Aristotle University of Thessaloniki Greece

An overview of Remote Sensing of forest fire research and applications in Mediterranean ecosystems

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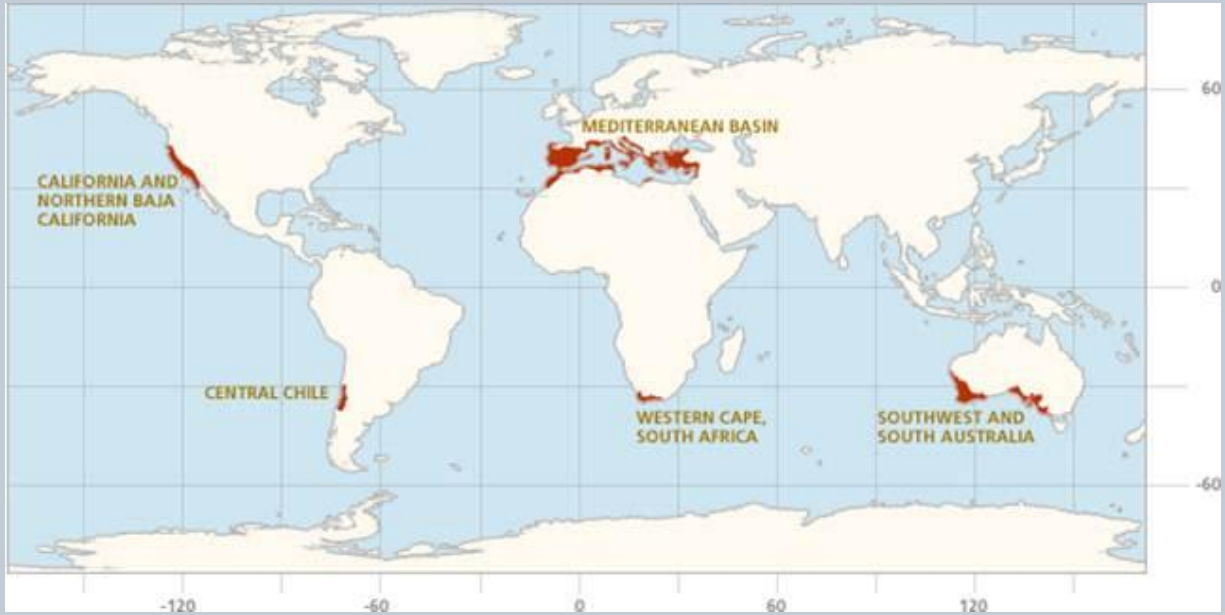
FMRS

Presentation Structure

- ✓ Mediterranean ecosystems and their characteristics
- ✓ Forest fires in the Mediterranean
- ✓ Forest Fire Management related Remote Sensing (and GIS) applications

Mediterranean ecosystems

Mediterranean ecosystems are limited to five relatively small areas around the planet



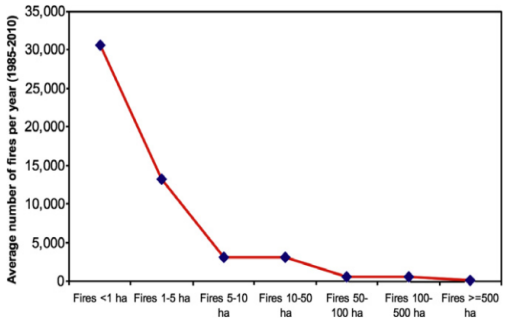
The Mediterranean forests, woodlands, and scrub biome can be found in the world's five Mediterranean climate zones, on the west coast of continents in the mid-latitudes.

Mediterranean ecosystems (characteristics)

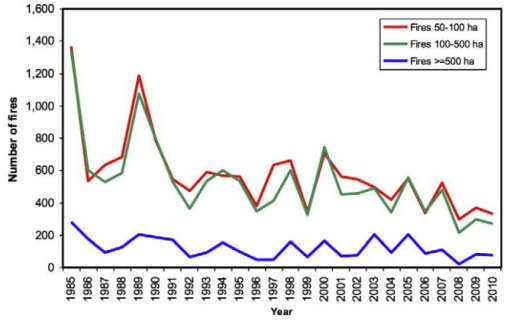
- ✓ The climate is characterized by hot, dry summers and mild, wet winters.
- ✓ Vegetation types can range from forests to woodlands, savannas, shrublands, and grasslands.
- ✓ High biodiversity (uniquely adapted animal and plant species) due to the limited extent and isolation of the Mediterranean climate regions.
- ✓ Of the most highly altered ecosystems on the planet due to high human impact (habitation, agriculture, recreation).

Forest fires in the Mediterranean

- Natural fires are an integral part of many terrestrial ecosystems including the Mediterranean.
- Every year, more than 500,000 ha are destroyed by forest fires in Europe and most of the total burned area is predominantly observed in Portugal, Spain, France, Italy and Greece.
- Although the number of fires has decreased since 2000, the phenomenon of climate change is expected to cause a pronounced increase in the frequency and severity of fire events.



Distribution of fires by size in the EU Mediterranean region (period 1985-2010).



Trends of fires by size category in the EU Mediterranean region.

San-Miguel-Ayanz, Jesús, Jose Manuel Moreno, and Andrea Camia. Analysis of large fires in European Mediterranean landscapes: lessons learned and perspectives. Forest Ecology and Management 294 (2013): 11-22.

Forest Fires
(examples from the Mediterranean region)

Lebanon 2007

Greece 2007

Turkey 2006

Italy 2007

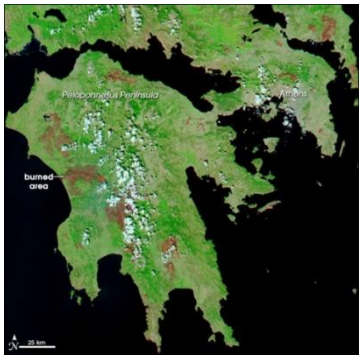
Portugal 2005

France 2003

Spain 2006

Fire, both natural and human-caused, has played a major role in shaping the landscape in the Mediterranean.

Forest Fires in Greece
(the Peloponnese - August 2007)



Forest Fire Factors

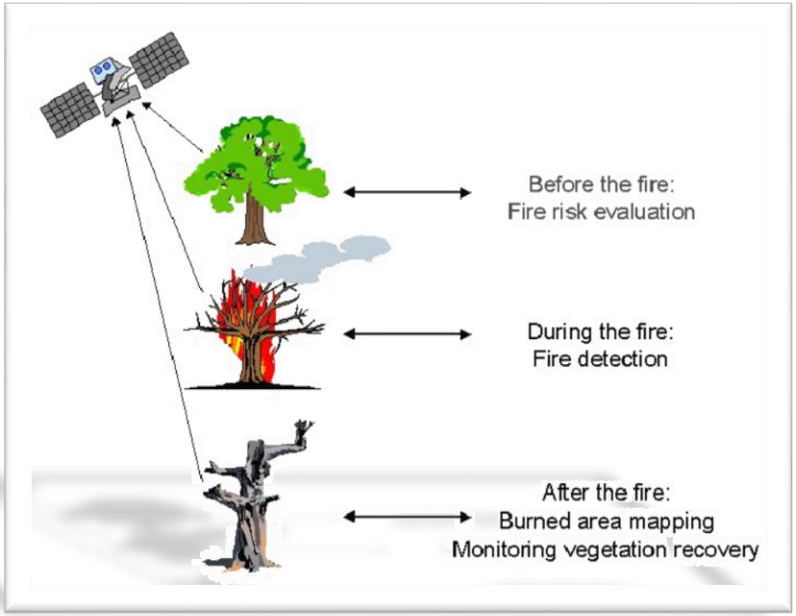
Weather patterns

Human activities

Topography

Fuels

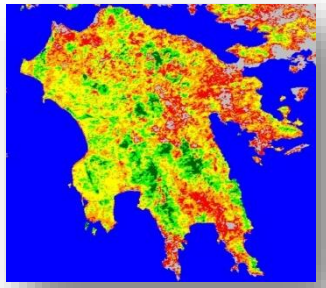
Forest Fire Management

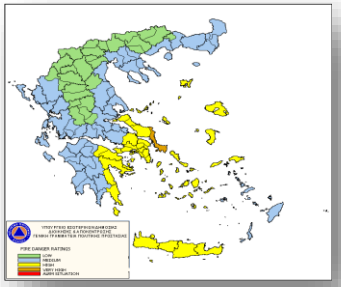


A complete fire management programme includes the following:

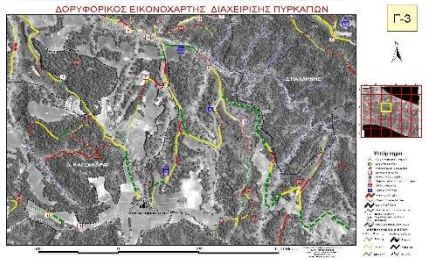
- **pre-fire planning** (e.g. creation of fire-breaks, fuel type mapping, topography)
- **fire detection and monitoring** (e.g. FUEGO, EARTH-i)
- **fire suppression** (e.g. use of retardants), and
- **post-fire evaluation** (e.g. burned area mapping, regeneration mapping and monitoring).

Remote Sensing and GIS in Forest Fire Management

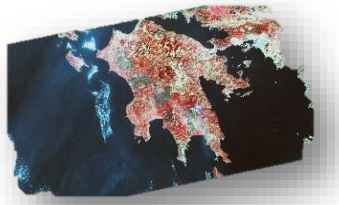


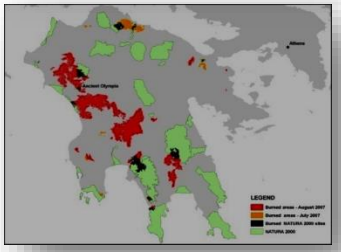


Pre-fire Operations



During fire Operations





Post-fire Operations

Remotely sensed data and GIS analysis may be used in all phases of a fire management programme.

The range of RS applications related to forest fires is increasing as a result of the following:

A. an increase in the number of sensors with different characteristics suitable for studying aspects of fire

B. the development of new advanced digital image analysis techniques

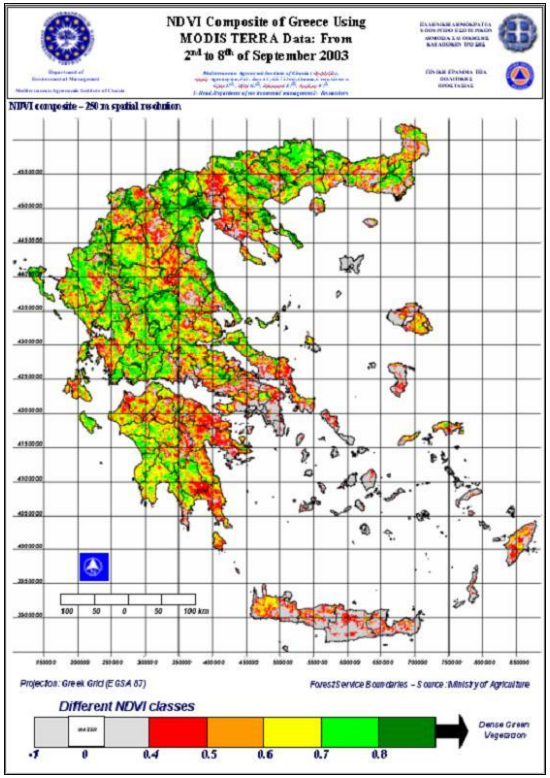
C. improved access to and availability of satellite data and derived products

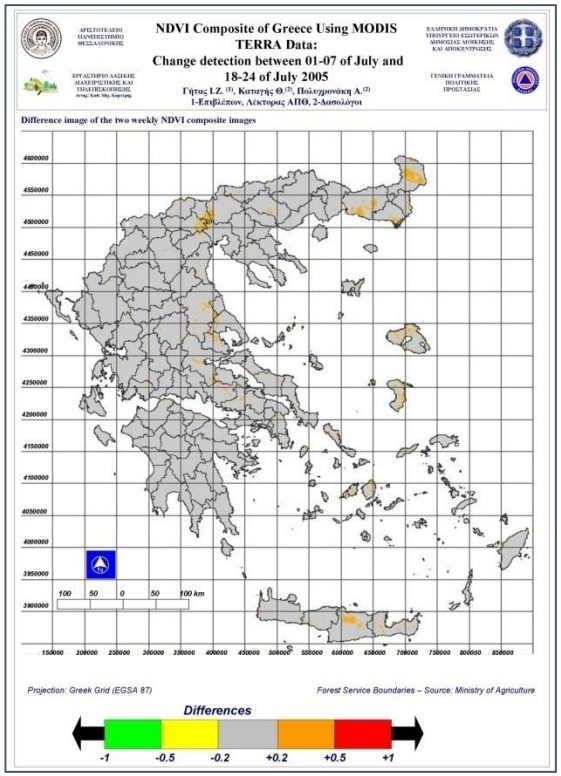
Forest Fire Management related Remote Sensing (and GIS) applications

- Pre-fire planning
  - Fuel type mapping (e.g. ArcFuel, NOFFi-FTM)
  - Estimation of vegetation density
  - Fire Suppression
- During fire (assist operations)
- Post-fire impact assessment
  - Burned area mapping
  - Operational Burned Area Mapping at National Level (e.g. NOFFi-OBAM)
  - Burn Severity mapping
  - Short and long term damage assessment
- Services

Pre-fire Planning

Vegetation dryness mapping (MODIS – 250 m) produced for the period 2002 – 2013 on a weekly basis



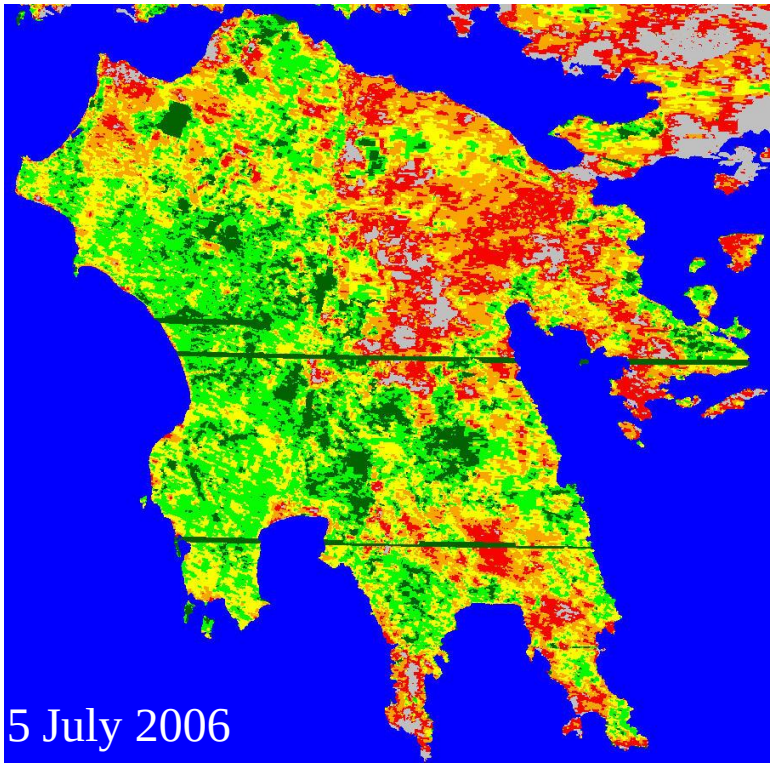


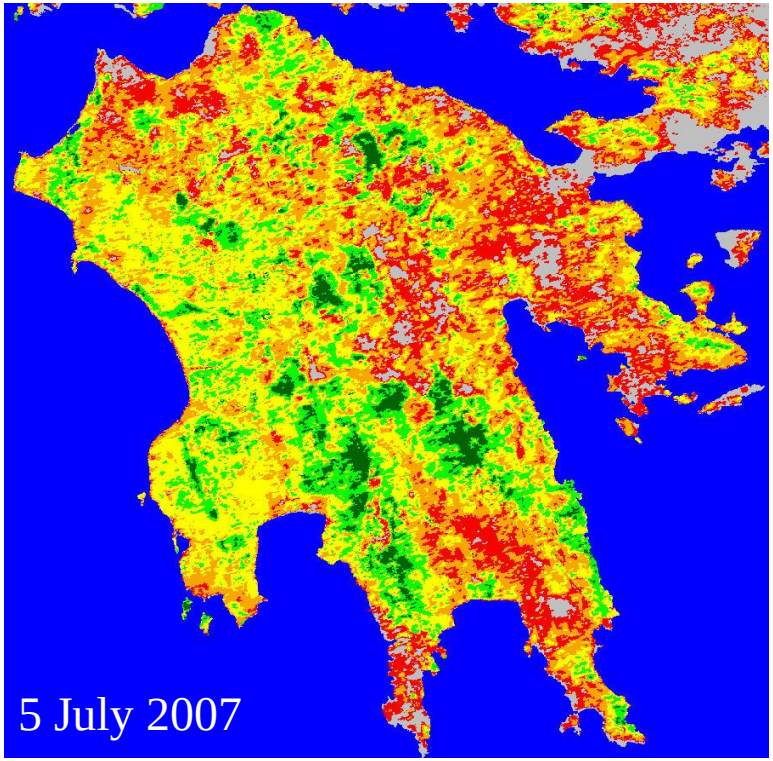
Vegetation monitoring at approx. weekly basis

