10TH ADVANCED TRAINING COURSE ON LAND REMOTE SENSING

Forest fires with optical and thermal remote sensing observations

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The lecture will discuss the potential of optical and thermal remote sensing observations to support research and development as well as operational planning for forest fires.

The potential is examined with respect to all three stages of a forest fire, namely: pre-fire, active fire and post-fire.

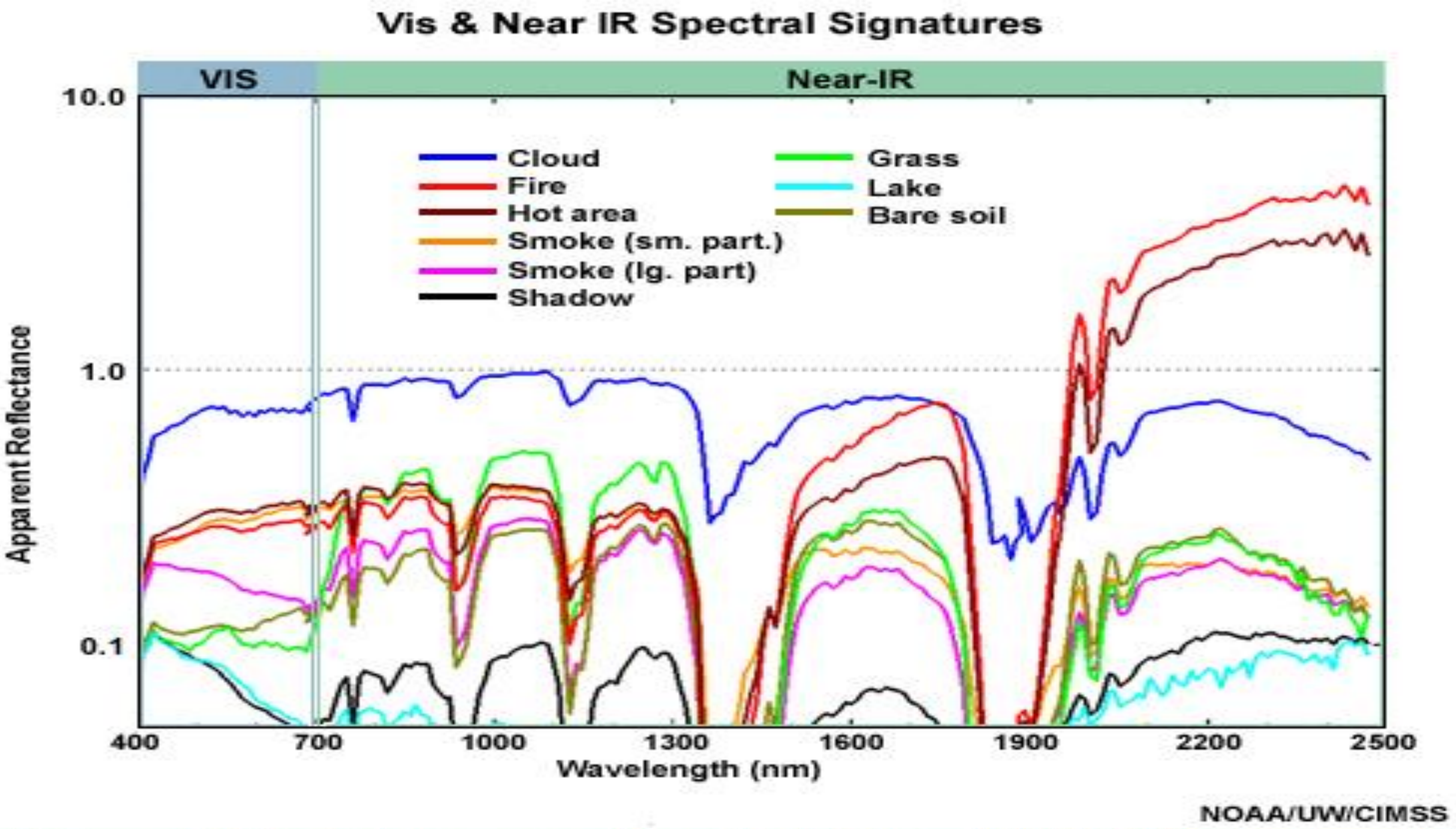
Special consideration is given to the assessment of the above mentioned potential with respect to the spectral, spatial and temporal resolution of the related satellite missions.

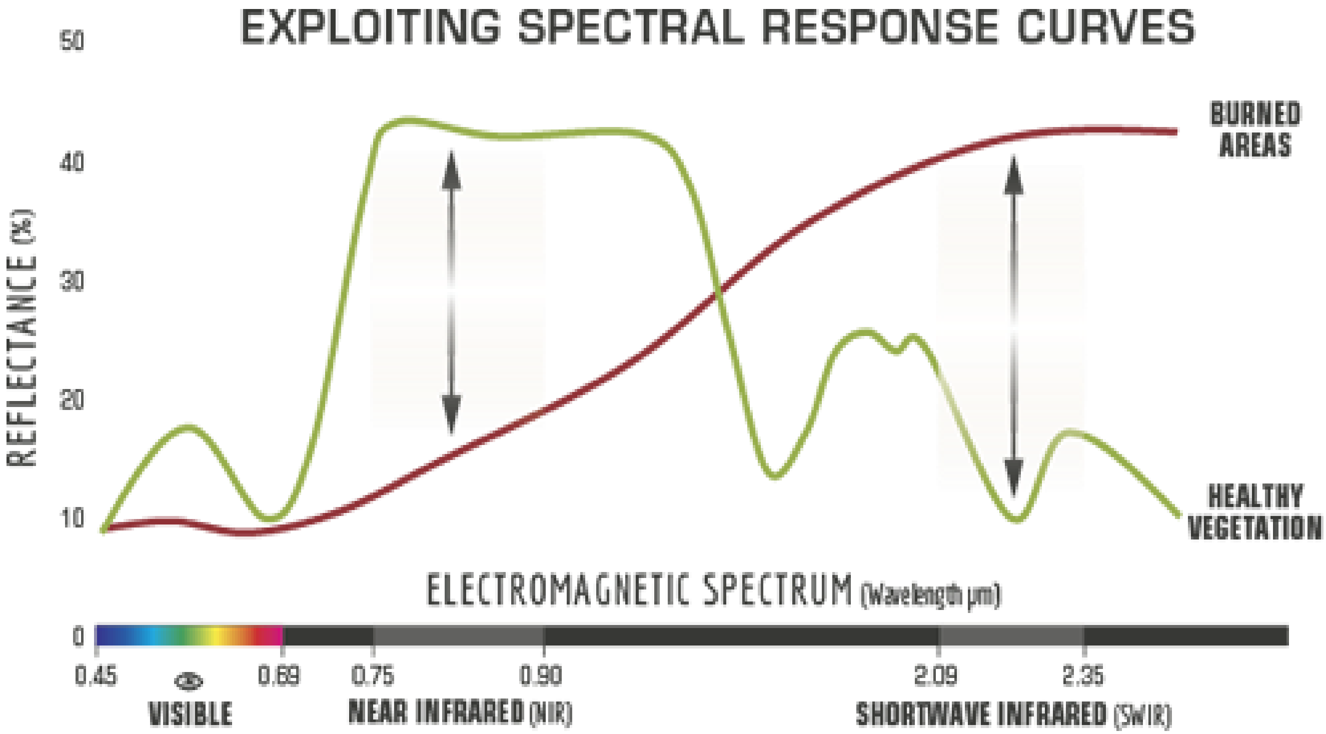
Finally, an assessment is made on the basis of recent forest fires analysis.

The structure of the lecture

1. Introduction on the radiometry of forest fires
2. Remote sensing observations and forest fires
3. The pre-fire stage
4. The active fire stage
5. The post-fire stage (including case studies)
6. Sources of information
7. Conclusions

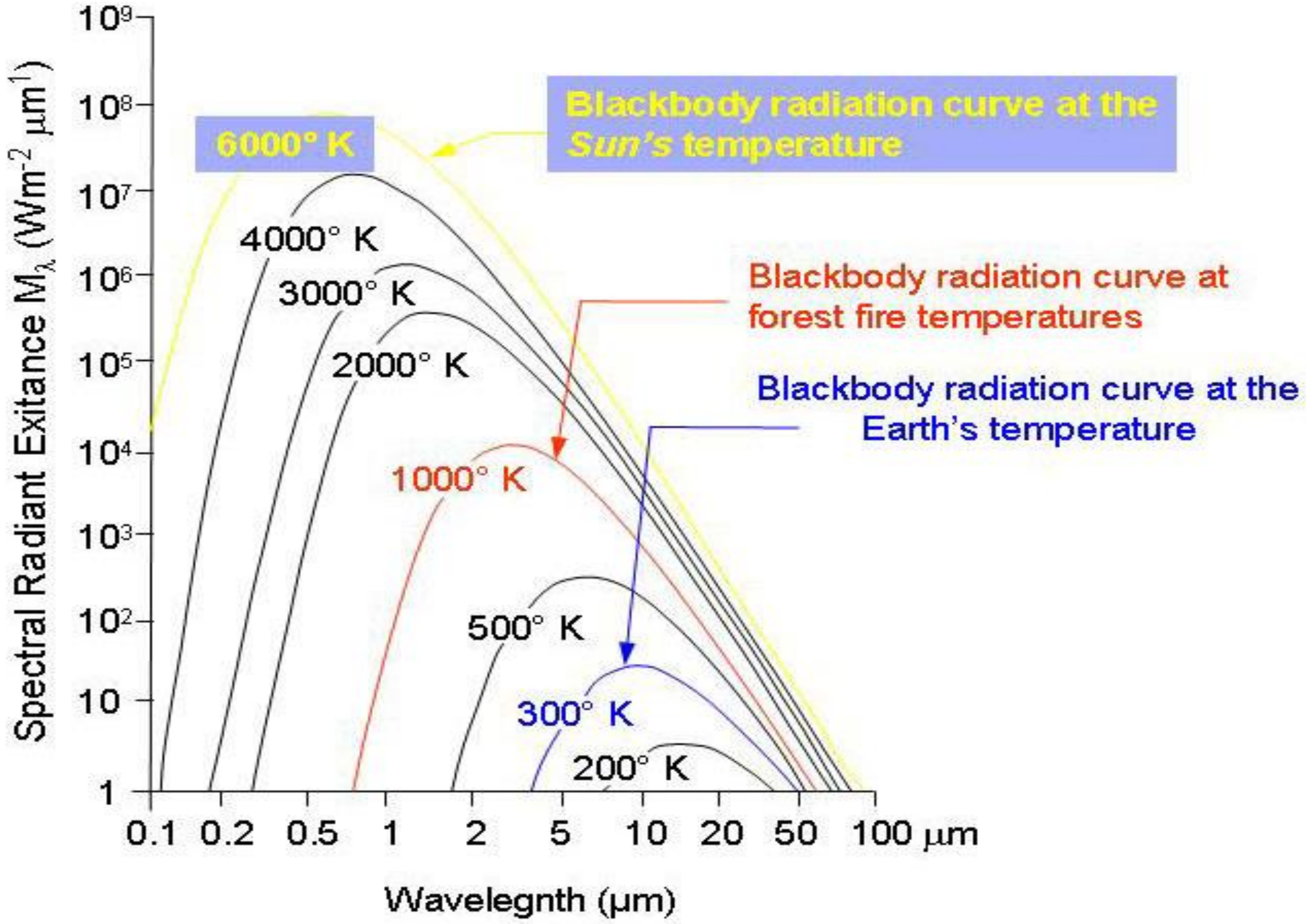
1. Introduction on the radiometry of forest fires


Vis & Near IR Spectral Signatures
VIS
Near-IR
10.0
1.0
0.1
Apparent Reflectance
Cloud
Fire
Hot area
Smoke (sm. part.)
Smoke (lg. part)
Shadow
Grass
Lake
Bare soil
400
700
1000
1300
1600
1900
2200
2500
Wavelength (nm)
NOAA/UW/CIMSS



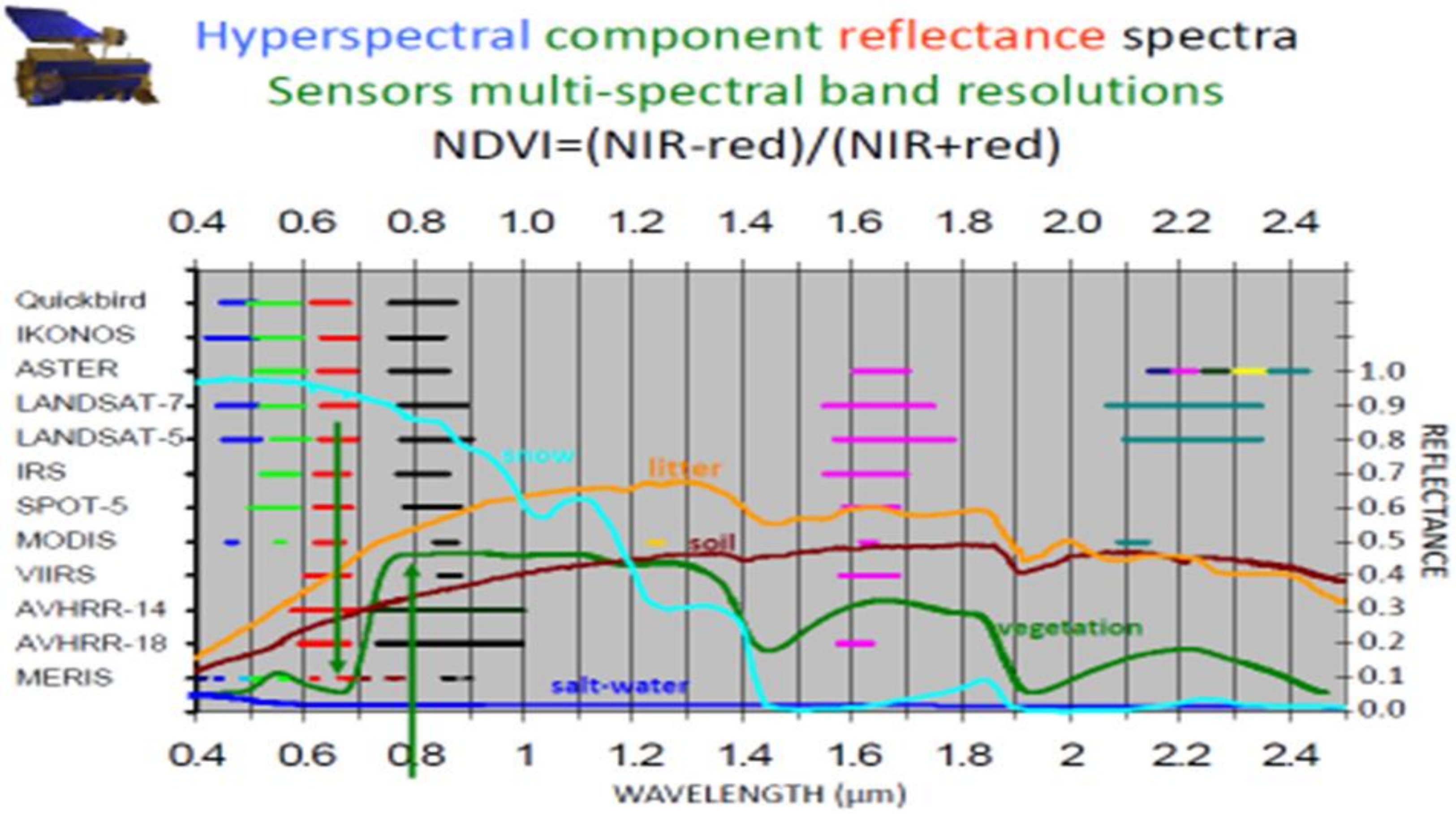
Healthy plant species reflect more energy in NIR but weakly in SWIR. This spectral characteristic is useful for detecting burned areas such as dead soil/plant material on forest floor. Source: US Forest Service.

