FRAMEWORK SERVICE CONTRACT FOR

COPERNICUS EMERGENCY MANAGEMENT SERVICE

RISK & RECOVERY MAPPING

TECHNICAL REPORT

EMSN170: Post-wildfire damage assessment in North Attica, Greece

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Date	08.09.2023
Issue	1.0

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

Acronyms	Signification
AOI	Area of Interest
AU	Authorized User
CEMS	Copernicus Emergency Management Service
CENEM	Civil Protection and Emergencies
CLC	Corine Land Cover
FAO	Food and Agriculture Organization of the United Nations
EMSN	Emergency Management Service No rush
ESDAC	European Soil Data Centre
GSD	Ground Sampling Distance
HR	High Resolution
IGN	Instituto Geografico Nacional
IWG-SEM	International Working Group on Satellite-based Emergency Mapping
JRC	Joint Research Centre
LIC	Lugar de Importancia Comunitaria
LULC	Land Use Land Cover
NDVI	Normalized Difference Vegetation Index
ONA	Off Nadir Angle
OSM	OpenStreetMap
RM	Rapid Mapping
RRM	Risk and Recovery Mapping
RUSLE	Revised Universal Soil Loss Equation
SIOSE	Sistema de Información sobre Ocupación del Suelo de España
SP	Service Provider
SRF	Service Request Form
STD	Standard
SWIR	Short Wavelength Infrared
VHR	Very High Resolution
ZEPA	Zona de Especial Protección para las Aves

1   INTRODUCTION

1.1   ACTIVATION DETAILS

COPERNICUS RISK AND RECOVERY MAPPING ACTIVATION	
ACTIVATION DETAILS	
Activation Name	EMSN170: Post-wildfire damage assessment in North Attica, Greece
Authorized User	General Secretariat for Civil Protection, Emergency Planning and Response Directorate, Ministry of Climate Crisis and Civil Protection GR
End User	N/A
Date and Time of Activation (UTC)	24.08.2023
EVENT DETAILS	
Event Type(s)	Wildfire
Location	North Attica, Greece
Date and Time of the Event (UTC)	22.08.2023 09:56

Table 1-1: Activation Details

1.2   EVENT DESCRIPTION AND CONTEXT

The CEMS Risk and Recovery Standard (RRM STD) has been activated on 24 August 2023 by the Greek General Secretariat for Civil Protection, Emergency Planning and Response Directorate, Ministry of Climate Crisis and Civil Protection, as Authorized User (AU), following the forest fire that broke out in North Attica (Greece).

On Tuesday of 22 August (11:56 local time) a wildfire started in a forest area near the monastery of Kleiston on Parnitha Mountain in Attica Region. The fire has led to the destruction of houses and vehicles in suburb of Fyli.

Figure 1–1 Several homes were damaged or completely destroyed by the fire at Fyli on the foot of Mount Parnitha [1].

Within the framework of the activation EMSR690, a first Delineation Product has been delivered on 23/08/2023, followed by 3 Delineation Monitoring on 24/08/2023, 25/08/2023 and 28/08/2023 (https://rapidmapping.emergency.copernicus.eu/EMSR690/download). More than 6,193 ha of burnt areas and about 276 of potentially affected buildings were counted.

The AU specified in the SRF that he wants to activate the Copernicus EMS Risk and Recovery STD to provide the P07-Wildfire delineation and grading product. This product will be used to confirm the perimeter, assess the damages and the impact of the fire.

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[1] Source: https://greekreporter.com/2023/08/23/wildfire-mount-parnitha-north-athens/

