GIS, cartographic and statistical tools to probe the inter-relationship between several factors (ecological conditions like and anthropogenic pressures), we explored data with spatial libraries in python (like geopandas, numpy, plotly) and PostgresSQL to create dynamic charts and maps that help us better understand the spatial distribution of forest fires in the Mediterranean area, particularly in south-eastern France.

Figure 2: Schema of methodology

2.1- PostgresSQL Database

After the data acquisition stage of the project was completed, we proceeded to the create a PostgreSQL database in order to start the pre-processing of the data. This process included for example, joining of layers and extraction of different landcover types from the land cover maps. It also included filtering of data tables and grouping of values by department and year**.**

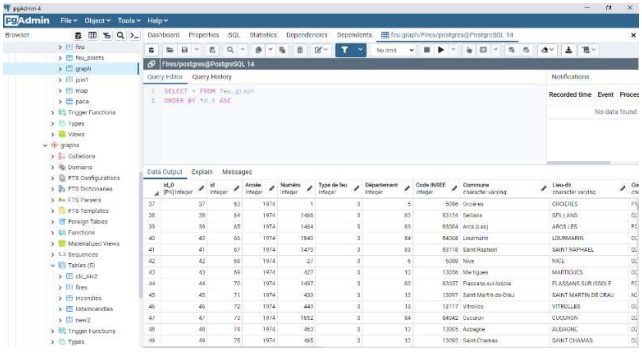

Figure 3: PostgreSQL database

2.2- Python

Most of the data analysis was done in Python and this involved importing the data from the PostgreSQL database and then using various Python libraries like geopandas, numpy plotly, matplotlib and hvplot to performed data analysis on them. At the end of the process a dashboard with various parameters that can be visualized according to the years and department was created.

A video explaining the functionality of the dashboard is attached to this report, the dashboard can be found and deployed in the in the Jupiter notebook and html file also attached to the report.

