

*3rd International Meeting of Fire Effects on Soil Properties*

## **Field Trip Guidebook**

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## 4. Forest Fires in the Portuguese northwest

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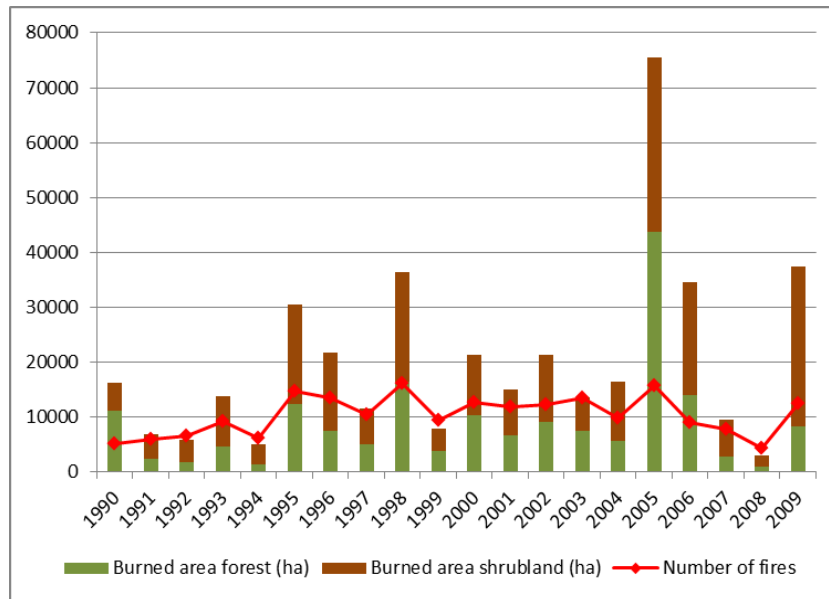
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The number of occurrences of forest fires and the scorched areas in the Portuguese northwest is remarkably high. In the period from 1990 to 2009 there were a total of 206423 occurrences, representing 43,7% of the total occurrences on the national level. However, in relation to the area scorched by forest fires the same period registered a total of 387395 hectares, which represented only 16,01% of the total area scorched in the whole of the Portuguese territory for the period under consideration (Table I and Figure 1).

**TABLE I** – Historical record of the number of forest fires occurrences and scorched areas (hectares) in the Portuguese northwest in the period of 1990 – 2009

Year	Number of fires	Scorched forest area (ha)	Scorched Shrubland área (ha)	Total Scorched area (ha)
1990	5049	11219	5062	16281
1991	5867	2434	4461	6895
1992	6476	1753	4047	5800
1993	9179	4689	9013	13702
1994	6207	1329	3623	4952
1995	14657	12307	18263	30570
1996	13489	7380	14394	21774
1997	10394	5087	6530	11617
1998	16136	16482	19851	36333
1999	9492	3871	4069	7940
2000	12667	10245	11162	21407
2001	11947	6671	8405	15076
2002	12228	9191	12225	21416
2003	13465	7462	6204	13666
2004	9760	5601	10773	16374
2005	15688	43663	31869	75532
2006	9025	13940	20705	34645
2007	7772	2882	6605	9487
2008	4394	1009	1946	2955
2009	12531	8245	29218	37463
<b>Total</b>	<b>206423</b>	<b>175460</b>	<b>228425</b>	<b>403885</b>