Wien's law

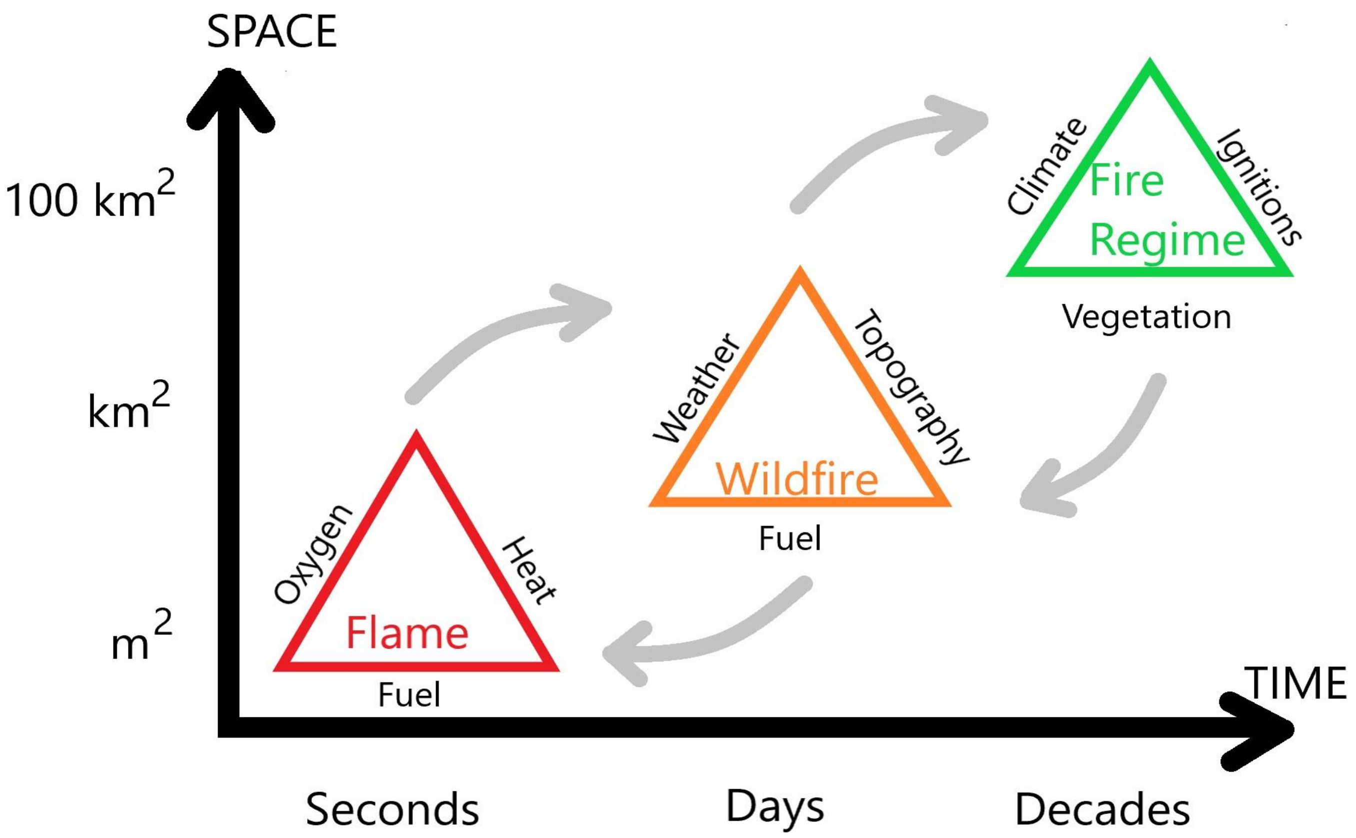


Blackbody radiation curve at the Sun's temperature
6000° K
4000° K
3000° K
2000° K
Blackbody radiation curve at forest fire temperatures
1000° K
Blackbody radiation curve at the Earth's temperature
500° K
300° K
200° K
Spectral Radiant Exitance M_λ ($Wm^{-2}\ \mu m^{-1}$)
10^9
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10
1
0.1 0.2 0.5 1 2 5 10 20 50 100 µm
Wavelegnth (µm)

Spectral signature of vegetation



2. Remote sensing observations and forest fires


SPACE
100 km^2
km^2
m^2
TIME
Seconds
Days
Decades
Flame
Oxygen
Heat
Fuel
Wildfire
Weather
Topography
Fuel
Fire Regime
Climate
Ignitions
Vegetation

The 3 Stages of a Forest Fire

Pre-Fire Risk Assessment	Vegetation density and extent Soil moisture/drought severity Topography Fire risk mapping
Active Fire Detection	Hot Spot Detection Total area burning Fire Radiative Power and Thermal Infrared Pyro cloud formation
Post Fire Assessment	Total area burned Burn severity Post fire vegetation regrowth Landscape regeneration

3. The pre-fire stage

Earth Observation in support of Fire Risk Mapping

Fire Risk Mapping	Ignition	NO	-
	Land cover	YES	VIS and SAR
	Soil moisture and drought severity	YES	Microwaves
	Vegetation type and stage	YES	VIS
	Burning fuel	YES	VIS
	Topography	YES	VIS and SAR
	Meteorological parameters	LIMITED	VIS and TIR
	Land surface temperature	YES	TIR

To provide reliable Fire Risk Mapping, spatial resolution needs to be high

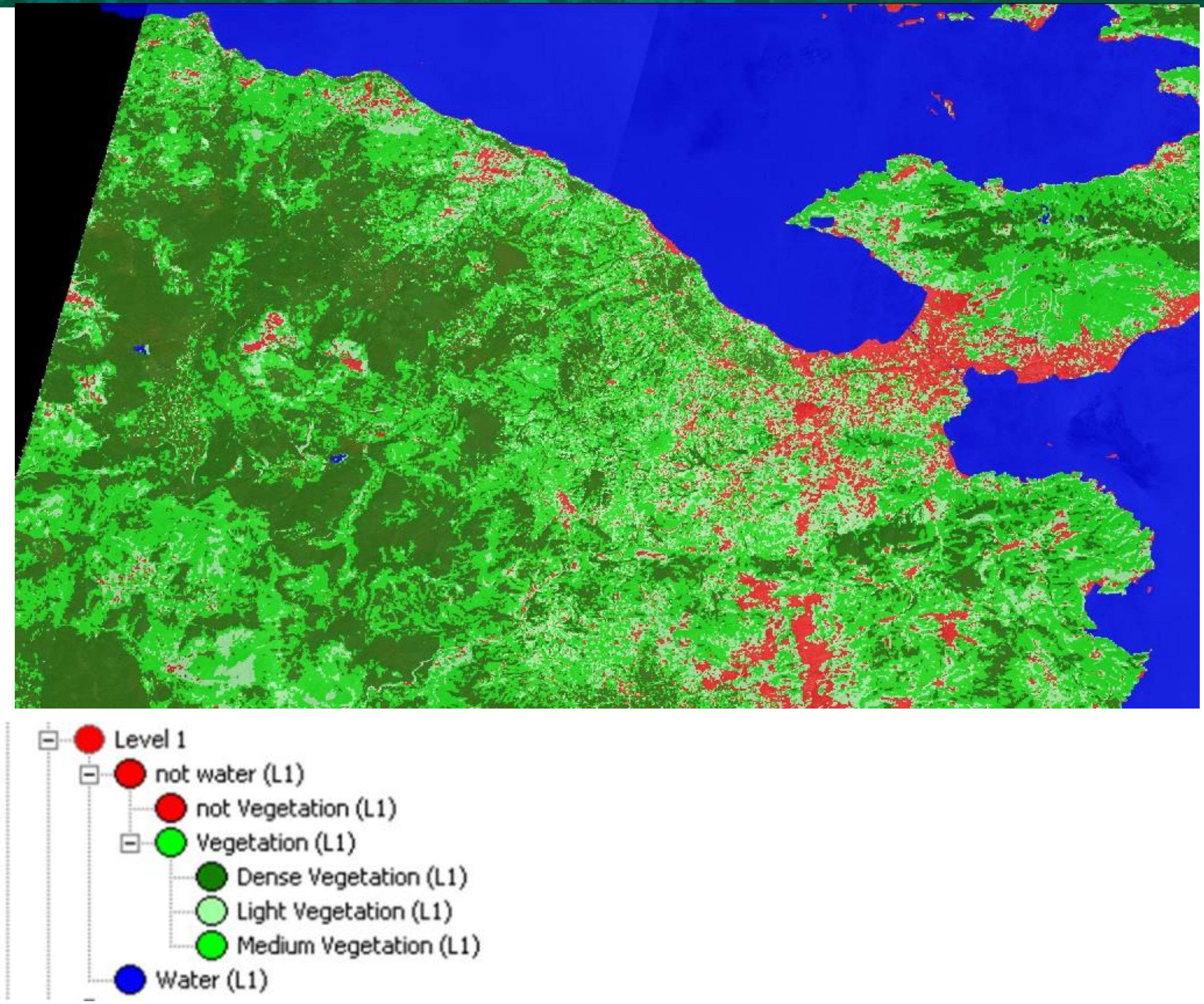
VIS: Visible; TIR: Thermal Infrared; SAR: Synthetic Aperture Radar

Land cover classification – Vegetation density

Fire risk as varies with vegetation density VD.

VD also influences fire dispersion.

Classification of a forest in terms of VD depends strongly on spatial resolution



Land cover classification – vegetation type

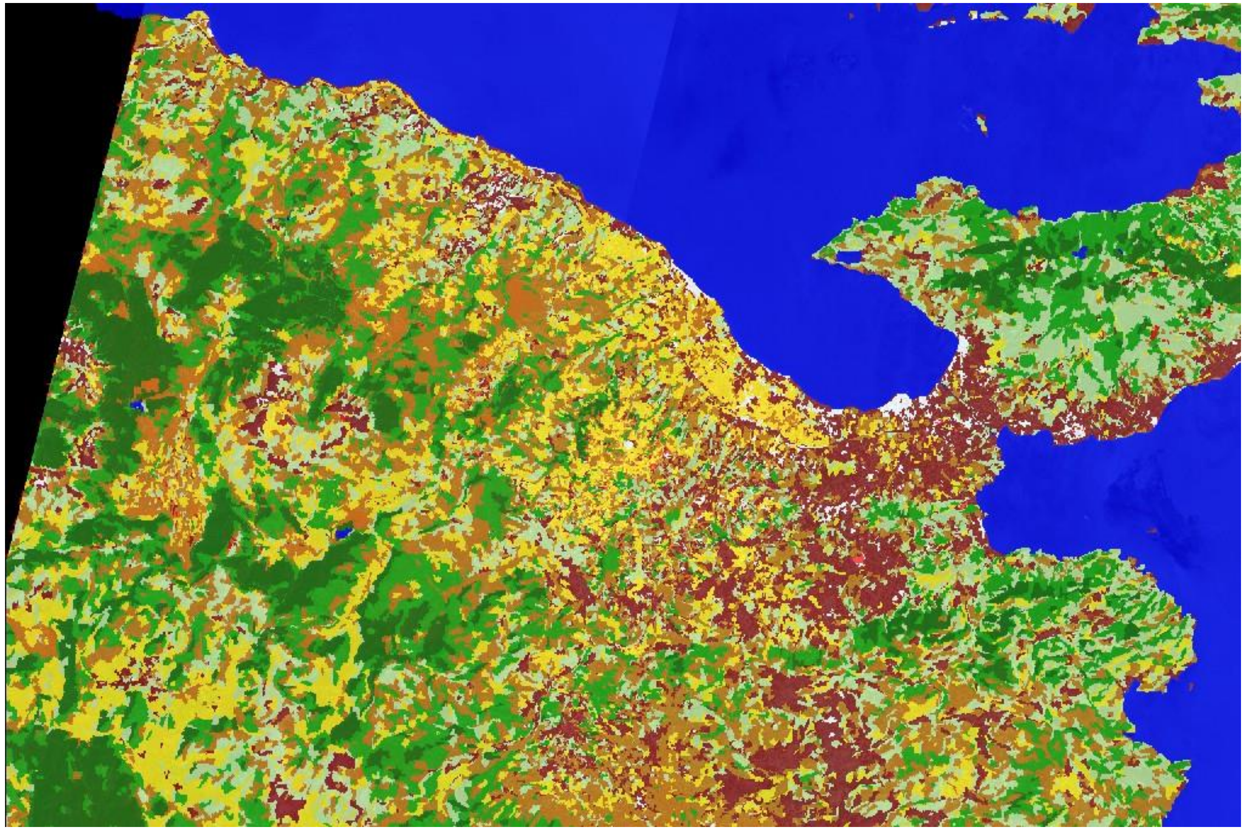
Based on classification which supports the grouping of spectrally similar pixels to a land cover class.

Important to define an urban – forest class, so as to delineate the borders of a forest to a nearby urban area.

Furthermore urban areas slow down forest fires, a fact which is important for fire modelling.

Fuel behavior (ignition and dispesion) varies with vegetation type (VT).

For instance, areas with olive trees slow down the fire. On the contrary, areas with pine trees (typical species for the Mediterranean biodiversity), ignite and disperse easier.



Brown: olive trees; Yellow: agricultural cultivations; Green: conifers; light green: Shrubs

Vegetation stage – Land Surface Phenology

Unhealthy vegetation has a higher percentage of dead leaves, providing easier to burn fuel for fires.

Satellites can be used to track seasonal patterns of variation in vegetated land surfaces through indices:

- NDVI - Normalized Difference Vegetation Index
- EVI - Enhanced Vegetation Index
- SAVI - Soil-Adjusted Vegetation Index
- Vegetation index anomalies

Earth Observation based Vegetation Indices

1/ **NDVI is widely used as a metric for vegetation health.**

• Values range from -1.0 to 1.0

– Negative values to 0 mean no green leaves.

– Values close to 1 indicate the highest possible density of green leaves.

• NDVI Formula: **(Near-Infrared – Red)/(Near-Infrared + Red)**

2/ **Enhanced Vegetation Index (EVI)**

- Can be used in place of NDVI to examine vegetation greenness
- More sensitive in areas with dense vegetation, making it better for fuels assessment in dense forests

EVI, Italy. Acquired on 8.10.2017, processed by Sentinel Hub.

$$EVI = G * \left(\frac{(NIR-R)}{(NIR+C1*R-C2*B+L)}\right)$$

Constants
$G = 2.5$
$C1 = 6$
$C2 = 7.5$
$L = 1$

R:red; B: blue; NIR; near infrared

Evaporative Stress Index

ESI is based on satellite observations of land surface temperature, which are used to estimate water loss due to evapotranspiration (ET) – the loss of water via evaporation from soil and plant surfaces and via transpiration through plant leaves.

EIS can be used as a measure **of vegetation dryness prior to and during the fire season.**

Soil Moisture

Soil moisture is measured by **active microwave scatterometers** such as ERS1&2/AMI and MetOp/ASCAT as well as by **passive microwave radiometers** such as Sentinel 1, Aqua/AMSR-E, Coriolis/WindSat, DMSP 5D-2,-3/SSM I, GCOM-W1/AMSR2, Nimbus-7/SMMR, TRMM/TMI, and SMOS/MIRAS.

All these active and passive microwave sensors are weather-independent, i.e. they can look through clouds, and they can take images at day and night.

Accurate soil moisture estimates are limited to regions that have either bare soil or low to moderate amounts of vegetation cover.