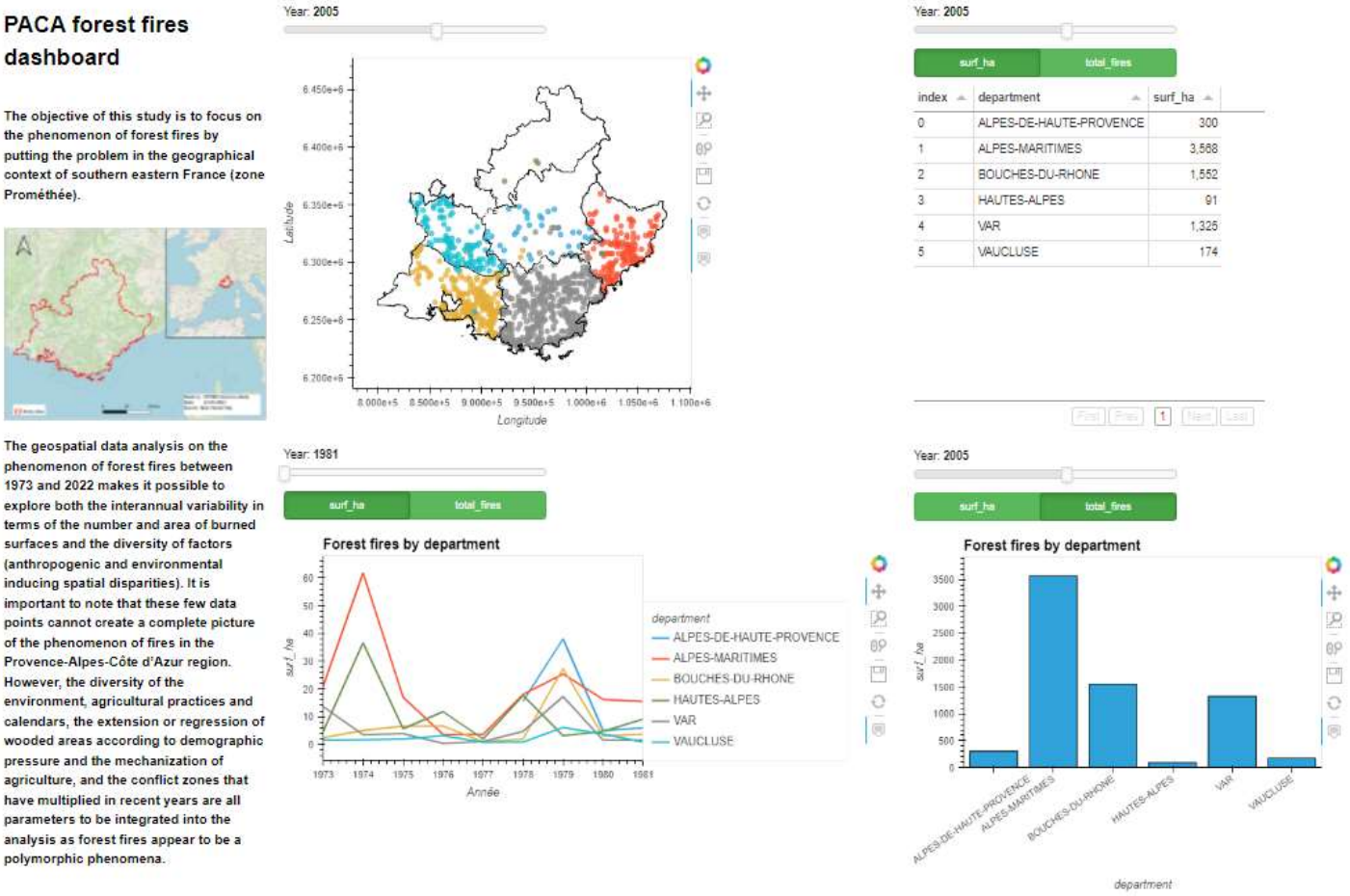

Figure 4: Screenshot of dashboard created

3 RESULTS AND DISCUSSIONS

FOREST FIRES: A REOCCURRING PHENOMENON.

The map below shows forest fires in the region of Provence-Alpes-Côte between 1973 and 2022. It can be seen on the map that the fires are distributed in a heterogeneous way over the area. The largest numbers are found in the region south of the Alpes-Maritimes, Var, and Bouches-du-Rhône.

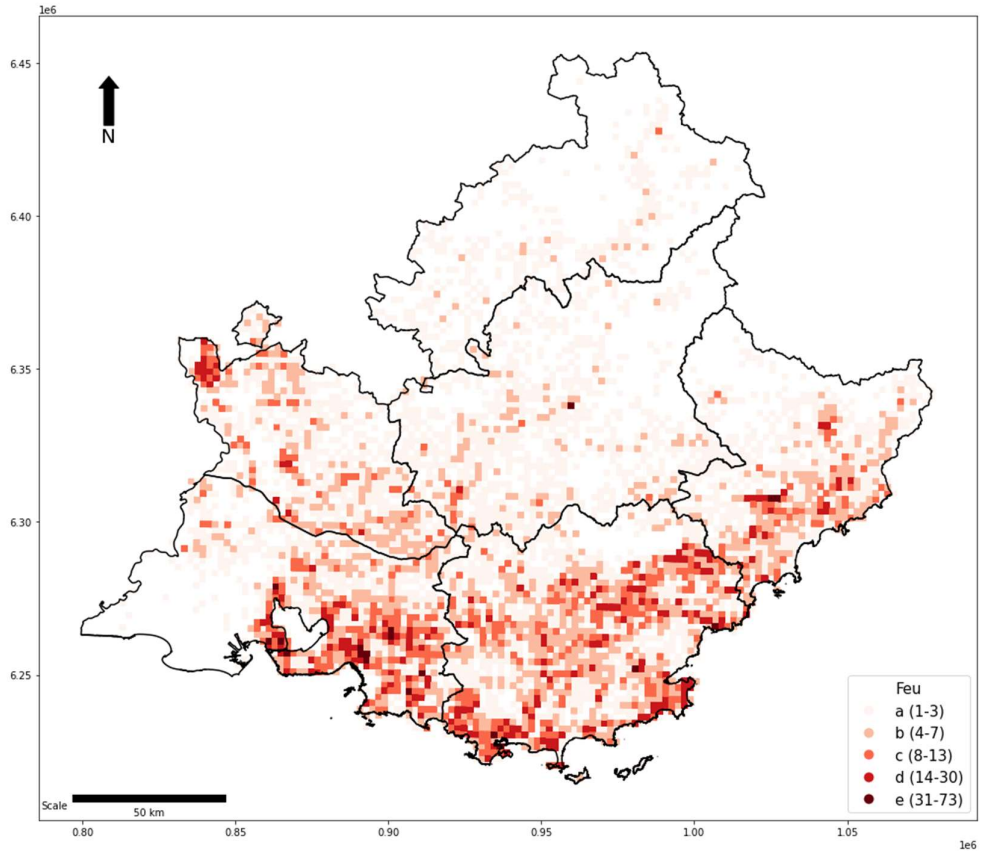

Figure 5: Geographical location of forest fires in PACA (1973 to 2022)

The analysis of the figure below allows us to say that between 1973 and 2022, there is an overall decrease in fires in the surface area and number of fires in the region. The year 2003 recorded a high rate of fire, this can be explained by the fact that 2003 was a very bad year on the fire front in France. It is one of the eight years most strongly affected by fire since 1977 (Vincent Clément, 2005).

