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Multiscale characterization of fuel pattern using multisensor remote sensing data

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In the context of fire management, fuel maps are essential information requested at many spatial and temporal scales. Remote sensing data provide valuable information for the characterization and mapping of fuel types and vegetation properties as well at different temporal and spatial scales from global, regional to landscape level.

This study aims to ascertain how well remote sensing data can characterize fuel type at different spatial scales in fragmented ecosystems. For this purpose, multisensor and multiscale remote sensing data such as, hyperspectral MIVIS and Landsat-TM (acquired 1998 to 2004) as well as Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) and MODIS (acquired 1999 to 2004) have been analysed for some test areas of southern Italy that are characterized by mixed vegetation covers and complex topography. Fieldwork fuel types recognitions, performed at the same time as remote sensing data acquisitions, were used as ground-truth dataset to assess the results obtained for the considered test areas.

Two different approaches have been adopted for fuel type mapping: the well-established classification techniques and spectral mixture analysis.

Conventional classification techniques (such as the Maximum Likelihood, Parallelepiped) assume that all image pixels are pure, nevertheless, this assumption is often untenable. In mixed land cover compositions, as pixel increases in size, the proportion of mixed cover type distributed at pixel level will likewise increase and information at sub-pixels level will be of increasing interest. Consequently, in fragmented landscapes conventional "hard" image classification techniques only provide a poor base for the characterization and mapping of fuel types giving, in the best case, a compromised accuracy, or, in the worst case, a totally incorrect classification.

In these conditions, the use of spectral mixture analysis (SMA) can reduce the uncertainness of conventional classification techniques since it is able to capture, rather than ignore, sub-pixel heterogeneity. The SMA allows us to classify the proportions of the ground cover types (end-member classes) covered by each individual pixel. End-member classes can be taken from "pure" pixel within an image or from spectral libraries. Over the years, different model of spectral mixture have been proposed. Among the available models, the most widely used is Linear Spectral Mixture Analysis, that is based on the assumption that the spectrum measured by a sensor is a linear combination of the spectra of all components within the pixels.

There were three main goals of this study: (1) quantify the potential errors resulting from classification of lower spatial resolution images by using re-sampled classifications of higher spatial resolution data, (2) develop spectral libraries by using hyperspectral MIVIS data, and (3) evaluate performances from the available linear unmixing models (constrained and unconstrained least square solutions) and from the use of minimum noise fraction (MNF) as well.