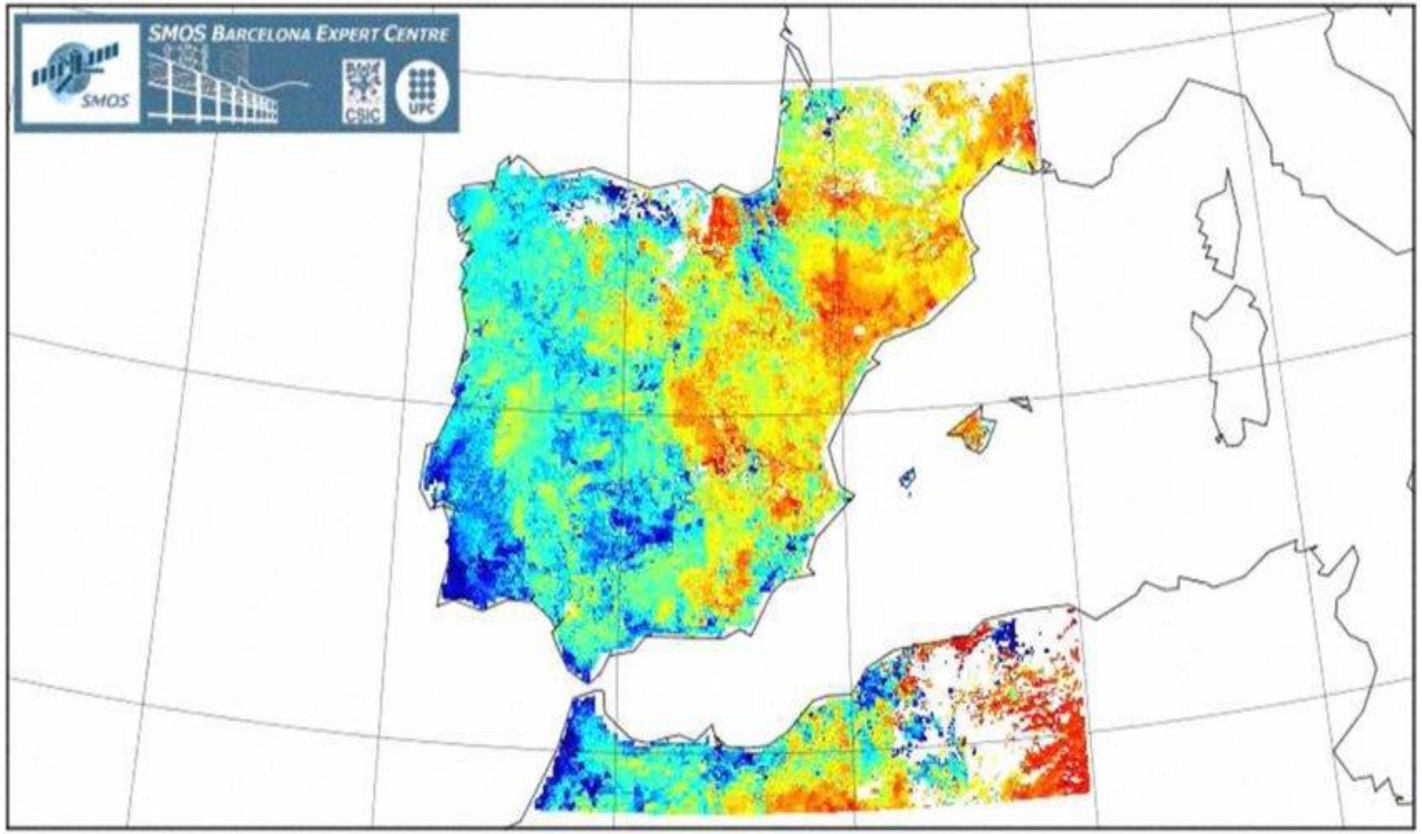
In a greyscale image, brighter pixels indicate higher soil moisture than darker pixels.

Vegetation-Based Fire Applications:

– Vegetation Moisture: Soil moisture acts as a proxy for vegetation moisture and evaporative stress.

– Drought information can also identify areas with dry fuel.

• Measures the moisture in the top 5 cm of the soil globally every 3 day.



Example of high resolution (1 km) soil moisture maps of the Iberian peninsula generated from SMOS data (10 days average)

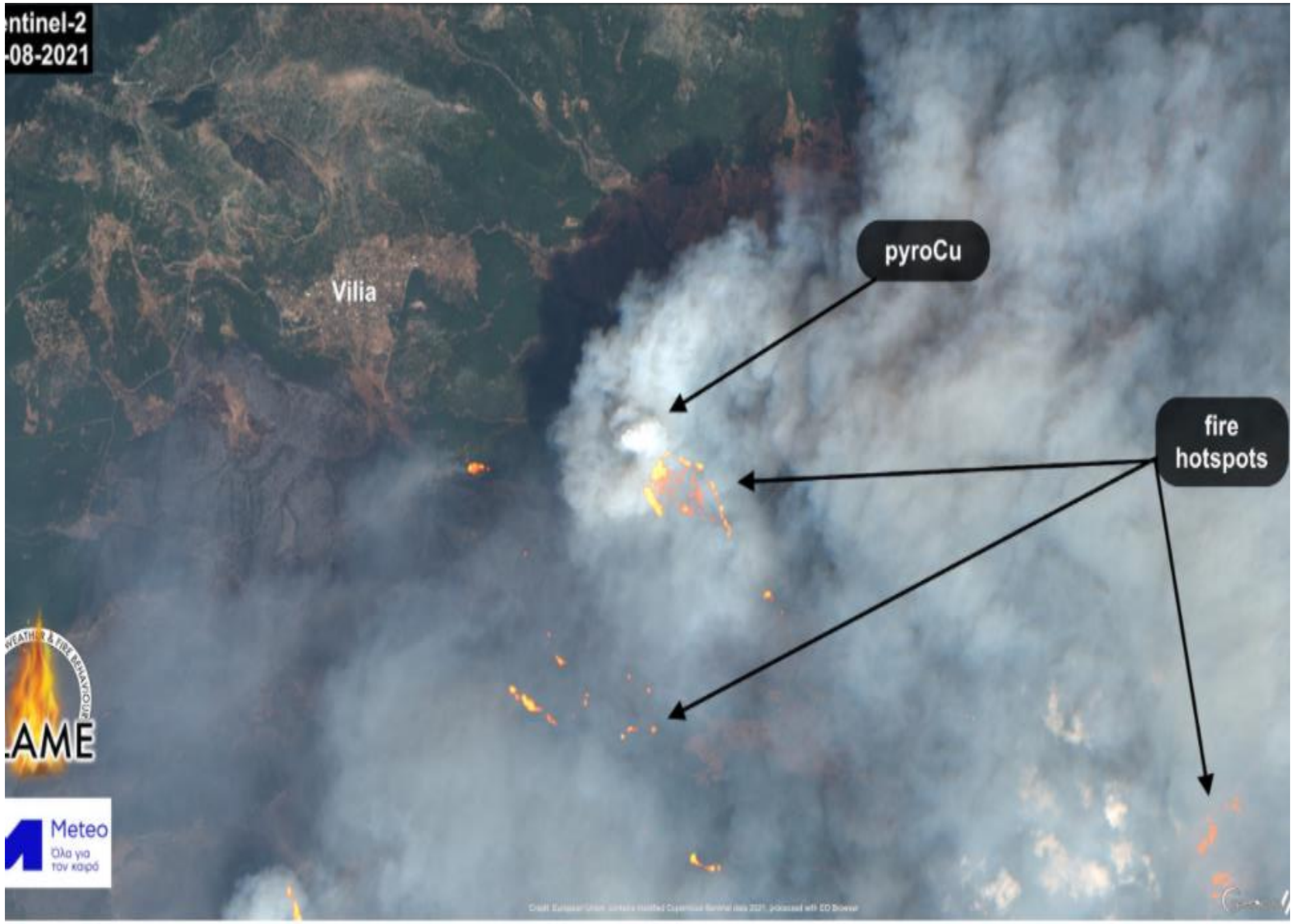
https://directory.eoportal.org/web/eoportal/satellite-missions/s/smos

Foucras et al. (2020) estimated surface soil moisture at a spatial resolution of 500 m and a temporal resolution of at least 6 days, by combining remote sensing data from Sentinel-1 and optical data from Sentinel-2 and MODIS (Moderate-Resolution Imaging Spectroradiometer).

The proposed methodology is based on the change detection technique, resulting in a moisture index ranging between 0 and 1, with 0 corresponding to the driest soils and 1 to the wettest soils.

Myriam Foucras,Mehrez Zribi,Clément Albergel,Nicolas Baghdadi,Jean-Christophe Calvet and Thierry Pellarin, Estimating 500-m Resolution Soil Moisture Using Sentinel-1 and Optical Data Synergy, Water 2020, 12(3), 866; https://doi.org/10.3390/w1203086

Local meteorology (pyrocumulus)



In the event of excessive ground and plant dryness, forest fires develop their own weather and propagate even in the presence of winds of low intensity.
In addition, the vertical transfer of smoke and water vapour result in "pyrocumulus"

Sentinel 2 image, August 2021, Vilia (north west of Athens)

Satellite/sensors for Vegetation-based Fire Applications

Satellite/Sensor	Vegetation-Based Fire Applications
Landsat	Land Class, Vegetation Indices, Moisture
Sentinel-2	Land Class, Vegetation Indices, Moisture
MODIS	Land Class, Vegetation Indices
VIIRS	Vegetation Indices
SMAP	Soil Moisture
ECOSTRESS	Moisture, Evaporative Stress
EO-1 Hyperion	Land Class, Dry Matter Content
AVIRIS	Land Class, Dry Matter Content
GEDI	Vegetation Structure
SRTM	Topography
Sentinel-1	Land Class, Structure, Moisture
ALOS PALSAR	Structure, Topography

SAR in support of optical remote sensing for forest fires

Sentinel-1 SAR (C-band SAR data, 12-day revisit, Resolution: 5 x 20 meters)

• Vegetation-Based Fire Applications:

– Vegetation Type and Extent: Land classification, fuels mapping

– Vegetation Structure: Density and height

– Vegetation Moisture: Fuel moisture content and dryness

Sentinel-2 Vegetation-Based Fire Applications (-day revisit, Resolution: 10 meters)

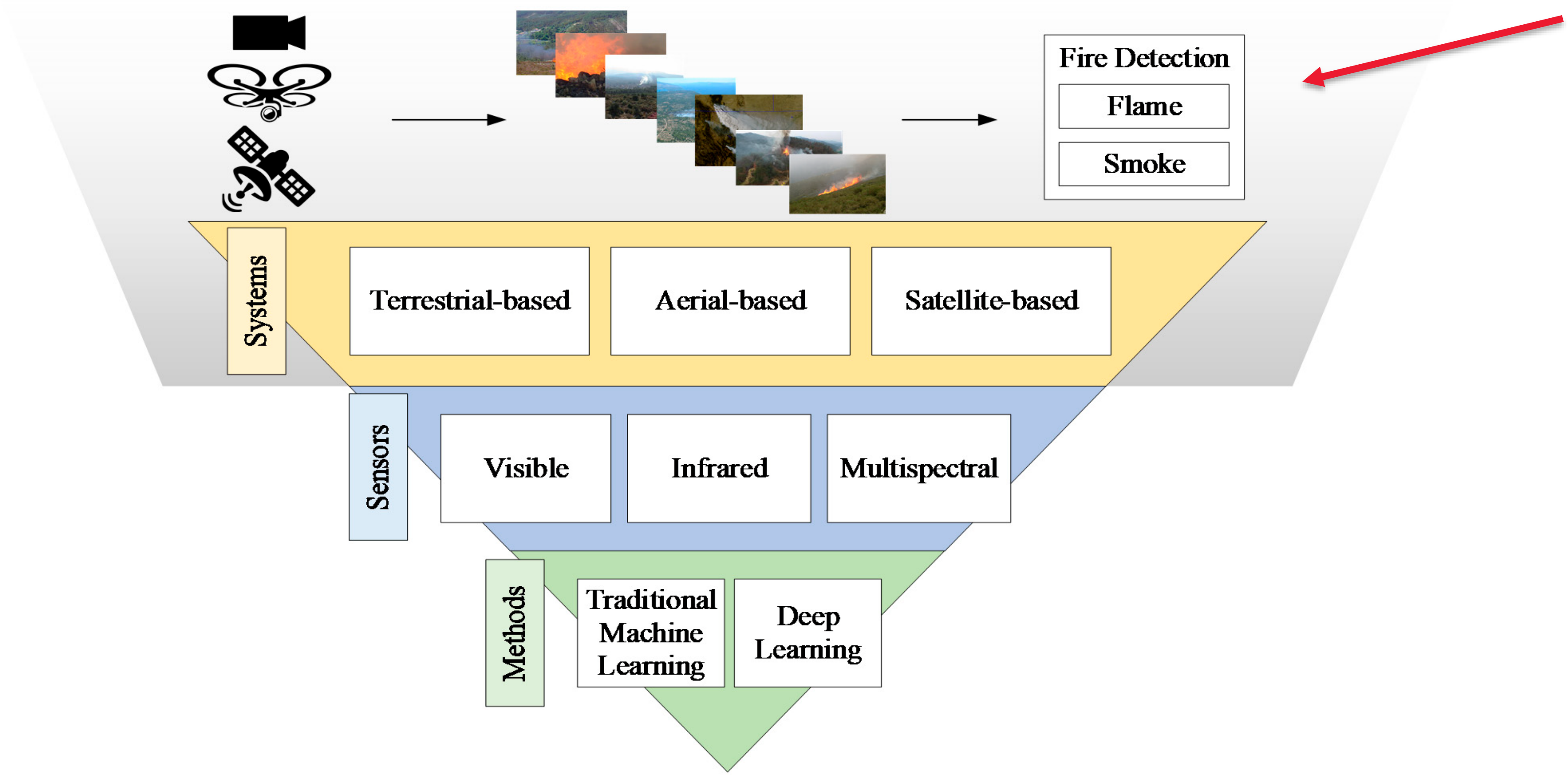
– Vegetation Extent and Type: Land cover classification

– Vegetation Stage and Health: Variety of vegetation indices, including NDVI, EVI, SAVI

– Vegetation Moisture: NDWI

4 .The Active fire stage

Pre-Fire Risk Assessment	Vegetation density and extent Soil moisture/drought severity Topography Fire risk mapping
Active Fire Detection	**Hot Spot Detection** **Total area burning** **Fire Radiative Power** **Pyro-cloud formation**
Post Fire Assessment	Total area burned Burn severity Post fire vegetation regrowth Landscape regeneration

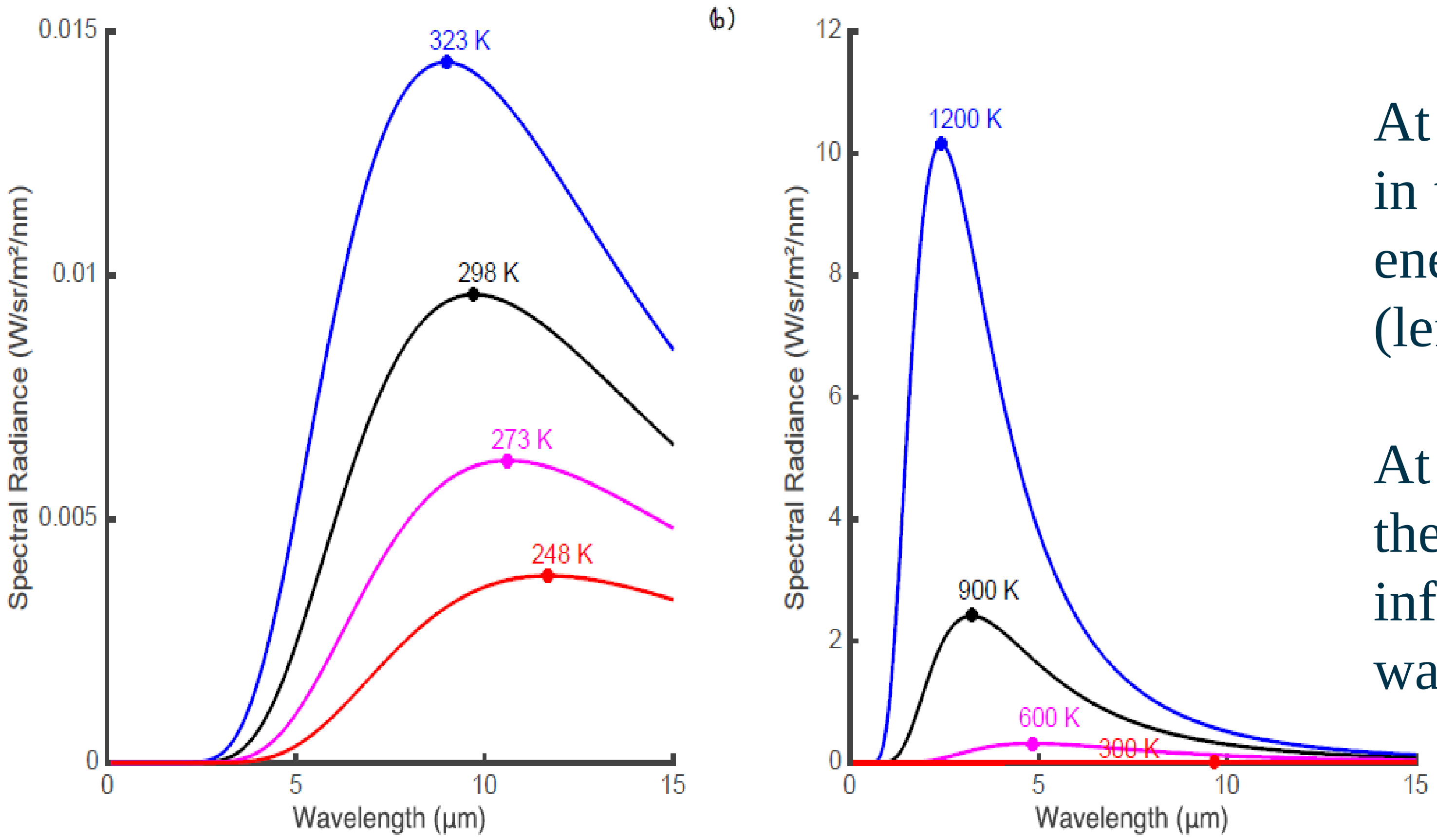


From: Barmpoutis, P., Papaioannou, P., Dimitropoulos, K. and Grammalidis, N., Review on Early Forest Fire Detection Systems Using Optical Remote SensingSensors 2020, 20, 6442; doi:10.3390/s20226442

As fires burn much hotter than the typical temperature of surfaces on the Earth, heat provides a strong signal for the detection of fire.

