EO based Operational applications for the fire management within the SERV_FORFIRE project, by <u>Rosa Lasaponara</u>[1], Carmen Fattore[1], Nicodemo Abate[1], Angelo Aromando[1], Gianfranco Cardettini[1], Monica Proto[1], Guido Loperte[2]

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In the framework of SERV_FORFIRE project, the use of satellite data has been adopted as operational tool. An example of best practice is provided by the Basilicata pilot area, where CNR-IMAA has further improved the operational tools already devised for the various phases of the fire management with specific attention to the estimation of: (i) fire danger and (ii) post fire monitoring, in terms of burnt areas and burn severity mapping using satellite sentinel 1 and 2 data.

All the sentinel platforms provide satellite big data which require expensive hardware infrastructures and pose challenges linked with the processing, interpretation and validation issues, for transforming data into useful information. To face the need of suitable infrastructure today there are several cloud facilities as Google Earth Engine (GEE), available as open and free tools for research purposes or at low cost for other applications. Within SERV_FORFIRE, with the joint efforts of all the partners and several end –users, several tools have been developed which have been firstly adopted and tested in the pilot areas and later also applied and validated in other EU e non EU countries as shown from the figures.

In particular, Figure 1 and Figure 2 show the small fire detected in Basilicata, along with the bigger events detected in France through the use of USGS (United States Geological Survey) thresholds for the characterization of Fire Severity as it can be seen in Figure 3. While, Sentinel-5 (S5) were used for the analysis of pollutants emissions due to the combustion of fires occurred in August 2019 in the south of Brazil, in the area of Mato Grosso do Sul (fig. 4).

As in example, the methodologies developed and applied in Basilicata have been continuously improved and joint tested by the Argon laboratory research team of the CNR-IMAA and the decision-makers of the Civil Protection Office of Basilicata Region. In particular,

- ✓ fire danger system is fully operational and daily updated during the fire season and (http://www.protezionecivilebasilicata.it/protcivbas/css/themes/01/images/mappa.jpg) developed by CNR-has been further improved using Copernicus products and satellite Sentinel data.

- ✓ Google Earth Engine tools have been developed to identify and map burnt area and burn severity

- ✓ Artificial Intelligence has been applied to improve the automatic categorization of several fire danger degrees as well as the different fire severity levels

- ✓ Assessment of cascading effects on soil erosions and landslides

Among the other tools, the joint use of Sentinel-2 satellite data and Google Earth Engine (GEE) has been set up to promptly map burnt areas and burn severity. The outputs from these tools are currently under validation in the diverse pilot areas of SERV_FORFIRE. The case study herein highlighted is the Basilicata Region (Southern Italy) selected as it is characterized by heterogeneous and fragmented ecosystems generally affected by very small fires (often ranging from less than 10 to 1 hectares). Today, it is widely recognized as a pressing issue because these fires, though small, are generally quite frequent and therefore strongly impacting the ecosystems and they were not captured by the medium space resolution satellite data as MODIS or Landsat TM, but they can be now captured using sentinel 1 and 2 data.

