12th EARSeL Forest Fires SIG Workshop
Remote sensing of forest fire: Data, science and operational applications
3-5 October 2019
Rome , Italy

Analysis, interpretation and discussion on mismatch of Fire severity mapping from UAV, Sentinel-2, and EFFIS: case studies in the Basilicata Region

Nicodemo Abate[1,2], Carmen Fattore[1,2], Rosa Lasaponara[2]

1 University of Basilicata, Potenza, Italy.
2 National Research Council – Institute of Methodologies for Environmental Analysis, Tito Scalo (PZ), Italy.

Introduction

The purpose of this study is to compare the fire severity between EFFIS (Modis) and Sentinel-2 through the use of UAV (Unmanned Aerial Vehicle) data for the validation of field data. The study is on a wildfire of 15th July 2019 near the urban centre of Pisticci (Matera, Basilicata, Italy) (Figure 1).
EFFIS (European Forest Fire Information System) has been part of the EU Copernicus Programme since 2015, as part of the Emergency Management Service (EMS), and involves all European and extra-EU countries. The identification of the areas burned during the fire season is verified through the Rapid Damage Assessment (RDA) system that uses the daily images of Modis sensors, with a spatial resolution of 250m.
Furthermore, the mapping of burnt areas with Modis images does not show any distinction between forest fires, environmental fires and prescribed fires. This non-differentiation causes some inconvenience to the user who has to work on the case to be investigated.
Fire severity is estimated using the Difference Normalized Burnt Ratio (dNBR) as described by Key and Benson [1] but dNBR is not enough to estimate the damage. EFFIS provides important information about the event, such as (i) geographical location, (ii) the beginning and the end of events, (iii) the extent of damage, (iv) the quantity of hectares burned.
The lack of discrimination of the event type and the spatial resolution of Modis data makes this information sometimes not accurate

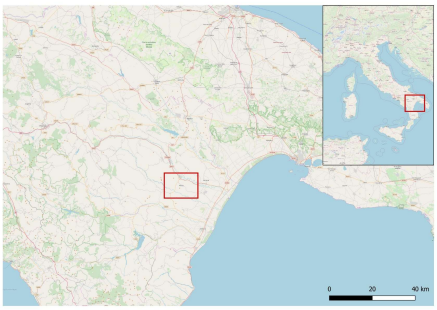

Figure 1. Pisticci (Matera, Basilicata, Italy).

Materials and Methods

EFFIS (Modis) data report the Pisticci fire as a Hotspot with an average fire severity level, which mainly involved agricultural areas (33.7%) and "other natural areas" (66.3%).
The use of Sentinels 2, with a spatial resolution of 10m, allowed to better identify burnt area, through the use of spectral indices such as NDVI, NBR and OSAVI [2], making the comparison of pre- and post-fire indices [3]. Analysis of Sentinel-2 images returned values of low vegetative coverage (0.1 < NDVI < 0.3), with an abundance of bare soil and shaded areas (-0.6 < OSAVI < 0.1) and a moderate-low fire severity (0.27 < dNBR < 0.35) (Figure 2).

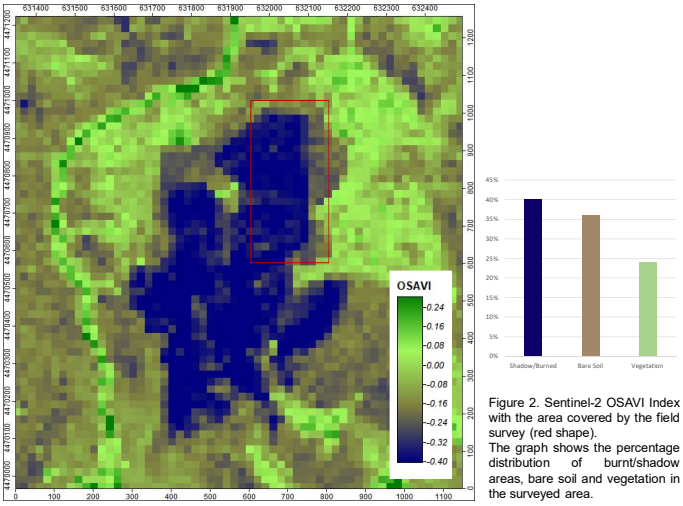

Figure 2. Sentinel-2 OSAVI Index with the area covered by the field survey (red shape).
The graph shows the percentage distribution of burnt/shadow areas, bare soil and vegetation in the surveyed area.

