



Copernicus EMS Risk & Recovery Mapping Technical Report

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FRAMEWORK SERVICE CONTRACT FOR
COPERNICUS EMERGENCY MANAGEMENT SERVICE
RISK & RECOVERY MAPPING
TECHNICAL REPORT

***EMSN167: Post-wildfire damage assessment in Sterea Ellada
Region, Greece***

Organization(s) Author	e-GEOS, Telespazio Iberica
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ACRONYMS

Acronyms	Signification
AD	Applicable Document
AOI	Area of Interest
AU	Authorized User
CEMS	Copernicus Emergency Management Service
EMSN	Emergency Management Service No rush
EMSR	Emergency Management Service Rush
GSD	Ground Sampling Distance
JRC	Joint Research Centre
MMU	Minimum Mapping Unit
NBR	Normalised Burn Ratio
NDVI	Normalised Difference Vegetation Index
ONA	Off Nadir Angle
RD	Reference Documents
RRM	Risk and Recovery Mapping
SRF	Service Request Form
STD	Standard
VHR	Very High Resolution

1 INTRODUCTION

1.1 ACTIVATION DETAILS

COPERNICUS RISK AND RECOVERY MAPPING ACTIVATION	
ACTIVATION DETAILS	
Activation Name	EMSN167: Post-wildfire damage assessment in Sterea Ellada Region, Greece
Authorized User	General Secretariat for Civil Protection, Emergency Planning and Response Directorate, Ministry of Climate Crisis and Civil Protection GR
Date and Time of Activation (UTC)	24.08.2023 07:41
EVENT DETAILS	
Event Type(s)	Wildfire
Location	Sterea Ellada, Greece
Date and Time of the Event (UTC)	21.08.2023 06:59

Table 1-1: Activation Details

1.2 EVENT DESCRIPTION AND CONTEXT

On the 22 August 2023, two wildfires started in a forest area near Prodromos village (Sterea Ellada Region) and in the afternoon in a forest area near Kyriaki village. The event lasted several days affecting a vast area and the residents of the villages Prodromos, Paralia Sarandi, Karioti, Tarsos, Panagia Kalamiotissa and Agios Athanasios were ordered to evacuate.

Given the severity of the event, the Authorised User (AU) triggered Copernicus EMS Rapid Mapping service. Through the EMSR687 activation, after an initial First Estimate Product (derived from Sentinel-3 imagery), a Delineation Product and a Delineation Monitoring 01 (Figure 1-2) have been delivered on the 24 and 29 August 2023, respectively (<https://rapidmapping.emergency.copernicus.eu/EMSR687/download>).

Updated information on the status and results of the EMSR687 can be found in the Situational Report available at <https://rapidmapping.emergency.copernicus.eu/EMSR687/reporting>.

Around 8200 ha of burnt areas were detected on the latest observation.