In Italy, as common for the whole Europe, the operational mapping of burned areas is performed on the basis of in situ analyses conducted at the end of the fire season in the locations where fire occurred. This is of course time consuming and moreover, no information /records are collected about burn severity, that is a critical information needed to support reliable mitigations strategies at diverse spatial and temporal scale, and in particular those that must be activated immediately after the fire occurrence.
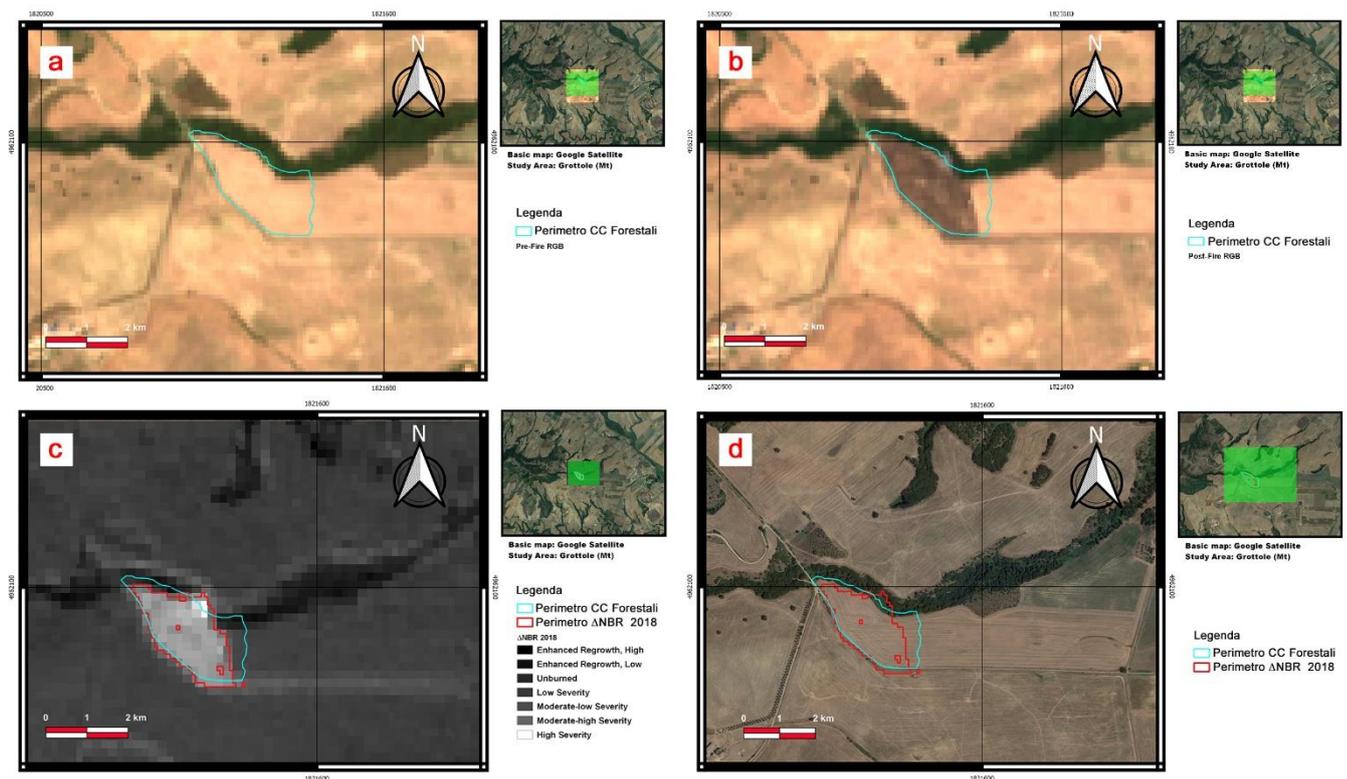