The AOI01 evolved during the EMSR690 activation. The AOI in red was the last AOI used to produce the Delineation Monit03 (Figure 1-2). The AOI has been optimized close to the burnt area (in green) for this CEMS RRM STD activation:
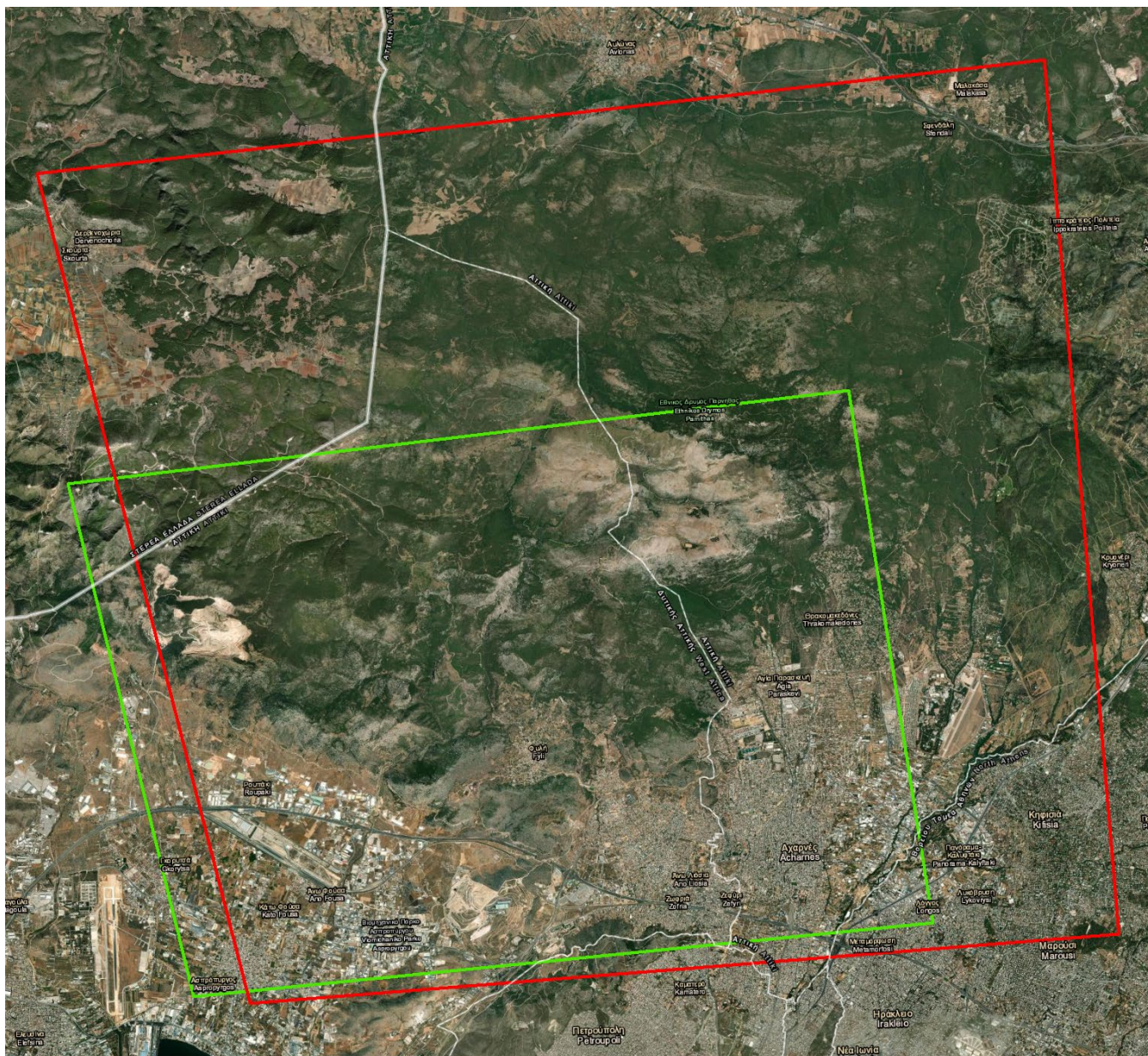
- **AOI01-PARNITHA MOUNTAIN** (in green, 223.1 km^2)

Figure 1-2 AOI01-PARNITHA MOUNTAIN
(Red: AOI used for EMSR690 DEL Monit03; Green: AOI proposed for EMSN170)

1.3   SERVICE REQUEST

1.3.1   OBJECTIVE

The goal of the activation is to provide wildfire damage delineation and grading products within the AOI01, aiming at providing the ecological value of the affected area, as well as to assess the damages caused by the wildfire event.

1.3.2   FEASABILITY STUDY

The EMSN170 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 products (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 products

Following the feasibility study, the service provider committed the delivery of the following products:

- **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: PARNITHA MOUNTAIN (223.1 km^2)	N/A	✔

Table 1-3 Technical feasibility statement for the EMSN170 Activation

1.3.3 PRODUCTS DESCRIPTION

The products generated within this activation are 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 either slightly, moderately or highly damaged, based on analyzing 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	1:31000	1
GDB	2	-	Geodatabase with results	GDB	-	1
Technical Specifications FWC	3	AOI01	.geojson files of: - AOI01 - P07 Delineation product - P07 Grading product	Vector	1:25000	3
	4	-	Symbology used for delivered vectors	.lyr, .sld files	-	6
	5	-	Consequence tables of: - P07 Wildfire delineation and grading	.xlsx files	-	1

Product Name		AOI	Description	Type	Scale	Num.
	6	-	Metadata for the GDB and all the feature classes within the gdb and maps 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 EMSN170 consist in a pre-event Worldview-3 image and a post-event GeoEye-1 image used for the P07-Wildfire delineation and grading product. Ancillary datasets retrieved from OpenStreetMap (and EMSR690) were used to improve the readability of the cartographic products.