The total energy (integrated across all wavelengths) radiated from a surface increases rapidly with its temperature (proportional to the fourth power of temperature as described by the Stefan-Boltzmann law).

However, the radiance is not uniform across wavelength and the distribution peaks at a wavelength that varies inversely with the temperature.



At normal ambient temperature, the peak is in the range 8–12 µm and most of the radiant energy lies at wavelengths greater than 5 µm (left image).

At higher temperatures typical of forest fires, the peak of the response shifts to mid-wave infrared (MWIR, 3–5 µm) or shorter wavelengths (right image).

•A fire at 500K will be sensed, as it grows

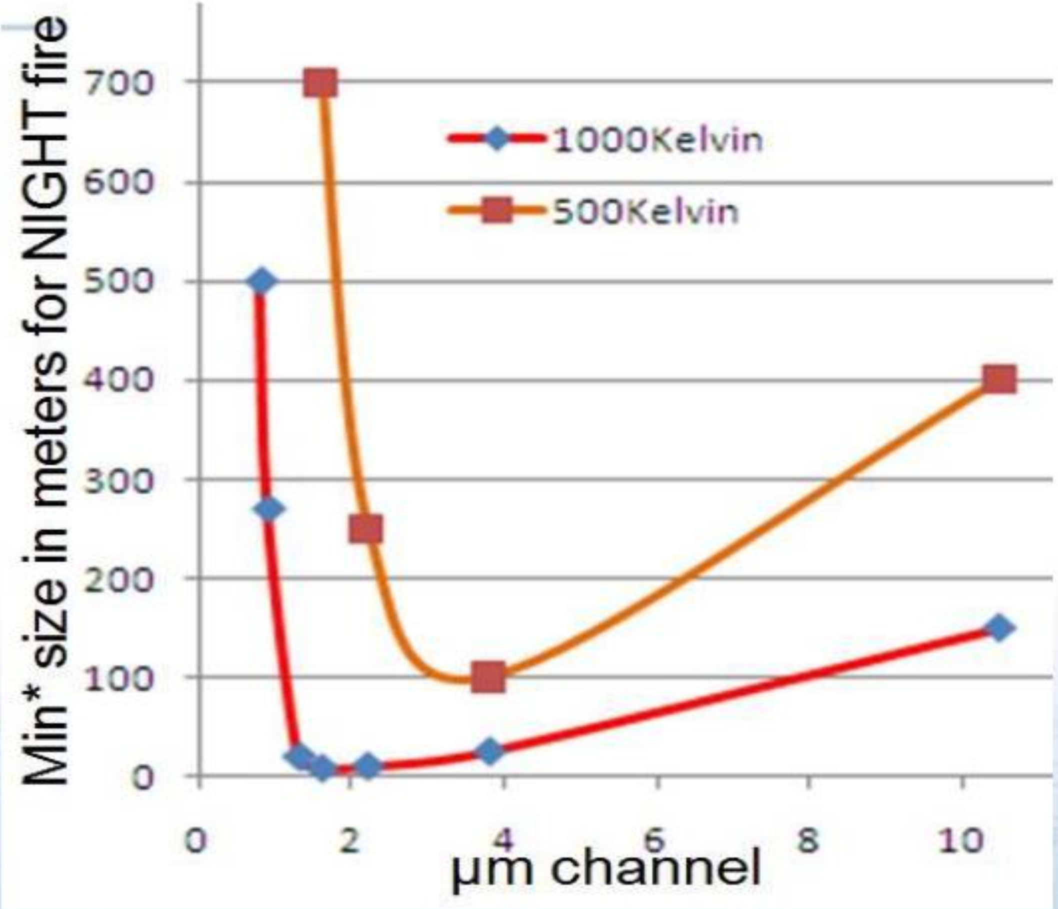
•first by 3.9µm(at ~100m)

•second by 2.2µm (250m)

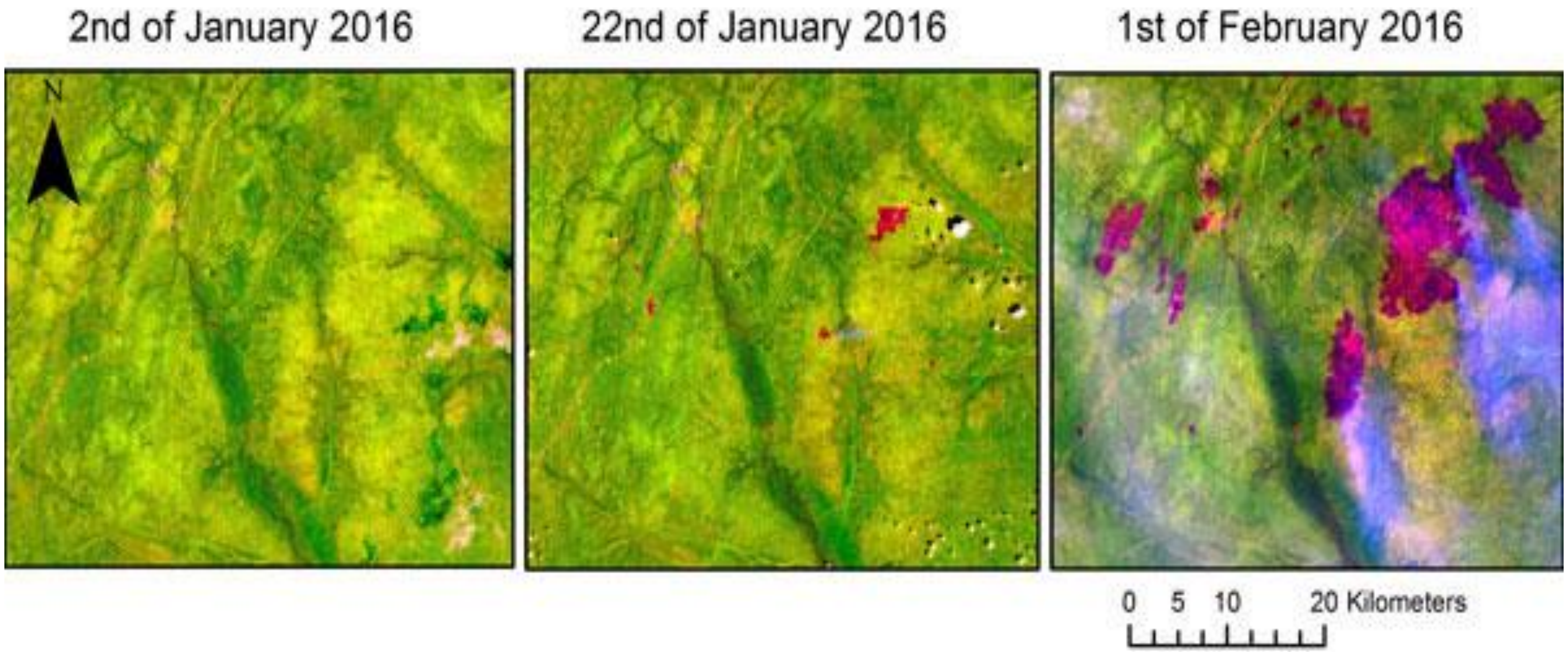
•third by 10.8µm (400m)

•An RGB=(3.9;2.2;10.8) might be a good indicator for severity of a fire.

•For a hotter fire (1000K), typically gas flares, channels in the solar domain react faster than 3.9µm



http://eumetrain.org/data/4/421/421.pdf



https://sentinels.copernicus.eu/web/sentinel/-/sentinels-detect-and-monitor-forest-fires

Comparing window channels in near and thermal infrared

Near infrared (1.6 µm)	More adequate for smoke detection than 3.9 µm Small fires not visible No CO2 absorption (higher fire temperature) High sub pixel sensitivity
Middle infrared (3.9 µm)	High temperature sensitivity - major sub pixel effects (hot spots are easily detected) Negligible absorption by atmospheric humidity Close to a CO2 absorption band, 4-7 Kelvin signal reduction Brightness is temperature of the CO2 layer above the fire
Thermal infrared (10.8 µm)	1-2 Kelvin absorption by atmospheric humidity No signal reduction by CO2 Lower temperature sensitivity (small subpixel effects) No risk of sensor blinding by fires Low values compared with 3.9 µm due to semi transparent cloud or smoke

Source:http://eumetrain.org/data/4/421/421.pdf

Points for consideration

1. Atmospheric absorption in the region 5-8 μm of the infrared spectrum is strong, a fact that makes this region unsuited for remote imaging.

2. TIR imaging has an advantage in this regard in that even thick smoke is transparent at these wavelengths allowing imaging of hotspots through smoke. This can be a useful property in monitoring active fires and searching for spot fires.

3. There is a need to combine and jointly processed signal from different spectral channels.

For instance, for a pixel partly covered by a fire, the radiance at 3.9 μm is larger than at 10.8 μm due to the stronger response at 3.9 μm to the warmer portion (fire) inside the pixel. Using the temperature difference IR3.9-IR10.8 as a proxy for fire probability - the larger the difference, the higher the probability.

Temporal resolution – a critical parameter

Detecting forest fires is feasible (flame and smoke), but how close to the ignition time?

The majority of satellites providing earth imagery are either geostatic or in the near-polar sun-synchronous orbit and include multispectral imaging sensors.

Sun-synchronous satellites provide data with **high spatial resolution but low temporal resolution** while geostationary satellites have **high temporal resolution but low spatial resolution.**

Forest fires from MODIS

To the left: RGB synthesis (RGB-143)
To the right: IR synthesis (RGB-721)

Fire detection

Sensor/Satellite	Channels	Product		Spatial/Temporal
SEVIRI/Meteosat	3.9µm, 10.8µm	FIR (Active Fire Monitoring)	Fire radiative power	3 km/5 min
MODIS/Aqua and Terra (constellation of two)	4µm, 11µm	Active Fire	Fire radiative power	1km/ 1-2 days per satellite
SLSTR/SENTINEL 3 (constellation of two)	3.7µm, 10.8µm	Active Fire	Fire radiative power https://sentinels.copernicus.eu/web/sentinel/technical-guides/sentinel-3-slstr/level-2/fire-radiative-power-frp	1km/approx. 1 day
SENTINEL 1 (constellation of two)	Radar	Burned area	Indirectly through the propagation of the burned area – in support of the assessment of fire dispersion	5m/2 days at mid-latitudes
SENTINEL 2 (constellation of two)	Vis	Burned area	Indirectly through the expansion of the burned area – in support of the assessment of fire dispersion	10 m/2-3 days at mid-latitudes
AVHRR/NOAA	3.7µm	FIMMA	Fire radiative power	1km/ 5-6 times per day
VIIRS/ Suomi-NPP	4µm, 11µm	Active fire	Fire radiative power	375m/ 3-4 times per day

Forest fire detection at high temporal resolution

MSG SEVIRI (Meteosat) generates images every 5 and 15 min, thus fulfilling the critical precondition of high temporal resolution.

Furthermore, the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) as well as the EUMETSAT LSA-SAF (Satellite Application Facility on Land Surface Analysis), provide several fire products based on MSG data that can be *used* for detection and monitoring of wildfires.

Such products are the **Rapid Scan Active Fire Monitoring** (FIR), **the Fire Radiative Power** (FRP), and the **Fire Detection and Monitoring** (FD&M).

FIR is a fire detection product indicating the presence of fire within a pixel. It is based on a threshold technique, using SEVIRI channels 4 (3.9 µm) and 9 (10.8 µm). The algorithm is applied for all land surface pixels, excluding bare soil surface pixels and coastal pixels. The underlying concept of the algorithm takes advantage of the fact that SEVIRI channel IR3.9 is very sensitive to hot spots, which are caused by fires.

FD&M is based on the algorithm FIDALGO (Fire Detection Algorithm) developed within the LSA-SAF to identify SEVIRI/METEOSAT pixels potentially contaminated by fires.

Finally, the **FRP** product takes advantage of the temporal resolution of SEVIRI and relies on information from SEVIRI channels (namely 0.6, 0.8, 3.9, 10.8 and 12.0 µm) together with information on illumination angles; it identifies the location and quantifies the radiative power of any hotspot present on land that radiates a heating signal within a pixel size of 1 km^2.