Figure 1. Fire occurred on the 25 July 2018 in the Grottole municipality (MT) affecting an area of about 4,04 ha mostly agricultural activities. A) Sentinel-2 pre-fire; and in b) post-fire; c) spectral index adopted to highlight the fire-affected area; d) comparison of fire mapping as obtained from satellite (in red line) and from the Carabinieri Forestali (in cyano line) in Italy in charge to perform the operational mapping of burnt area in situ
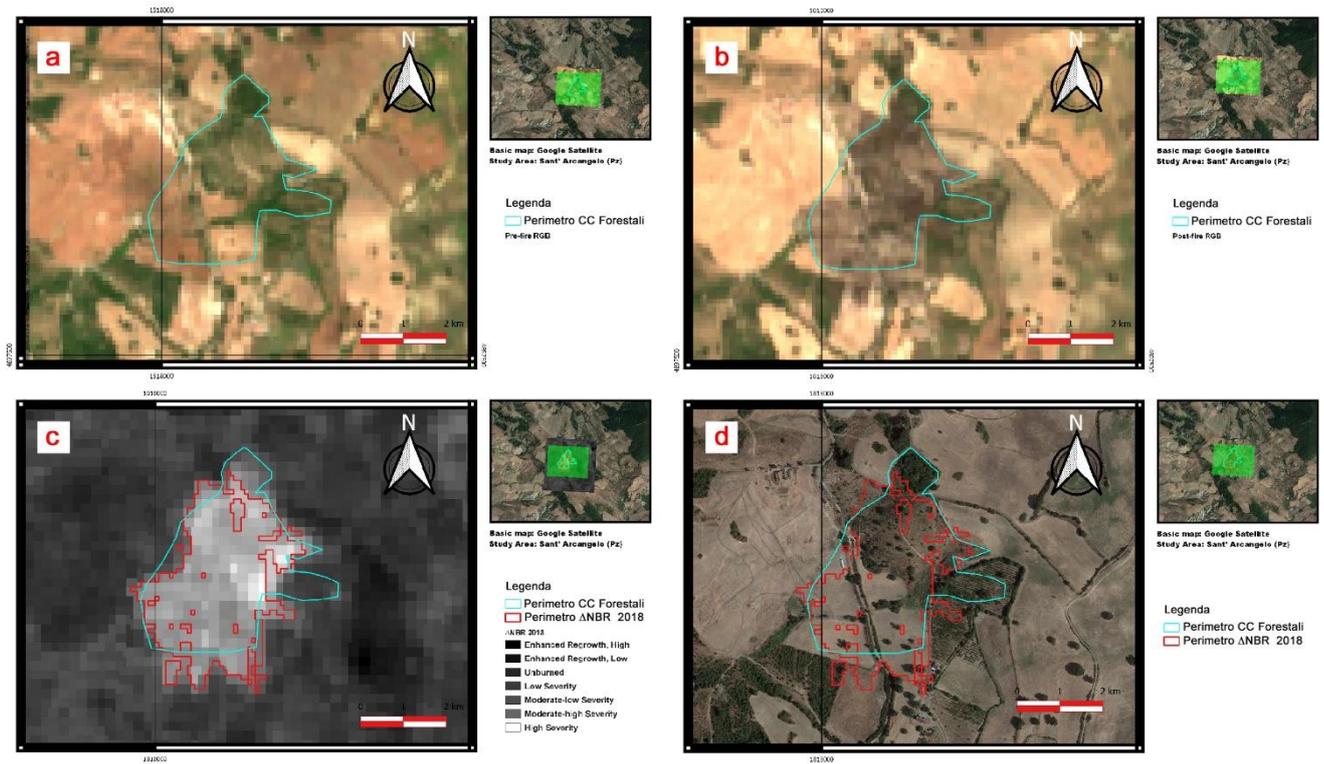
Figure 2. Fire occurred on the 16 July 2018 in the Sant'Arcangelo (PZ), affecting an area of about 9,56 ha mostly agricultural activities. A) Sentinel-2 pre-fire; and in b) post-fire; c) spectral index adopted to highlight the fire-affected area; d) comparison of fire mapping as obtained from satellite (in red line) and from the Carabinieri Forestali (cyano) in Italy in charge to perform the operational mapping of burnt area in situ
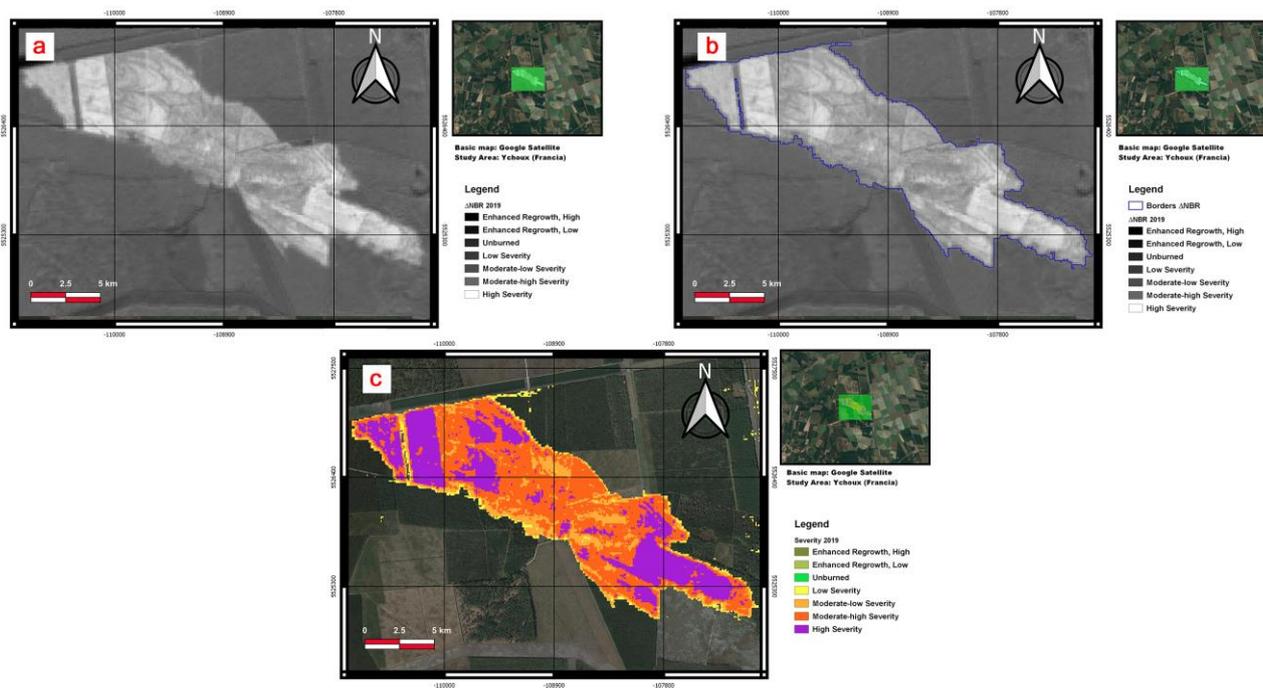

