PROJECT:

Post-fire vegetation recovery monitoring using remote sensing

Within the FP7 project *FUME - Forest fire under climate, social and economic changes*.

TEAM:

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Context:

In the last decades, a marked increase both in the number and extent of wildfires has been registered in Mediterranean Europe which has been attributed either to land use changes or to climatic warming. Although wildfires constitute an integral part of Mediterranean ecosystems, changes in the fire regimes are responsible for land degradation and may lead to desertification. A minimum of 30% in vegetation cover is enough to protect the soil against water erosion. Vegetation has different responses to diverse fire regimes and to distinct landscape structures and, thus, fires have complex effects on vegetation recovery. Therefore, vegetation recovery monitoring following wildfires, particularly the assessment of driving factors, is crucial in land management and ecosystem conservation.

In the Mediterranean Europe, Portugal is the country with more burnt area in the last decade. The fire seasons of 2003 and 2005 were particularly devastating, with total burned areas of 425 000 and 338 000 ha, which is several times higher than the corresponding average. These two remarkable fire seasons coincided with two extreme climatic events – a major heatwave that has stricken Western Europe in August 2003 and, in 2005, one of the most severe droughts since early 20th century.

Remote sensing has shown to be a powerful tool in studying vegetation dynamics and in monitoring post-fire vegetation recovery, at broad spatial scales, with fairly good resolution and with moderate costs. The Normalized Difference Vegetation Index (NDVI), a vegetation index that consists on the normalized difference of reflectances in the red and near-infrared spectral bands is considered to provide good estimations of photosynthetic activity and vegetation density and has been widely used to monitor vegetation activity globally.

A vegetation recovery model using remotely sensed data has been developed by Gouveia et al. (2010) and has shown to be able to provide good estimations of vegetation recovery time as well as to assess the influence of diverse driving factors on post-fire vegetation response (Bastos et al., 2011).

Objectives:

The main goals of this work are:

1) To estimate vegetation recovery times following the fire seasons of 2003 and 2005 in Portugal;

2) To evaluate the influence of fire damage and pre-fire land-cover type in post-fire recovery times.

Description of the project:

This work relies on remotely sensed data of NDVI at 1km spatial resolution, acquired by the VEGETATION sensor, extracted from the S-10 products of the VITO database (http://free.vgt.vito.be). These products consist on 10-day composites that are already corrected for atmospheric and geometric effects. Data were selected over the period spanning from September 1999 to August 2009 and over a region extending from 37ºN to 42ºN and from 10ºW to 6ºW. Monthly composites of NDVI were computed and correcting using a weighted Fourier analysis to create a phenological consistent time-series.

According to the methodology described in Gouveia et al. (2010), a K-means spatial cluster analysis was performed on monthly NDVI anomaly values following each fire season in order to identify very large burnt scars in 2003 and 2005 (Fig. 1) and the mono-parametric vegetation recovery model was then applied to selected burnt scars (Fig. 2) in order to estimate recovery times and identify driving factors of recovery.

Results:

1. Burnt scars identification

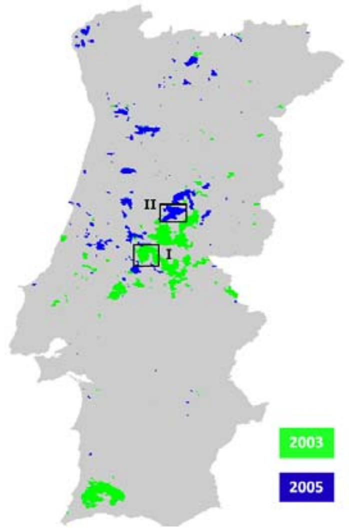

Fig. 1 Burnt areas over Continental Portugal as identified by the cluster analysis for the fires seasons of 2003 (green pixels) and 2005 (blue pixels). Selected areas for the present work and respective nomenclature (labels on rectangular frames).

2. Vegetation recovery model

The vegetation model relies on a single parameter *y* (the so called lack of greenness) that is simply the difference between observed NDVI values and an ideally healthy vegetative cycle (GY), computed by selecting monthly maximum values for each pixel.

