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Urban fire analysis in Lisbon Metropolitan Area

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Abstract: Urban fires are one the major threats to the security of the urban population. Given their spatial context they have direct impact on the economy, inhabitants and destruction of property and heritage in the community. In Lisbon metropolitan area, almost 75% of the urban fires occurred in residential buildings, between 2006 and 2020 and were recorded 150 deaths and 275 severely injured victims. The analysis of the urban fire cases suggests that the nearest suburban municipalities from Lisbon record the highest number of residential fires and victims. Allied with geographic information techniques, theses detailed studies are crucial for the city's urban planning and security and risk reduction strategies.

Keywords: urban fires, Lisbon metropolitan area, urban risk.

1. Introduction

Cities face an increased risk of fire, as result of the combination of a high-density buildings and contiguous buildings, that facilitate fire propagation and difficult their extinction by rescue units (Vicente et al, 2011). Likewise, there are another urban fire conditioning factors, such as the building's conservation status and the construction materials associated with the date of construction. This can be seen in older buildings that tend to have more inflammable materials, faulty electrical systems and lack of maintenance, similarly to vacant units (Castro et al, 2005; Vicente et al, 2011). Social demographic factors are equally as important to understand the distribution of urban fires (Jennings, 2013). For instance, residential fires are the most common urban fires, being more likely to happen in lower-income and higher population density neighbourhoods due to: overcrowded units, poor housing, unsupervised children, and improper use of domestic appliances and dangerous substances (Jennings, 1999; Castro et al, 2005).

This study takes place in the Lisbon Metropolitan Area (Portugal), with 18 municipalities and 118 parishes. According to the population census (INE, 2021) this is the most populated area of the country, with 2.8 million people living in 1.5 million residential buildings. Almost half of these buildings had been built before 1980. Additionally, there are more buildings built before 1919 (4%) than buildings built between 2001 and 2021 (3.1%). Lisbon municipality contributes the most for this statistic. In the peripheral areas, 30% of Barreiro and Montijo's buildings are at least 60 years old, while Alcochete, Mafra and Sesimbra municipalities have almost 30% of their buildings built in the last 20 years (INE, 2021).

In this study, an urban fires database obtained from the National Emergency and Civil Protection Authority (ANEPC) was used to characterize the temporal evolution and the spatial distribution of the urban fires cases at the parish and municipality level in the LMA for the period 2006 – 2020.

2. Data and methods

The ANEPC database combines the records of the incidents which the firefighters were called. The information available includes the geographic coordinates, time (year, month, day, and hour), classification of the dispatch, duration of the fire (in minutes), municipality, parish, building typology (residential,

administrative services; army, security forces and emergency unit; dilapidated and vacant building; hospital, health center and nursing home; factory, workshop and warehouse; mall and transport station; parking lot; school and university; show and museum; sports and leisure), victims (fatalities, seriously injured people, injured people, other victims) and a description of each event. The urban fire database provided by the ANEPC, includes 36,986 urban fires records in LMA during 2006-2020. For this analysis were not considered incidents classified as false alarms (26%), firefighter's dispatches (1.6%) or with missing information (0.3%), meaning only 29,133 records were eligible for a detailed analysis.

The description field is the only optional answer and open answer field, therefore the information is miscellaneous and could include: information about the source of ignition, transcripts of the emergency call, and full addresses. However most of the records are blank. It was assumed that the coordinates were not accurate after noticing discrepancy patterns. Using satellite images in a GIS environment, each record was associated with the quality of the georeferencing process: (a) building location, if the address was available on the description field; (b) parish's centroid. Additionally, one more attribute was created, regarding the source of ignition of each record of urban fire, according to Vicente et al. (2010) classification: (a) electrical; (b) thermical; (c) chemical; (d) mechanical.

3. Results

3.1 Urban fires in LMA

Between 2006 and 2020, 29,133 urban fires occurred in the LMA distributed by 11 building types. Nearly 75% of the urban fires took place in residential buildings, therefore the other building types are less relevant. Fires in factories, workshops and warehouses represent 7.8%, hotels and restaurants have almost 6% and dilapidated and vacant buildings about 5%. Only 0.3% of the urban fires could be associated with the respective building, 37.6% with the parish's centroid and the remainder 62.1% were impossible to verify their accuracy, therefore they were located at the parish's centroid.

Table 1 – Urban fires frequency, type and consequences from 2006 to 2020, in LMA municipalities

Municipality	Urban fires (Nr.)	False Alarms (%)	Seriously Injured (Nr.)	Fatalities (Nr.)	Residential Fires (%)
Alcochete	218	28.0	7	1	62.8
Almada	2355	19.0	35	17	74.1
Amadora	1816	25.9	19	14	78.1
Barreiro	949	28.6	4	2	70.0
Cascais	2403	33.4	17	7	75.2
Lisboa	3021	14.7	23	24	75.7
Loures	2180	25.0	20	15	73.3
Mafra	813	27.7	9	1	65.4
Moita	722	15.1	3	6	72.4
Montijo	638	24.1	6	4	63.8
Odivelas	1543	23.1	19	9	74.7
Oeiras	2001	41.8	10	9	75.3
Palmela	769	24.2	5	3	68.1
Seixal	1797	19.4	28	5	78.1
Sesimbra	492	26.6	8	2	74.2
Setúbal	1696	34.6	24	5	69.3
Sintra	4277	32.1	31	22	77.4
Vila Franca De Xira	1347	28.2	7	4	71.0

Regarding the source of ignition, only 10% could be exploited from the urban fires analysed, nevertheless the most common is electrical, then thermical and per last chemical, with almost none expression.