Change detection map

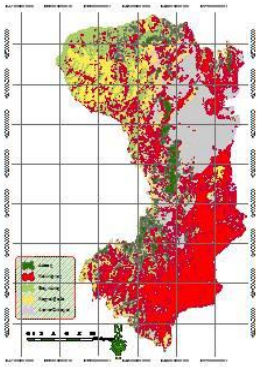
Alexandridis, T.K., Katagis, T., Gitas, I.Z., Silleos, N.G., Eskridge, K.M., Gritzas, G. Investigation of aggregation effects in vegetation condition monitoring at a national scale (2010) International Journal of Geographical Information Science, 24 (4), pp. 507-521.
DOI: 10.1080/13658810902798107

Vegetation dryness monitoring (inter-annual comparison)

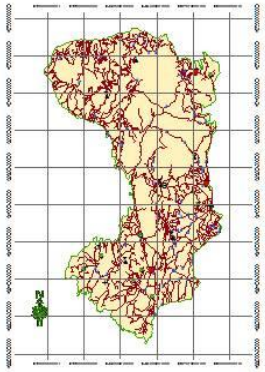




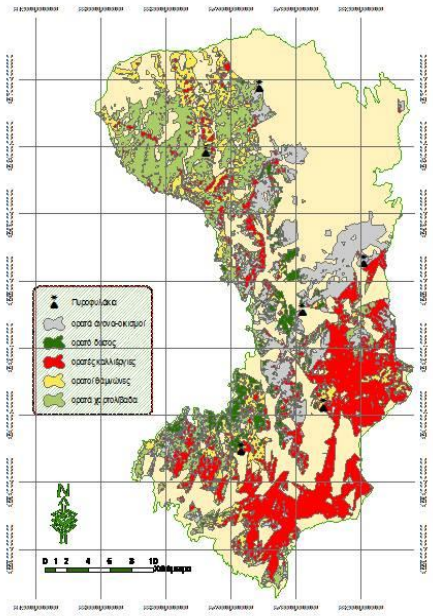
Fire tower visibility analysis



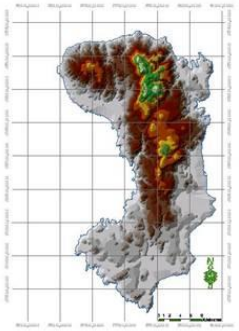
Land



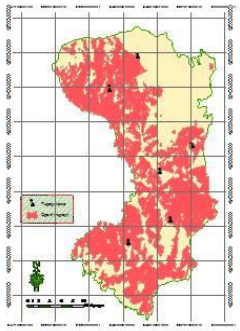
Road network



Visibility map

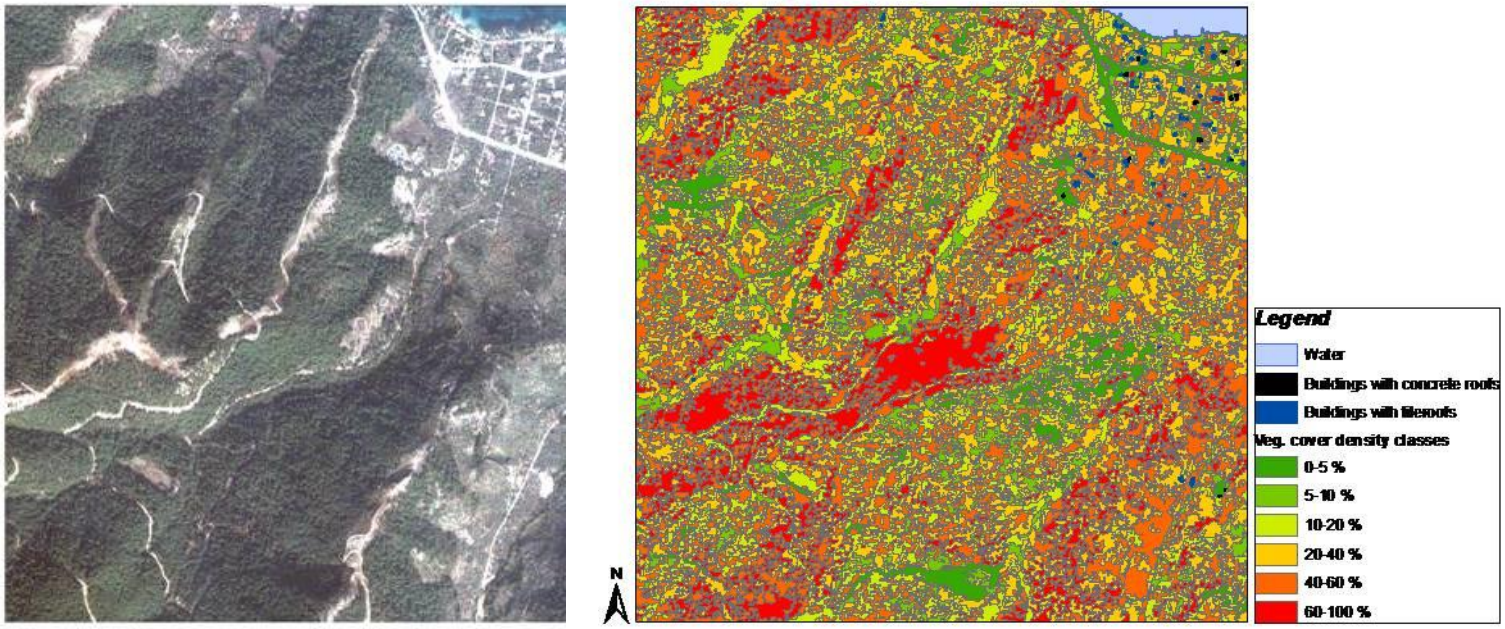


DEM

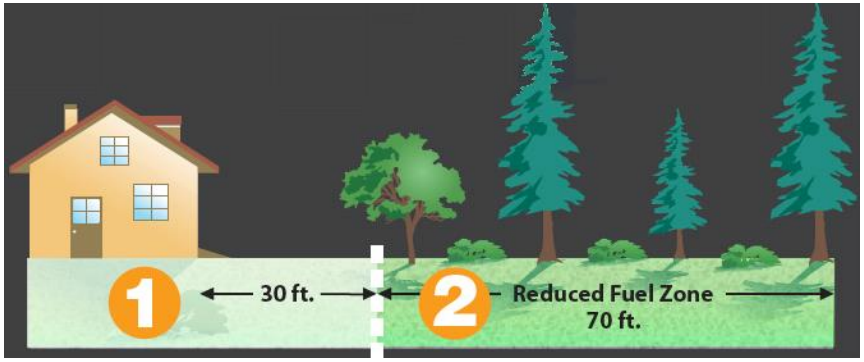


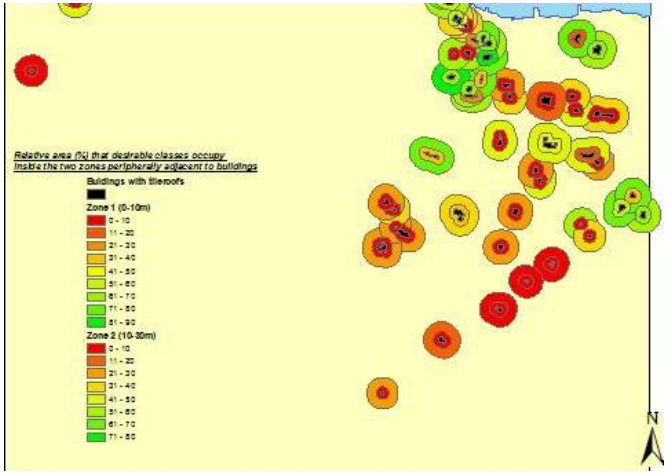
Map of existing fire towers

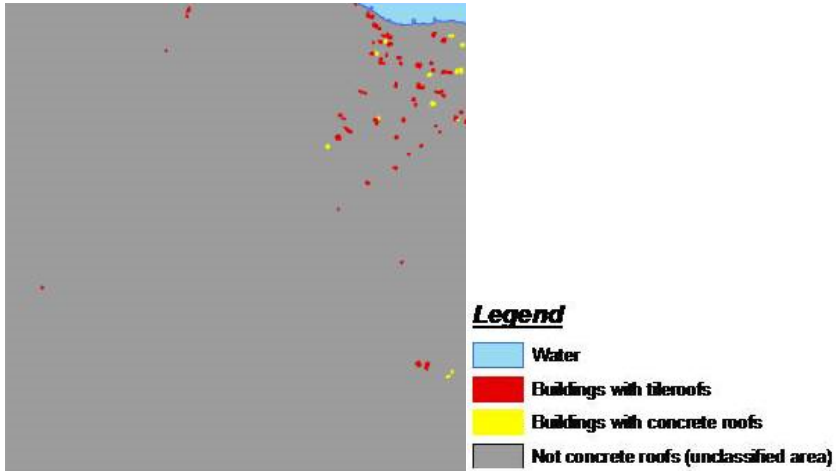
Estimation of vegetation density



Estimation of defensible space







The PROMETHEUS fuel classification system

Land fuels (grasslands)

Low shrubs

Medium shrubs

High shrubs

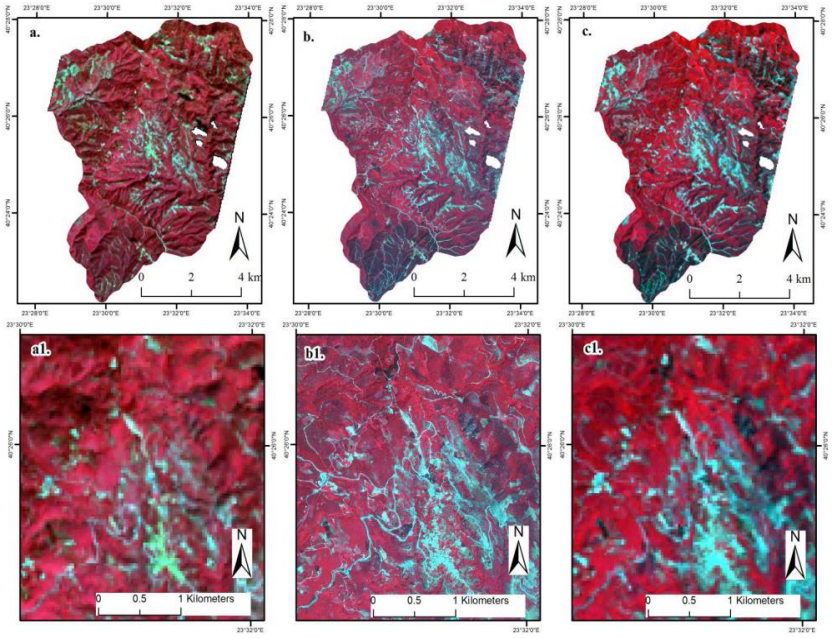
Forest without undergrowth

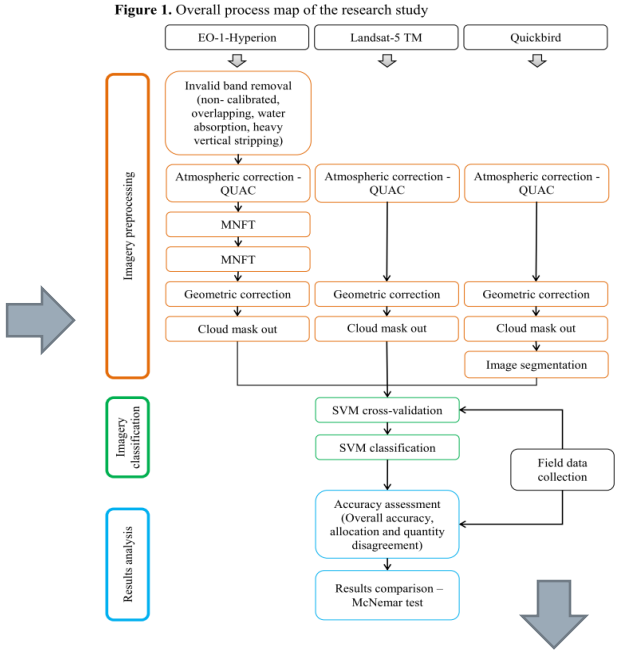
Forest with medium undergrowth

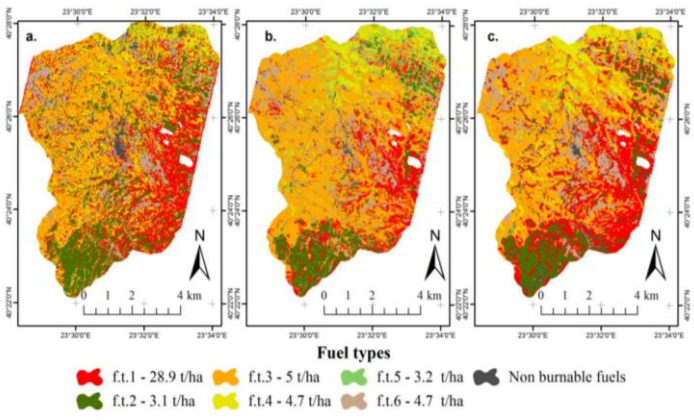
Forest with high and dense undergrowth

Prometheus, S. (2000). Management techniques for optimization of suppression and minimization of wildfire effects. System validation. European Commission–contract number ENV4-CT98-0716.

A comparative analysis of Hyperion, Quickbird and Landsat TM and imagery for fuel type mapping of a typical Mediterranean landscape

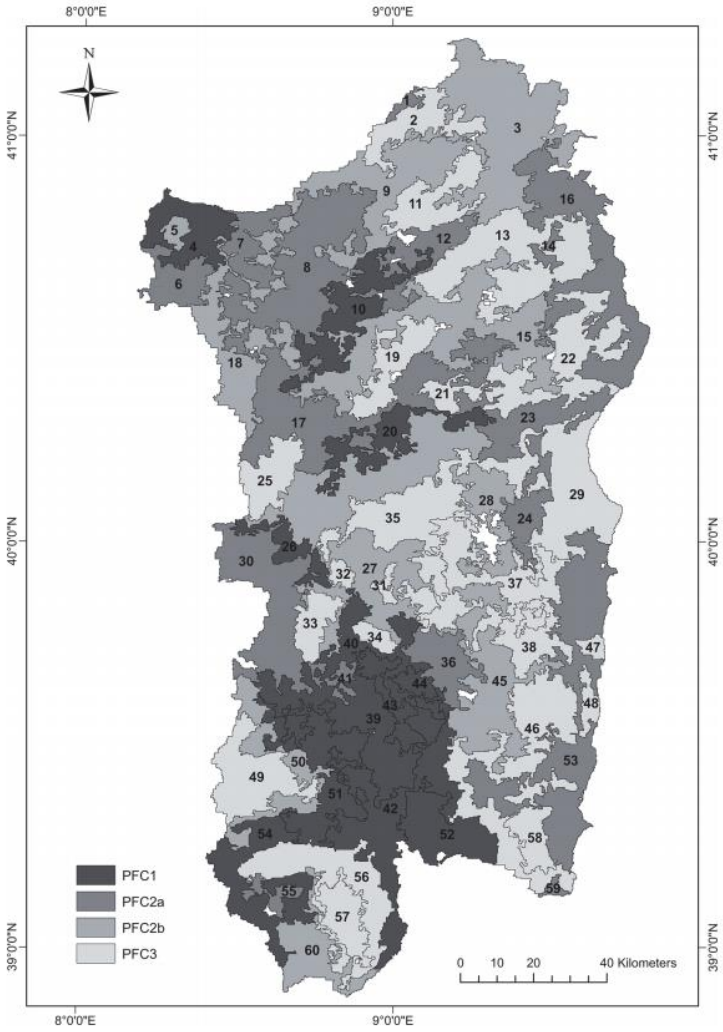






G. Mallinis, G. Galidaki, I. Gitas, A Comparative Analysis of EO-1 Hyperion, Quickbird and Landsat TM Imagery for Fuel Type Mapping of a Typical Mediterranean Landscape, Remote Sensing 6(2), 1684-1704, 2014.