High Rate SEVIRI	Every 15 minutes
Meteosat Rapid Scanning	Every 5 minutes
Typical temperature of forest fire	500-1000 Kelvin
Minimum detectable size of forest fire	10-50 acres (100.000 to 500.000 sq. meters)
The detectable size depends on vegetation density and burning load Range of detection: 3 km Potential false alarms due to: CO2 concentration, humidity, sharp temperature variations	

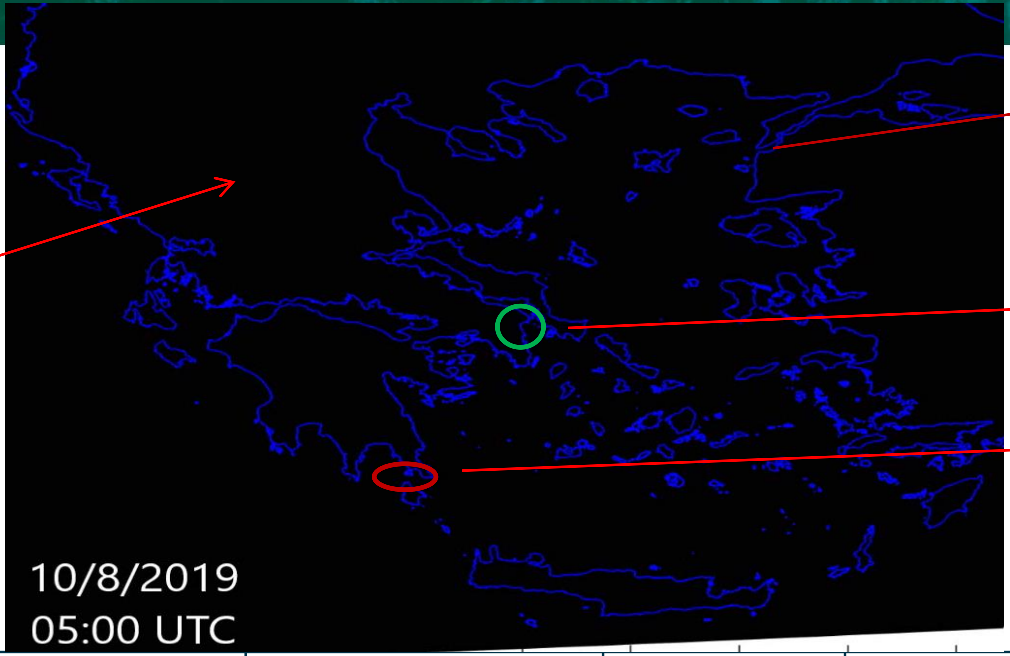
Detection algorithm - Criteria

Brightness temperature of channel IR3.9

Brightness temperature difference of channel IR3.9 and IR10.8

Test	**Fire**	
	Day	Night
IR3.9	>310	>290
IR3.9-IR10.8	>8	>0
StdDev IR10.8	<1	<1
StdDev IR3.9	>4	>4

Detection from FIREX (15min)



Fire broke out near Behramlı village on the Çanakkale peninsula (Turkey) during 10/8 night

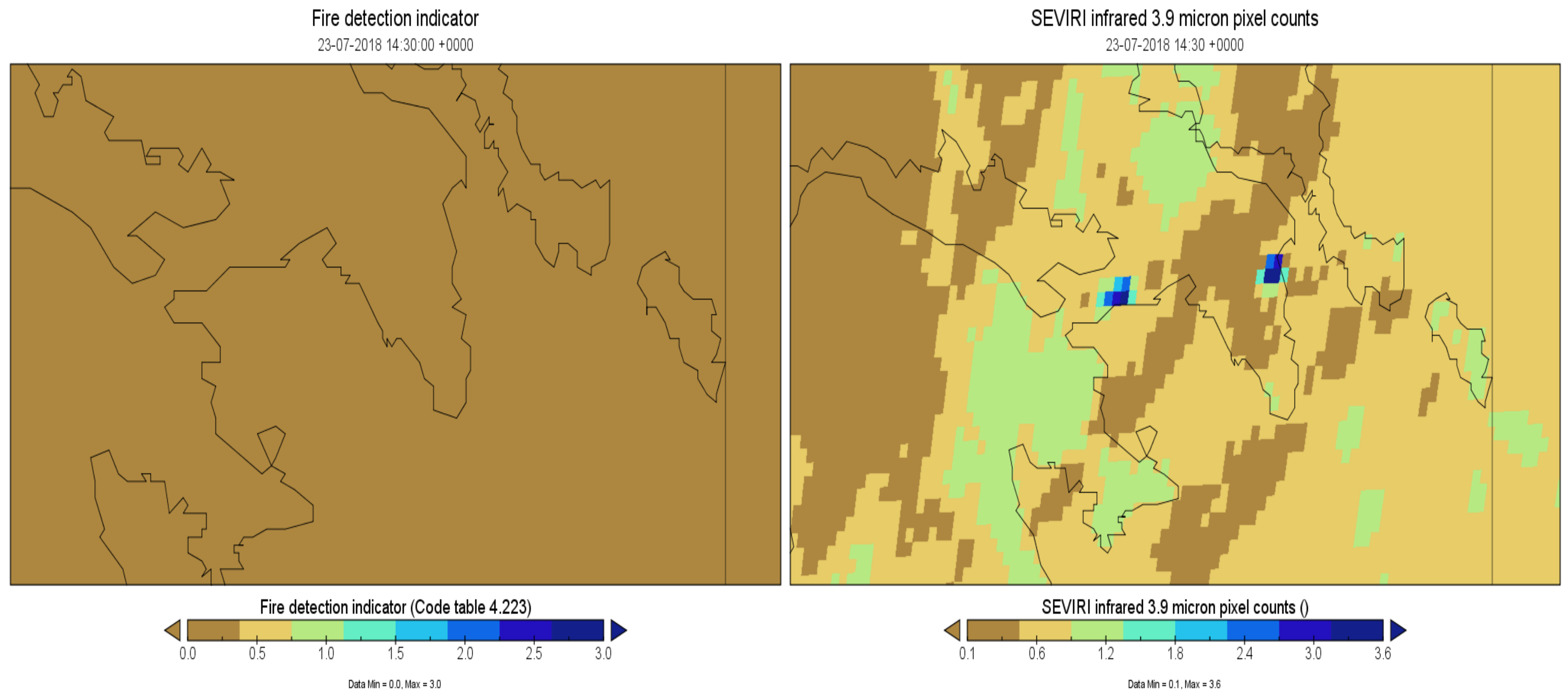
Marathonas fire

Elafonisos Fire

	Fire Ignition (Fire service)	FIREX 1st detection	# FIREX Detected scans (time range UTC)	# FIR scans (EUMETSAT)	# FRP scans (LSA SAF)	# FD&M scans (LSA SAF)
Elafonisos	10/8 5:00 UTC	10/8 6:30 UTC	69/97 (10/8 5:00-11/8 5:00)	No detection	Non-processed pixel	Non-processed pixel
Marathona s (Small fire)	10/8 12:00UTC	10/8 12:30UTC	2/17 (10/8 12:30-10/8 16:30)	No detection	Non-processed pixel	2/17

FIR product - Greece

East Attica Fire 23-07-2018 and Kineta Fire (as detected from Ch4 **but not from FIR**)



Resolving problems due to coarse spatial resolution

Detection algorithm - Criteria

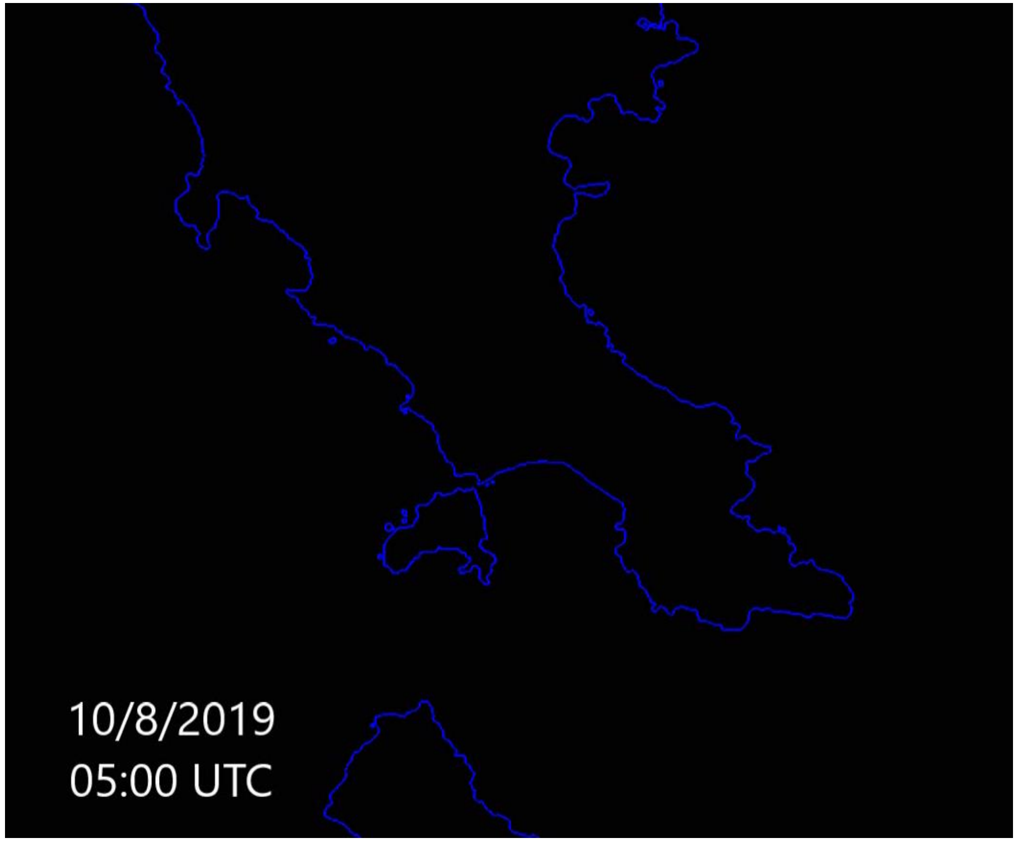
Brightness temperature of channel IR3.9

Brightness temperature difference of channel IR3.9 and IR10.8

Test	**Fire**	
	Day	Night
IR3.9	>310	>290
IR3.9-IR10.8	>8	>0
~~StdDev IR10.8~~	~~<1~~	~~<1~~
~~StdDev IR3.9~~	~~>4~~	~~>4~~

Case Study: Forest fire at the Elafonisos island (August 2019)

Detection of Elafonisos fire from FIREX (15min)



	Fire Ignition (Fire service)	FIREX 1st detection	# FIREX Detected scans (UTC)	
Elafonisos	10/8 5:00UTC	10/8 6:30UTC	69/97 (10/8 5:00-11/8 5:00)	

Is there a way out?

Recently, advances in nanomaterials and micro-electronics technologies have allowed the use of tiny low-Earth-orbiting satellites, known as CubeSats.

CubeSats have significant advantages in comparison with traditional satellites regarding smoke and fire detection, since they are more effective in terms of costs, temporal resolution/response time, and coverage.

In addition, they are smaller in size than traditional satellites and need less time to be put into orbit; however, one issue that needs to be tackled is their poor ability to transmit large amounts of data to the ground.

CubeSats by launched in constellations succeed in improving considerably the temporal resolution while at the same time they reflect high spatial resolution (due to their low orbit).

5. The post-fire stage

Pre-Fire Risk Assessment	Vegetation density and extent Soil moisture/drought severity Topography Fire risk mapping
Active Fire Detection	Hot Spot Detection Total area burning Fire Radiative Power and Thermal Infrared
Post Fire Assessment	**Total area burned** **Burn severity** **Post fire vegetation regrowth** **Landscape regeneration**

Normalized Burn Ratio (NBR)

Normalized burn ratio (NBR) is the index that is used to measure burn severity by distinguishing areas that have been significantly altered in their spectral signature after a wildfire event. It is calculated using the energy intensity from the NIR and SWIR wavelength bands from the remotely sensed satellite imagery.

NBR for Sentinel 2 data is calculated as:

$$NBR = \frac{(NIR - SWIR)}{(NIR + SWIR)} = \frac{(Band\,8 - Band\,12)}{(Band\,8 + Band\,12)}$$

Healthy vegetation has very high near-infrared reflectance and low reflectance in the shortwave infrared portion of the spectrum.

Burned areas on the other hand have relatively low reflectance in the near-infrared and high reflectance in the shortwave infrared band.

A high NBR value generally indicates healthy vegetation while a low value indicates bare ground and recently burned areas.

Burn Severity and the delta normalized burn ratio

Burn severity is a term used to represent the degree to which an ecosystem is impacted by a wildfire event. **It is estimated as the difference between pre-fire and post-fire NBR derived from satellite images.**

To identify recently burned areas and differentiate them from bare soil and other non-vegetated areas, **the difference between pre-fire and post-fire NBR**, also known as **the delta normalized burn ratio (dNBR) index** is frequently used.

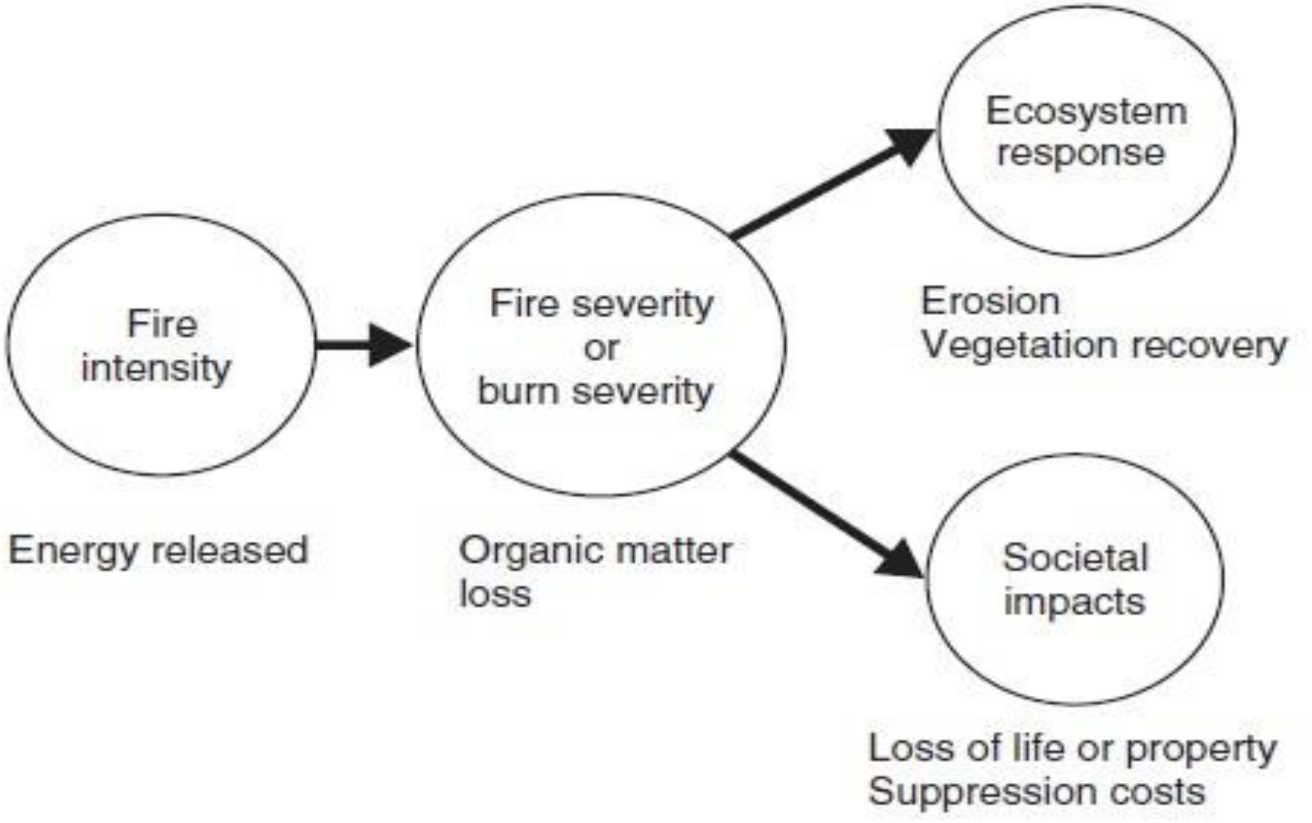
Areas with high dNBR value correspond to a higher degree of damage or burn severity.

In contrast, low dNBR values represent areas that are unaffected from the fire event or regions that have rebounded via regrowth of plant species following a wildfire incident.