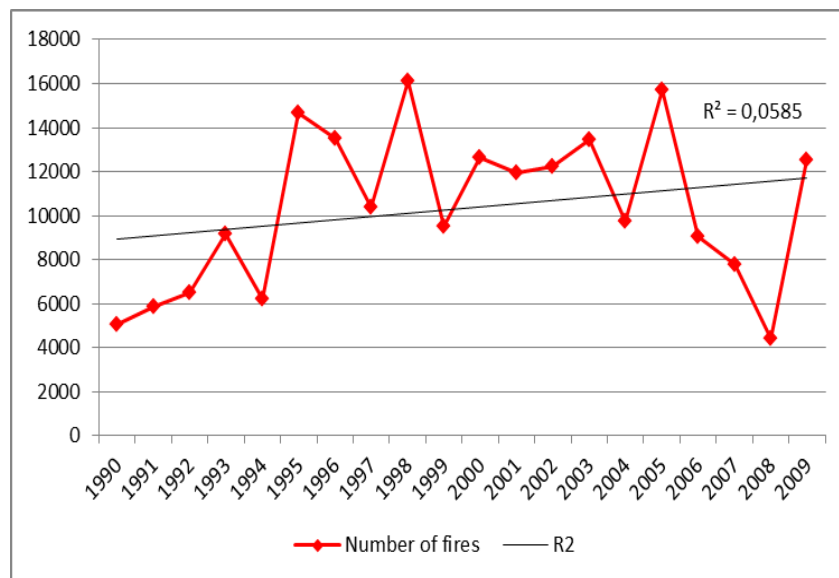
Source: AFN, 2010



Source: AFN, 2010

**Figure 1** – Evolution of the annual number of forest fire occurrences and total scorched area in the Portuguese Northwest in the period of 1990 – 2009

Just as was case in the national context, the years of 1998 and 2005 registered the highest number of occurrences in the northwest region, with 16136 and 15688 respectively. The reduction of occurrences in the years between 2005 and 2008 (presenting the lowest value in the 19 year period under analysis) are worth signalling. This tendency was inverted in 2009. Nevertheless, we can confirm a tendency, though slightly attenuated ( $R^2=5,8\%$ ) for the rise in the number of occurrences (Figure 2).

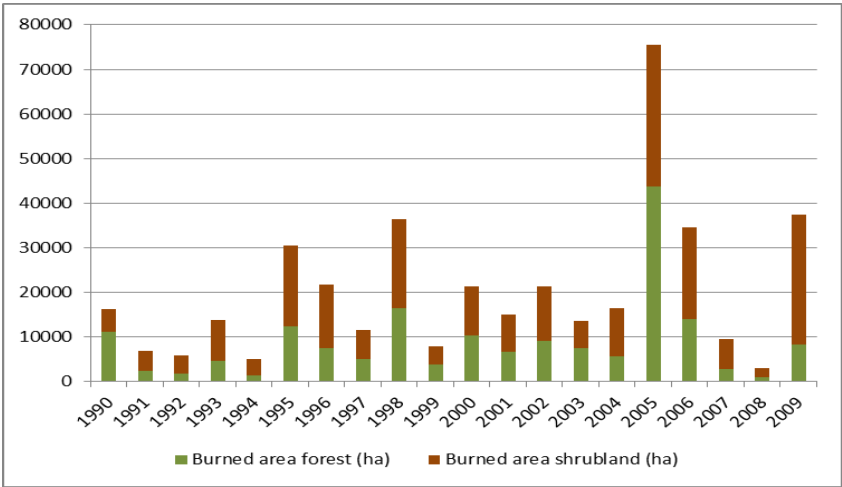


Source: AFN, 2010

**Figure 2** – Evolution of the annual number of forest fire occurrences and tendency line for the Portuguese northwest for the period of 1990 - 2009

Regarding the area scorched in the northwest region, the years 1998, 2005, 2006, and 2009 registered higher values and it is interesting to note that while 2003 had the highest

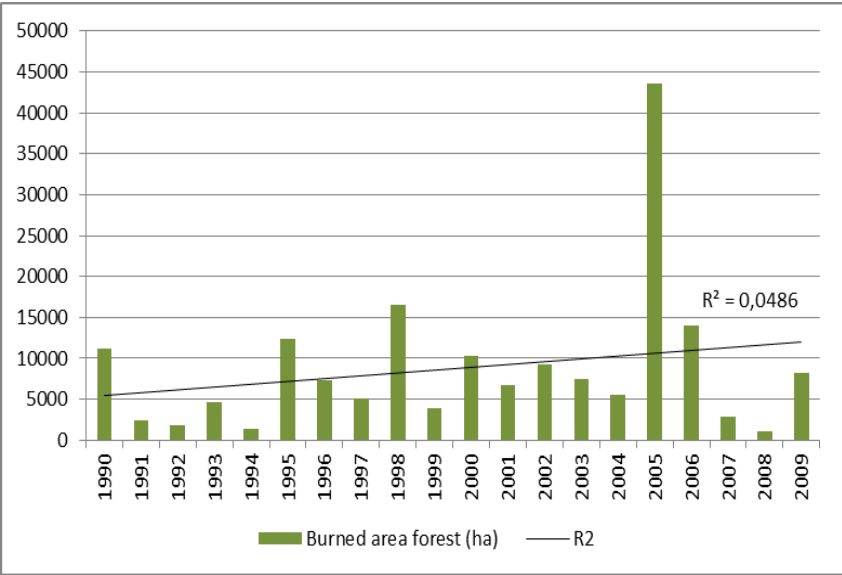
value at the national level, in regional terms it presented a rather diminished area. For the northwest 2005 witnessed the largest area scorched. 2008 stands out as the lowest value for this time series (Figure 3).