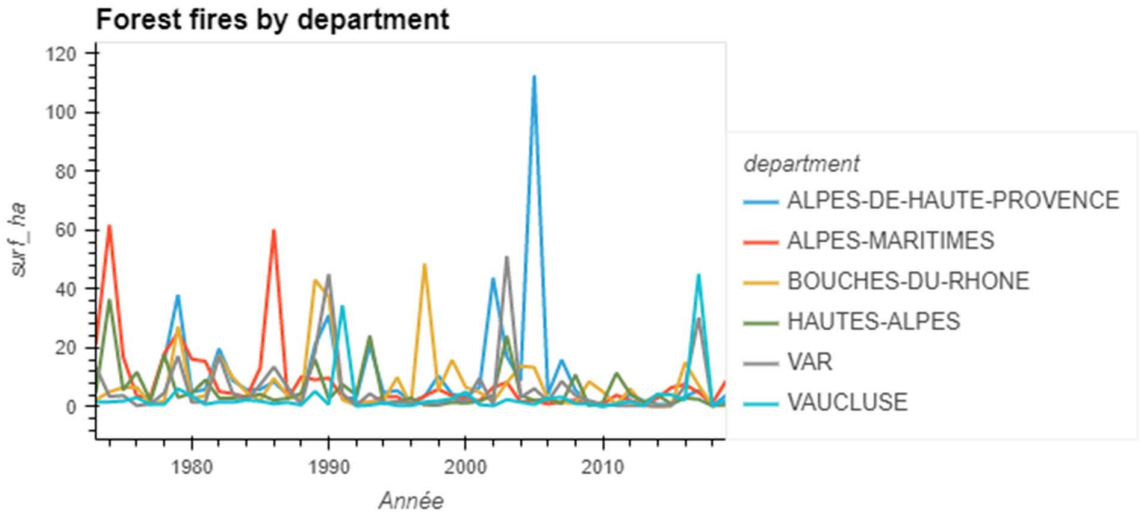

Figure 6: Plot of burned area by department and year

There was also a high rate of fire in 1989 and 1990, an order of magnitude comparable to that of 2003. But 2003 is an exception, since the 90s, the evolution of prevention and control policy combined with the appearance of new means has led to a significant decrease in fire activity (Helène Fargeon, 2020).