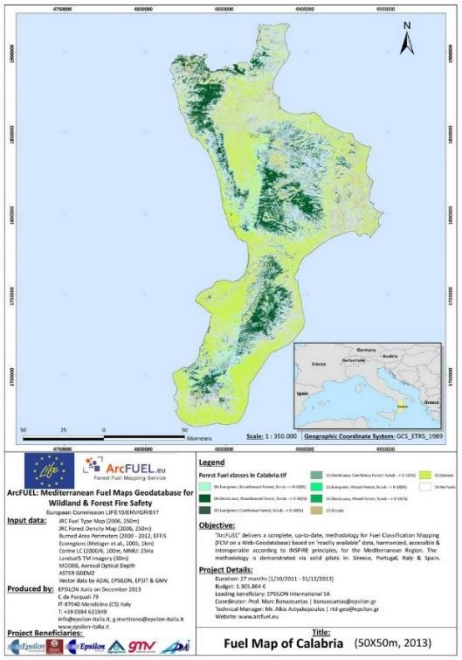
Mapping forest fuels through vegetation phenology

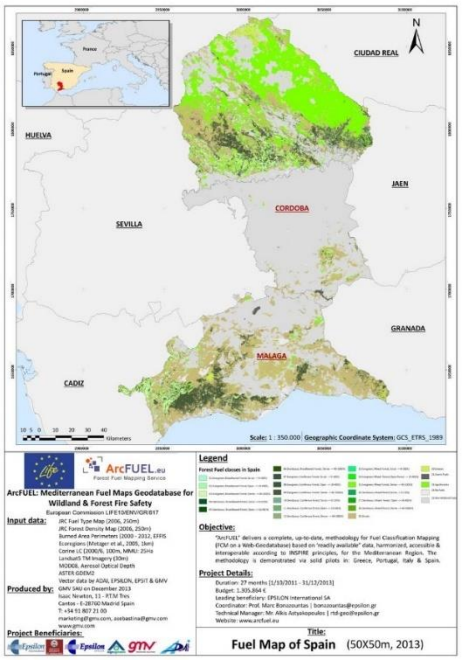


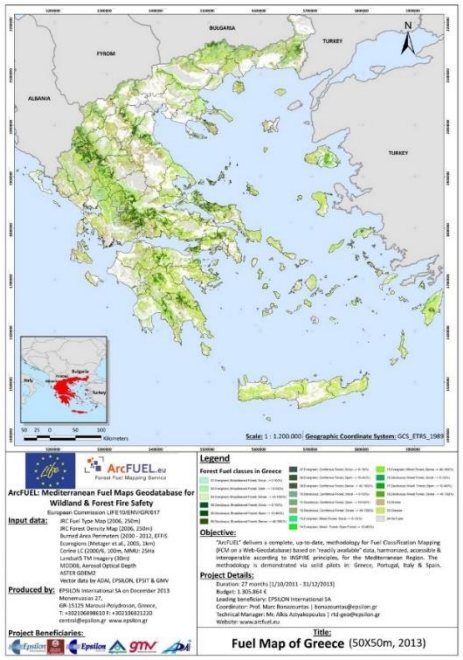
- Example of the spatial distribution of 60 phenological units and the four phenological fuel classes.

Bajocco, S., Dragozi, E., Gitas, I., Smiraglia, D., Salvati, L. and Ricotta, C. (2015). Mapping Forest Fuels through Vegetation Phenology: The Role of Coarse-Resolution Satellite Time-Series. PloS one 10(3): e0119811.

The ArcFuel method



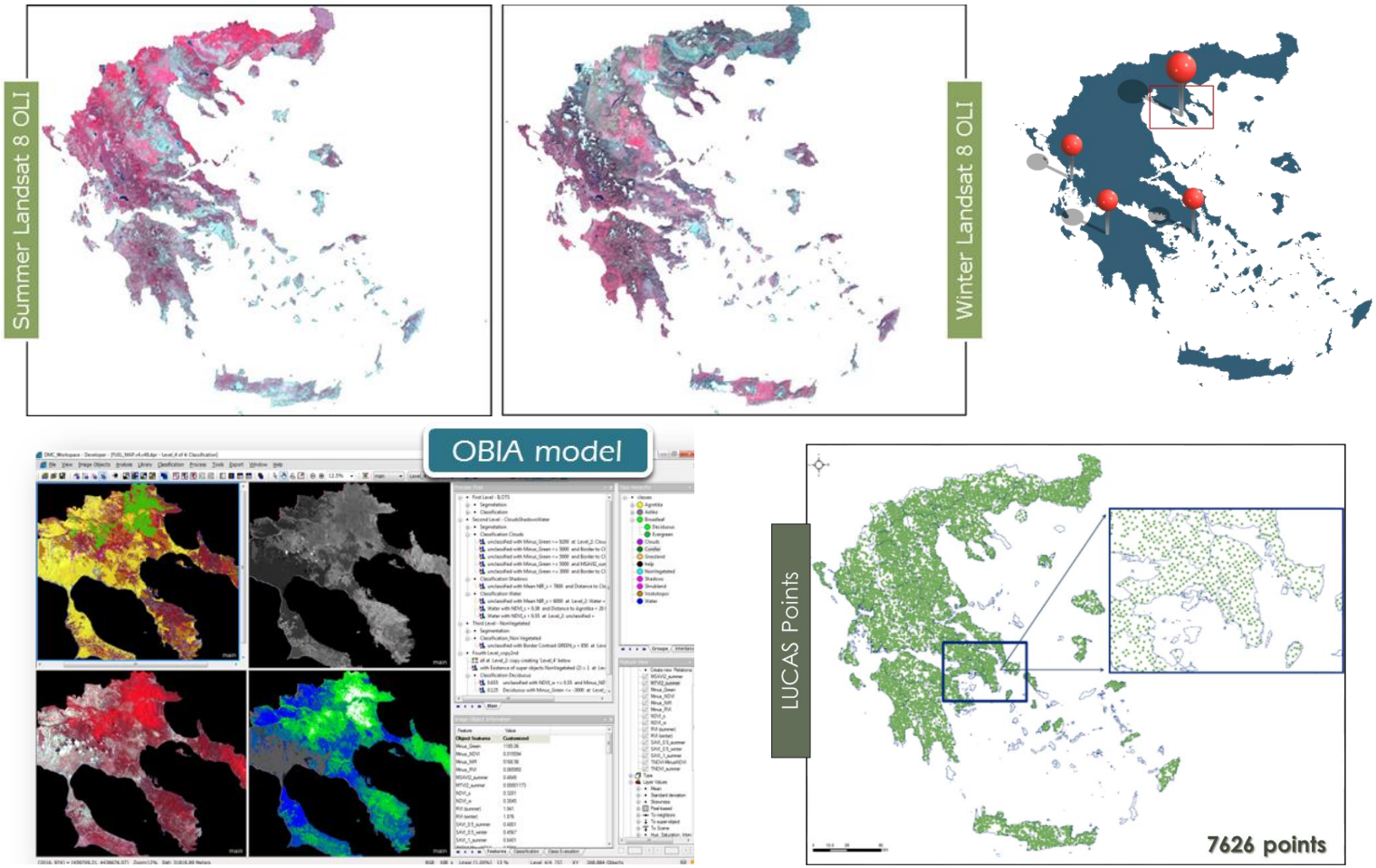




The ArcFuel is a multi-resolution multi-source mapping approach that was recently developed within the frame of the ArcFUEL LIFE project (http://www.arcfuel.eu/index.php/en/).

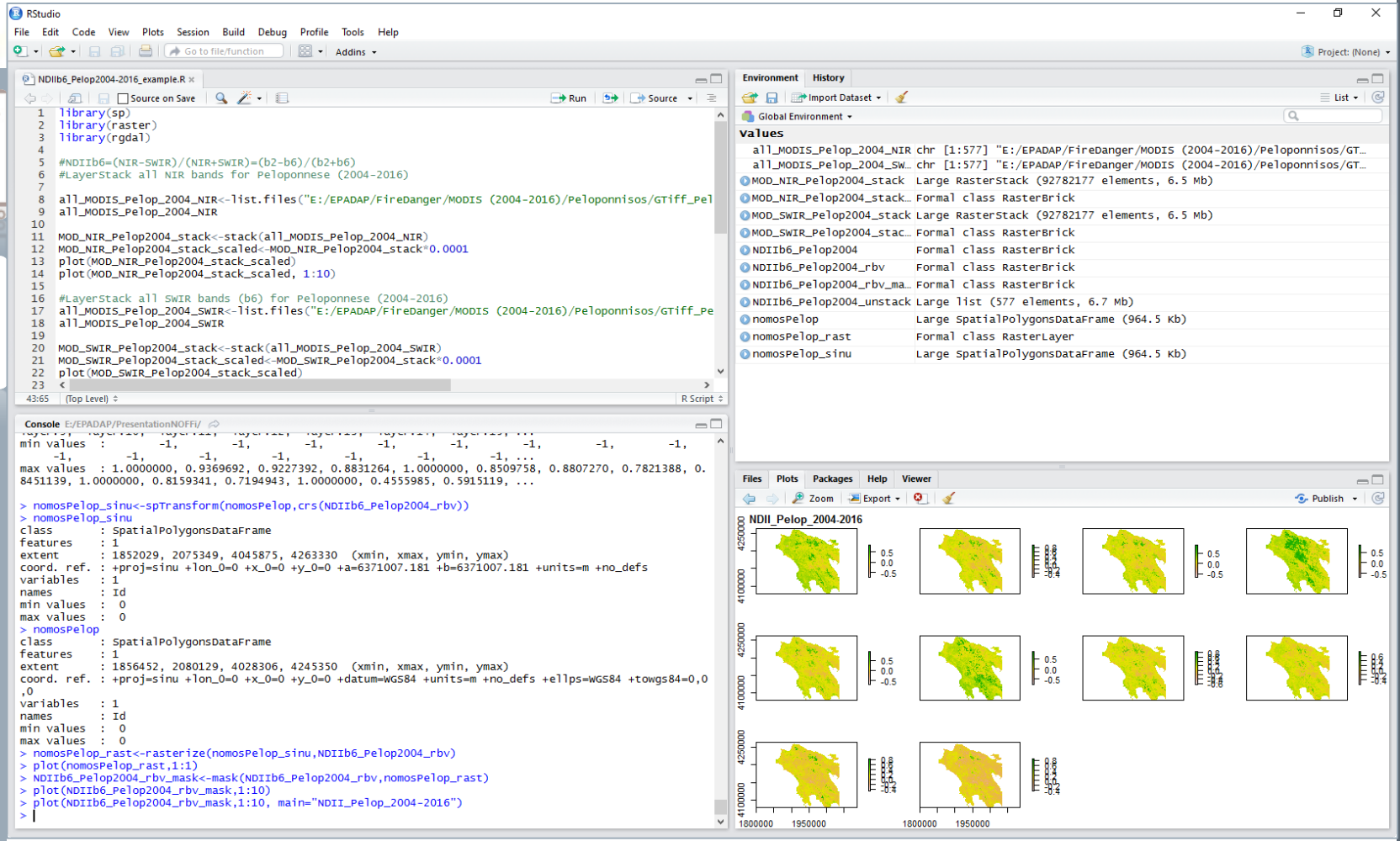
Toukiloglou, P., Eftychidis, G., Gitas, I., & Tompoulidou, M. (2013, August). ArcFuel methodology for mapping forest fuels in Europe. In First International Conference on Remote Sensing and Geoinformation of Environment (pp. 87951J-87951J). International Society for Optics and Photonics.

The NOFFi fuel mapping methodology



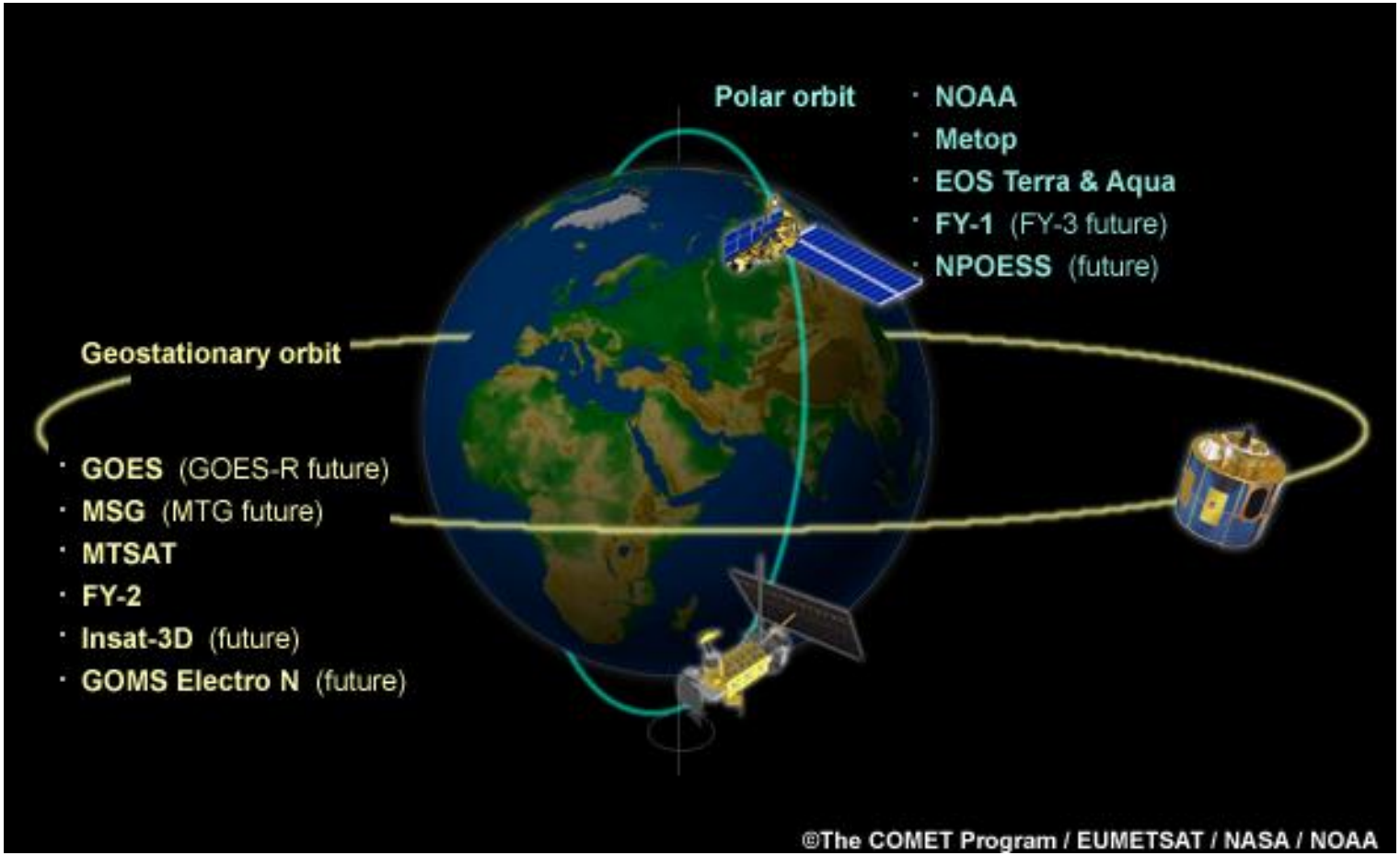
Maria Tompoulidou, Dionysios Grigoriadis, Alexandra Stefanidou, Eleni Dragozi, Dimitris Stavrakoudis, & Gitas, I. (2015, 2-5 November 2015). Fuel Type Mapping on a National Scale Using Object Based Image Analysis and Landsat 8 OLI imagery: The National Observatory of Forest Fires (NOFFi) case. 10th EARSeL Forest Fire Special Interest Group Workshop, Limassol, Cyprus.

