Previous drought conditions and losses produced at the Valencia de Alcántara forest fire in August 2003

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Keywords: drought monitoring, SEQUIA software, NDVI anomaly, fire risk assessment

ABSTRACT: The forest fire that occurred in Valencia de Alcántara county (Cáceres) during the first week of August 2003, was one of the biggest fires in Spain in that year. The fire started and quickly spread due to vegetation cover status. The present paper analyses vegetation drought conditions of the study area through the use of NDVI (Normalized Difference Vegetation Index) evolution analysis performed with the SEQUIA software, developed by the Remote Sensing Laboratories of the University of Valladolid (LATUV) and the INIA. This paper also presents an assessment of burnt area by means of the analysis of a TERRA-MODIS image captured on August 8th, 2003.

1 INTRODUCTION

In the context of the European Union, the importance of Remote Sensing applications for firefighting has been recognised by the development of the GMES Communitarian initiative (www.gmes.info) and the Forest Focus Communitarian Regulation Proposal. The latter is relative to forest monitoring itself and forests interactions with the environment within the European Union territory (COM/2002/0404).

Wildfire events occurred in Southern Europe during summer 2003, which included a number of exceptionally large and uncontrolled fires, caused the destruction of a large part of the landscape (European Commission 2004). In particular, the total burnt area in Portugal and Spain was over 550,000 ha (European Commission 2004).

Due to the extreme losses caused by the fire season, the Portuguese Government received over 48.5 million Euro from the European Union.

Concerning the Spanish territory and according to the Environment Ministry statistics (www.incendiosforestales.org/estadisticas.htm), burnt forest areas reached 130.045 ha in 2003, which is slightly below the average area value for the period 1993-2002.

Extremadura (situated in West Spain) was the Spanish Autonomous Community most affected by fires in 2003, with a burnt forest area of 38,759 ha (including the wildfire occurred at Valencia de Alcántara (Cáceres)). The burnt area of the Extremadura region represented 29.8% of the total affected area of Spain.

The most devastating fire occurred in Spain during summer 2003, was located in Valencia de Alcántara (Cáceres). This fire started near the border between Spain and Portugal on August 1st, 2003 and it lasted for five days. The total affected area was around 26,200ha, 69% of which was located in Spain.
The objective of the present work was to analyse the vegetation status in Valencia de Alcántara county during the previous days, and to evaluate the burnt area through the analysis of a TERRA-MODIS image dated on August 8\textsuperscript{th}, 2003.

2  DROUGHT MONITORING

The Remote Sensing Laboratories of the INIA and the University of Valladolid (LATUV) are involved in the monitoring of the Spanish vegetation cover, by means of maximum 10-day composites of NDVI as derived from the Advanced Very High Resolution Radiometer (AVHRR) on-board NOAA satellites (González-Alonso \textit{et al.}, 2004). In order to achieve this, both Laboratories developed together the SEQUIA software, a tool for drought conditions analysis.

The incidence of drought over forested areas for a given time period within certain year, was found to be related to NDVI values below mean NDVI for the same period but considering the whole dataset, which is 1987-2003. In the Extremadura Region, 2003 was found to be the driest year since 1995.

Figure 1 shows the NDVI ‘anomaly’ during the first ten days of August 2003 for the whole Spain. As one can see, the Extremadura Region was characterized for low NDVI values.

![Figure 1. NDVI anomaly during the first ten days of August 2003.](image1)

Figure 2 shows the NDVI anomaly evolution for the period February-October within the Valencia de Alcántara county, for the period 2000-2003. The strongly decreasing NDVI anomaly evolution in that county for the first ten days of August 2003 can be seen on this figure.

![Figure 2. NDVI anomaly evolution in Valencia de Alcántara county for the period February-October, 2000 to 2003 (2000: red, 2001: grey, 2002: green, 2003: blue).](image2)
Figure 3 shows the accumulated anomalies along the year, for the period 2000-2003. It can be seen that 2003 was drier than the preceding years, specially from July on.