Source: AFN, 2010

**Figure 3** – Evolution of the total scorched area (ha) in the Portuguese northwest for the period 1990-2008

The area of the settlements scorched annually is marked by annual variations which vary from a minimum of 1009 ha (in the year 2008) to a maximum of 43663 ha (in 2005). The year 2005 is an exception since it recorded unusually high values for the region (Figure 4).



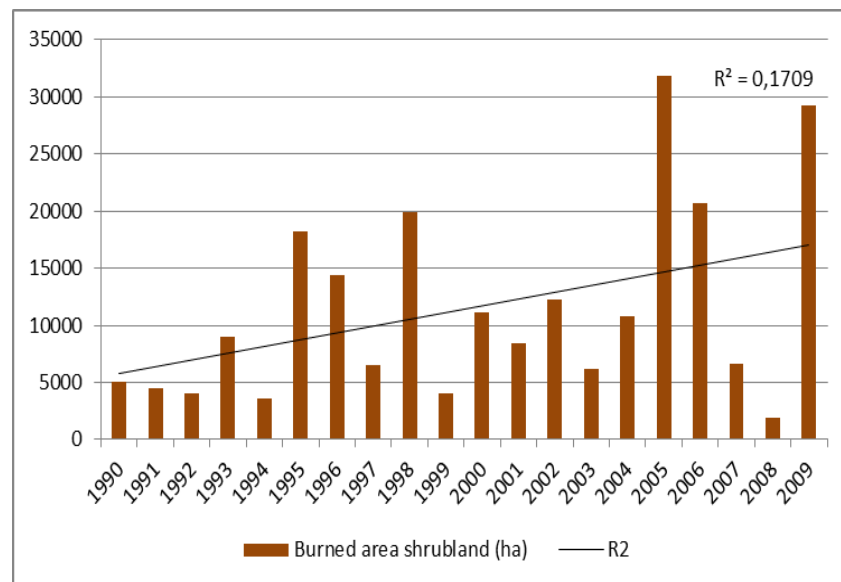
Source: AFN, 2010

**Figure 4** – Evolution of the scorched areas of settlements (ha) and tendency line for the Portuguese northwest for the period 1990-2009

By analyzing the tendency line we can observe the existence of a positive correlation between the scorched settlement areas and the temporal evolution. More precisely, we can verify a tendency for augmentation of the scorched areas in the long run. However, the square

of the correlation coefficient ( $R^2$ ) indicates that only 4,86% of that growth can be correlated with the temporal evolution (Figure 4).

The area of shrubland scorched annually varies considerably. The lowest value was 1946 ha in 2008, which contrasted to the 31869 ha of 2005. Since 1993, only five years lowered under 500 ha (1991, 1992, 1994, 1999, and 2008). 2005 registered the highest value in the series with 31869 ha, while 2008 revealed the lowest value with 1946 ha. There is also a tendency for the area of shrubland scorched to augment over time. The correlation between the temporal evolution and the referred to scorched areas ( $R^2$ ) is 17,09% (Figure 5).



Source: AFN, 2010

**Figure 5** – Evolution of the scorched area of shrublands (ha) and tendency line in the Portuguese northwest for the period 1990-2009