The NOFFi fire danger index

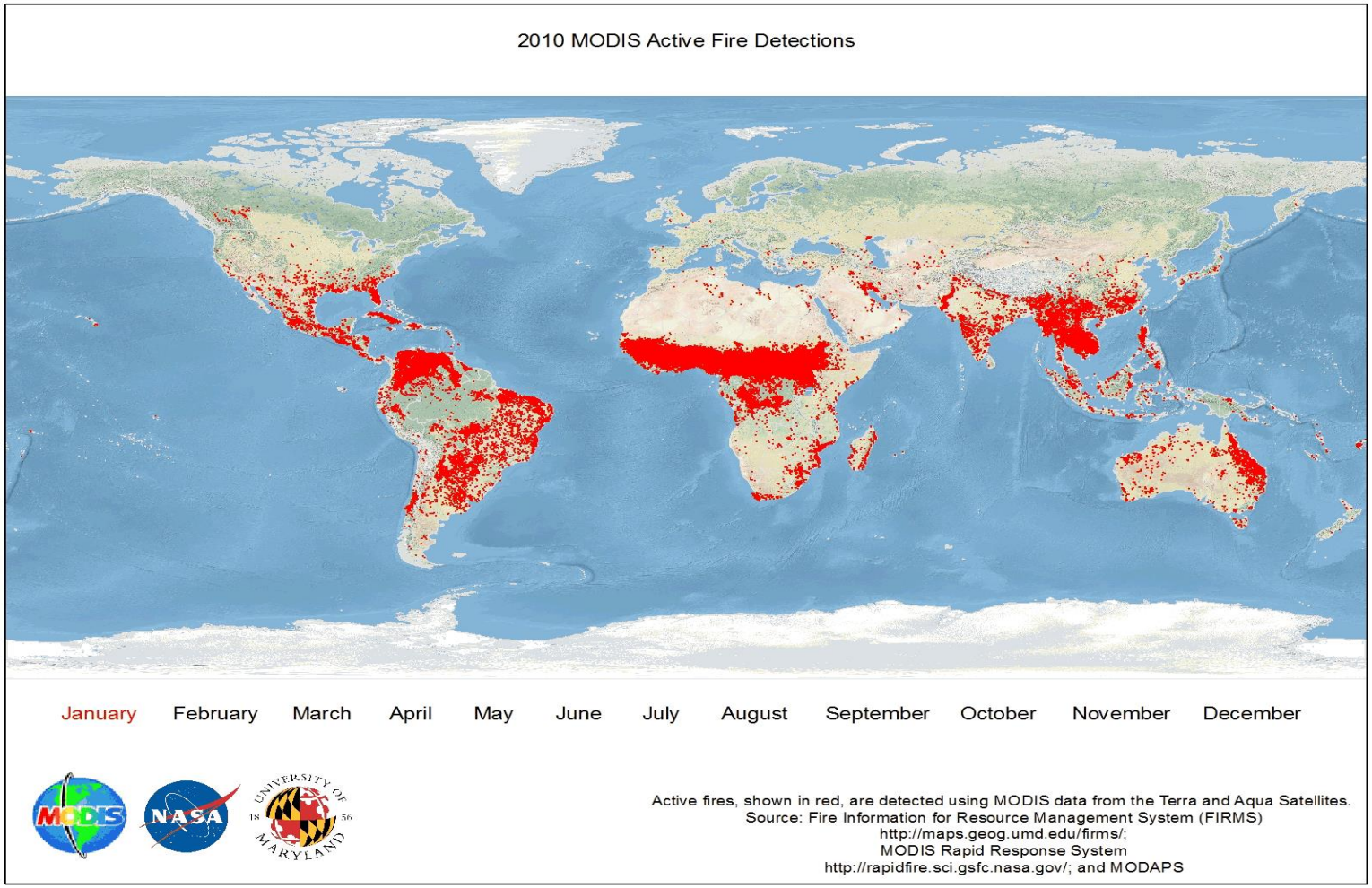


During fire

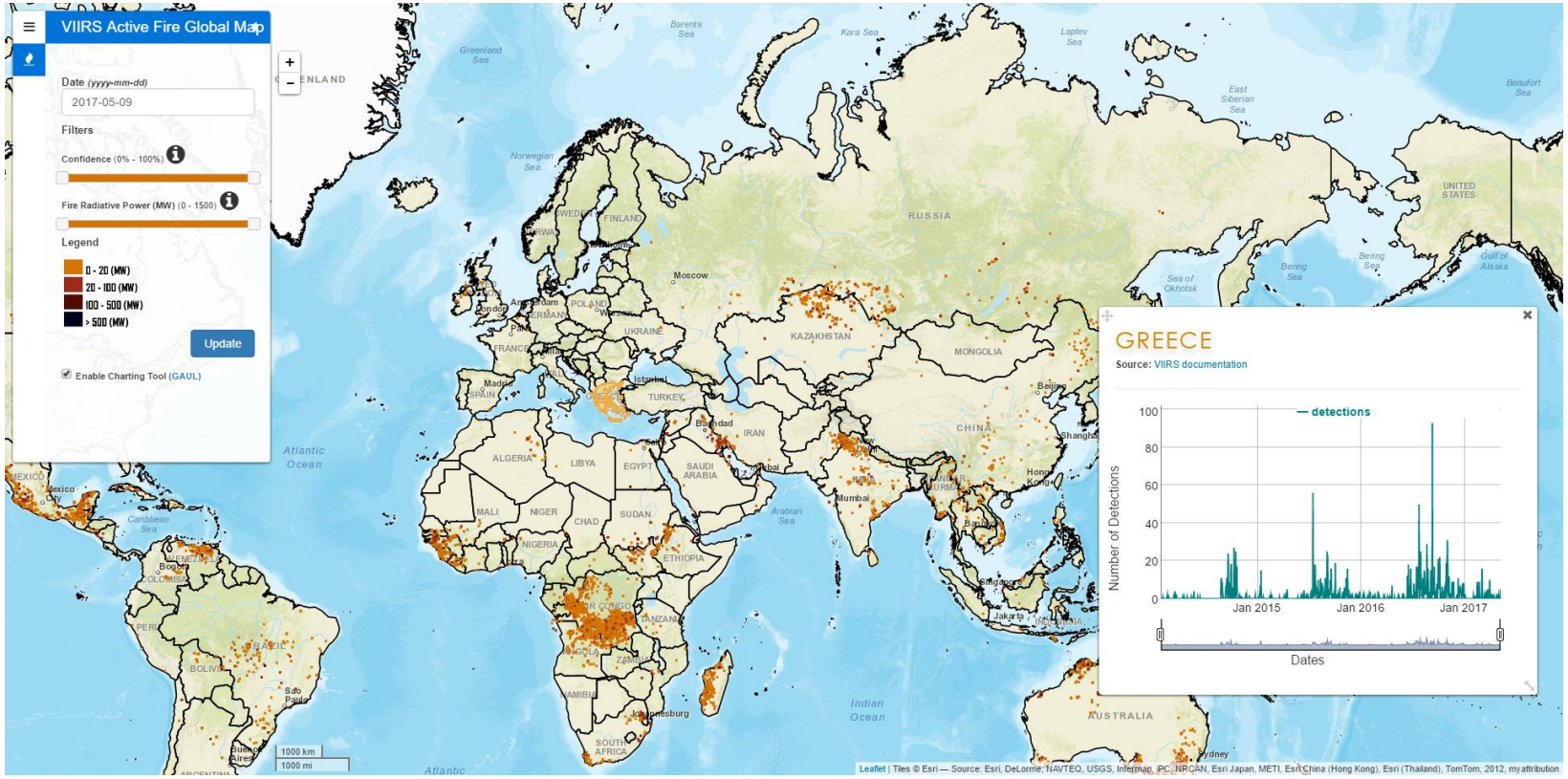
Satellites with Fire Detection & Monitoring Capabilities



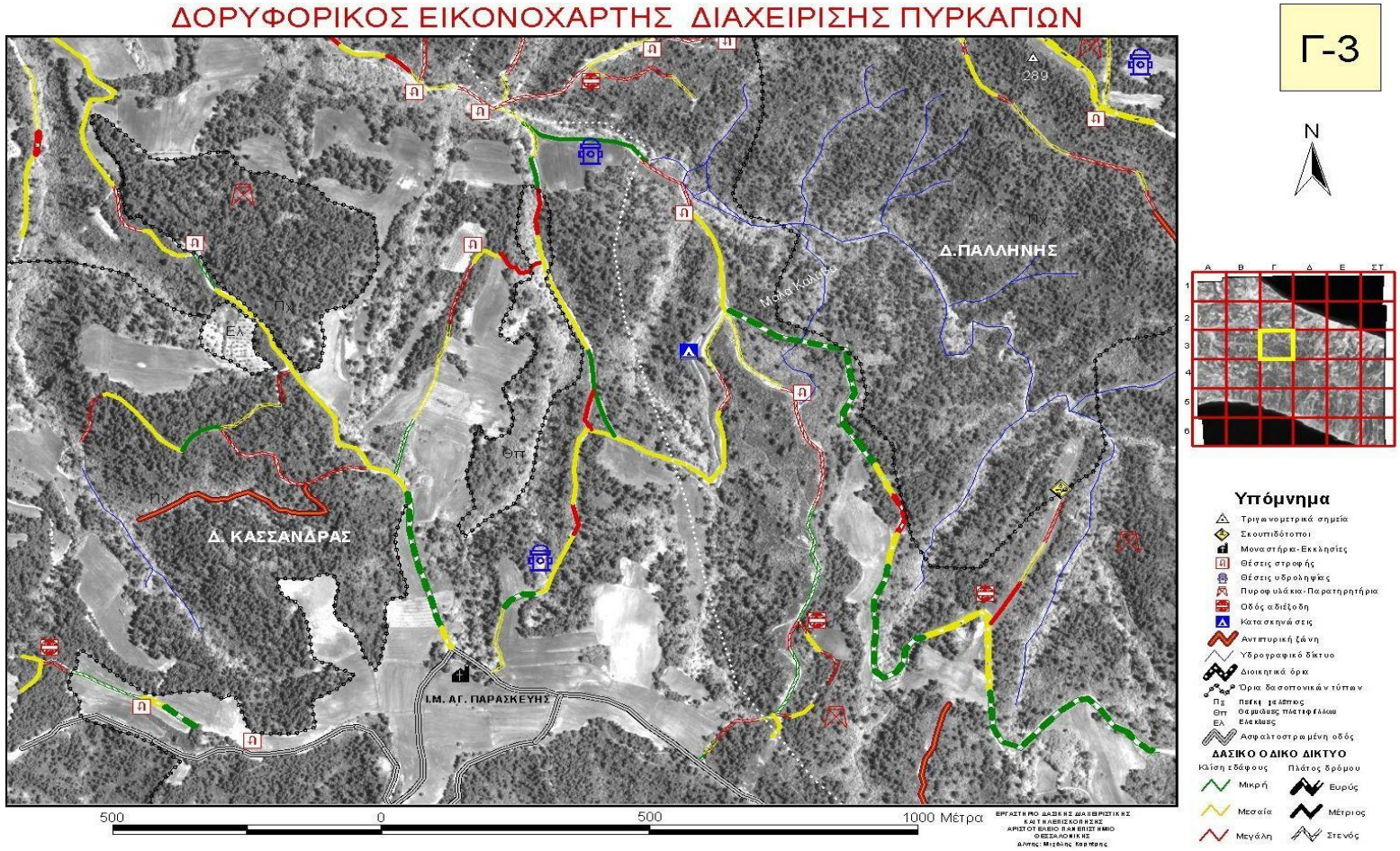
MODIS Active Fire Global Mapping



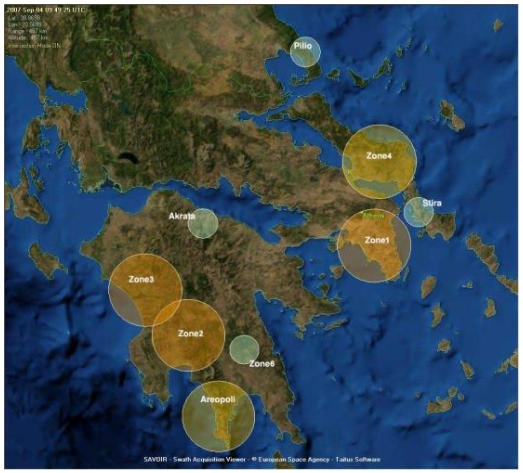
VIIRS Active Fire Global Mapping



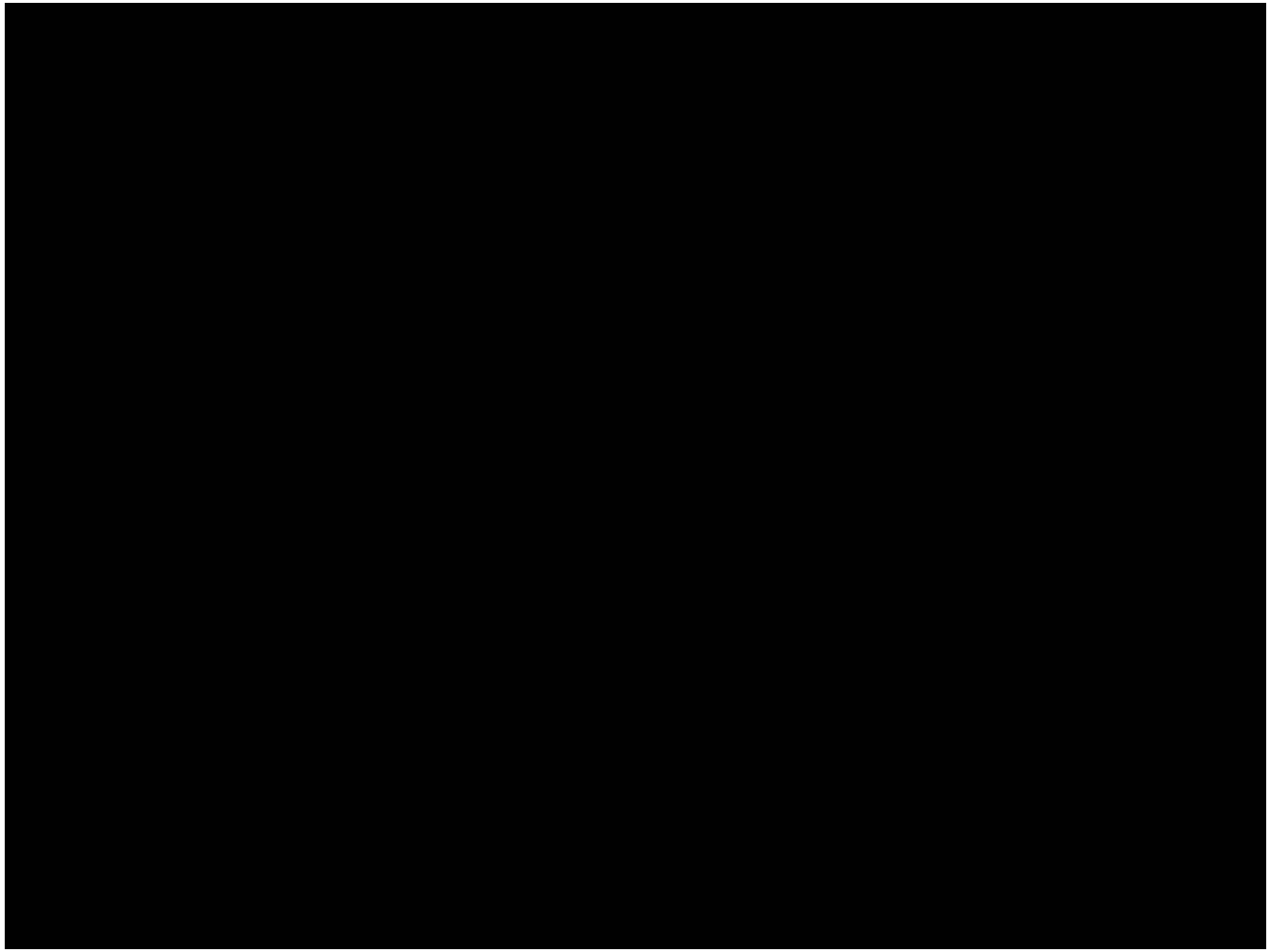
Satellite map for fire-fighting resources allocation