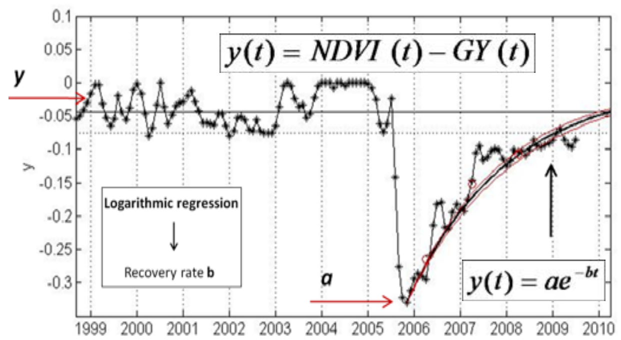

Fig.2 Time series of observed (lines with asterisks) and modelled (bold curve) monthly values of y, over scar II. Red curves indicate the 95% confidence limits of the regressed curve. Vertical arrow points the month of recovery, when the modelled curve crosses the 90% of the median value of y during the pre fire period (horizontal dotted line).

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3. Vegetation recovery assessment

The model was applied to each pixel to compute recovery time fields in each scar:

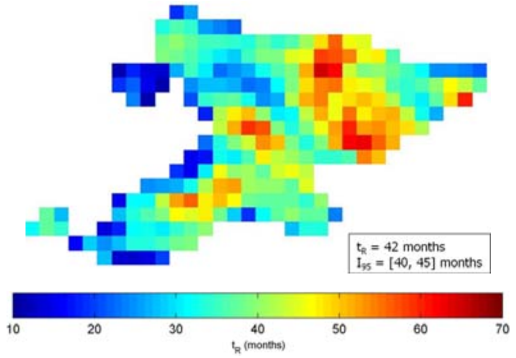

Fig. 3 Average recovery time with respective 95% confidence intervals (boxes) and spatial distribution of recovery times (in months) for scar II as estimated by applying the recovery model to individual pixels.

4. Fire damage

Fire damage is defined as the impact of fire on the following vegetative cycle:

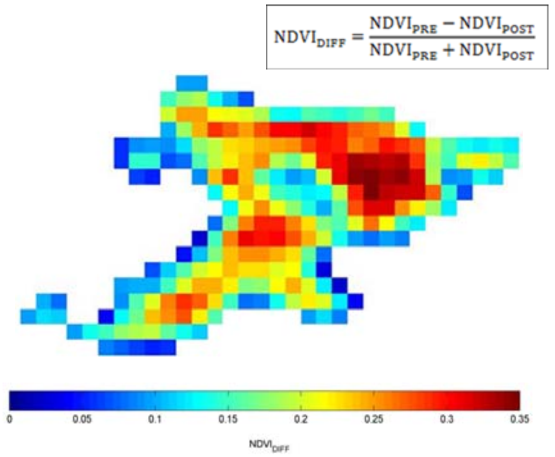

Fig. 4 Distribution of $NDVI_{DIFF}$ over burnt scar II.

5. Driving factors assessment

In order to evaluate the influence of some of the known driving factors of vegetation recovery in each scar, recovery times were compared to: fire damage, pre-fire land-cover type, slope aspect.

Fire damage

The analysis of the dispersion diagram of the centroids computed by an unsupervised cluster analysis performed on the pair *{t_R,$NDVI_{DIFF}$}* suggests a monotonic relationship between the two variables (Fig. 5).

Results concerning the other variables are shown in the poster.

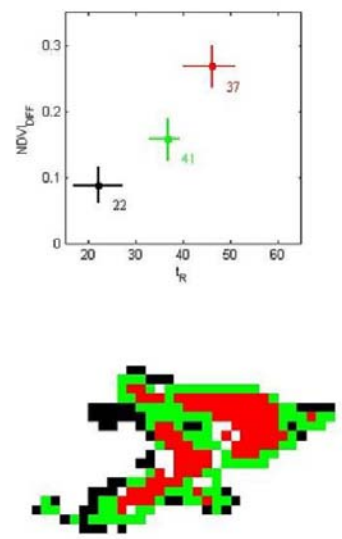

Fig. 5 Dispersion diagram (upper panel) and spatial distribution (lower panel) of centroids as obtained by the K-means cluster analysis performed on the pair {t_R,$NDVI_{DIFF}$} over scar II for the two main land cover classes. Coordinates of the centroids are identified by circles; horizontal and vertical bars indicate interquartile ranges.

REFERENCES

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Gouveia C., DaCamara C.C, Trigo R.M., 2010. Post fire vegetation recovery in Portugal based on SPOT-VEGETATION data. Natural Hazards and Earth System Sciences, 10, 673-684.