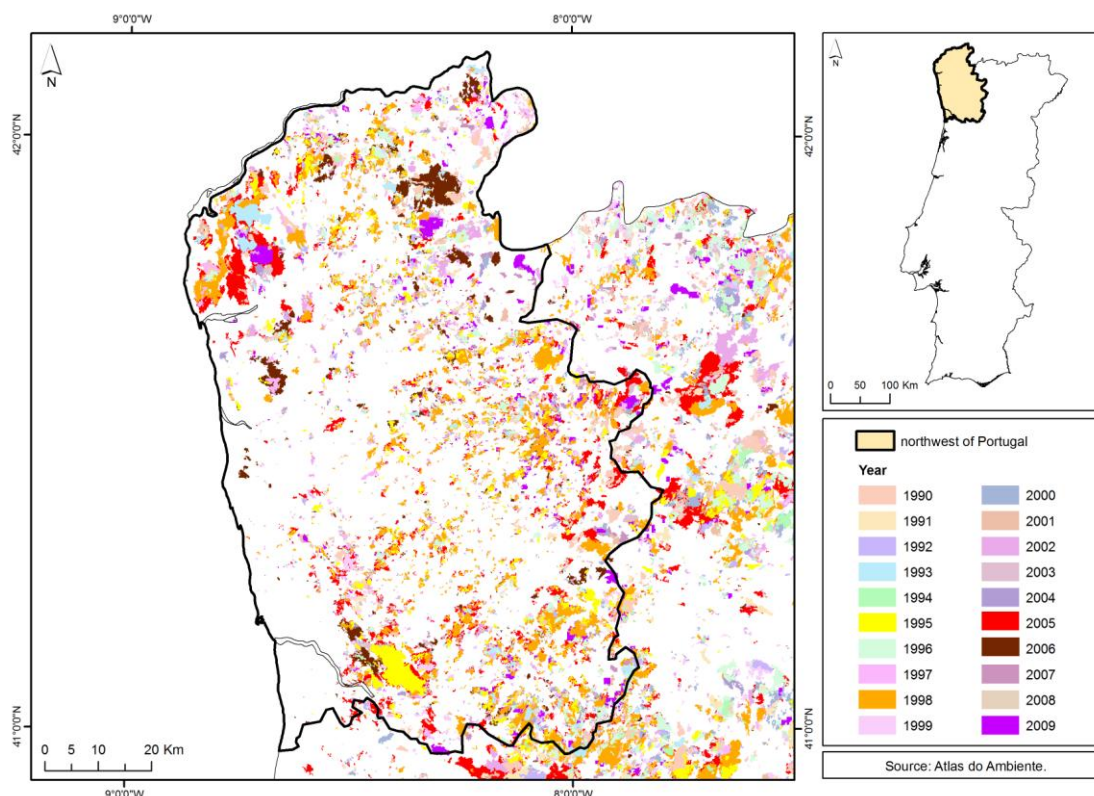
In summary, an annual variability of the scorched areas (settlements and shrublands) is verified. Equally, the forest fires also display an annual variability. Nevertheless, there is a tendency in the long run for a rise in the scorched areas and number of occurrences.

The value of the scorched areas and the number of occurrences of a particular year do not seem to influence the value of the following year (APIF/ISA, 2005). This estocastic behaviour can be explained in part by the variability of the meteorologic conditions of the summer season.

The geographic distribution of the forest fires in the Portuguese northwest is não even. The number of occurrences is higher in the more urban municipalities. There is a positive correlation between the number of occurrences and the number of inhabitants (APIF/ISA, 2005).

The distribution of the scorched areas in the northwest is also characterized by a accentuated difference between the coastal and central municipalities and the more interior municipalities. This distinction is evident when we analyze the maps of the scorched areas of the region for the period between 1990 and 2009<sup>6</sup> (Figure 6). Here we can verify that the more interior, mountainous municipalities, with their demographic debilities and the predominance of forest areas over the other land uses (Figure 1, 2. Mountain wild spaces in Portuguese northwest), present more extensive scorched areas, contrary to the distribution pattern of the forest fire occurrences.

<sup>6</sup> Information provided in *shapefile* format for Arcview by AFN.



Source: AFN, 2010

**Figure 6** – Scorched area per year in the Portuguese northwest for the period 1990-2009

The geographic distribution of scorched areas per municipality in the northwest reveals the vulnerability of the mountain municipalities. The municipalities covered by the “moisture barrier”, deserve special mention (Figure 3, 1.Geographic Characterization, Hydrography)

The climate also significantly affects the quantity and type of plant life in each region. The seasonal dynamics, with its percentage of humidity, indirectly influences the occurrence of forest fires and their propagation (PYNE *et al.*, 1996). This implies that the high volume of rainfall in the northwest – with an annual average of over 2000 mm – is an important factor in the production of biomass (Table II)

**Table II** – Rain stations located in the Cabreira Mountain, in the municipality of Vieira do Minho (1961-1990)

Rain station	Average annual rainfall R (mm)	Station altitude (meters)
Brancelhe	2118,7	380
Guilhofrei	2705,7	350
Salamonde	2281,9	550
Zebral	3071,1	775

Source: IMNG

The high level of rainfall is unquestionably the most outstanding climatic characteristic of the northwest region. It contributes to the great level of productivity of