Detection and near real-time monitoring

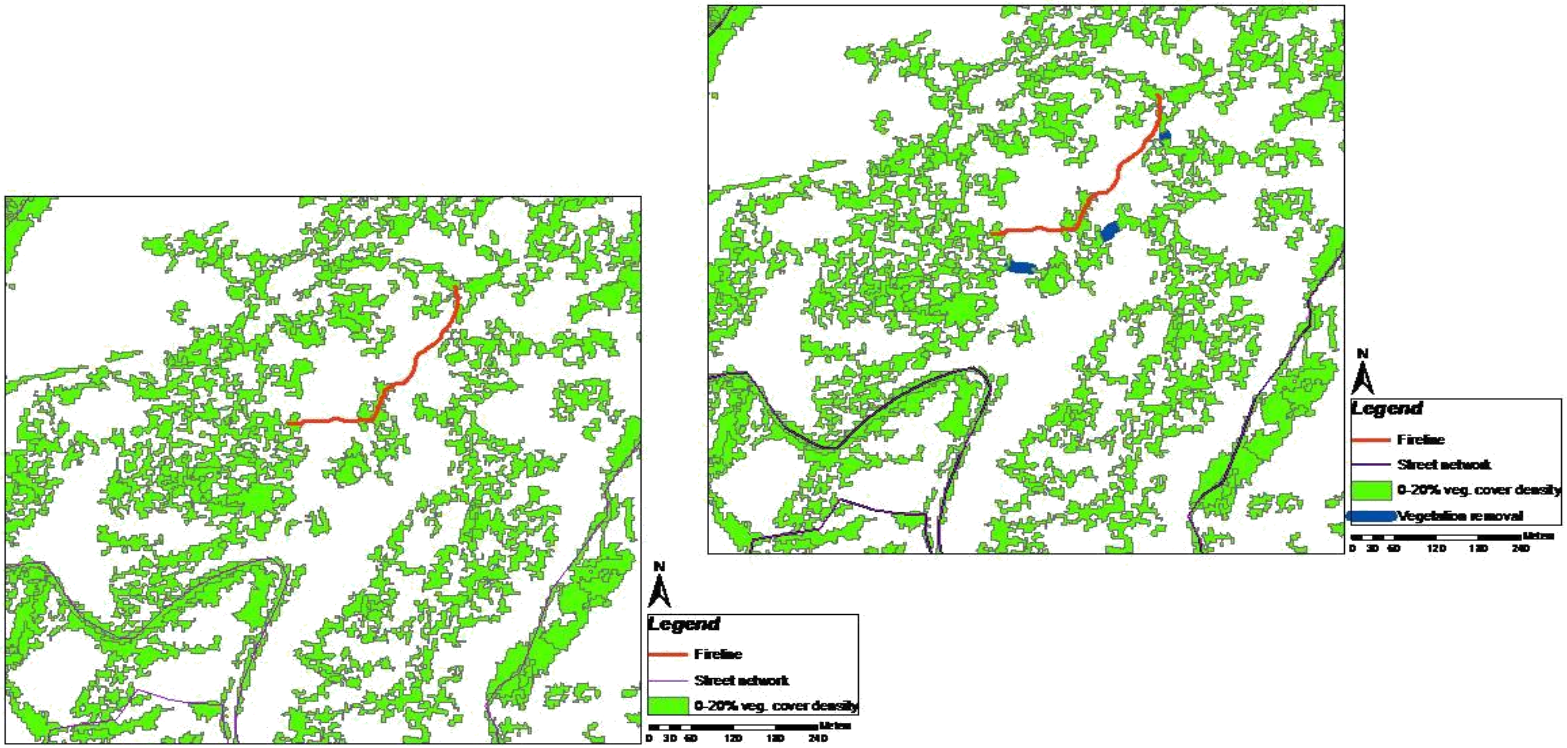


Detection and near real-time monitoring



source: ESA

Planning the 'line of defence'

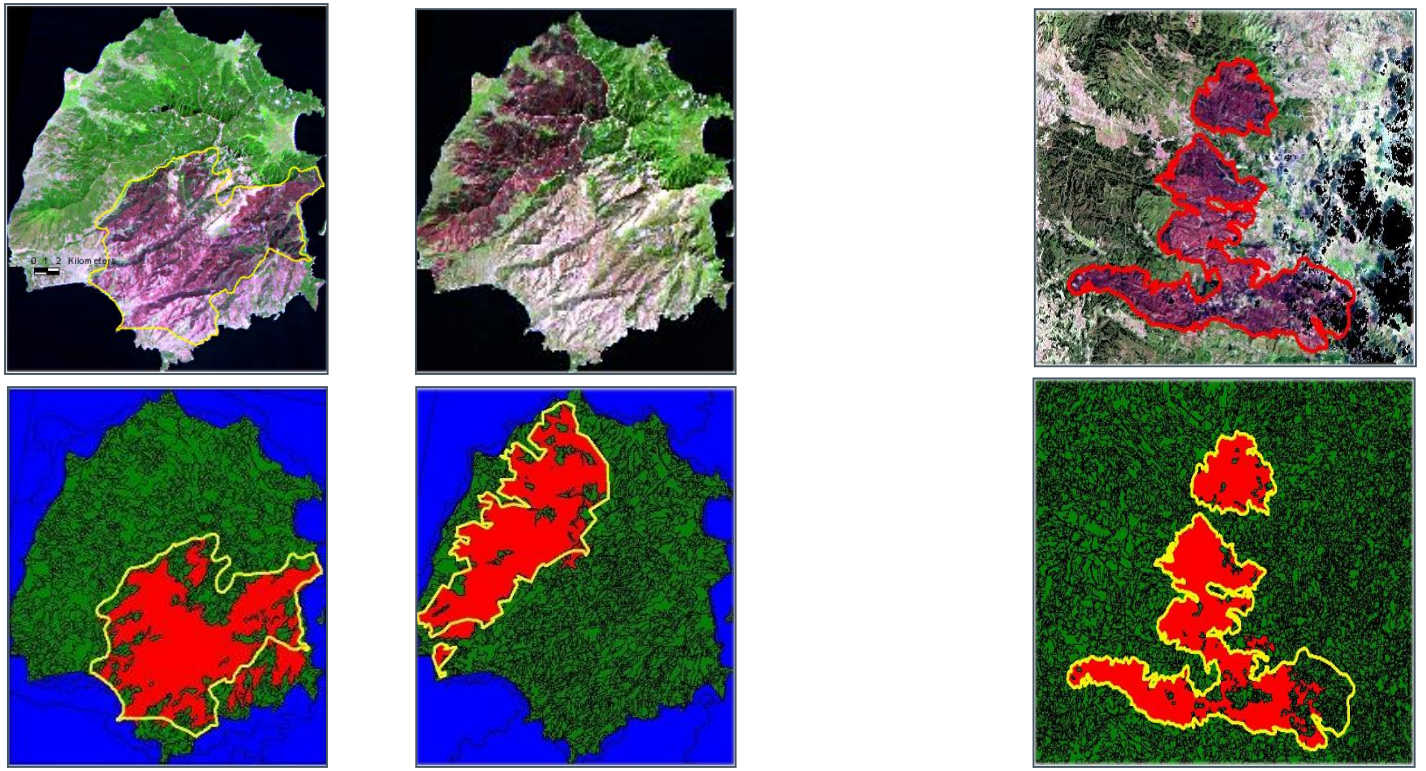


- GIS analysis for locating the 'line of defence'

Post-fire mapping and monitoring

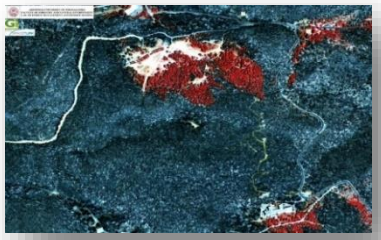
Semi-automated burned area mapping

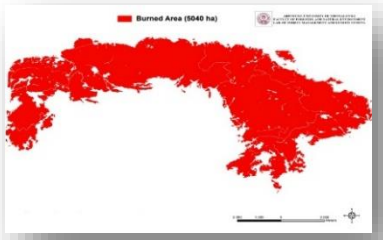
- ✓ Object-Based Image Analysis (OBIA)

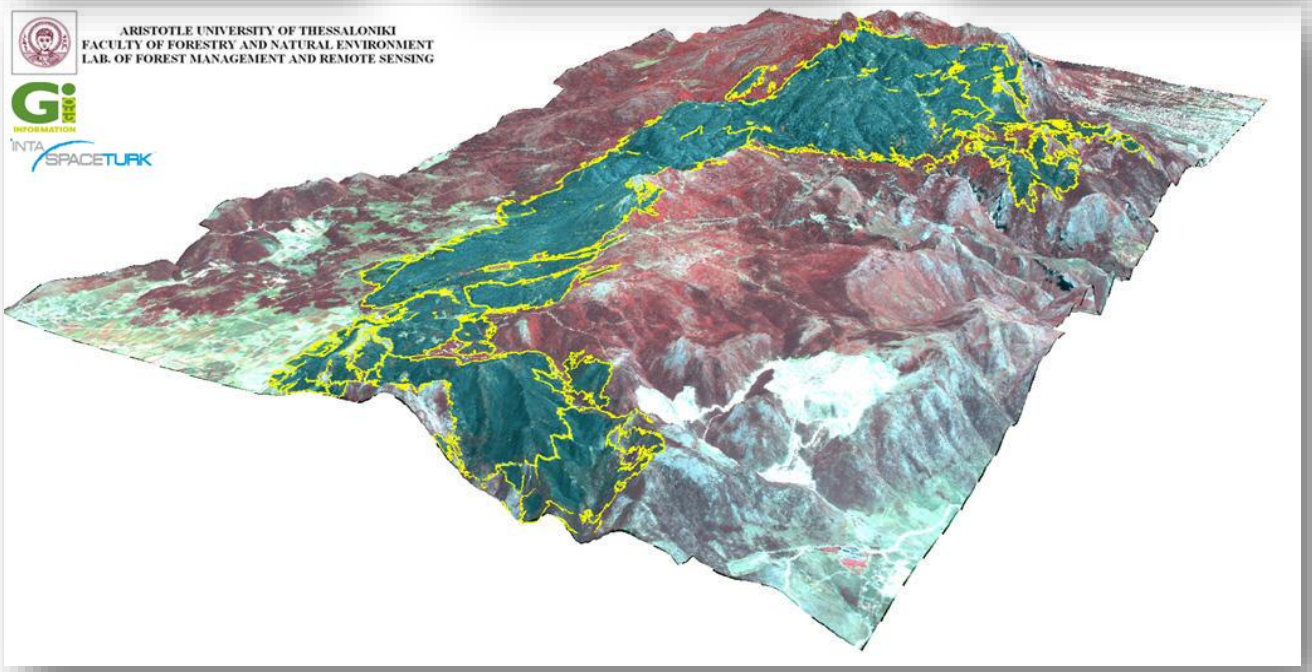


Mitri, G.H., Gitas, I.Z. A semi-automated object-oriented model for burned area mapping in the Mediterranean region using Landsat-TM imagery (2004) International Journal of Wildland Fire, 13 (3), pp. 367-376.

Burned area mapping using VHR imagery (Parnitha 2007 - IKONOS)

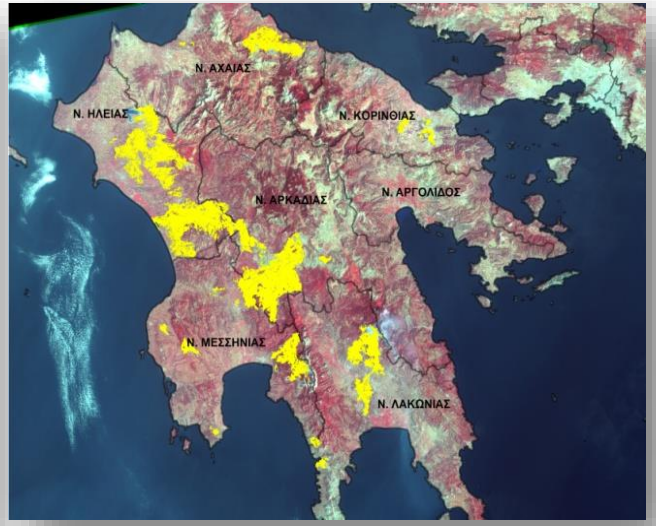


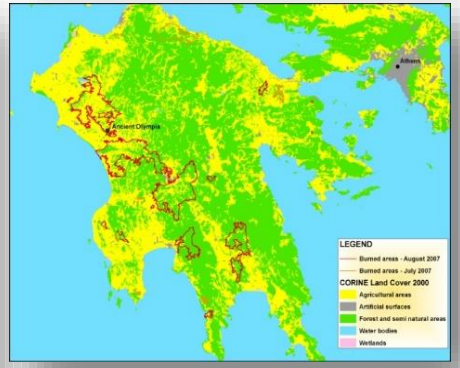


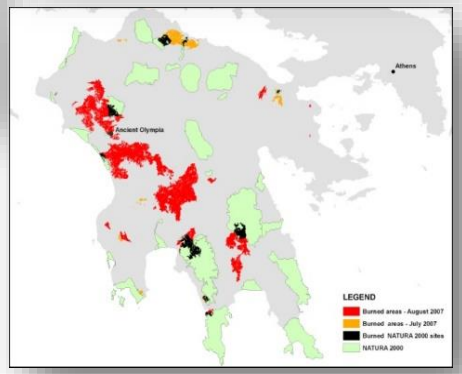


Gitas et al. (2007) Wildfires & Remote Sensing - Fast Mapping Results Provide Deeper Insights, GEOInformatics, October/November 2007,

Burned area mapping and rapid damage assessment An FMRS - DMC ii - WWF Hellas partnership

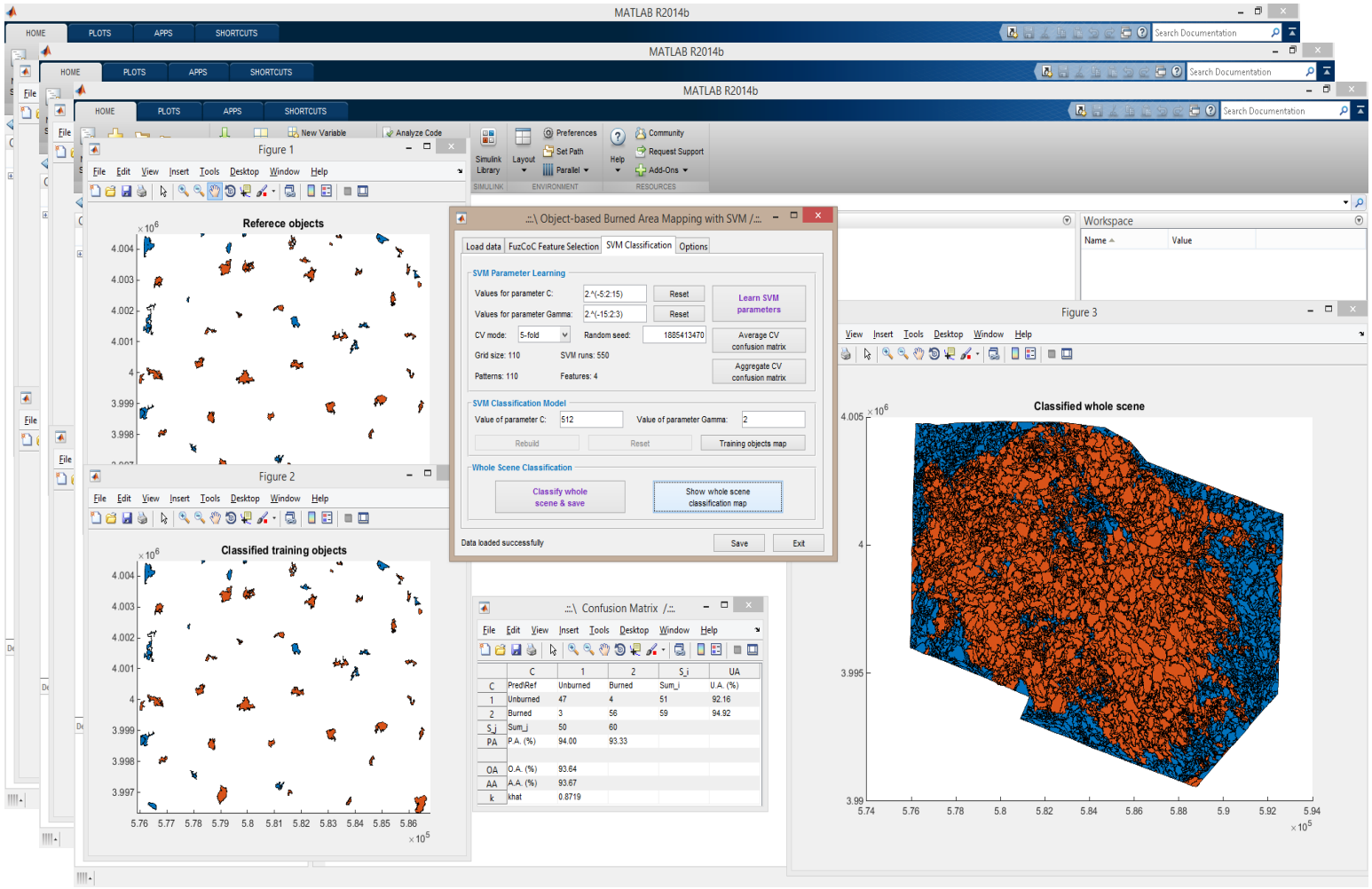






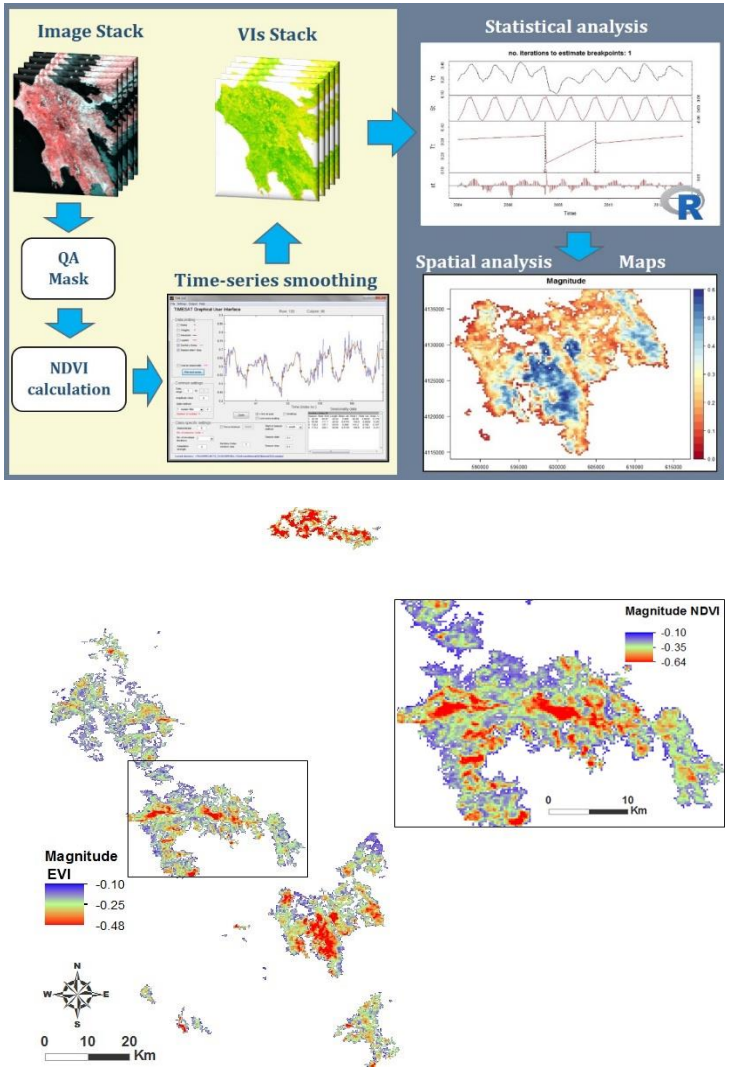
Gitas, I. Z., Polychronaki, A., Katagis, T. and Mallinis, G. (2008) Contribution of remote sensing to disaster management activities: A case study of the large fires in the Peloponnese, Greece, International Journal of Remote Sensing, 29:6, 1847 – 1853

