POST-FIRE VEGETATION MONITORING USING HYPERSPECTRAL AHS-INTA IMAGES IN GUADALAJARA (SPAIN)

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1. INTRODUCTION AND OBJECTIVES

Each year, wildfire affects millions of hectares of forests around the world. Forest fire effects at a local scale alter the ecosystem functionality due to the fact that fire plays an essential role in vegetation composition, biodiversity, soil erosion and water cycle [1]. In addition, forest fires release a significant amount of greenhouse gases, particulates and aerosol emissions into the atmosphere, which significantly increases the anthropogenic CO_2 emissions [2]. The global warming effect has been increasing the intensity and frequency of droughts in many areas, creating more destructive and frequent wildfires. This fact is especially important in the Mediterranean region where forest fires are the main cause of natural resources destruction and wildfire trends are more common and severe during years of drought [3]. Besides, frequency and intensity of forest fires are expected to increase in the following years due to the increase of temperature and the reduction of rainfall, facts which in turn will amplify the risk of desertification in this region. For all these reasons, a good understanding of the forest fire phenomenon is essential nowadays.

Recent advances in sensor technology have led to the development of new hyper-spectral instruments capable of measuring reflected radiation in a wide range of wavelengths. In this sense, it is possible to assess diverse characteristics of vegetation recovery that are only noticeable in some parts of the electromagnetic spectrum. Such technology is applied in this work for the study of a forest fire that occurred in the Rodenal of Guadalajara (Central Spain) between the 16th and 21st July, 2005. This paper focused on two objectives: (i) the development of accurate level-of-damage maps and (ii) the monitoring of post-fire vegetation recovery.

2. MATERIALS

The Remote Sensing Laboratory of CIFOR-INIA accounts for a set of four hyper-spectral images for the study area. The images were acquired by the hyper-spectral AHS-INTA sensor that flies onboard a CASA-C212 plane.

This sensor has 80 bands of variable width in the VIS/NIR, SWIR, MIR and TIR regions, and a spatial resolution of 3m. Several field campaigns were also carried out in order to sample any combination of level-of-damage and vegetation type (A-samples), as well as in order to define training areas for non-affected vegetation and bare soil (B-samples). Both sets of samples were used for both training and validation purposes.

3. METHODOLOGY AND RESULTS

First task consisted on delineating the fire-affected area. For doing so, the 2005 AHS image (the closest to the fire event) was processed using a matched filtering analysis. This method assigns a probability value to any single pixel that estimates how similar certain pixel in comparison with an endmember collection is. The later was defined using a sample of 100 pixels of the AHS image itself. The resulting image was classified using an Isodata algorithm in which the threshold values were selected in order to best fit the results [4]. Burned area was finally estimated in 12.938,5 hectares (129,4km^2).

Level-of-damage was estimated using the Normalized Burn Ratio (NBR) that is calculated using pixel reflectance in the NIR and SWIR bands. This spectral index was selected for being sensible to due-to-fire changes in vegetation [5]. This index varies between -1 (indicating high severity) and +1 (indicating low severity or non-affected vegetation). Sensor bands for NBR calculation were selected based on their lowest noise and largest variability, what resulted in the selection of band 13 (centered at 0,8µm) and bands 31, 38 and 41 (centered at 2,13, 2,22 and 2,25µm, respectively). In this sense, three severity indices (NBR1, NBR2 and NBR3) were calculated. Field data was used to assess the NBR-derived severity maps resulting that the one based on the NBR1 produced the highest accuracy of 70%.

Post-fire vegetation recovery was carried out using the Normalized Difference Vegetation Index (NDVI) that is calculated based on red and NIR reflectance values [6]. The analysis of the NDVI evolution was completed with a more detailed analysis of the vegetation cover that was estimated using a spectral unmixing algorithm, for which pure bare soil and vegetation endmembers had been previously extracted.

4. CONCLUSIONS

AHS-INTA hyper-spectral images in combination with field data have been proved to be a reliable way for estimating burned area, levels of damage (severity levels), as well as, for monitoring post-fire vegetation recovery trends. The data and maps derived in this way may be very useful in order to locate priority intervention areas and plan forest restoration works.

5. REFERENCES

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