Figure 4 shows NDVI anomaly evolution for the first ten days of August, during the period 1987-2003 in Valencia de Alcántara county. It can be seen that August 2003 was the driest since 1992.

Figure 4. NDVI anomaly evolution for the first ten days of August, 1987-2003.

Figure 5 represents the histograms corresponding to the NDVI anomaly for Valencia de Alcántara county during the first ten days of August, for the years 2003 and 2002 respectively. In 2003, the mean NDVI anomaly was 84%, and values for the 99.6% of pixels in the county were below 100% (standard value). In 2002, the mean NDVI anomaly was 92%, and 75.7% of pixels had assigned values of NDVI anomaly lower than 100%.

Figure 5. Histograms corresponding to the NDVI anomaly for Valencia de Alcántara county during the first ten days of August, for the years 2003 (a) and 2002 (b).
Following the former analyses, it can be concluded that vegetation water stress was exceptionally high in the mentioned county during the first ten days of August 2003. This situation increased fire risk in the area, resulting in the great forest fire that took place from the 1st to the 5th of August, 2003.

3 BURNT AREA ESTIMATION

A radiometrically and geometrically corrected post-fire JPEG MODIS image, available through a NASA web site (http://rapidfire.sci.gsfc.nasa.gov), was downloaded for a quick estimation of affected area within the Valencia de Alcántara county. The image was a RGB composite corresponding to bands 7 (middle infrared), 2 (near infrared) and 1 (red). The processing of the MODIS image involved the following steps: (i) subsetting of the study area, (ii) low pass filtering for image smoothing, (iii) unsupervised classification using the k-means algorithm, (iv) reclassification of clusters, (v) majority filtering for classification noise reduction and (vi) statistics evaluation for burnt area estimation. The resulting image was also used to delineate the affected area border in order to produce a vector file which highlighted the final result together with the administrative division, as shown in figure 6.

![Figure 6. Burnt area estimation over the study area.](image)

Burnt area mapping allowed some interesting statistics as those referred to administrative division (shown in table 1) where it can be seen that almost 30% of the Valencia de Alcántara territory was burnt. Figure 7, on the other hand, shows the distribution of affected area over different forest classes as derived from the CORINE Land Cover coverage, where it is worth highlighting that ‘sclerophyllous vegetation’ was the most affected class.

<table>
<thead>
<tr>
<th>Municipal district</th>
<th>Area (ha)</th>
<th>Burnt area (ha)</th>
<th>Burnt area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valencia de Alcántara</td>
<td>59.777,28</td>
<td>17.581,25</td>
<td>29,41</td>
</tr>
<tr>
<td>San Vicente de Alcántara</td>
<td>10.717,12</td>
<td>275,00</td>
<td>2,57</td>
</tr>
<tr>
<td>La Codosera</td>
<td>7.040,92</td>
<td>206,25</td>
<td>2,93</td>
</tr>
<tr>
<td>Portugal</td>
<td></td>
<td>8.106,25</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>26.168,75</td>
<td></td>
</tr>
</tbody>
</table>

4 CONCLUSIONS

The present study gives evidence of the usefulness that can be derived from the monitoring of NDVI anomaly evolution through the year, as an assessment of vegetation water stress. The use of adequate analysis tools, such as SEQUÍA software, can be very useful in order to characterize high fire risk situations in an objective, synthetic and easy way. This can be an important help for forest managers, making fire prevention and fire fighting more feasible. The implementation of such tools through the Internet could allow a great diffusion of these techniques, leading to a real-time monitoring of vegetation water status, specially in forest areas. It can be also concluded that remote sensing estimations of burnt areas may produce reliable and feasible results, provided that the availability and distribution of images are guaranteed through the Internet or via ftp.

ACKNOWLEDGEMENTS

This research was possible thanks to funding received from the INIA-SC00-50 Project from the Agrarian and Food Research Program, and to an Agreement between the Spanish Agrarian Institute and the Ministry of Environment (INIA-MMA CC02-0015).

REFERENCES