Figure 1-1 The forest fire raging near Prodomos village, Sterea Ellada, Greece¹

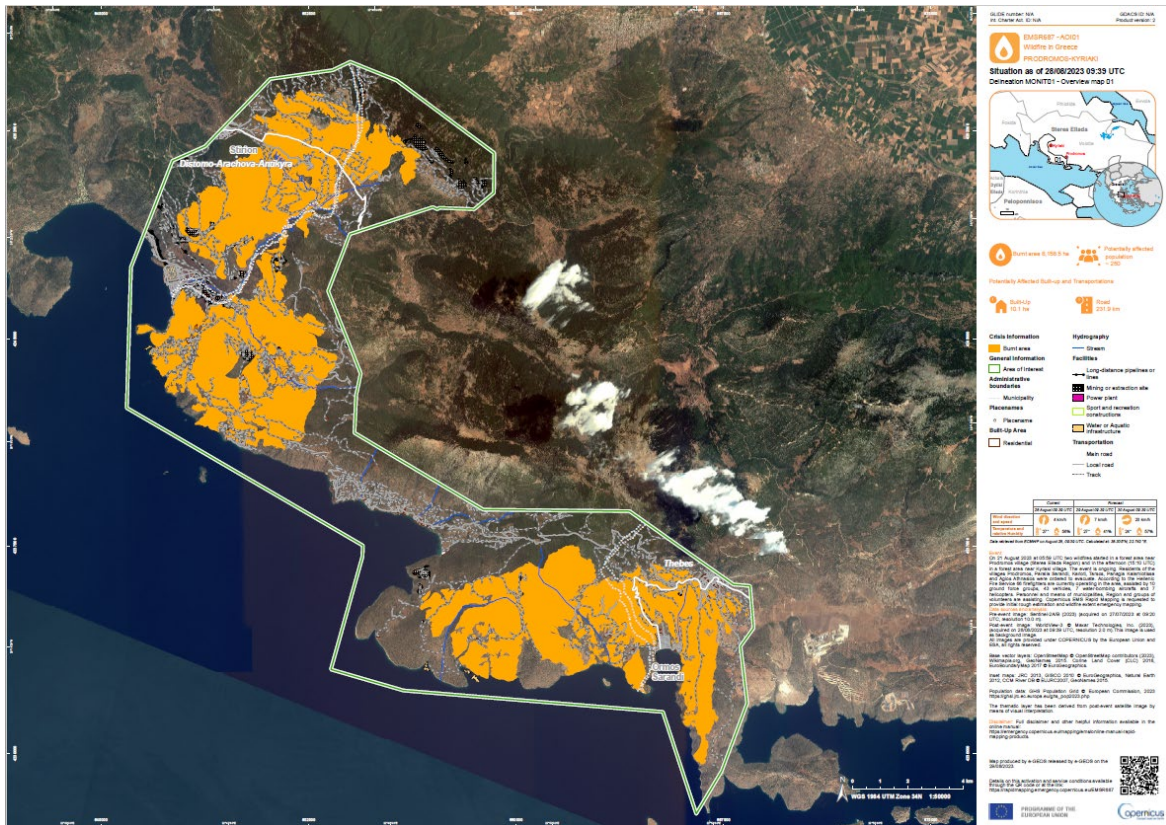


Figure 1-2 EMSR687 Delineation Monitoring 01, derived from WorldView-3 imagery acquired on the 28.08.2023.

¹ Source: <https://greekcitytimes.com/2023/08/21/one-shepherd-dead-prodomos/>

Since grading of Land Use/Land Cover requires detailed analysis and optimal imagery, a post-event assessment has been requested through the delivery of the P07-Wildfire delineation and grading product, belonging to the CEMS RRM Standard portfolio.

The AOI used during the EMSR687 has evolved throughout the activation, and the AOI used for the Delineation Monitoring 01 product is represented in red in Figure 1-3.

The AOI has been furtherly reshaped in order to better focus around the burnt areas (orange fields) detected in the Delineation Monitoring 01 product. The latest version of the AOI, used for this CEMS RRM STD activation, is shown in green in the Figure 1-3 below:

- **AOI01- PRODRAMOS-KYRIAKI (150.5 km²)**



Figure 1-3 AOI used for EMSR687 (in red) for the Delineation Monitoring 01 product and the revised version (in green) considered for EMSN167

1.3 SERVICE REQUEST

1.3.1 OBJECTIVE

The goal of the activation is to provide wildfire damage delineation and grading product to support local authorities in the recovery and restoration planning of the affected area.

1.3.2 FEASIBILITY STUDY

The EMSN167 activation was accepted as a result of an accurate feasibility analysis that was carried out to define the requirements necessary to assure the generation of the requested product (see Table 1-2).

REQUESTED PRODUCTS						
Product Code	Product description	Scale	Image resolution class/Sensor type	Input Data (obligatory)	AOI (km ²)	Delivery time (days)
P07	Wildfire delineation and grading	1:25000	VHR, HR	Image data	25-500	5-10

Table 1-2 Technical details for requested standard product.

The feasibility study has led to the commitment of the following product:

- **P07-Wildfire delineation and grading**


FEASIBILITY OF REQUESTED PRODUCTS					
PRODUCT CODE	PRODUCT DESCRIPTION	SCALE	AOI(s)	Other details	Feasible/Not Feasible
P07	Wildfire delineation and grading	1:25000	AOI01: PRODROMOS-KYRIAKI (150.5 km ²)	N/A	

Table 1-3 Technical feasibility statement for the EMSN167 Activation

1.3.3 PRODUCTS DESCRIPTION

The product generated within this activation is described in Table 1-4.

	AOI	Product description
P07	AOI01	The wildfire delineation and grading product shows the delineation of the burnt area and the associated level of damage as derived from post-event optical VHR images. The majority of the burnt areas have been assessed as highly damaged based on the analysis of the variation of the NDVI.

Table 1-4 Products description

The final delivery includes the products reported in Table 1-5.