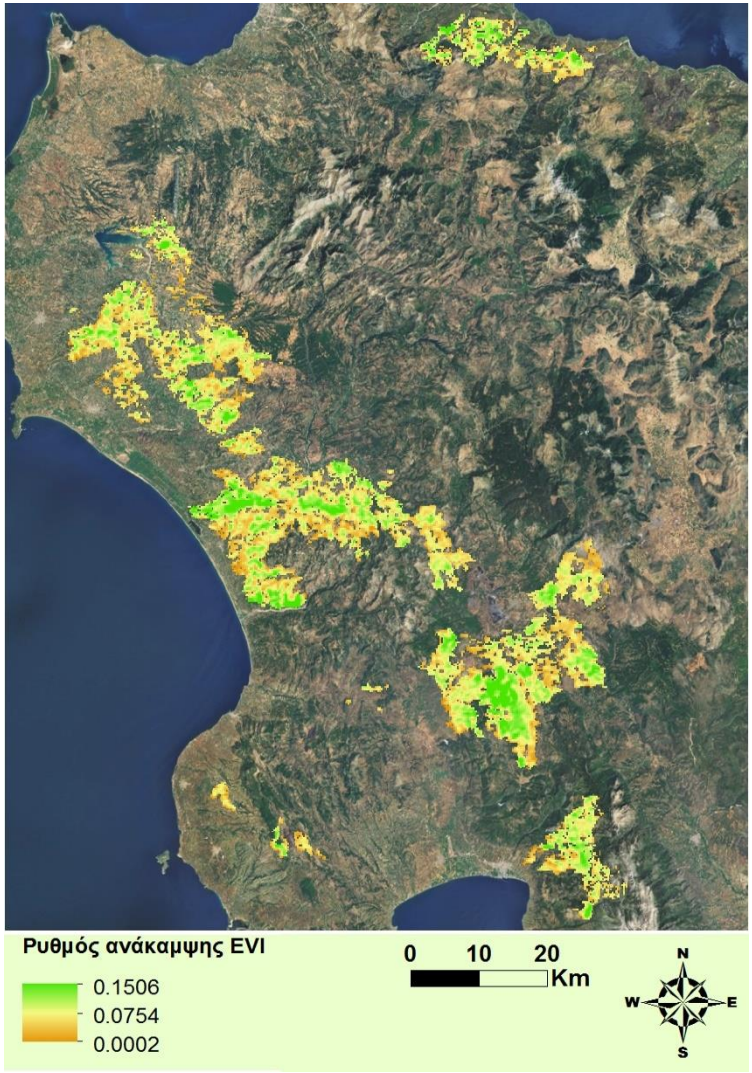
Operational burned area mapping product



Dragozi, E., Gitas, I. Z., Stavrakoudis, D.G., Theocharis, J.B. 2014. Burned Area Mapping Using Support Vector Machines and the FuzCoC Feature Selection Method on VHR IKONOS Imagery, Remote sensing 6(12), pp. 12005-12036.

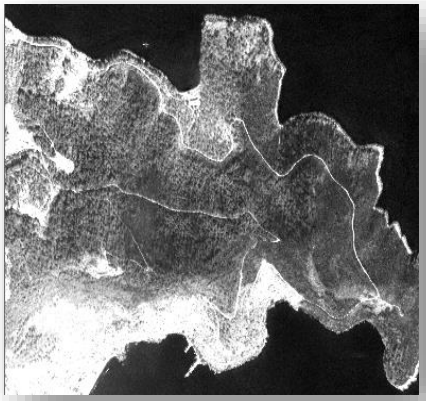
Burned area mapping & post-fire monitoring

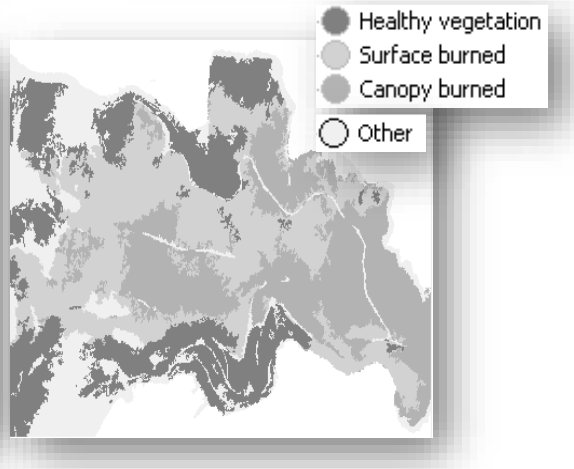




Gitas I. Z., Katagis T., and Toukiloglou P. 2012. Burned area mapping and post-fire monitoring of a Mediterranean forest using NDVI time-series of low resolution imagery and the BFAST method. Ambiência, Special Ed. Vol. 8, No 4, Pages 461-470.

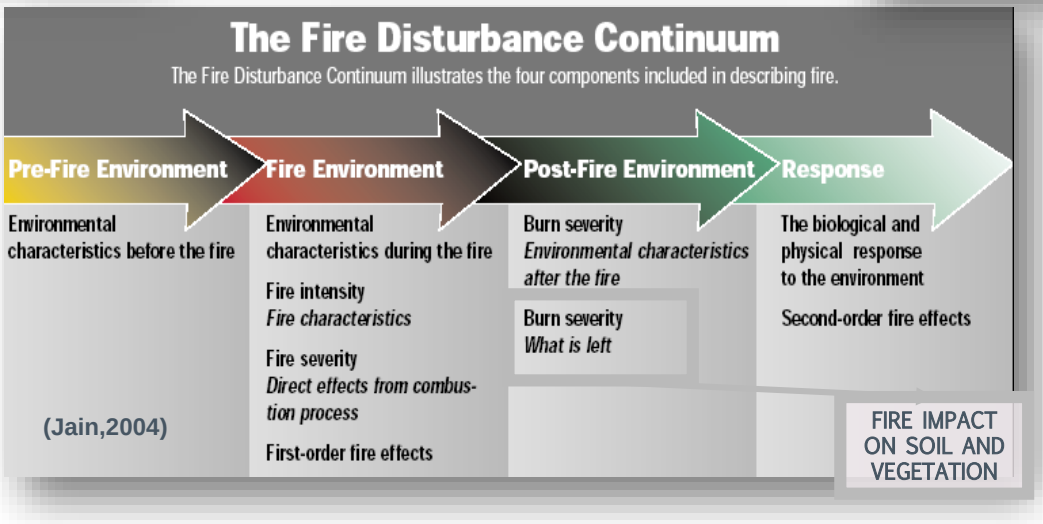
Fire type mapping using IKONOS imagery





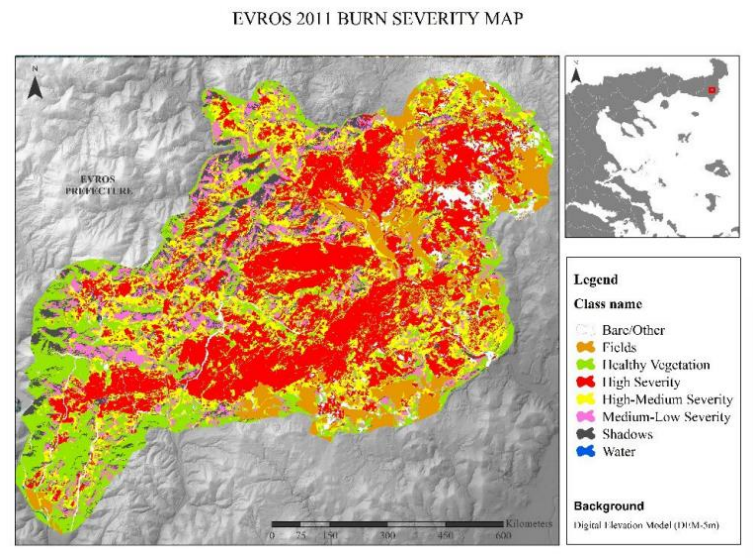
Mitri G.H. and Gitas I.Z. (2006) Fire type mapping using object-based classification of Ikonos imagery. International Journal of Wildland

Burn severity-Definition

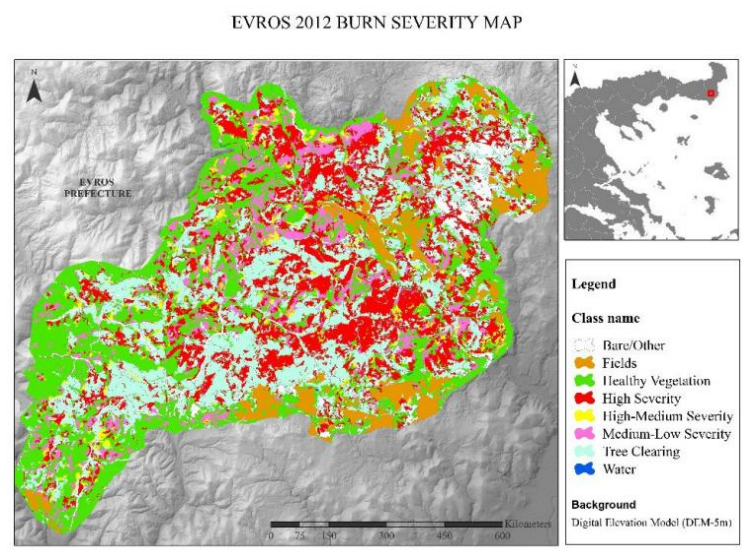


Burn severity is a descriptive term that integrates the physical, chemical and biological changes on a site as a result of fire disturbance

Burn severity estimation using GeoEye imagery



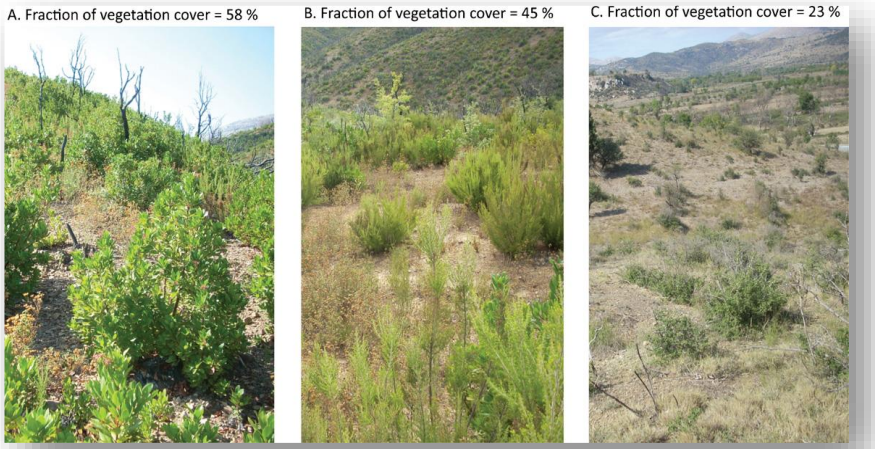
Burn severity map of the year 2011



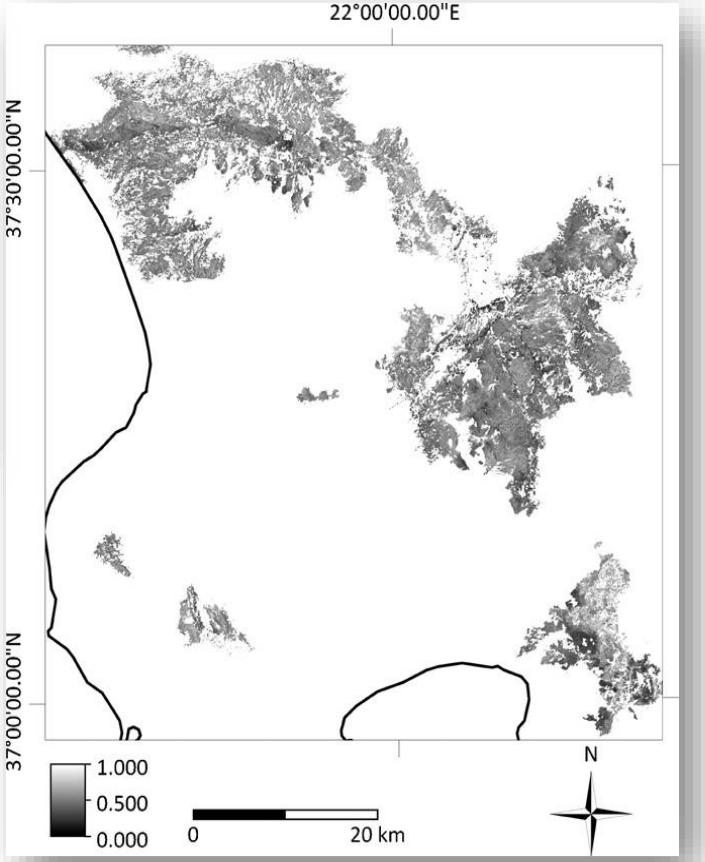
Burn severity map of the year 2012

Dragozi, E., et al. Burn severity estimation using GeoEye imagery, object-based image analysis (OBIA), and Composite Burn Index (CBI) measurements. Third International Conference on Remote Sensing and Geoinformation of the Environment. International Society for Optics

Post-fire vegetation monitoring using Landsat data and SMA

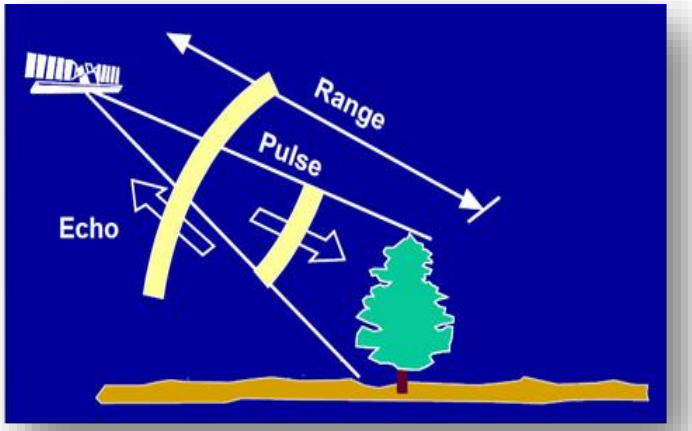


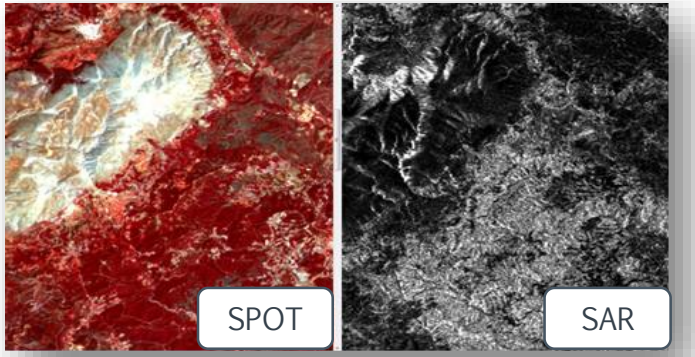
Generation of fractional vegetation cover maps with the use of Spectral Mixture Analysis (SMA) method.