Figure 3. Fire occurred on the 12 July 2019 in the Ychoux (France), affecting an area of about 153 ha mostly agricultural activities and forest of coniferous. A) Sentinel-2 ΔNBR; b) Perimeter (blue) of Sentinel-2 ΔNBR; c) Fire Severity threshold classification by USGS.
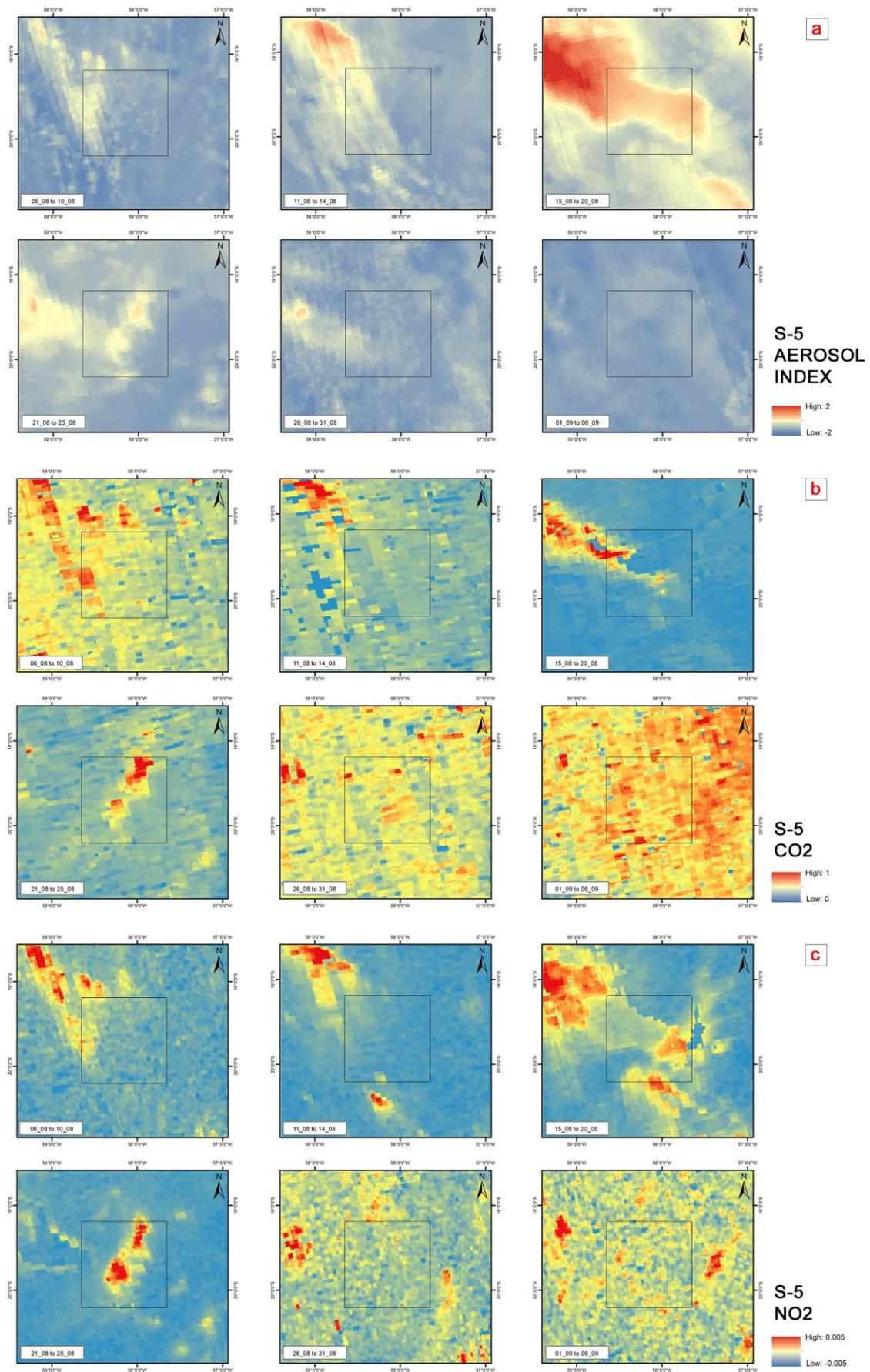
Figure 4. Sentinel-5 imagery of pollutant emissions in the Mato Grosso do Sul, (Brazil). A) Aerosol index; b) CO2 (carbon dioxide); c) NO2 (nitrogen dioxide).