Flight operations were carried out on 1st August 2019 using a Parrot Disco Ag Pro fixed-wing UAV equipped with a Parrot Sequoia multispectral camera. The survey was conducted in a flat area, chosen within the burnt area as sample, in order to facilitate the take-off / landing operations of the drone. The flight covered 0,092km2 / 9,2ha. The data processing was carried out using Pix4D mapper Pro software (version 4.4.12), useful for the creation of georeferenced (i) orthophotomosaics, (ii) point cloud, (iii) DEM and (iv) reflectance maps. The multispectral outputs have a GSD (Ground Sampling Distance) of 6.91cm/pixel and were used for the processing of several indices and images within SAGA (System for Automated Geoscientific Analysis) software [4].
A High Resolution False-Colour Infrared image were created (R: Nir, G: Red, B: Green), in order to observe the real situation of the area; while the multispectral bands have been combined to obtain indices (NDVI, NDRE, OSAVI) useful to discriminate between live green vegetation, bare soil and burnt area. The high resolution image shows that the fire has involved a small area of Mediterranean vegetation and stubble, leaving unburned forest, olive trees and cultivated fields. Pixels with a negative value or close to zero occupy 19.8% of the image(1,76ha) and most of them are produced by shadow (south, west and north-west); bare soil is 52,28% (4,97ha), and low vegetation/grass and forest are 27,92% (Figure 3).

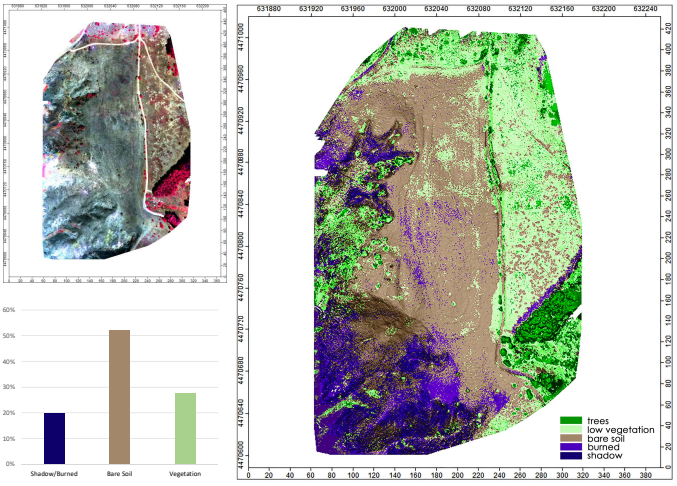

Figure 3. False Colour Infrared image and OSAVI index classification of the surveyed area.
The graph shows the percentage distribution of burnt/shadow areas, bare soil and vegetation in the surveyed area.

Conclusions

The data collected by the drone, even if with a different resolution, are close to those acquired by the Sentinel images. In both cases the effects of Fire Severity seem much less critical than those described by EFFIS and the bare soil/rock is the major component of the area (Figure 4). The usefulness of EFFIS is well documented on large events, where the classification of the Fire Severity is accurate, but loses its effectiveness on small events (≃70ha), failing to calculate an accurate Fire Severity due to the resolution of the Modis sensor. For this reason, in the case of small events or hotspots, an accurate classification of the burnt area still requires the use of higher resolution tools, such as Sentinel-2 or UAV.

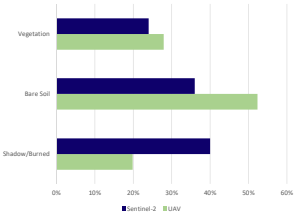

Figure 4. The graph shows the differences between Sentinel-2 and UAV distribution of burnt/shadow areas, bare soil and vegetation in the surveyed area.

References

[1] Key CH, Benson NC (2005) *Landscape assessment: ground measure of severity, the composite burn index; and remote sensing of severity, the normalized burn ratio.* In: Lutes DC, Keane RE, Carratti JF, Key CH, Benson NC et al. (eds.), FIREMON: Fire Effects Monitoring and Inventory System. Ogden, UT: Rocky Mountain Research Station-RMRS, 25–36.
[2] Szajewska A, *Classification of a burnt area based on spectral images*, MATEC Web of Conferences, **2018**, 247:00017.
[3] Keeley JE, *Fire intensity, fire severity and burn severity: A brief review and suggested usage*, International Journal of Wildland Fire **2009**, 18(1),116-126.
[4] Carvajal-Ramírez F, Marques da Silva J, Agüera-Vega F, Martínez-Carricondo P, Serrano J, Moral FJ, *Evaluation of Fire Severity Indices Based on Pre- and Post-Fire Multispectral Imagery Sensed from UAV*, Remote Sens. **2019**, 11, 993.