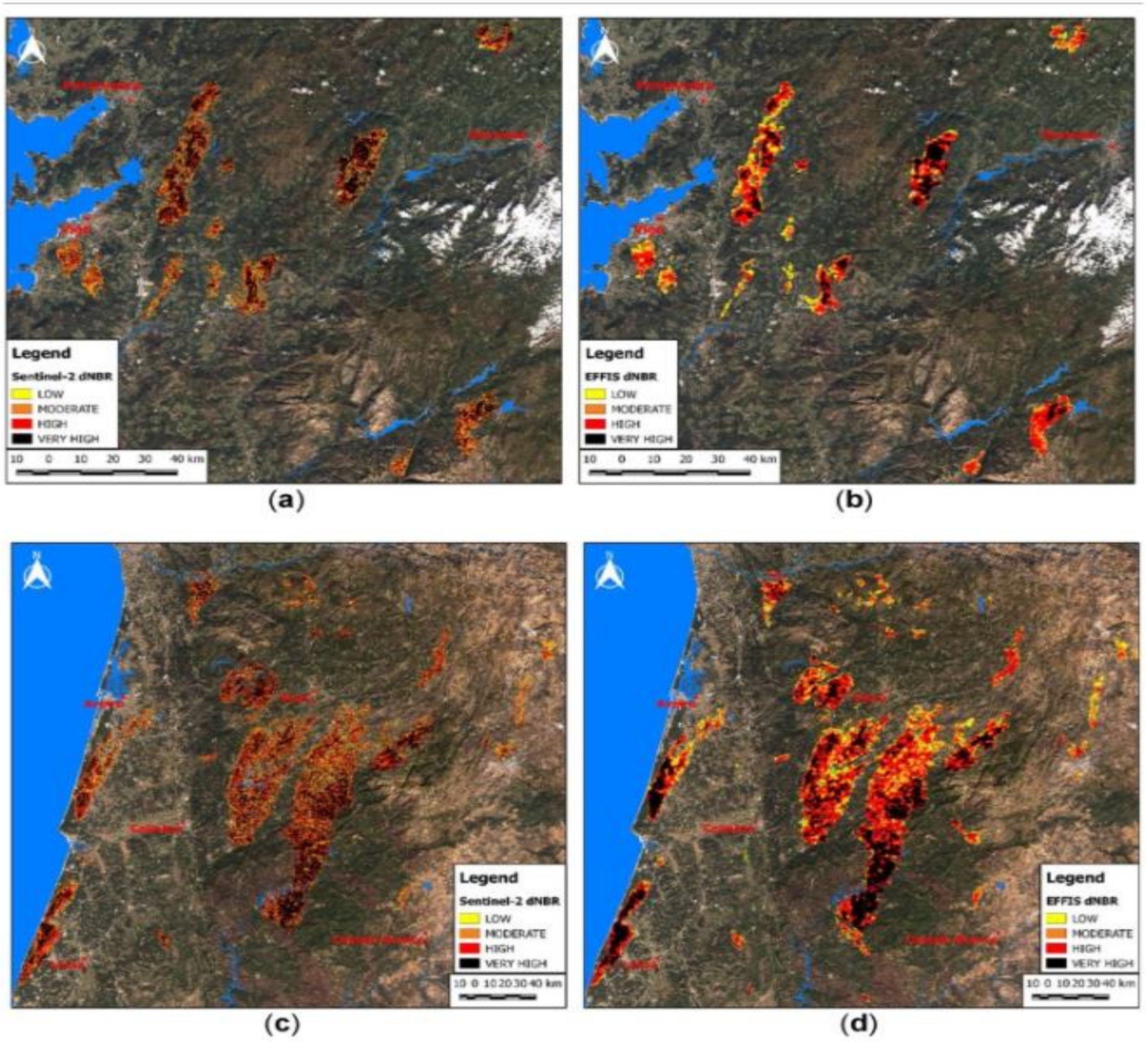
Classification of Burn Severity Level

EFFIS thresholds	Severity Level
dNBR < 0.100	Unburned / Very Low
0.100 ≤ dNBR ≤ 0.255	Low
0.256 ≤ dNBR ≤ 0.419	Moderate
0.420 ≤ dNBR ≤ 0.660	High
dNBR > 0.660	Very High

Why is burn severity important?



Burned areas and burn severity – Spain and Portugal 2017

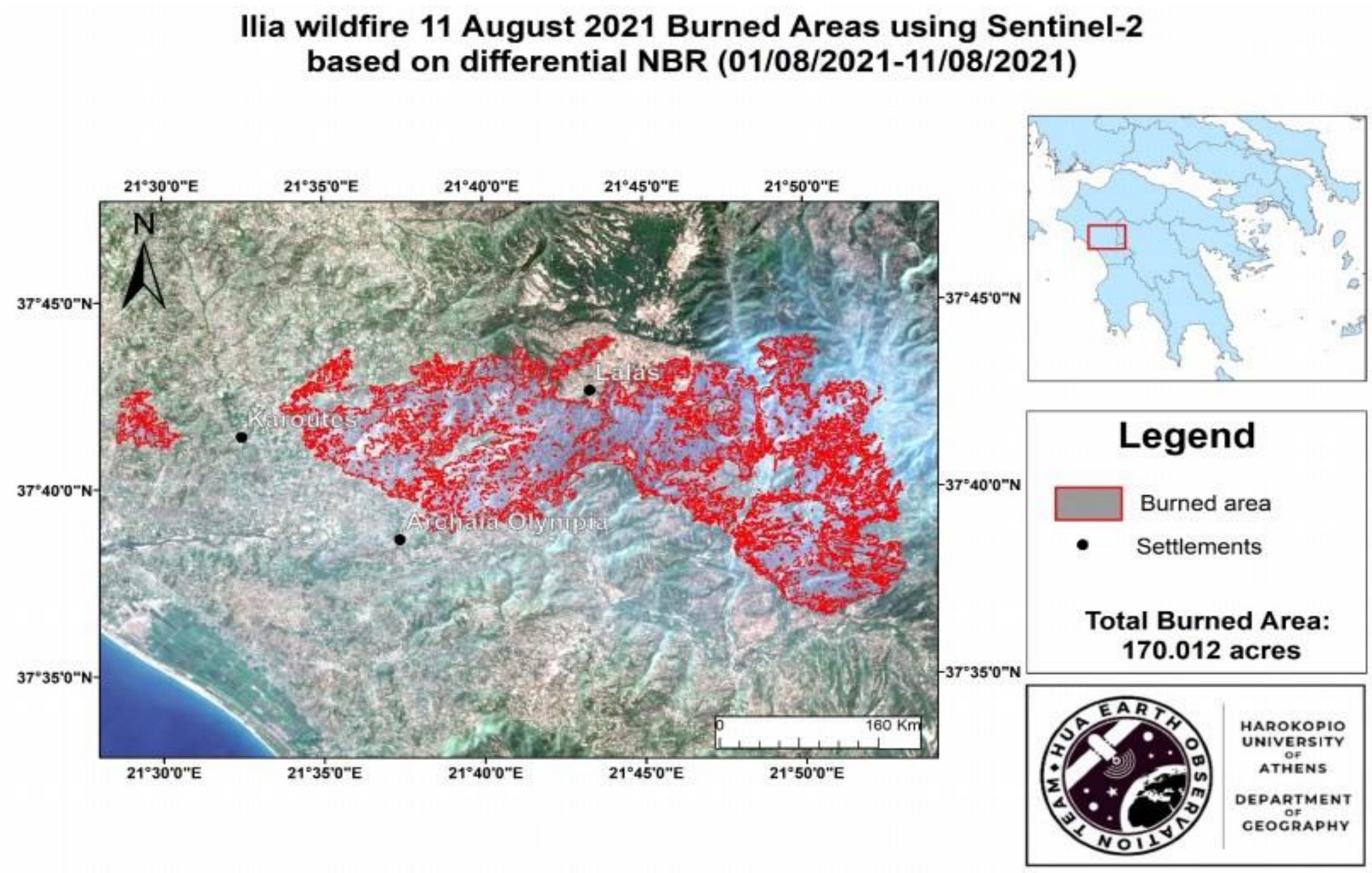


(a) Sentinel-2 dNBR image using Post-1 images in Galicia wildfires;
(b) EFFIS dNBR image in Galicia wildfires;
(c) Sentinel-2 dNBR image using Post-1 images in Portugal wildfires;
(d) EFFIS dNBR image in Portugal wildfires. Water areas are masked (blue color).

from:
Rafael Llorensa, José Antonio Sobrino, Cristina Fernández, José M.Fernández-Alonso, José Antonio Vega, A methodology to estimate forest fires burned areas and burn severity degrees using Sentinel-2 data. Application to the October 2017 fires in the Iberian Peninsula, International Journal of Applied Earth Observation and Geoinformation Volume 95, March 2021, 102243
https://doi.org/10.1016/j.jag.2020.102243

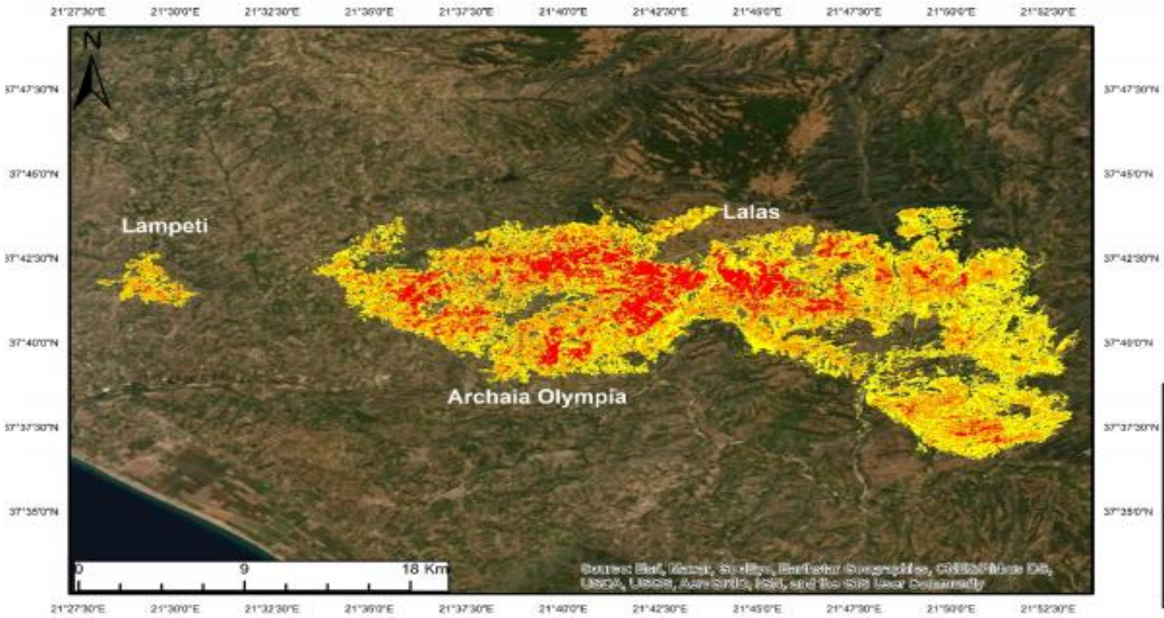
Case study. Ancient Olympia (August 2021)

Forest Fire – Ancient Olympia (August 2021)



THE AUGUST 2021 WILDFIRES IN ANCIENT OLYMPIA AND GORTYNIA AREAS
BURN SEVERITY MAP

Ilia August 2021 Burned Areas



Legend

Burned areas according to Burn Severity

- Low Severity
- Moderate - Low Severity
- Moderate - High Severity
- High Severity

Total Burned Area: 170,012 km²

Burn Severity	Area (Km²)	Percentage (%)
Low	76,112	44,76
Moderate – Low	69,391	40,81
Moderate – High	24,494	14,4
High	0.015	0.03

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Burned Area mapping and classification according to Burn Severity.

Satellite Images of Copernicus Sentinel-2 Mission were utilized.

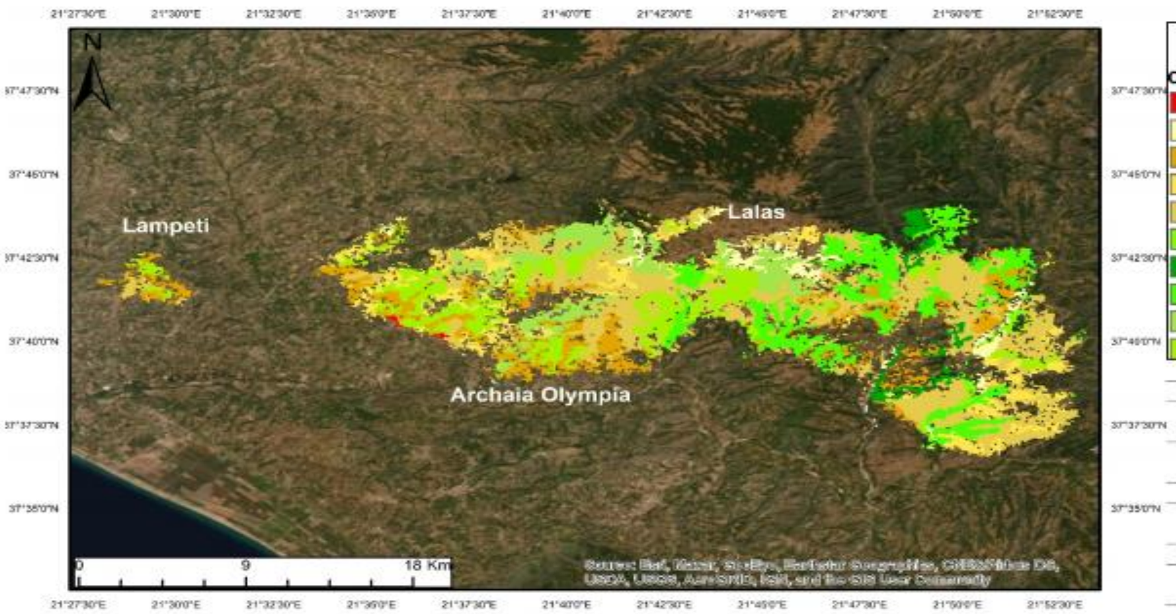
Pre-event Image: Sentinel-2B L2A 1/8/2021 09:20 EEST
Post-event Image: Sentinel-2B L2A 11/8/2021 09:20 EEST

Projection: WGS 1984 UTM Zone 33N

August 2021

THE AUGUST 2021 WILDFIRES IN ANCIENT OLYMPIA AND GORTYNIA AREAS
LAND COVER MAP BASED ON CORINE LAND COVER 2018

Ilia August 2021, Corine Land Cover 2018 over Burned Areas



Legend

CLC 2018

- 112: Discontinuous urban fabric
- 211: Non-irrigated arable land
- 223: Olive groves
- 242: Complex cultivation patterns
- 243: Land principally occupied by agriculture, with significant areas of natural vegetation
- 311: Broad-leaved forest
- 312: Coniferous forest
- 313: Mixed forest
- 323: Sclerophyllous vegetation
- 324: Transitional woodland-shrub

CLC Code	Area (Km²)	Percentage (%)
112	0,268	0,15
211	6,239	3,66
223	22,077	12,98
242	16,394	9,85
243	55,313	32,93
311	1,941	1,14
312	4,262	2,51
313	23,366	13,94
323	15,271	8,98
324	23,741	13,96

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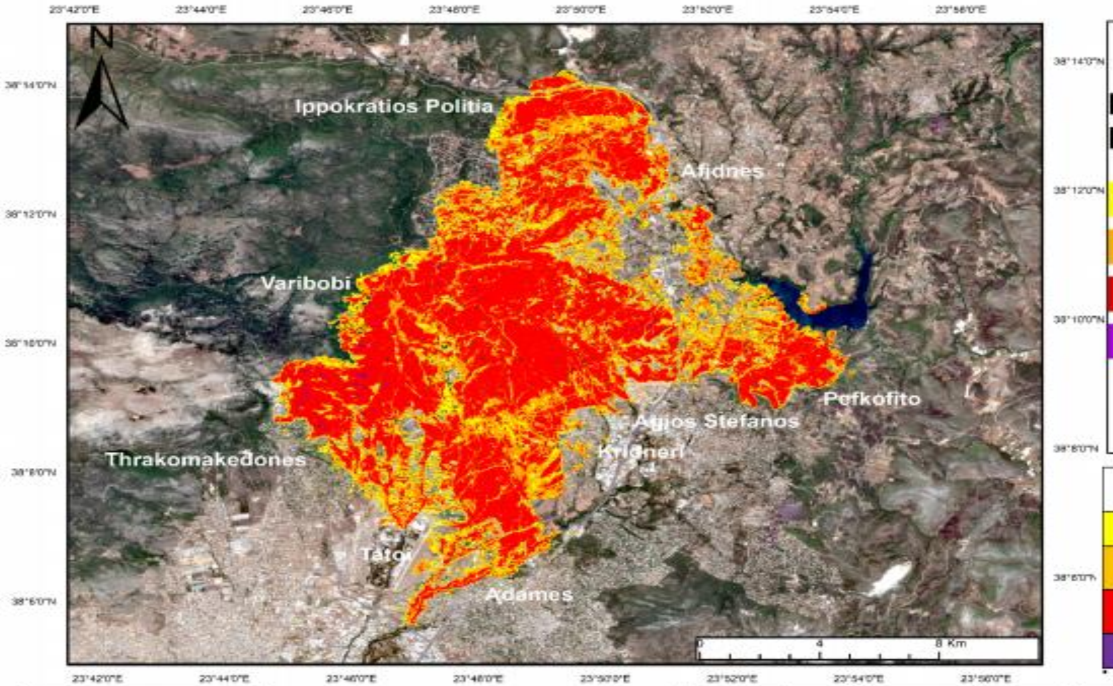
Post-event Image: Sentinel-2B L2A 11/8/2021 09:20 EEST

Projection:
WGS 1984 UTM Zone 33N

August 2021

THE AUGUST 2021 WILDFIRES IN ATTICA
BURN SEVERITY MAP

Attica August 2021 Burned Areas



Legend

Burned areas according to Burn Severity

- Low Severity
- Moderate - Low Severity
- Moderate - High Severity
- High Severity

Total Burned Area: 79,334 km^2

Burn Severity	Area (Km^2)	Percentage (%)
Low	11,589	14,62
Moderate – Low	21,994	27,72
Moderate – High	45,447	57,28
High	0,304	0,38

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DEPARTMENT OF GEOGRAPHY
HUA EARTH OBSERVATION TEAM

Burned Area mapping and classification according to Burn Severity.