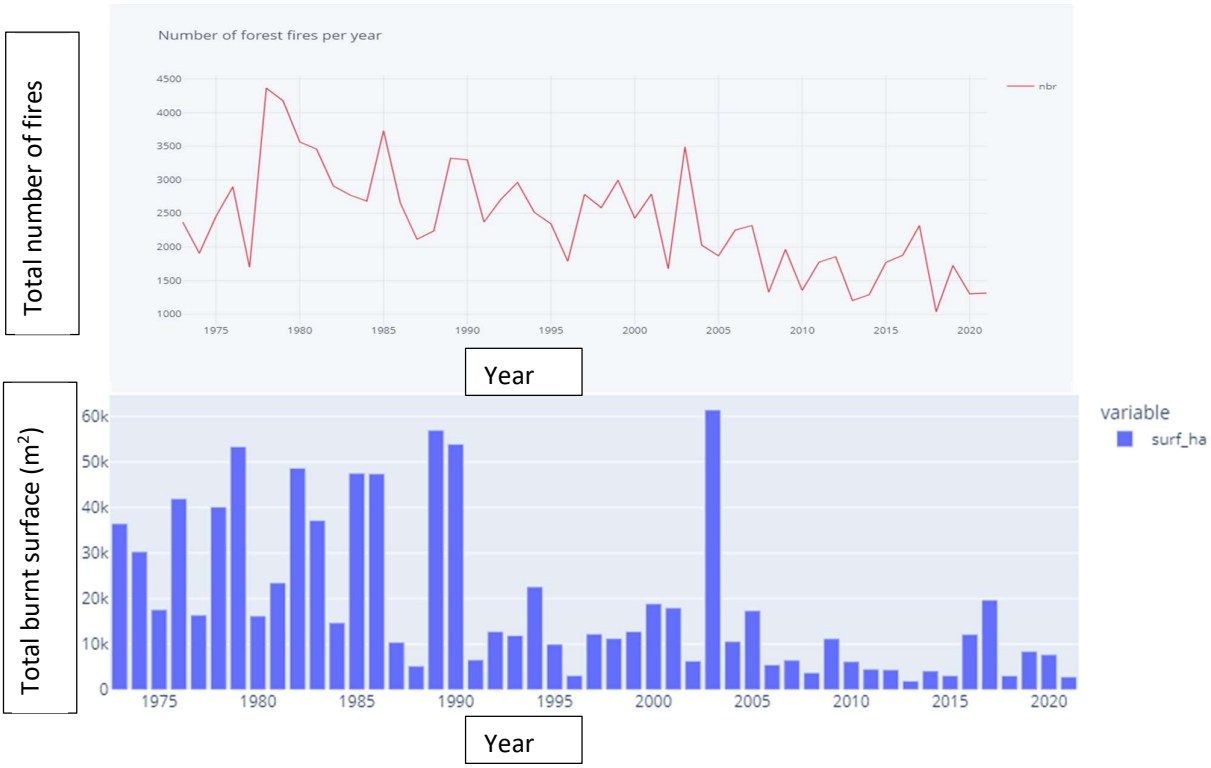

Figure 7: Evolution of forest fires in PACA (1973 to 2021)

3.2 FOREST FIRES AND CLIMATE

Between 1 February and 18 August 2003, south-eastern France and Corsica received only 200 mm of precipitation, representing a rainfall deficit of 50% compared to normal (Vincent Clément, 2005), the effect of these high temperature was seen in the exceptionally high occurrence of forest fires in 2003, maximum temperatures reached very high values, the effects of which had been amplified by the rain deficit.

The maps below represent the climate typology of the study area, there are 5 main types of climates: mountain climates, semi-continental climate and the climate of the mountain margins, the altered Mediterranean climate, the climate of the South-West basin, and the frankish Mediterranean climates.

