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An automatic algorithm for near real-time burned area mapping from Sentinel-2 data: validation results for 2019-2021 fire seasons over Italy

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The damages generated by fire events on vegetation structure and its evolution and the economic impacts on human activity, life and infrastructures have led the scientific interest to develop tools and algorithms able to support the detection and monitoring of burned areas (BAs).

The possibility of monitoring the fire evolution and mapping the BAs has been strongly promoted in last decades by the opportunity to use a significant quantity of satellite observations. Earth observation (EO) data represent one of the key components in supporting both government agencies and local decision-makers in monitoring natural disasters such as wildfires. Among EO instruments, multispectral sensors have demonstrated their suitability for BA mapping, because fire has significant effects on vegetation reflectance. The Copernicus Sentinel-2 (S2) with 20-m spatial resolution and a 5-day return period is a good candidate for near real-time (NRT) monitoring of the fire situation throughout the fire season.

Pulvirenti et al. (2020) proposed an automatic NRT BA mapping approach based on S2 data. They developed the AUTOmatic Burned Areas Mapper (AUTOBAM) tool to respond the need of the Italian Department of Civil Protection in monitoring spatial distribution and numerousness of the BAs during the fire season (June- September) over the Italian territory. It is used, in pre-operational mode, since summer 2019. The atmospherically corrected Level-2A(L2A) surface reflectance products from S2 are used by AUTOBAM: the automatic chain downloads and processes the most updated L2A products available on Copernicus Open Access Hub over the studied area. Then, a change detection approach is applied to the three spectral indices chosen to map BA (Normalized Burn Ratio, the Normalized Burned Ratio 2, and the Mid-Infrared Burned Index). AUTOBAM compares the values of these indices acquired at current time with the values derived from the most recent cloud-free S2 data. The procedure for BA mapping is based on different sequential image processing techniques such as clustering, automatic thresholding, region growing that conduce to a final BA map with grid pixel size of 20m. Finally, a quality flag is included for each AUTOMAB BA to certify a temporal and spatial correspondence with ancillary data, such as active fire products derived from MODIS and VIIRS, as well as national fire notifications.

This processing chain has been tested for the fire seasons of years 2019-2021, and the AUTOBAM-derived BAs have been compared with the burned perimeters compiled by Carabinieri Command of Units for Forestry, Environmental and Agri-food protection. A validation procedure in fact has been realized to verify a-posteriori the ability of AUTOBAM to detect the actual BAs mapped by Carabinieri after local surveys. Timing and spatial criteria are adopted to validate AUTOBAM mapping, and a threshold of 20% overlapping is fixed to make an AUTOMBAM BA classified as a reliable detection.

Results indicate that the proposed method has potential for NRT mapping of BAs.