Product Name	AOI	Description	Type	Scale	Num.	
RRM OVERVIEW MAP	1	AOI01	P07-Wildfire delineation and grading	Overview Map	1:50000	1
	2	-	Geodatabase with results	GDB	-	1
Technical Specifications FWC	3	AOI01	.geojson files of: - AOI - P07 Delineation product - P07 Grading product	Vector	1:25000	3
	4	-	Symbology used for delivered vectors	.lyr, .sld files	-	4
	5	-	Consequence tables of: - P07 Wildfire delineation and grading	.xlsx files	-	1
	6	-	Metadata for the GDB and all the feature classes within the gdb and map delivered	.xml files	-	7
	7	-	Flyer	Report	-	1
	8	-	Factsheet	Report	-	1
	9	-	Final Report	Report	-	1

Table 1-5 Deliverables description

2 INPUT DATA

Input data for EMSN167 mostly consist in pre and post-event VHR optical images used for the P07-Wildfire delineation and grading product. In addition, OSM reference data and (affected) settlements released with EMSR687 products, were used for the map representation.

2.1 EO DATA

Data type	Sensor	Acquisition date and time (UTC)	GSD (m)	Off-nadir angle (°)	Cloud cover (%)	RRM STD Products
PRE-EVENT SATELLITE IMAGERY	PlanetScope	07.08.2023 08:59	3.0	2.1	0.0	P07
POST-EVENT SATELLITE IMAGERY	WorldView-3	28.08.2023 09:39	2.0	37.2	0.0	P07

Table 2-1 EO Data for EMSN167 P07 product

Data type	Sensor	Acquisition date (or interval)	Request submission date and time (UTC)	Reception date and time (UTC)
PRE-EVENT SATELLITE IMAGERY	PlanetScope	07.08.2023 08:59	06.09.2023 15:00	06.09.2023 15:55
POST-EVENT SATELLITE IMAGERY	WorldView-3	28.08.2023 09:39	06.09.2023 07:35	07.09.2023 08:30

Table 2-2 EMSN167 Imagery procurement details

2.2 OTHER INPUT AND ANCILLARY DATA

Data source	Provider	Format	Availability	Use
OSM	OSM	Vector	www.osm.org	Thematic layers for map production

Table 2-3 Input and ancillary data for EMSN167 products

3 METHODOLOGY

3.1 P07 – WILDFIRE DELINEATION AND GRADING

The P07- Wildfire delineation and grading products provide an assessment of the event’s impact, its spatial distribution, and extent. The product covers any event type related to wildfire and provides generic information about the affected land. The product is directly derived from the image data, acquired as soon as possible after the emergency event, and consists of the collection of burnt areas together with damage grade information.

Figure 3-1 below shows an example proving that given the large spectral difference between vegetated and burnt areas, the spectral image processing approach is applicable in mapping burnt areas.

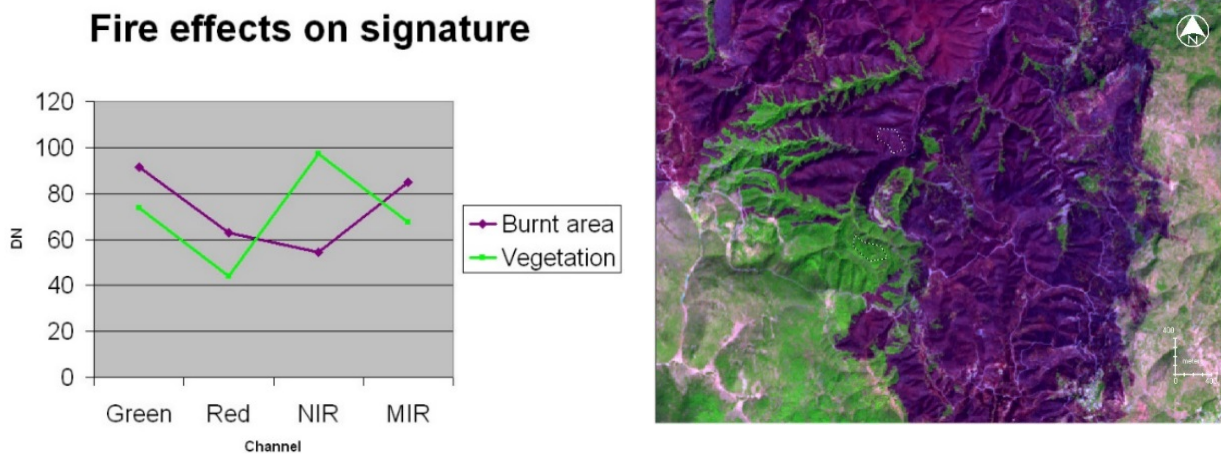


Figure 3-1: Digital number counts used to compare healthy vegetation (green) with a burnt area (purple) within the same image. One can note a relative increase in the visible and Short Wave InfraRed (SWIR) channels and dramatic decrease in values within the Near Infrared channel. The values are derived from a SPOT 5 image acquired on the 02 September 2007, ©CNES 2007, distribution AIRBUS DS, all rights reserved.

