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# Mapping Areas Affected by Fires across Natural and Agricultural Ecosystems in Europe from Spectral Indices

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Mapping the areas affected by fires is necessary for the assessment of the environmental damage (on both the landscape and the atmosphere), the prevention of future fires and for monitoring the recovery of vegetation. Satellite data constitute a unique source of information for achieving these objectives and the images acquired by the Landsat TM and ETM sensors offer the temporal and spatial resolutions which are suitable for fire monitoring in Europe. Moreover the large dataset of Landsat TM/ETM images made available free of charge by the US Geological Service (USGS) has driven the attention of the scientific community towards the improvement of operational methods for mapping the areas affected by fires.

An algorithm for routinely mapping burned areas should be above all robust to be applicable across sites (pre-fire vegetation characteristics and conditions, soil properties, fire severity and post fire vegetation recovery) and over time (difference in atmospheric conditions and geometry of acquisition). Spectral indices obtained by combining different bands have been widely used for regional burned area mapping although the performance of each index is often site-dependent.

We propose a pixel-based method to integrate several spectral indices using fuzzy logic and contextual analysis (region growing) on the base of previous experiment conducted on ASTER data. The strength of our work is the use of a large training and validation dataset built from Landsat TM/ETM images acquired across Europe during the 2003 fire season. We derived multiple spectral indices (e.g. NBR, NDVI, CSI, SAVI, MIRBI and EVI) and we built fuzzy membership functions for each index from the distribution of frequency values over photo-interpreted burned areas. The fuzzy membership functions map the value of each index into the [0, 1] domain (the degree of membership), which gives the likelihood of burn. The membership degrees are integrated to derive a synthetic score in the domain [0,1], which is used first for extracting seeds from the very high scores and for growing the perimeters of the burned areas. The method is able to integrate the information brought by each index, which can be either complementary or redundant. The analysis of separability carried out on the training dataset clearly shows that each index performs differently in separating the burned areas from surface targets which have similar spectral features (e.g. cloud shadows, soils with low albedo) confirming what was investigated for ASTER data. At the same time the method can manage redundant information brought by the spectral indices: redundancy can be exploited to reinforce the evidence of a burned pixel.

The algorithm is tested by using Landsat TM images acquired over several sites in Europe in the Mediterranean basin (from Greece to Portugal): the accuracy of the classification is assessed against burned pixels extracted by photointerpretation. The results are promising with most of the pixels indentified by the photointerpreter correctly classified as burned by the automated method and overall performance for the various sites with no systematic error in different ecosystems and land cover types.