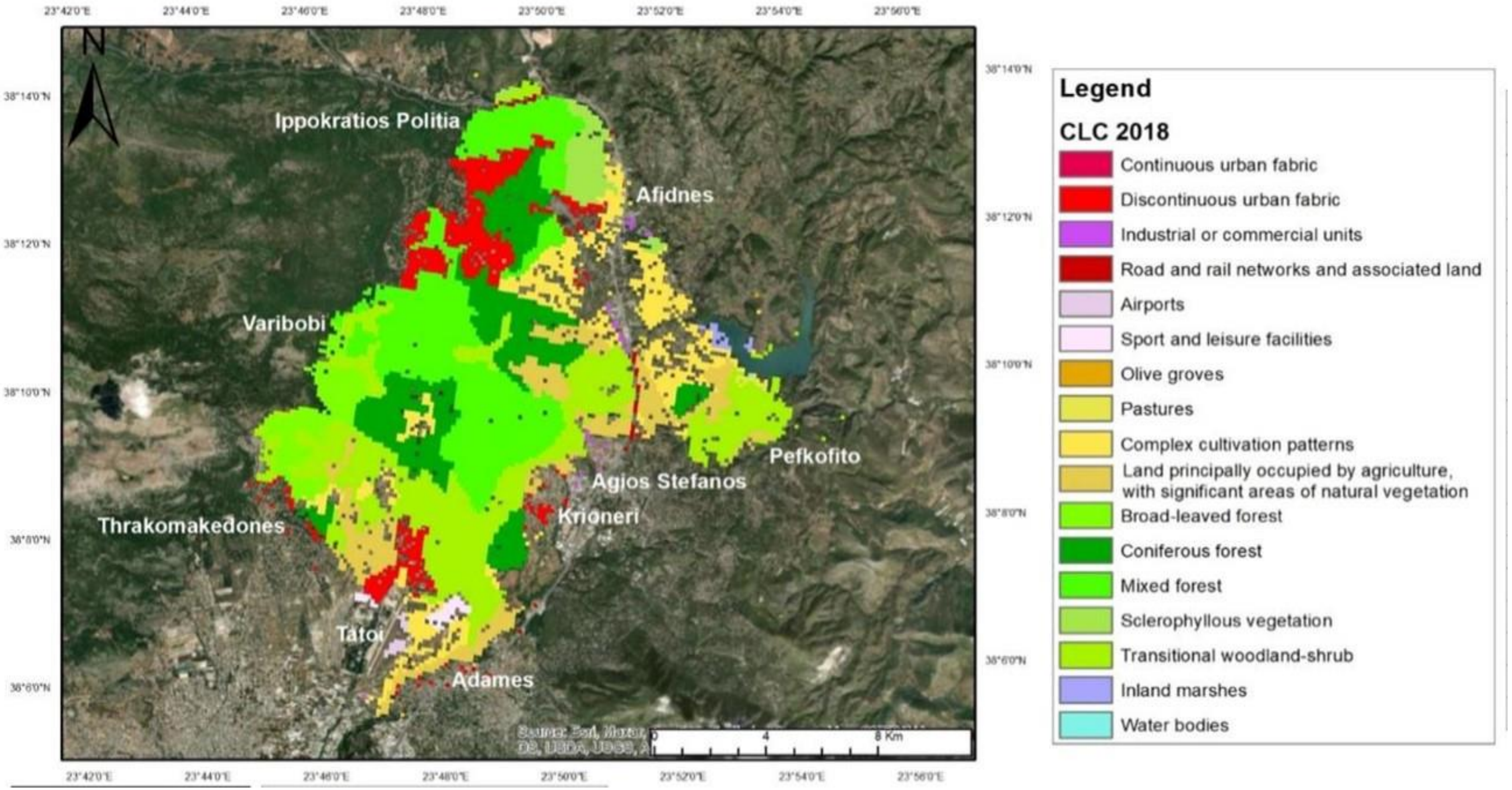
Satellite Images of Copernicus Sentinel-2 Mission were utilized.

Pre-event Image: Sentinel-2B L2A 29/7/2021 09:05 EEST
Post-event Image: Sentinel-2B L2A 8/8/2021 09:05 EEST

Projection: WGS 1984 UTM Zone 34N

August 2021

Attica August 2021, Corine Land Cover 2018 over Burned Areas

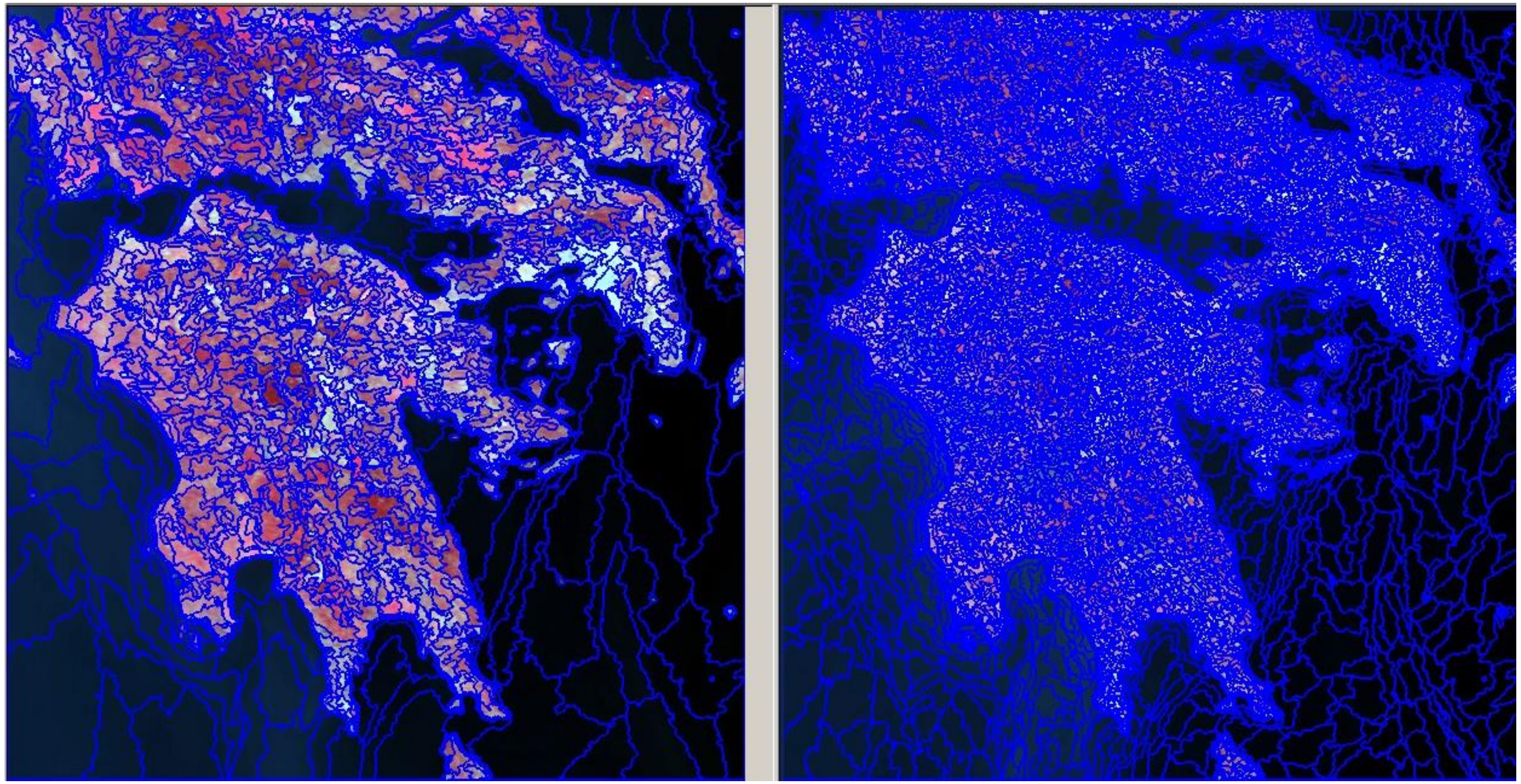


Methodology and steps for estimating burned areas from forest fires

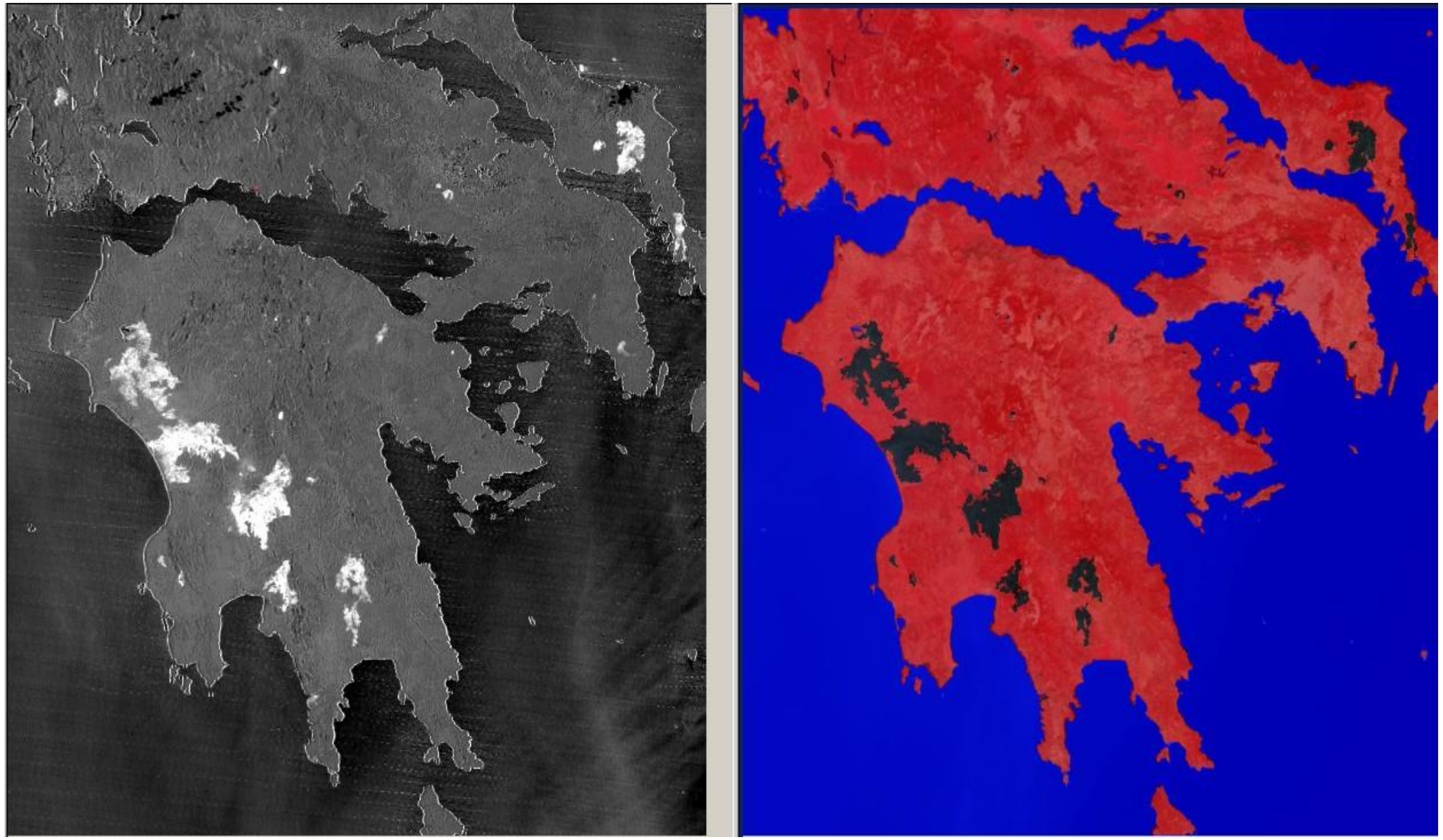
Step 1: Mapping the area before and after the forest fire

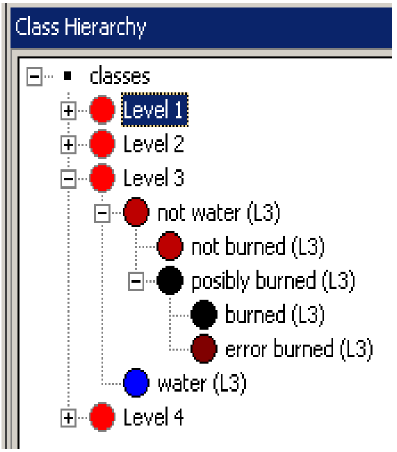
MODIS images prior and post a forest fire (RGB-124)

Step 2. Image segmentation



Step 3. Change detection





Potential errors in the delineation of burned areas

http://www.esa.int/var/esa/storage/images/esa_multimedia/images/2017/08/kalamos_fires/17122699-1-eng-GB/Kalamos_fires.gif

Two days later … 26,000 m^2 of the forest were burned

?

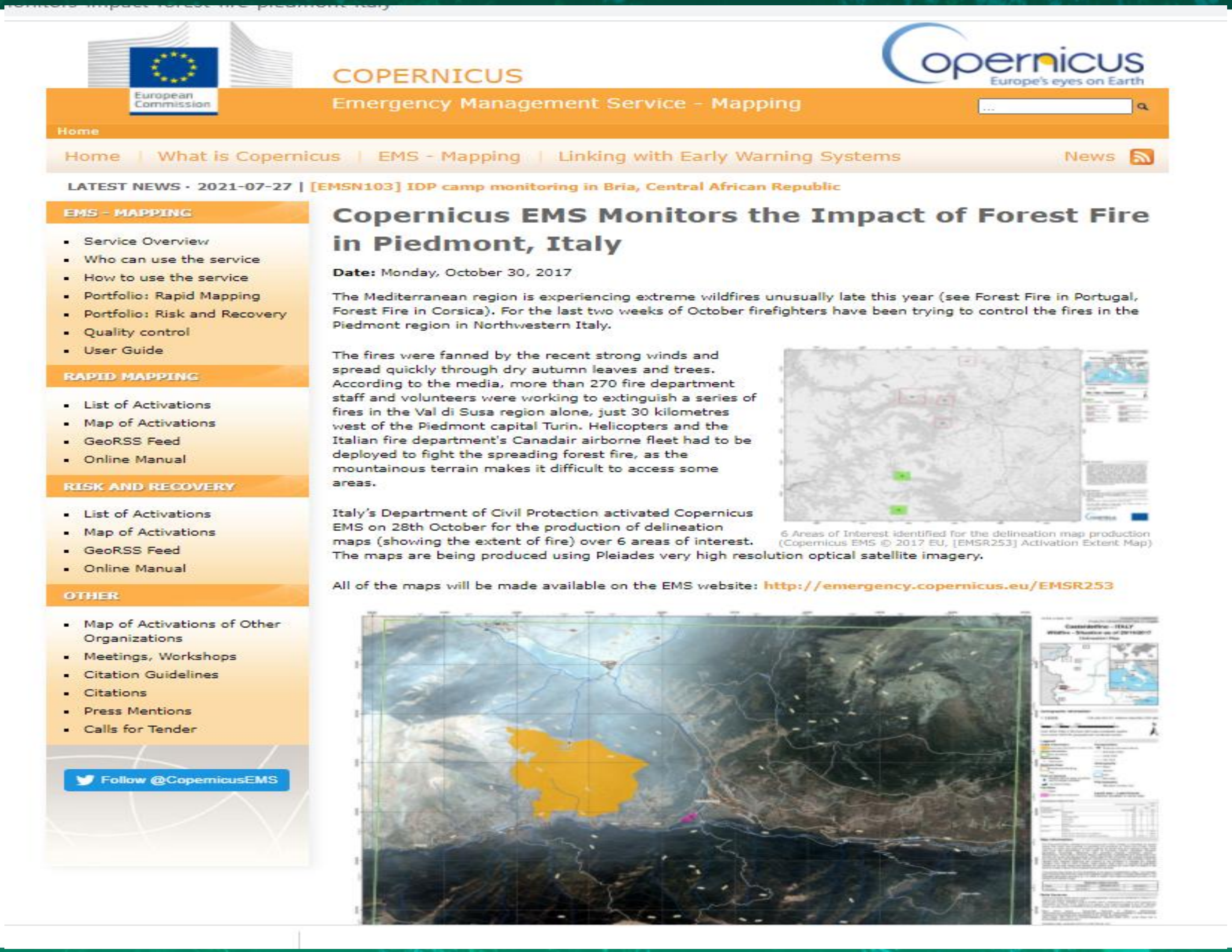
6. Sources of information

The European Forest Fire Information System (EFFIS)

The European Commission has developed the European Forest Fire Information System (EFFIS) **(http://effis.jrc.ec.europa.eu/)** to provide a fire risk forecast and a fire danger assessment in EU countries.