Despite this approach being suitable in most cases, it will never be perfect in areas of sparse vegetation, and unfortunately other areas can get mixed up. To obtain the most accurate results a manual validation phase is essential in the P07 production workflow.

3.1.1 WILDFIRE DELINEATION

The wildfire delineation product is based on change detection between dates prior and after the fire event. The first step is to select two sets of images relevant for the burnt area detection. Images should be acquired as close as possible to the event and to each other, to ensure a highly discriminable burnt scar and similar vegetation states in its surroundings for both dates. In the framework of the EMSN167 activation, the *Normalised Burn Ratio* (NBR) could not be calculated as PlanetScope data used for production do not have a SWIR channel. Objects under the Minimum Mapping Unit (MMU) equal to 0.25 ha were removed.

3.1.2 WILDFIRE GRADING

The wildfire grading is computed using the wildfire delineation previously mapped and the dNDVI layer. The procedure without SWIR channels has been applied in this activation.

The *Normalized Difference Vegetation Index* (NDVI) represents the vegetation health state and have strong capability in extracting wildfires burned areas and impacts. The NDVI is calculated as:

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

Once the index is calculated for the reference and crisis images, change detection is applied by subtracting the crisis indices layers from their respective reference layer, resulting in a dNDVI layer.

The damage grades will be specific to a given event, being presented by four classes namely:

- Destroyed
- Highly Damaged
- Moderately Damaged
- Negligible to Slight Damaged.

The method is straightforward and widely used and well described in the [IWG-SEM guidelines](#). The dNDVI is calculated and classified according to the adapted IWG-SEM classes, as illustrated by the table below. As four classes are requested in the standard P07 product, the *Moderate severity* class of the IWG SEM classification is split into two CEMS RRM classes, *Moderately damaged* and *Highly damaged*.

IWG-SEM classes	EMS RRM classes	dNDVI
Low severity	Negligible to slight damage	dNDVI <= 0.3
Moderate severity	Moderately damaged	0.3 > dNDVI <= 0.41
	Highly damaged	0.41 > dNDVI <= 0.55
High severity	Destroyed	dNDVI > 0.55

Table 3-1 Severity classes correspondence table between IWG-SEM and CEMS RRM

4 RESULTS

The main results and products of the activation are presented in the following sections.

4.1 P07 – WILDFIRE DELINEATION AND GRADING

The analysis performed in the framework of this EMSN167 activation shows that 8158.54 ha were burnt, most of which has been high damage (4217.91 ha). Most of destroyed areas are located in northern slopes.

The fire grading based on dNDVI thresholding is shown in Table 4-1 and in Figure 4-1.

	Unit of measurement	Destroyed	High damage	Moderate damage	Negligible to slight damage	Total affected
Burnt area	ha	1663.47	4217.91	2033.58	243.58	8158.54

Table 4-1 Break down of affected areas by fire severity grading for AOI01- PRODRAMOS-KYRIAKI