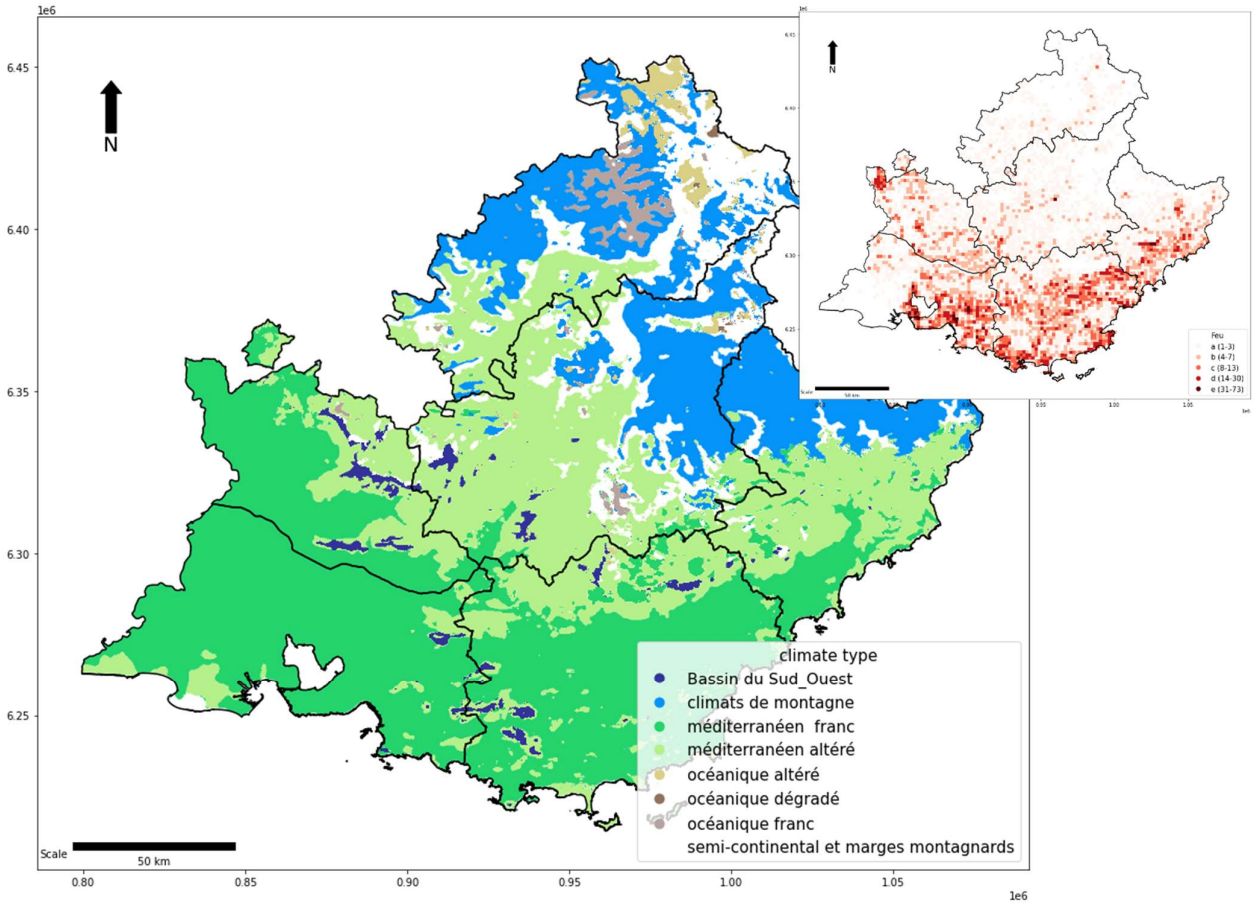

Figure 8: Climate zones and forest fires in PACA

It can be seen that the area occupied by the **Frankish Mediterranean** climate concentrates more forest fires. In view of the two maps, we can say that climate plays a role in the phenomenon of forest fires. We can also see from the figure below that there is a high occurrence of forest fires between July and August, especially in the Var and Bouches-du-Rhône departments which are characteristic of the Frankish Mediterranean climate.

Figure 9: Seasonal variation of forest fires in PACA

This situation can be explained by the fact that annual temperatures are high in this area and hot days are frequent. This confirms the thesis of Helène Fargeon (2020) who states that temperature also acts directly on the ignition and development of fire. Therefore, there is a low rate of fires in the **mountain climate** zone, because in these areas rainfall is high, and the average temperature is below 9.4°C. The interannual variability of July temperatures is in this zone is minimal and the summer is repetitively hot from year to year.

It must therefore be remembered that relative humidity acts via processes similar to temperature on the risk of fire. Low relative humidity of the air will lead to a decrease

in the water content of dead fuel, in equilibrium with the atmosphere at short characteristic times (Helène Fargeon, 2020).

3.3 FOREST FIRES AND FOREST TYPES

The Mediterranean Forest ecosystem is home to nearly 10% of the world's top plant species. The diversity and abundance of these ecosystems are the result of an evolutionary response to human disturbances that have been progressively applied for at least 50,000 years. In 2006, the national forest inventory listed 3.6 million hectares of forest stands that could be characterized as Mediterranean in France.

As a disturbance, fire in itself already has a wide range of facets resulting in differentiated impacts on a given ecosystem. The wooded areas of the south of France have a high fuel potential due to the species present and the climate. There are 6,000 French communes classified as "at risk of forest fires", i.e., one in six communes. Three-quarters of the French municipalities that have suffered fires are located in the southern half of France. In 2008, with 2,781 forest fires, France ranked 8th among the European countries most affected by forest fires. Each year on average, 4,000 fires start, and 24,000 ha of forests are burned in metropolitan France, this situation is explained by the fact that the departments of the French Mediterranean region have vegetation favourable to the outbreak of forest fires Céline Magnier (2011).

The figure above shows the areas exposed to forest fires. French Mediterranean forests have specific characteristics, which differentiate them from other forests (Léa Veuillen, 2016). They include forest stands, composed of stands whose species that have been mapped are: (Deciduous forests, Coniferous forests, mixed forests, Sclerophyll vegetation). It can be seen that the regions of the French Mediterranean area are experiencing a high rate of forest fires