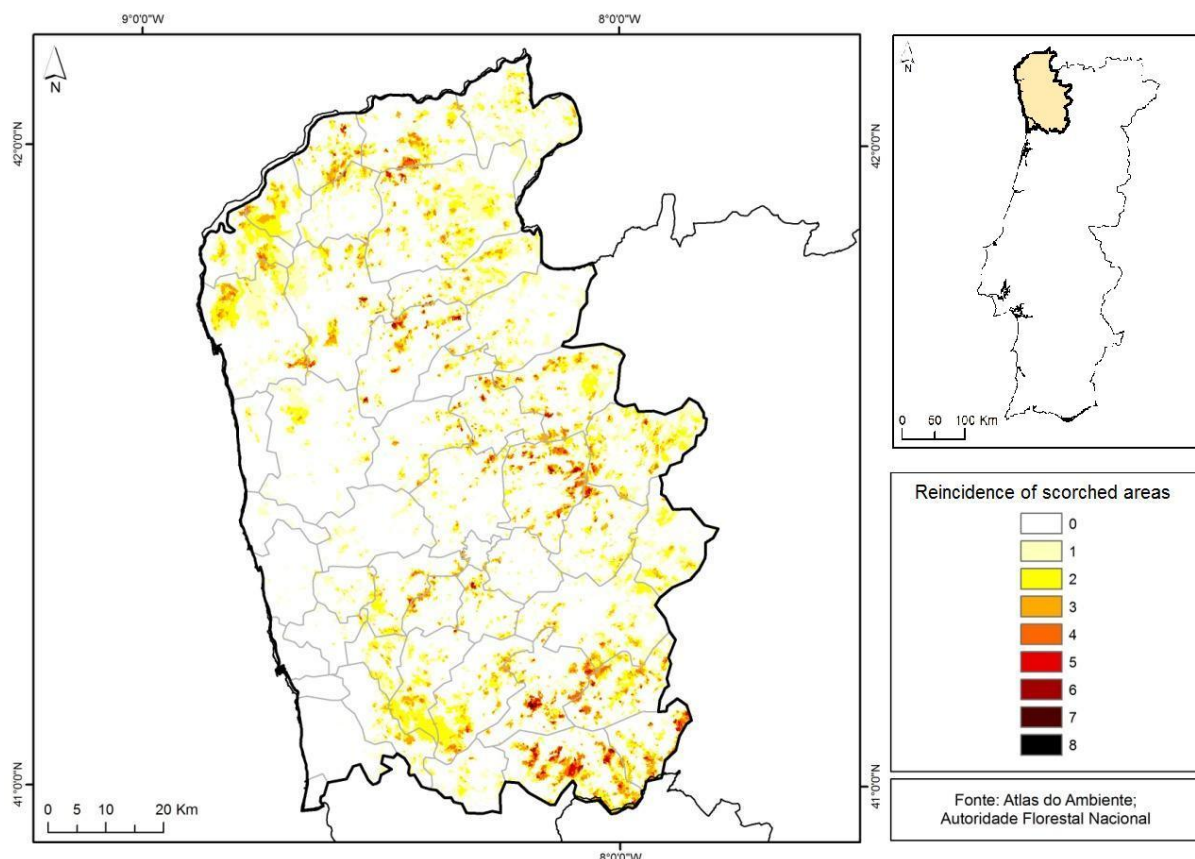
biomass of the region and, consequently, making the municipalities with the larger forest areas (generally the more mountainous) more vulnerable to the progression of fires.

The demographic situation of the northwest has an incontestable direct influence in the “forest protection” in that the aging population in the rural areas and the concentration in the main urban centres contribute to significant spatial imbalances. This implies an abandonment of the agricultural areas and forests in the interior areas with the consequent lack of management of these spaces and the growth of the combustible load (PNDFCI, 2005). Due to this reality and to a climate the auspicious to the production of biomass, the shrub layer spilled over into the agricultural fields transforming them in shrublands which then are dominated by forest spaces that are more vulnerable to the occurrence of forest fires (LOURENÇO, 2006).

As a result, the high production of biomass, the abandonment of the rural space, and, in particular, the mountain areas with their inherent problems and physical and social disadvantages (BENTO GONÇALVES 2006), generate conditions which are favorable to the rapid propagation/progression of forest fires. More precisely, the mountain areas are subject to a plethora of conflicts that result from a series of opposing interests – e.g., land use, coexistence between the rural life and urban visitors, cattle grazing and property rights, hunting, etc. – which make fighting fires more difficult and contribute to the extension of the scorched areas (BENTO GONÇALVES *et al.*, 2009).