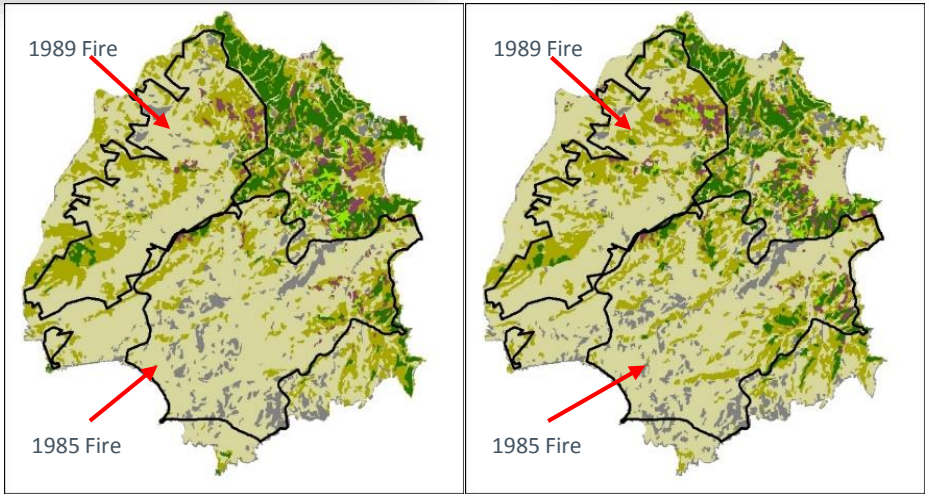


Veraverbeke et al. (2011) Spectral mixture analysis to assess post-fire vegetation regeneration using Landsat Thematic Mapper imagery: Accounting for soil brightness variation, International Journal of Applied Earth Observation and Geoinformation, Volume 14, Issue 1, 1-11.

Post-fire vegetation recovery monitoring



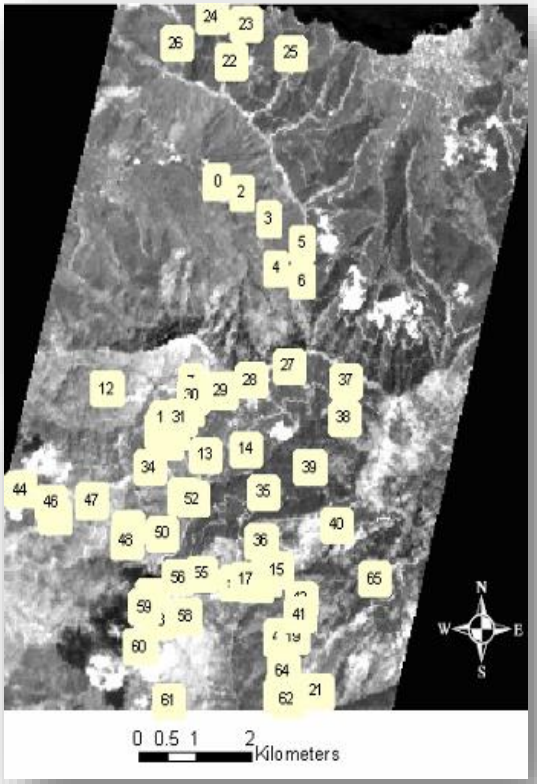


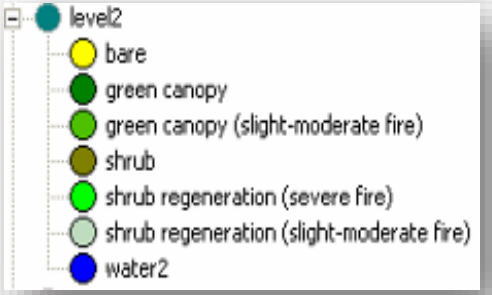


1995 Thasos Island 2006

Polychronaki, A., Gitas, I.Z., & Minchella, A. (2014) Monitoring post-fire vegetation recovery in the Mediterranean using SPOT and ERS imagery, International Journal of Wildland Fire, Volume 23, pp. 631-642

Vegetation regeneration monitoring – Thasos island





Mitri G.H. and Gitas I.Z. (2009) Mapping Postfire Vegetation Recovery Using EO-1 Hyperion Imagery, IEEE Transactions on Geoscience and

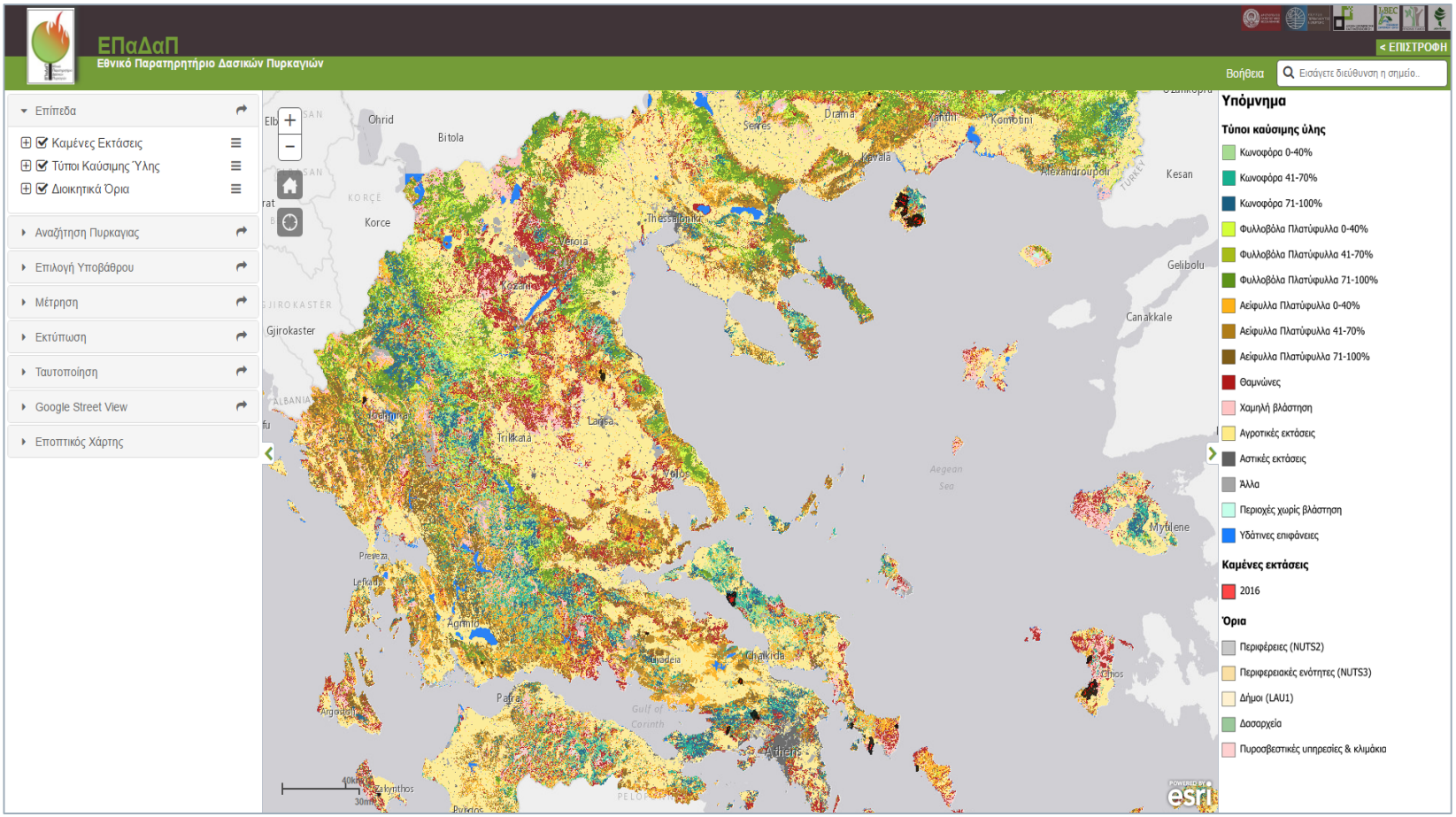
National & International Services

National Observatory of Forest Fires (NOFFi)

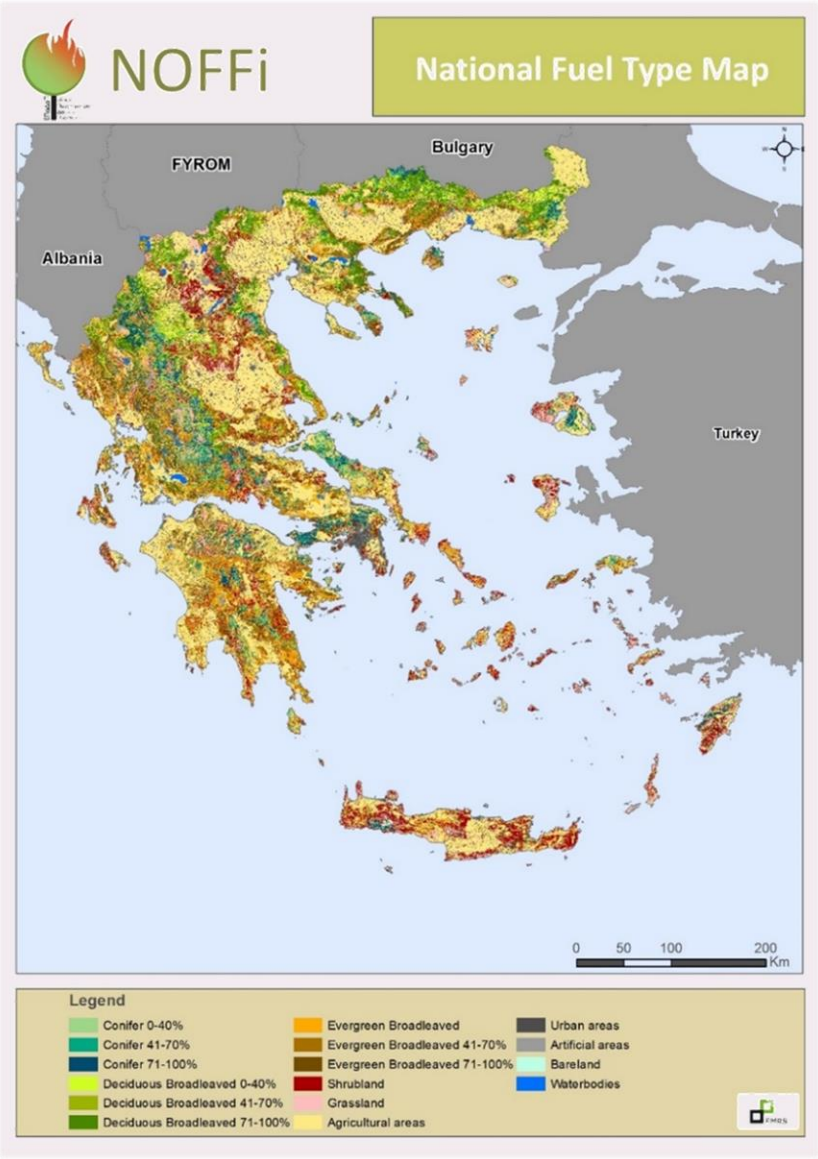
National Service

FMRS

NOFFi fuel mapping service

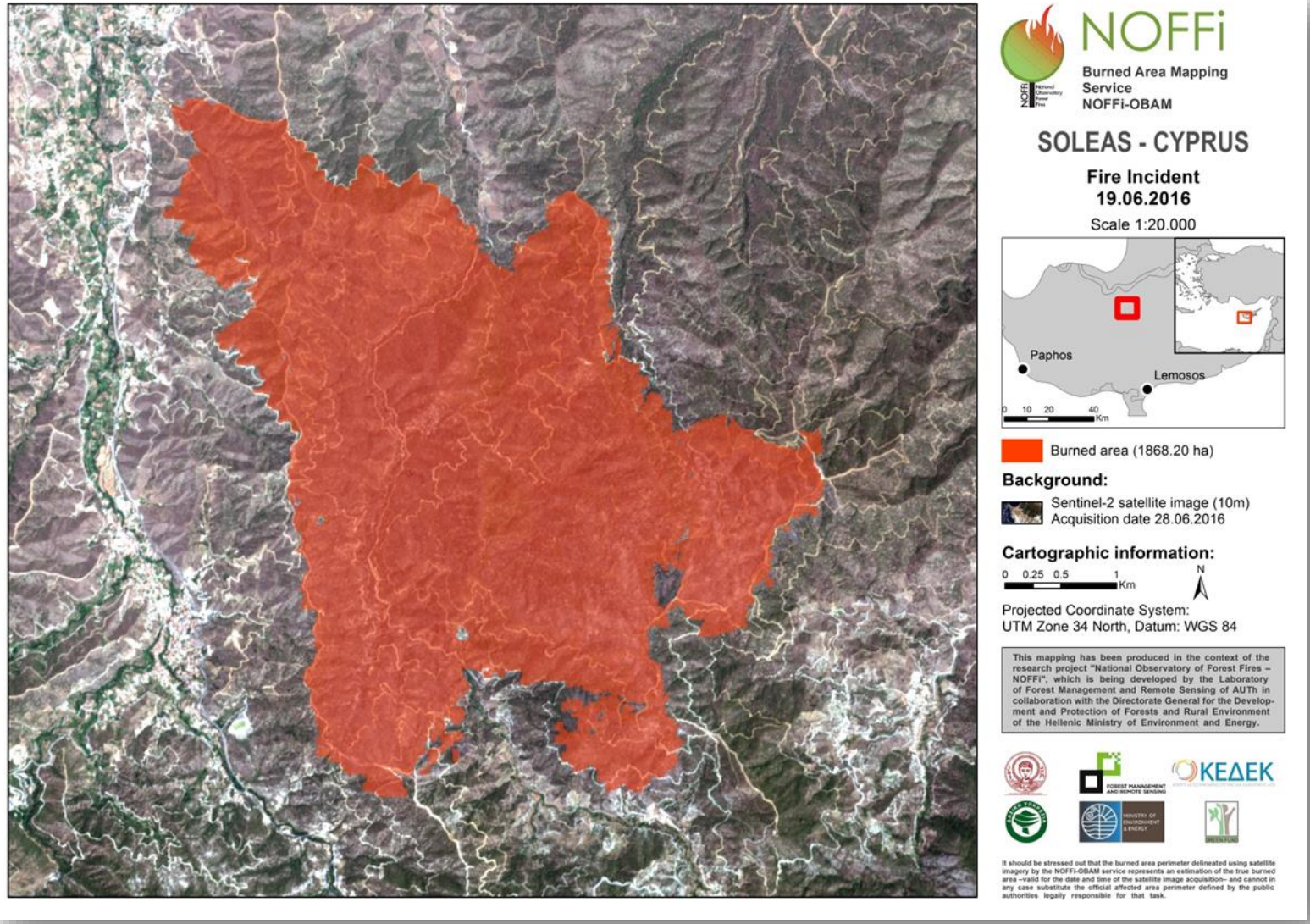


The NOFFi final fuel map



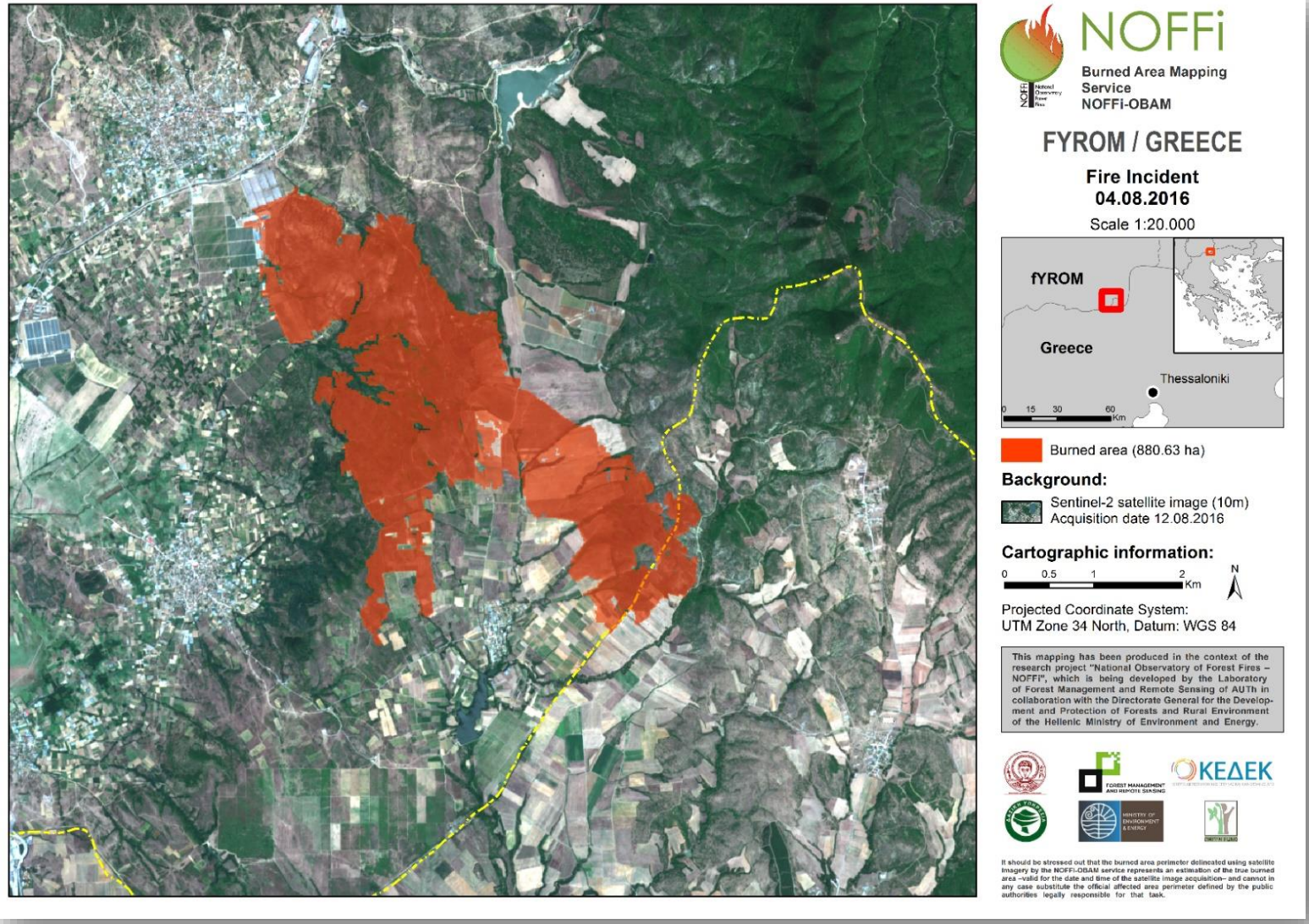
Burned area mapping service (NOFFi–OBAM)