EFFIS is one of the **Copernicus Emergency Services** and becomes an essential tool for providing most up-to date information on fire danger in EU, identify the evolution of wildfires and help national authorities to monitor these wildfires.

Copernicus Emergency Mapping



COPERNICUS

Emergency Management Service - Mapping

Copernicus Europe's eyes on Earth

European Commission

Home

Home | What is Copernicus | EMS - Mapping | Linking with Early Warning Systems | News

LATEST NEWS - 2021-07-27 | [EMSN103] IDP camp monitoring in Bria, Central African Republic

EMS - MAPPING

- Service Overview
- Who can use the service
- How to use the service
- Portfolio: Rapid Mapping
- Portfolio: Risk and Recovery
- Quality control
- User Guide

RAPID MAPPING

- List of Activations
- Map of Activations
- GeoRSS Feed
- Online Manual

RISK AND RECOVERY

- List of Activations
- Map of Activations
- GeoRSS Feed
- Online Manual

OTHER

- Map of Activations of Other Organizations
- Meetings, Workshops
- Citation Guidelines
- Citations
- Press Mentions
- Calls for Tender

Follow @CopernicusEMS

Copernicus EMS Monitors the Impact of Forest Fire in Piedmont, Italy

Date: Monday, October 30, 2017

The Mediterranean region is experiencing extreme wildfires unusually late this year (see Forest Fire in Portugal, Forest Fire in Corsica). For the last two weeks of October firefighters have been trying to control the fires in the Piedmont region in Northwestern Italy.

The fires were fanned by the recent strong winds and spread quickly through dry autumn leaves and trees. According to the media, more than 270 fire department staff and volunteers were working to extinguish a series of fires in the Val di Susa region alone, just 30 kilometres west of the Piedmont capital Turin. Helicopters and the Italian fire department's Canadair airborne fleet had to be deployed to fight the spreading forest fire, as the mountainous terrain makes it difficult to access some areas.

6 Areas of Interest identified for the delineation map production (Copernicus EMS © 2017 EU, [EMSR253] Activation Extent Map)

Italy's Department of Civil Protection activated Copernicus EMS on 28th October for the production of delineation maps (showing the extent of fire) over 6 areas of interest. The maps are being produced using Pleiades very high resolution optical satellite imagery.

All of the maps will be made available on the EMS website: http://emergency.copernicus.eu/EMSR253

https://emergency.copernicus.eu/mapping/ems/copernicus-ems-monitors-impact-forest-fire-piedmont-italy

→ THE EUROPEAN SPACE AGENCY

Zoom Earth

Live weather images are updated every 10 minutes from NOAA GOES and JMA Himawari-8 geostationary satellites.

EUMETSAT Meteosat images are updated every 15 minutes.

Animated surface wind speed forecast maps are generated using the NOAA-NWS GFS model.

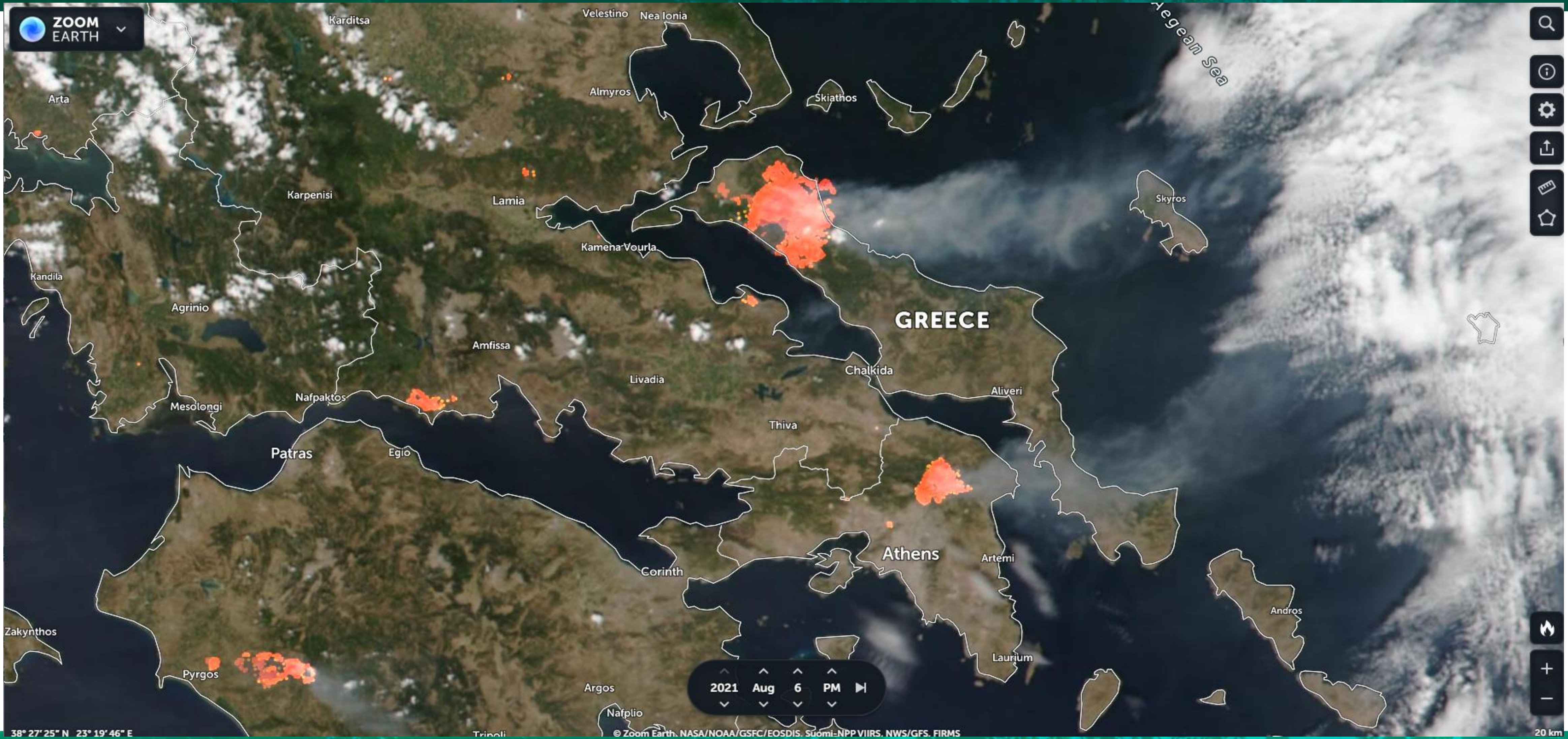
Fires & Heat shows the locations of wildfires and sources of high temperature using data from FIRMS and InciWeb.

High-definition satellite images are updated twice a day from NASA-NOAA polar-orbiting satellites Suomi-NPP, and MODIS Aqua and Terra, using services from GIBS, part of EOSDIS.

Imagery is captured at approximately 10:30 local time for “AM” and 13:30 local time for “PM”.

August 6, 2021

esa



August 6, 2021

→ THE EUROPEAN SPACE AGENCY

The Global Wildfire Information System (GWIS)

The Global Wildfire Information System (GWIS) is a joint initiative of the Group on Earth Observations (GEO), the NASA Applied Research and the EU Copernicus work programmes. Using advanced methods on data processing for wildfire detection and monitoring, numerical weather prediction models, and remote sensing, GWIS enables enhanced wildfire prevention, preparedness and effectiveness in wildfire management.

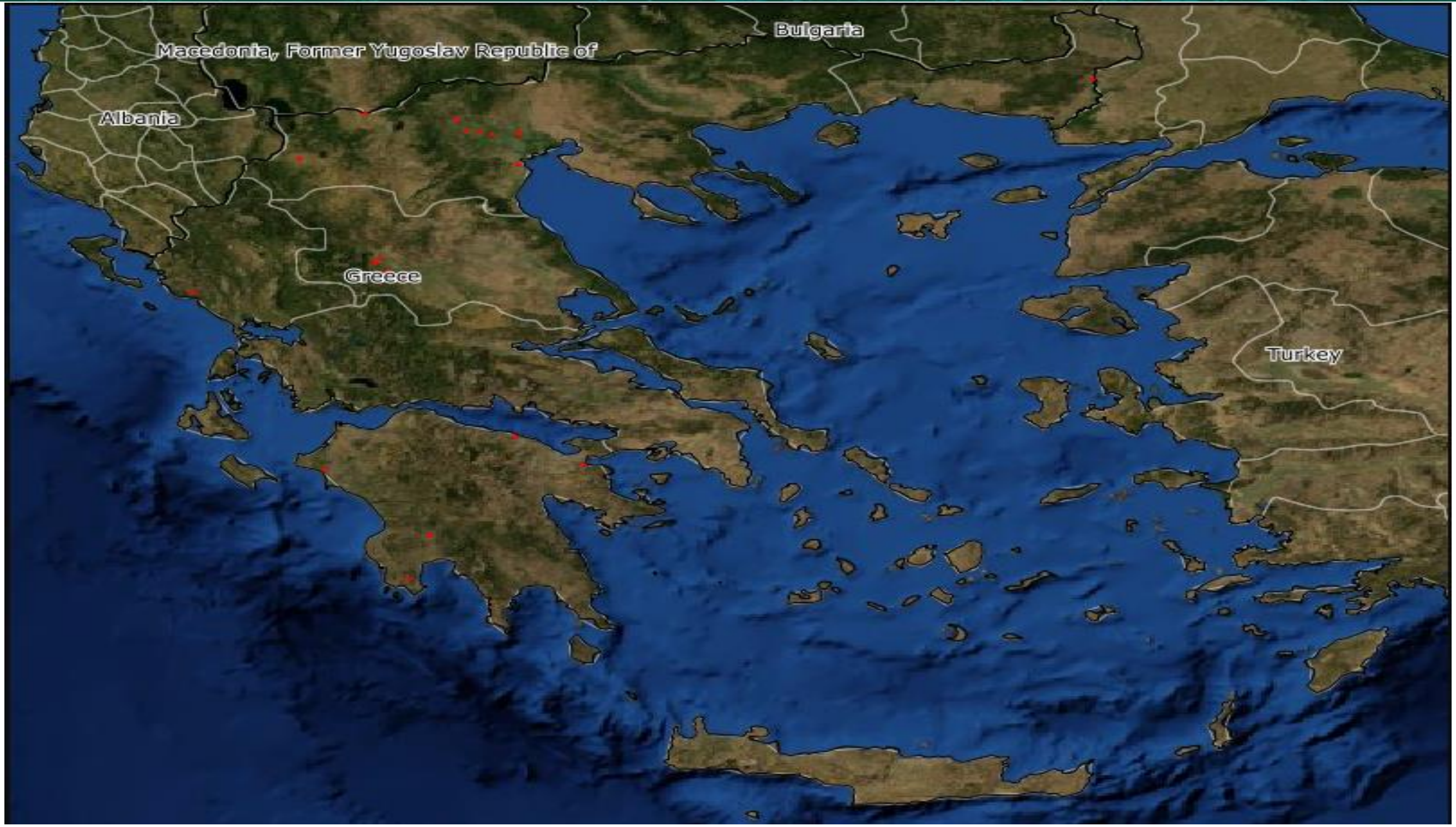
GWIS provides the first global database of wildfire events for a continuous time frame (between 2001-2019) enabling the analysis of wildfire regimes worldwide and providing the basis for the assessment of potential effects of climate change.

Fire Information for Resource Management System (FIRMS)

NASA's Fire Information for Resource Management System (FIRMS) distributes Near Real-Time (NRT) active fire data within 3 hours of satellite observation from NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) and NASA's Visible Infrared Imaging Radiometer Suite (VIIRS).

VIIRS NRT 375 m active fire products (VNP14IMGTDL_NRT from S-NPP and VJ114IMG_NRT from NOAA-20) complement the MODIS fire detections but the improved spatial resolution of the 375 m data provides a greater response of fires over relatively small areas. The 375 m data also has improved nighttime performance.

https://firms.modaps.eosdis.nasa.gov/



https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms

7. Conclusions

Conclusions - 1

Optical and thermal infrared remote sensing observations are considered supportive for the pre-fire and post-fires stages.

Fire detection is technically feasible (in mid and thermal infrared; Sentinel 3, SEVIRI on Meteosat, Landsat TM), yet satellites with good temporal resolution have poor spatial one and vice versa. Thus the contribution to operational plans in the active fire stage is constrained.

Sentinel 2 and 3 facilitate research and operation applications with respect to forest fires. Results are complemented by Sentinel 1 SAR observations.

Conclusions -2

In principle, low spatial resolution satellites/sensors (VIIRS, MODIS) are used for pre-fire risk mapping; during the post-fire stage, satellites of high spatial resolution may be used instead (Sentinel-2, Landsat, Worldview, etc.).

Optical images at critical time frame, are often unavailable due to frequent cloud cover. As an active sensing technology, not relying on solar radiation, SAR (Sentinel 1) is capable of penetrating clouds and smoke as well as imaging day and night.

Cubesats reflect a promising development as constellations of (many) small satellites will improve both temporal and spatial resolution.

Several forest fire related applications have been developed in the framework of the EU and ESA, as well in other parts of the world.

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Slides 59-63 are from E. Lekkas, I. Parcharidis, M. Arianoutsou, S. Lozios, S. Mavroulis, N.-I. Spyrou, V. Antoniou, P. Nastos, M. Mavrouli, Ph. Speis, K-N. Katsetsiadou, H. Kranis, Emm. Skourtsos, A. Bakopoulou, N. Karalemas, Ch. Filis, E. Kotsi, M. Gogou, M. Diakakis, P. Carydis, I. Papadopoulos, D. Bafi, A. Karavias, A.-K. Petani, I. Gkougkoustamos, T. Falaras, I. Tselka, M. Nikolidaki, N. Evelpidou, M. Tzouxanioti, Th. Gavalas, C. Cartalis, K. Philippopoulos, A. Polydoros, Th. Mavrakou, I. (2021). The July – August 2021 Wildfires in Greece. Newsletter of Environmental, Disaster and Crises Management Strategies, 25, ISSN 2653-9454.

https://edcm.edu.gr/images/docs/newsletters/Newsletter_25_2021_July_August_Wildfires_in_Greece.pdf