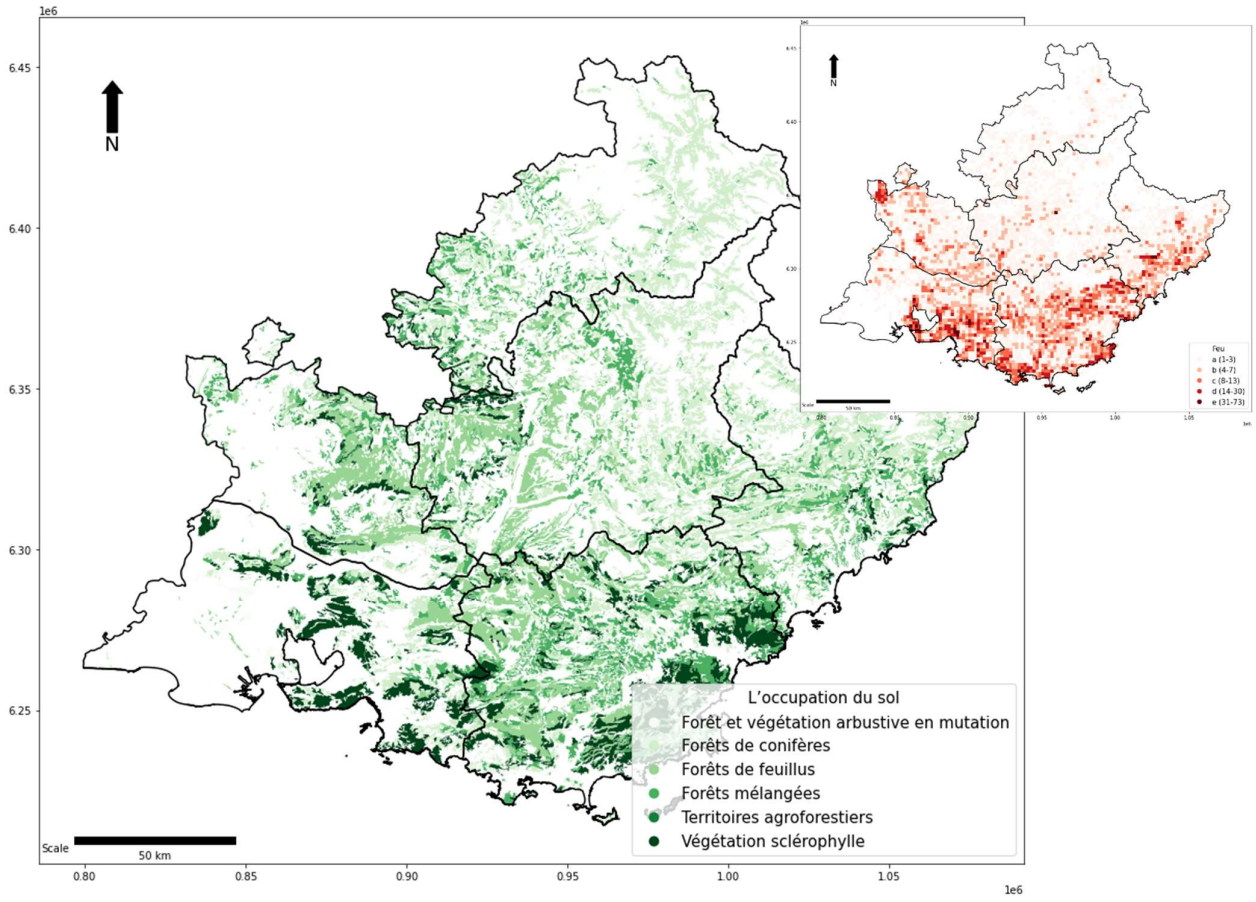

Figure 10 : Map of some forest species in PACA

3.4 FOREST FIRES AND URBAN ACTIVITIES

Indeed, 90% of fire outbreaks are linked to human activity in Mediterranean Europe. The map below represents the urban areas in the region of study, and the burnt areas between 1973 and 2022. We can see a concentration of built-up area in the southern part of the study area just like we observed on the fire map. As a result, the hypothesis according to which there is a correlation between urban areas and the location of fires is validated.