The reincidence of fires in the same places is, in part, also due to the aspects above.

The maps on the spatial distribution of the reincidence of scorched areas in the Portuguese northwest for the period 1990-2008 confirms the high vulnerability of some of these spaces to forest fires (Figure 7).



**Figure 7** – Reincidence of scorched areas in the Portuguese northwest in the period 1990-2008



We can verify that this region presents areas with a level of maximum incidences equal to that registered for the national level (8).

Of the total area of the northwest (785565,7 ha), 222648,5 ha, representing 28,3% of the region, have been scorched at least once. Of those spaces (222648,5 ha), 15,4%, corresponding to 121452,1 ha were scorched only once. 8,2% of the total scorched area in the northwest were scorched only twice and 3,1% were scorched at least three times. The areas scorched more than three times are very few. Records show that areas scorched residual values for areas scorched four (1,1%), five (0,45), six (0,08%), seven (0,01%), and even eight times (0,002%) (TABLE III e IV)

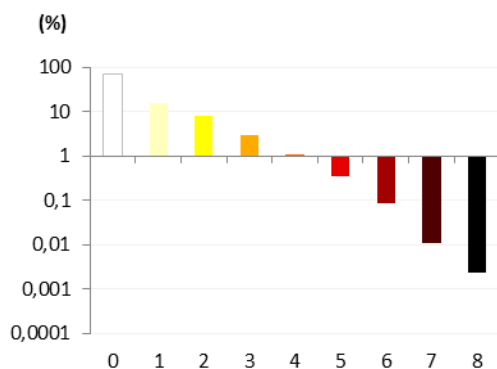
**TABLE III** - Scorched Area (ha) and percentage of scorched area in relation to the total area of the Portuguese Northwest in the period 1990-2008

	Scorched Area (ha)	Scorched Area /Total Area (%)
<b>Total Area Scorched</b>	222648,5	28,3
<b>Non-scorched Area</b>	562917,2	71,7
<b>Total Area</b>	<b>785565,7</b>	<b>100</b>

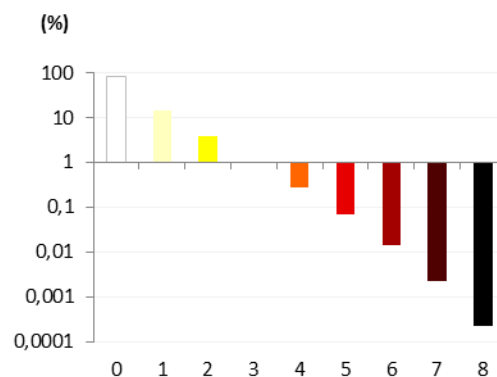
**TABLE IV** – Scorched Area (ha) and percentage of scorched area in relation to the total area of the Portuguese northwest in accordance with the number of times scorches in the period 1990 – 2008

Scorched Area (N. of Times)	Scorched Area (ha)	Scorched Area / Total Area (%)	Scorched Area/ Total Scorched Area (%)
<b>Only Once</b>	121452,1	15,4	54,5
<b>Only Twice</b>	64540,4	8,2	29,0
<b>Only Three Times</b>	24302,2	3,1	11,0
<b>Only Four Times</b>	8832,1	1,1	4,0
<b>Only Five Times</b>	2758,4	0,4	1,2
<b>Only Six Times</b>	659,8	0,08	0,3
<b>Only Seven Times</b>	85,4	0,01	0,04
<b>Only Eight Times</b>	18,1	0,002	0,008
<b>Total</b>	<b>222648,5</b>	<b>28,3</b>	<b>100</b>

While comparing the distribution of the area of the Portuguese northwest with the area of Portugal, in terms of the degree of forest fire incidences, we can verify that the total area of scorched land is higher in the northwest (28,3%/19,6%). The same hold true for the area effected by a fist incidence – i.e., 15,4% in the northwest and 14,4% in Portugal. It is after the first incidence that we can verify greater differences. In fact, the northwest registers, in percentage, a higher number value of scorched areas for the higher degrees of incidence. It is noteworthy to highlight the fact that the percentage of areas scorched eight times registers a value of 0,002%, in the northwest in comparison to the national value of 0,0002% (Figures 8 and 9).



**Figure 8** – Distribution of the area of the Portuguese northwest (%) by degree of forest fire incidences in the period 1990-2008



**Figure 9** - Distribution of the area of the Portuguese mainland (%) by degree of forest fire incidences in the period 1990-2008

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