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	Worldview-3	21.07.2023 09:45	0.5	43.7	0.0	P7
POST-EVENT SATELLITE IMAGERY	GeoEye-1	28.08.2023 09:31	0.5	35.0	0.0	P7

Table 2-1 EO Data for EMSN170 P07 product

Data type	Sensor	Acquisition date (or interval)	Request submission date and time (UTC)	Reception date and time (UTC)
PRE-EVENT SATELLITE IMAGERY	Worldview-3	21.07.2023 09:45	01.09.2023 15:23	01.09.2023 15:40
POST-EVENT SATELLITE IMAGERY	GeoEye-1	28.08.2023 09:31	01.09.2023 15:26	01.09.2023 15:50

Table 2-2 EMSN170 Imagery procurement details

2.2   OTHER INPUT AND ANCILLARY DATA

Data source	Provider	Format	Availability	Use
Transportation	OSM	Vector	www.osm.org	Reference for map production
Hydrography	OSM	Vector	www.osm.org	Reference for map production
Settlements and Facilities	OSM	Vector	www.osm.org	Reference for map production

Table 2-3 Input and ancillary data for EMSN170 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 (once extinguished), 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.
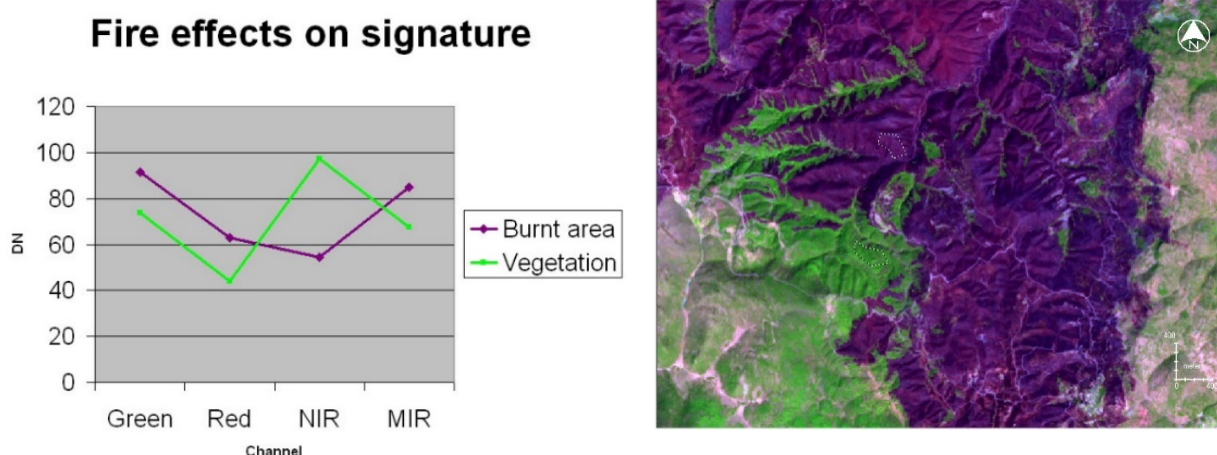

Figure 3–1: Digital number counts used to compare healthy vegetation (green) with a burnt area (purple) within the same image. One can note a relative increase in the visible and Short Wave InfraRed (SWIR) channels and dramatic decrease in values within the Near Infrared channel. The values are derived 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 EMSN170 activation, the *Normalised Burn Ratio* (NBR) could not be calculated as GeoEye-1 data used for production do not have a SWIR channel. Objects under the Minimum Mapping Unit (MMU) equal to 100 m^2 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 has a strong capability in extracting wildfires burnt 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
- High Damage
- Moderate Damage
- Negligible to Slight Damage.

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 3-1 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, *Moderate damage* and *High damage.*

IWG-SEM classes	EMS RRM classes		dNDVI
Low severity	Negligible to slight damage		dNDVI <= 0.3
Moderate severity	Moderate damage		0.3 > dNDVI <= 0.41
	High damage		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 wildfire has a size of 6076.21 ha which is approximatively 27 % of the AOI. The fire grading based on dNDVI thresholding is shown in Table 4-1 and in Figure 4–1. The size of the burnt area is important, and the fire has impacted urban areas. The most affected areas (Moderate damage, High damage or Destroyed) are located on the relief.