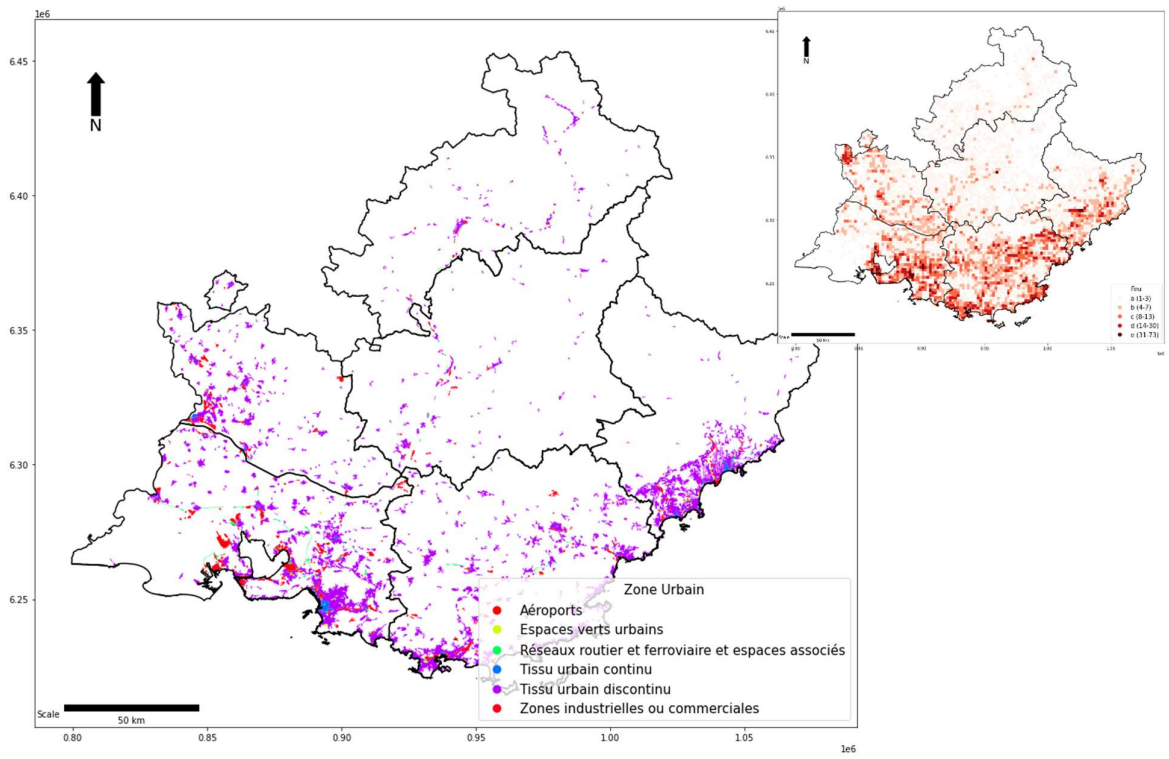

Figure 11: Urban areas and forest fires in PACA

Indeed, the influence of urbanization on the occurrence of forest fires in the region is a hot topic for many state actors and policy makers. Although we cannot conclusive say the vast majority of forest fires are linked to urban activities, however, the data from the Prométhée website shows that about 8% of the observed fires are linked to urban activities (travaux). This can not be ignored as a mere coincidence.

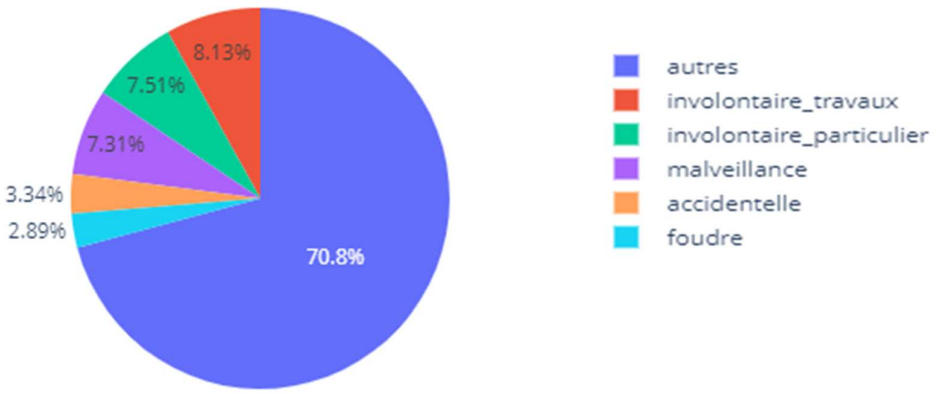

Figure 12: Causes of forest fires in PACA (1973 to 2021)

3.5 FOREST FIRE AND AGRICULTURAL ACTIVITY

In the most cases, many fires are caused voluntarily and are part of a process of economic development of the territories. The practices are most often framed by legal provisions and occur at key moments in the agricultural calendar, whether it is post-harvest slash-and-burn (straw cereals) or pastoral slash-and-burn. We therefore wanted to show in this part the correlation between the areas occupied by agriculture and the burned areas (figure 13).