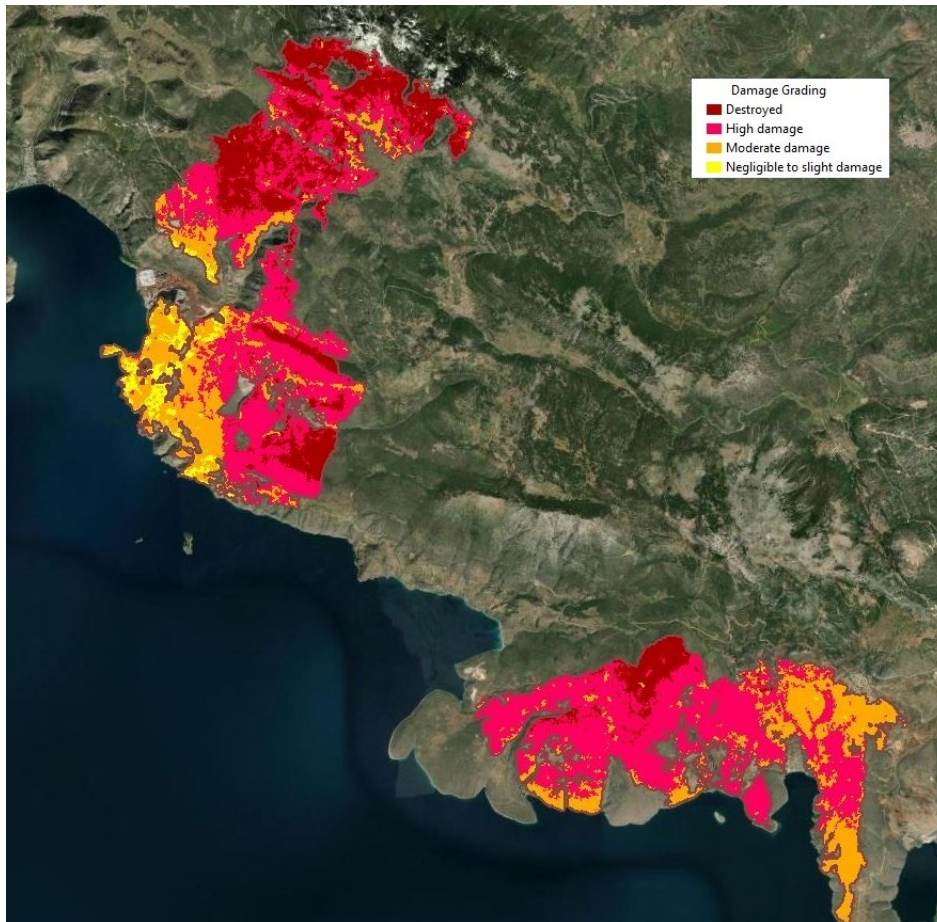


Figure 4-1 P07-Wildfire delineation and grading product in AOI01- PRODRAMOS-KYRIAKI

5 INTERNAL QUALITY CONTROL

5.1 P07 – WILDFIRE DELINEATION AND GRADING

5.1.1 THEMATIC ACCURACY

Thematic validation is performed to assess the thematic quality of P07 product. The wildfire delineation consists of a layer representing 2 classes: burnt and unburnt areas. Congalton, Russell G. and Kass Green (2002)² suggest that in the case of a change/no change map, a binomial class distribution is appropriate for assessing the sample size. An example is also presented; for a 90% accuracy and a confidence level of 95%, a sample size of 298 is required. The thematic accuracy required for P07 is 85%, so a sample size of 300 allows to ensure to reach this accuracy and even to be on the safe side.

The same authors proposed a method for increasing the number of samples in the areas surrounding the burned scar. The number of samples are dispersed as shown in Table 5-1.

Strata	Percentage of total samples	Number of samples
Burnt area	40	120
Direct surroundings	30	90
Rest of the AOI	30	90

Table 5-1: P07 - Sampling strategy

The sampling strategy is stratified and random. The “burnt area” stratum is self-explanatory. The “direct surrounding” stratum corresponds to areas in contact with the burnt area where confusions in the fire delineation are expected to be probable. This area is defined by a buffer of 200m around the burnt area. The “rest of the AOI” stratum is also self-explanatory.

For each sample point, the correctness of the classification was assessed manually on the same image used for production by an operator that was not involved in the previous steps of the production. The accuracy of the delineation product is assessed through Producer’s, User’s, and finally Overall accuracies. The Overall accuracy of the product must be over 85%. The result of this validation step is reported below.

² Congalton, Russell G., and Kass Green. *Assessing the accuracy of remotely sensed data: principles and practices*. CRC press, 2002.

		Validation assessment			User's Accuracy
		Unburnt	Burnt	Total	
Damage assessment	Unburnt	176	4	180	97.78%
	Burnt	7	113	120	94.17%
	Total	183	117	300	
Producer's Accuracy		96.17%	96.58%		OA = 96%

Table 5-2 P07-Wildfire delineation and grading validation results in AOI01- PRODRAMOS-KYRIAKI

The thematic accuracy of the grading product is the same as the delineation. Grading classes accuracy cannot be evaluated by photo-interpretation.

5.1.2 GEOMETRIC POSITIONAL ACCURACY

The positional accuracy of P07 product is dependent on the input satellite images positional accuracies. All images were delivered already orthorectified, so no positional accuracy was conducted.