Sintra and Lisboa are the most populated municipalities and consequently the ones with more urban fires, with 4,277 and 3,021 urban fires respectively (Table 1), opposing Alcochete (218) and Sesimbra (492) with less population and urban fires. The average percentage of false alarms is 26%, however Oeiras has almost 42% and Cascais, Setúbal and Sintra have values above the 30%.

The fires analysed resulted in a total of 8,000 injured people, of which 275 were seriously injured and with a greater representation in Almada (35) and Sintra (31). Lisboa has a higher concentration of fatalities (24) caused by urban fires, followed by Sintra (22). Moreover, Amadora and Seixal have the higher percentage of residential fires (78.1%) and Alcochete (62.8%) the least.

3.2 Temporal evolution of urban fires

The annual distribution of urban fires reveals a descendent trend with two distinct periods (Figure 1). Before 2012 the annual average number of urban fires was 2100 with a maximum of 2187 in 2006. After 2012 the average number of urban fires decreases more than 8% (1784). At the monthly scale the differences between the number of urban fires range from 7% to 10%. There are more incidents in the coldest months, January (9.7%) and December (10.3%), and less in the milder temperatures months, meaning April (7.6%) and October (7.4%). Additionally, an in deep analysis of the ANEPC database allow to observe that more urban fires occurred on weekends (30%) and more frequently between 6pm and 9pm (20.6%).

3.3 Spatial distribution of the urban fires

There is a concentration of urban fires on the Sintra-Amadora-Odivelas-Loures municipality axis (Figure 2). The parishes with more than 0.15 residential fires per number of residential buildings are the one by descending order: *Massamá and Monte Abraão* in Sintra; *Venteira* in Amadora; *Santo António dos Cavaleiros and Frielas* in Loures; *Cacém and São Marcos* in Sintra; *Agualva and Mira-Sintra* in Sintra; and *Odivelas* in Odivelas. The less hazardous parishes are for instance*: Sesimbra (Castelo*) in Sesimbra; *São Francisco* in Alcochete; *Almargem do Bispo, Pêro Pinheiro and Montelavar* in Sintra.

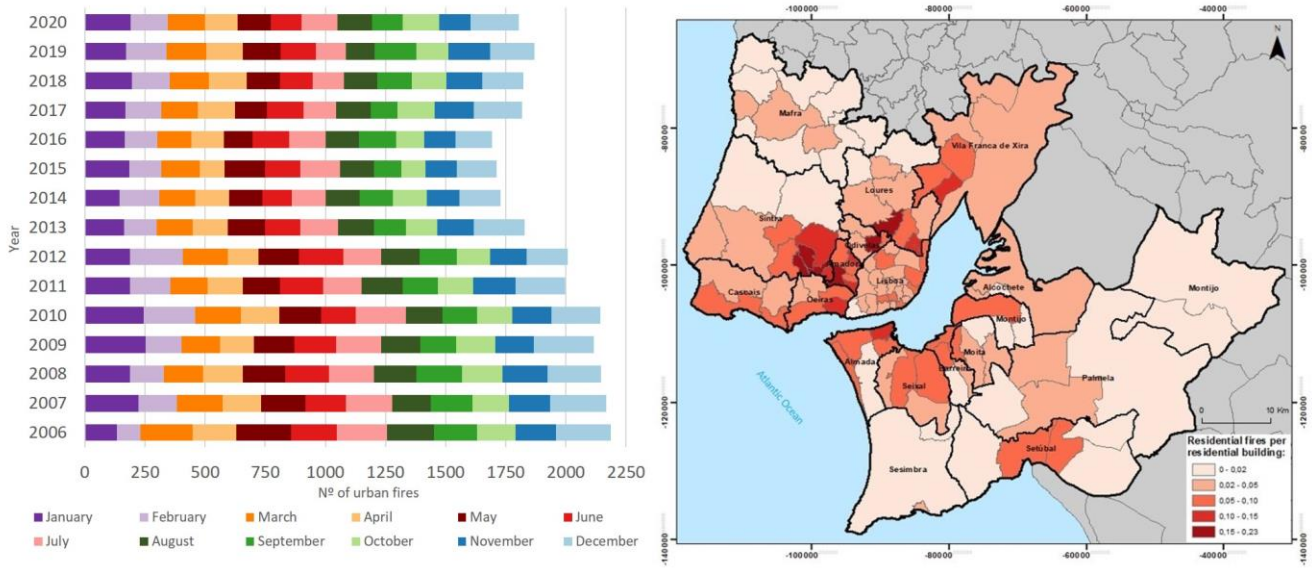

Figure 1 – Annual and monthly distribution of urban fires and residential fires by the number of residential buildings from 2006 to 2020, in LMA

4. Discussion and conclusions

This study explored an urban fire database in LMA, Portugal in the last 15 years. At the parish level, it was possible to demonstrate the spatial distribution and temporal evolution of urban fires. The results suggest that there are more urban fires in the north side of the LMA, especially residential fires in suburban municipalities of Sintra, Amadora and Odivelas. In addition, the most frequently urban fires occurred in the colder months, ignited by an electrical source, on weekends at dinner time. Although the results are valid there is a lack of accuracy in the geographic coordinates of the urban fires, which prevent the identification of hotspots at a neighbourhood level. Future work will be performed to assess urban fires susceptibility in the LMA at the parish level.

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