The Algorithms Behind The Burnt Scar Mapping Module of FireHub: A Scalable And Robust Approach For Multimodal Earth Observation Data

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We present the latest core algorithmic workflow behind the 2014 Copernicus awarded system FireHub (http://ocean.space.noa.gr/FireHub) for the systematic mapping of burnt areas after wildfires. The main advantage of our technical approach is the ability of the algorithm to be sensor-agnostic, hence accommodate satellite data of different spatial, temporal and spectral resolutions and characteristics, without any implicit compromises in thematic and spatial accuracies. FireHub workflow is scalable to cover entire Europe, the Middle East and North Africa.

The algorithms used for automated Burnt Scar extraction, is applicable to both middle (VIIRS, MODIS, FengYun-3, Sentinel-3) and high-resolution satellite systems (Sentinel-2, Landsat-8). It is based on an implementation of Level Set Methods, to which further modifications and optimizations were applied to enhance the thematic accuracy, and minimize omission and commission error rates, as well as to adapt the proposed algorithm to the heterogeneous land cover regimes across Europe.

The main advantages of the proposed algorithmic workflow are (i) the application of cascaded local standardization techniques that amplify local minima/maxima to distinguish burnt scar areas, (ii) the integration of diverse index capacities to better characterize the different levels of burn severity, (iii) the utilization of Level set methods that are parameter free, provide a direct way to estimate the geometric properties of the evolving structure, can change the topology and are intrinsic; they are designed for problems which have topological changes, curvature dependence and singularities formation, (iv) the adaptability to available optical sensors for burnt scar product extraction, provided that those sensors at least provide visible red, near-infrared and short-wave-infrared bands.

We test the proposed approach for the summer 2016 forest fires that occurred in Greece. We use Sentinel-2, MODIS and VIIRS data for the processing, while the thematic products are compared with datasets collected from the Greek Fire Brigade for the same period. Results show that among other techniques developed to derive burn scar information from remote sensing data, such as fixed thresholding, the proposed approach can extract the outline curve of fire burn scar more accurately. The proposed method has higher extraction accuracy and less algorithm complexity than that of the conventional methods. Compared to fixed threshold approaches, were the algorithm discriminates burn scar from neighbouring objects with empirically derived fixed sets of thresholds, this method clearly prevails because it automatically “chooses” the appropriate local thresholds.