	Unit of measurement	Destroyed	High damage	Moderate damage	Negligible to slight damage	Total affected
Burnt area	ha	39,44	20,02	1529,92	4486,83	6076,21

Table 4-1 Break down of affected areas by fire severity grading
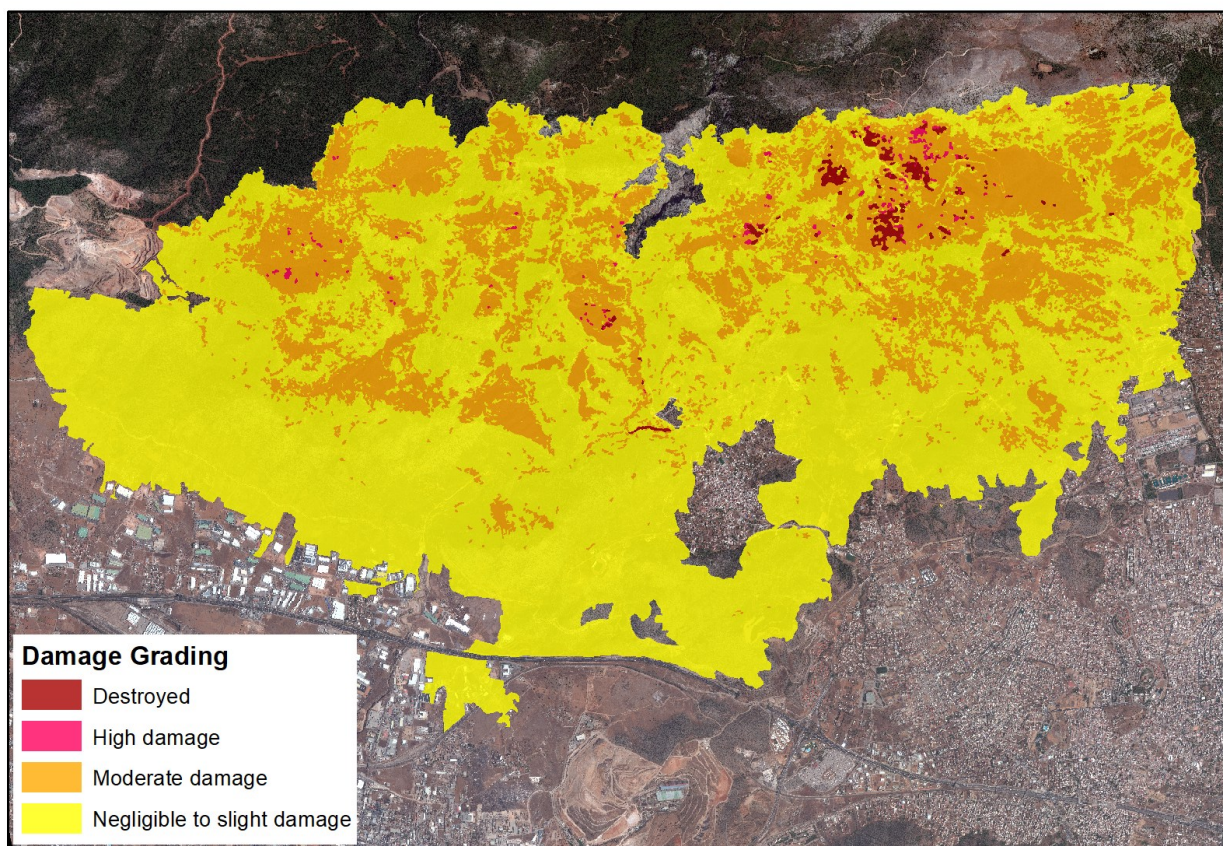

Figure 4–1 Zoom on the P07 Wildfire grading

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 100m 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.

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[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	129	2	131	98.7%
	Burnt	2	167	169	98.8%
	Total	131	169	300	
	Producer's Accuracy	98.7%	98.8%		OA = 98.75%

Table 5-2 P07-Wildfire delineation validation results

The thematic accuracy of the grading product is the same as the delineation. Grading classes accuracy cannot be evaluated by photo-interpretation. The only situation where a new assessment could be realized is if field data are available for the wildfire event.

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.