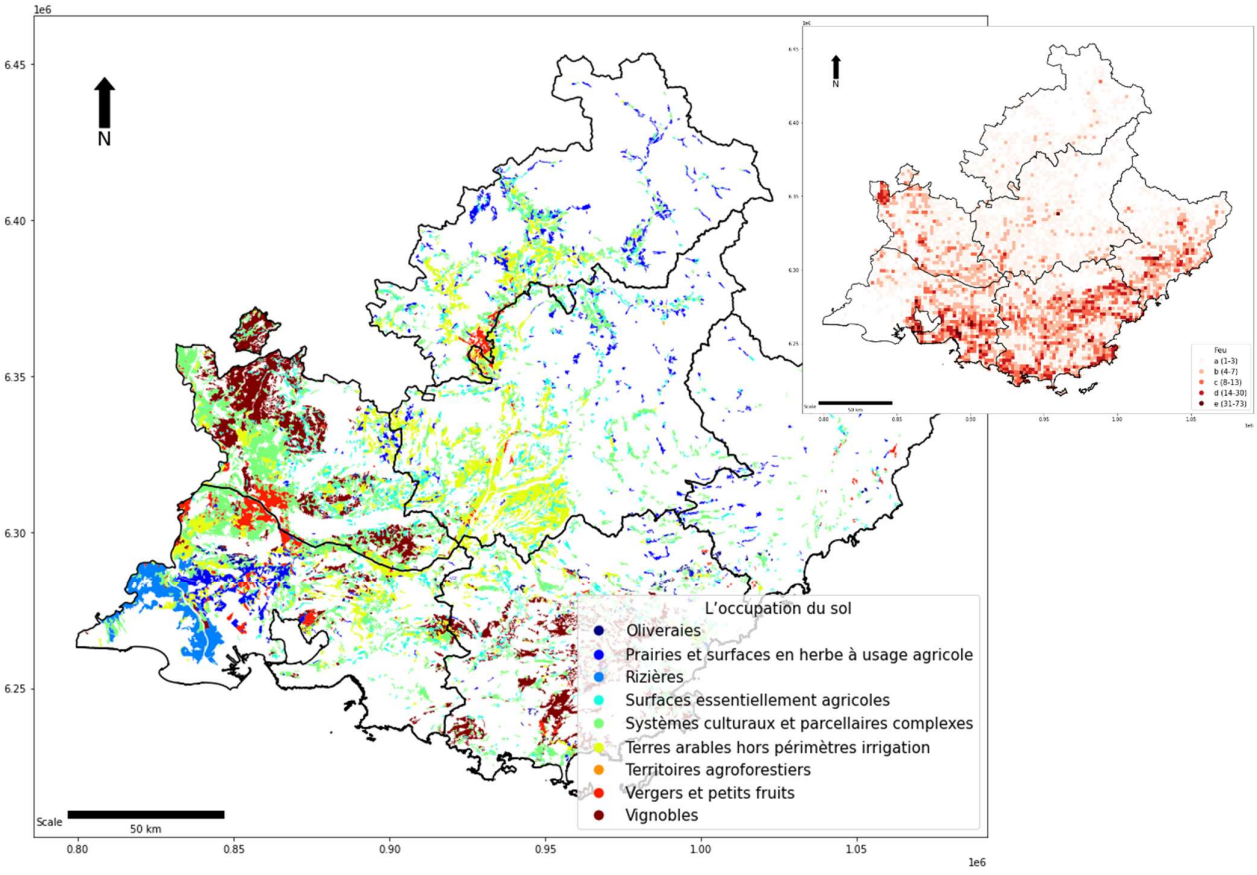

Figure 13: Correlation between agriculture and forest fires in PACA

On the analysis of this figure, we first see that agricultural areas are distributed in heterogeneous ways in the area. Logically, we can see on this map that most of the spaces occupied by agriculture are affected by the phenomenon of fire, we can therefore infer from the foregoing that there is a link between the two even though we have not considered any form of statistical correlation in this study.

CONCLUSION

To conclude, the geospatial data analysis report on the phenomenon of forest fires between 1973 and 2022 made it possible to explore both the interannual variability in terms of the number and area of burned surfaces and the diversity of factors (anthropogenic and environmental inducing spatial disparities). Indeed, the production of graphs and various maps made it possible to refute or confirm the correlation of fire outbreak and anthropogenic and environmental factors.

One of the most eloquent correlations mentioned in this report is that built-up areas in close contact with forests (habitat-forest interface) represent a source of danger for populations and should become a real concern for policy makers. It is important to note that these few pages cannot make it possible to make a complete statement of the phenomenon of fires in the Provence-Alpes-Côte d'Azur region.

However, it must be remembered that the diversity of the environment, agricultural practices and calendars, the extension or regression of wooded areas according to demographic pressure and the mechanization of agriculture, and the conflict zones that have multiplied in recent years are all parameters to be integrated into the analysis. Forest fires appear to be a polymorphic phenomenon, the dashboard provided can help state actors and policy makers visual and analyse the data, thus facilitate better decision making.

BIBLIOGRAPHY

- **Work:**

Céline Magnier, 2011 : The risk of forest fires in France, Revue, 44p, ISSN : 2102-4723 ISBN : 978-2-11-099417-2, http://www.statistiques.developpement-durable.gouv.fr

French COMMITTEE of IUCN, 2020: The Red List of Ecosystems in France - Chapter Mediterranean Forests of Metropolitan France, Technical Report, Paris, France, 301 pages + annexes. ISBN: 978-2-918105-83-1.

Hélène Fargeon, 2020: Effect of climate change on the evolution of forest fire hazard in metropolitan France in the 21st century, Thesis, 257p.

Léa Veuillen, 2016: Recognizing the particularities of French Mediterranean forests, Internship report, AgroParisTech, 38p.

Lefort Jerôme, 2006: Fighting fires: Prevention and management,
Organization of services, responsibilities, Le Moniteur Editions,

Régis Darques, 2013 : Myth and reality of the "great" fires in the Mediterranean, OpenEdition journal, Article p. 11-21 https://doi.org/10.4000/mediterranee.6796

- **Site**

- **https://www.promethee.com/fires**
- **https://fr.wikipedia.org/wiki/Provence-Alpes-C%C3%B4te_d%27Azur**
- **https://www.ecologie.gouv.fr**