- ✓ Examples



Burned area mapping service (NOFFi–OBAM)

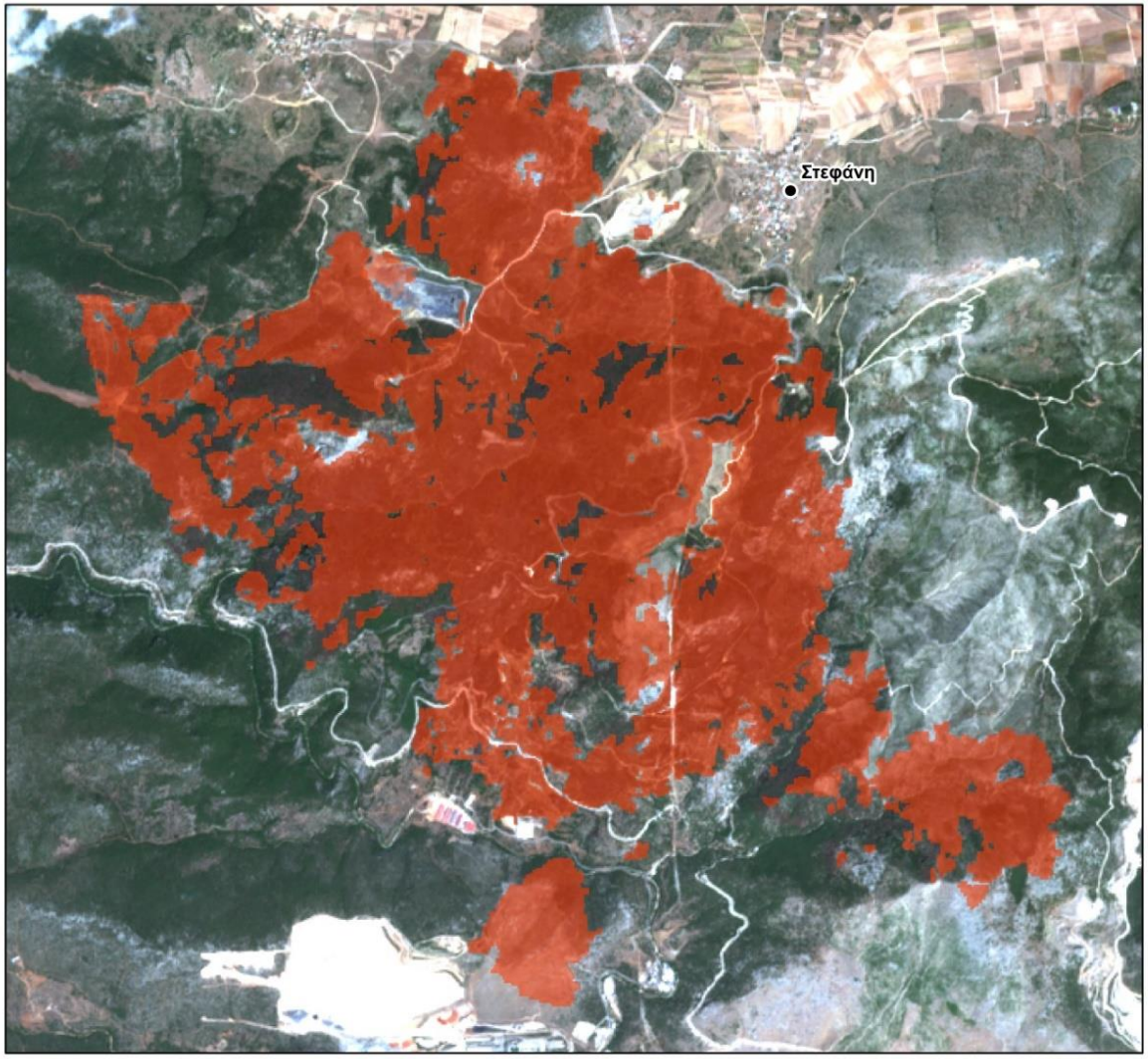
- ✓ Examples



National Service

Burned area mapping service (NOFFi–OBAM)

- ✓ Examples



ΕΠαΔαΠ

Υπηρεσία Χαρτογράφησης Καμένης Έκτασης NOFFi-OBAM

ΔΕΡΒΕΝΟΧΩΡΙΑ - ΒΟΙΩΤΙΑ

Πυρκαγιά 25.06.2016

Κλίμακα 1:20.000

Καμένη έκταση (1017.86 εκτάρια)

Υπόβαθρο:

Δορυφορική εικόνα Sentinel-2 (10μ)
Ημερομηνία λήψης 10.07.2016

Χαρτογραφική πληροφορία:

0 0.25 0.5 1 Χλμ

N

Προβολικό Σύστημα Συντεταγμένων:
UTM Zone 34 North, Datum: WGS 84

Η χαρτογράφηση εντάσσεται στο πλαίσιο του ερευνητικού προγράμματος "Εθνικό Παρατηρητήριο Δασικών Πυρκαγιών – ΕΠαΔαΠ", το οποίο υλοποιείται απο το εργαστήριο Δασικής Διαχειριστικής και Τηλεπισκόπησης του ΑΠΘ σε συνεργασία με την Γενική Διεύθυνση Ανάπτυξης και Προστασίας Δασών και Αγροπεριβάλλοντος του Υπουργείου Περιβάλλοντος και Ενέργειας

ΚΕΔΕΚ

Διευκρινίζεται ότι η περίμετρος της πληγείσας έκτασης, όπως έχει αποτυπωθεί μετά από ανάλυση δορυφορικών εικόνων, μέσω της υπηρεσίας NOFFi OBAM, απεικονίζει την κατάσταση κατά την ημέρα και ώρα λήψης των εικόνων από τους δορυφόρους και σε καμία περίπτωση δεν είναι δεσμευτική και δεν υποκαθιστά την οριοθέτηση πληγείσας έκτασης από τους αρμόδιους φορείς και υπηρεσίες με βάση το ισχύον θεσμικό πλαίσιο.

Burned area mapping service (NOFFi–OBAM)

- ✓ Examples

ΕΠαΔαΠ

Υπηρεσία Χαρτογράφησης Καμένης Έκτασης NOFFi-OBAM

ΦΑΡΑΚΛΑ - ΕΥΒΟΙΑ

Πυρκαγιά 30.07.2016

Κλίμακα 1:20.000

Καμένη έκταση (2565.02 εκτάρια)

Υπόβαθρο:

Δορυφορική εικόνα Sentinel-2 (10μ)
Ημερομηνία λήψης 02.08.2016

Χαρτογραφική πληροφορία:

0 0.5 1 2 Χλμ

N

Προβολικό Σύστημα Συντεταγμένων:
UTM Zone 34 North, Datum: WGS 84

Η χαρτογράφηση εντάσσεται στο πλαίσιο του ερευνητικού προγράμματος "Εθνικό Παρατηρητήριο Δασικών Πυρκαγιών – ΕΠαΔαΠ", το οποίο υλοποιείται απο το εργαστήριο Δασικής Διαχειριστικής και Τηλεπισκόπησης του ΑΠΘ σε συνεργασία με την Γενική Διεύθυνση Ανάπτυξης και Προστασίας Δασών και Αγροπεριβάλλοντος του Υπουργείου Περιβάλλοντος και Ενέργειας

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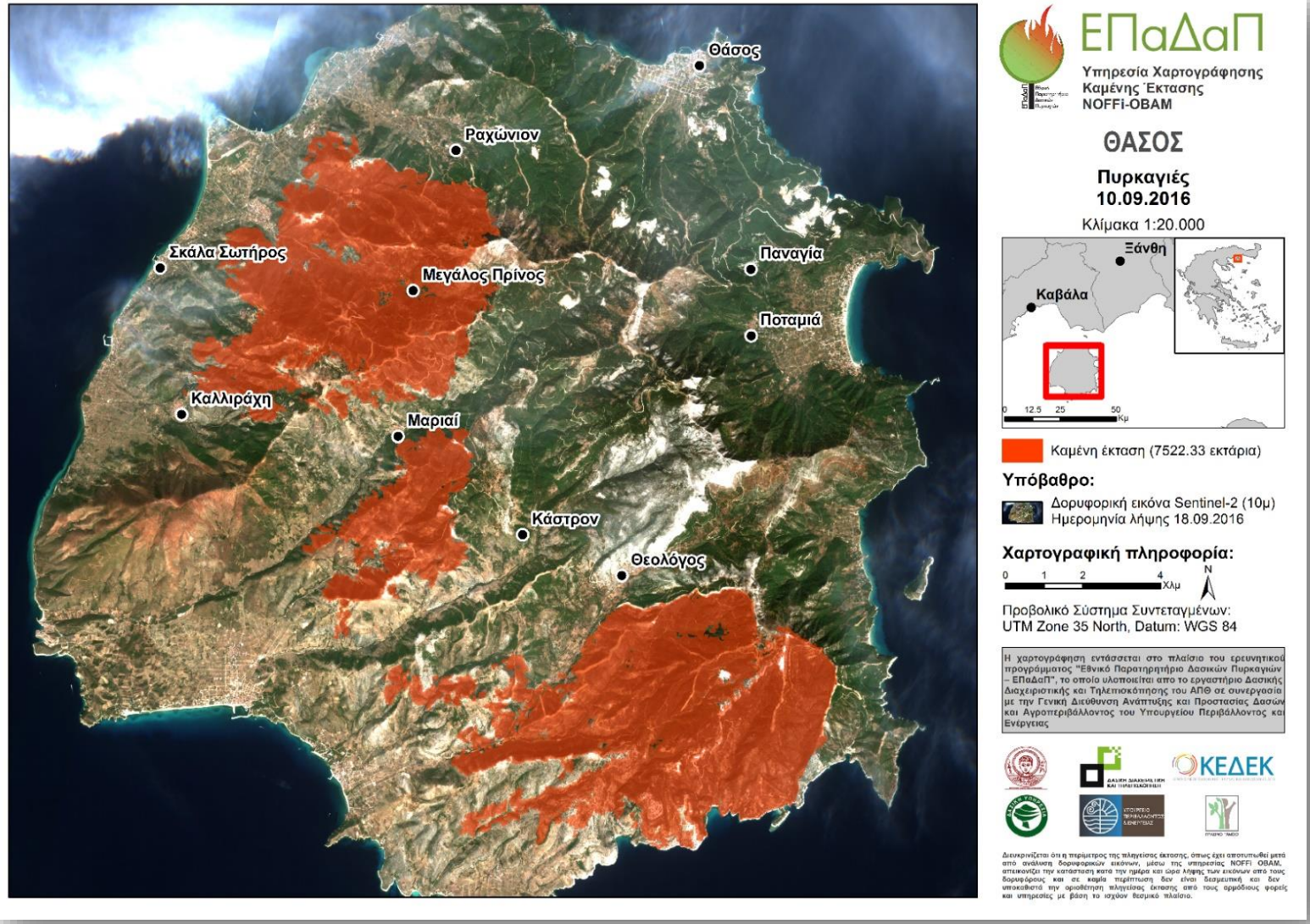
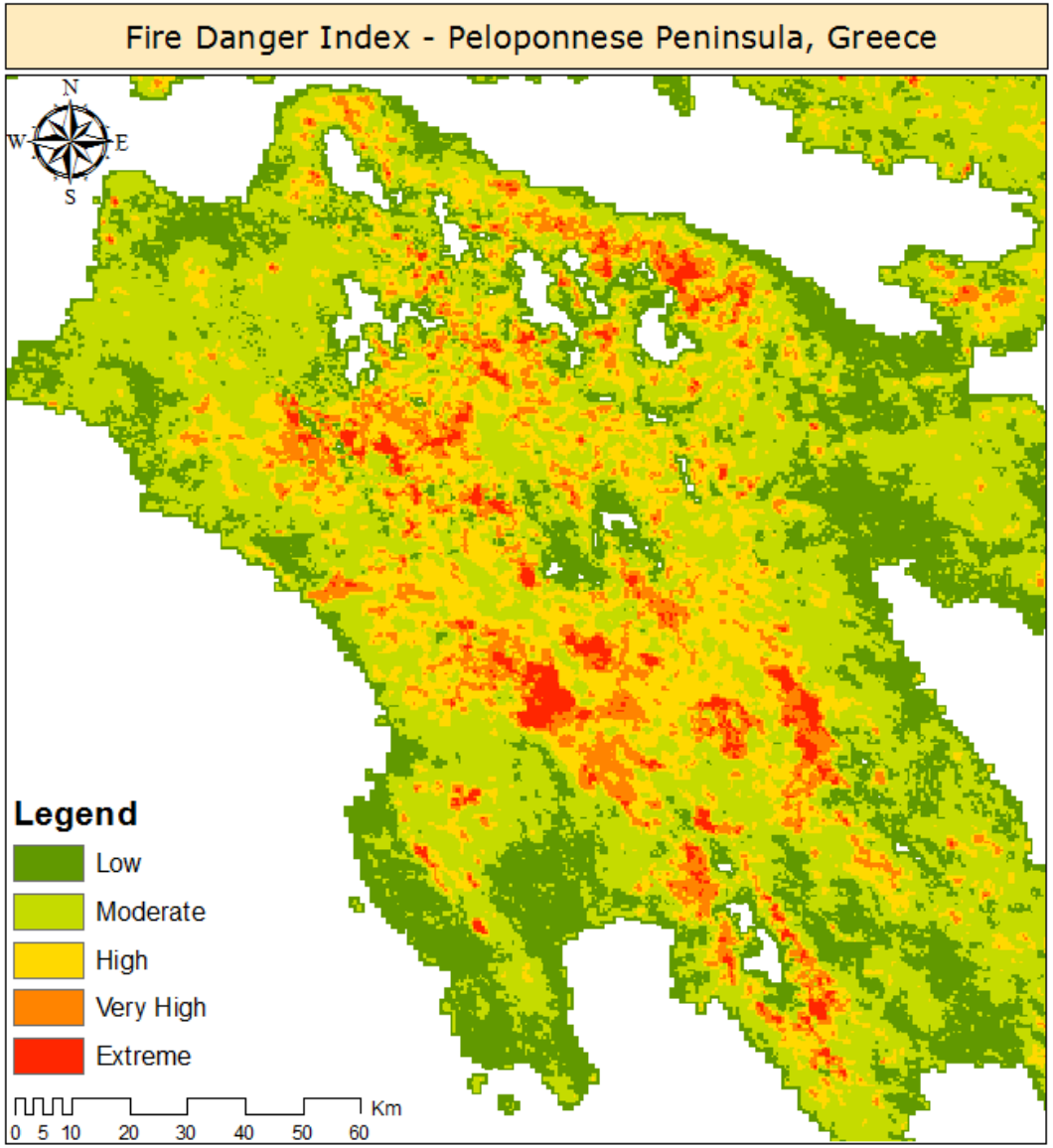
National Service

Burned area mapping service (NOFFi–OBAM)

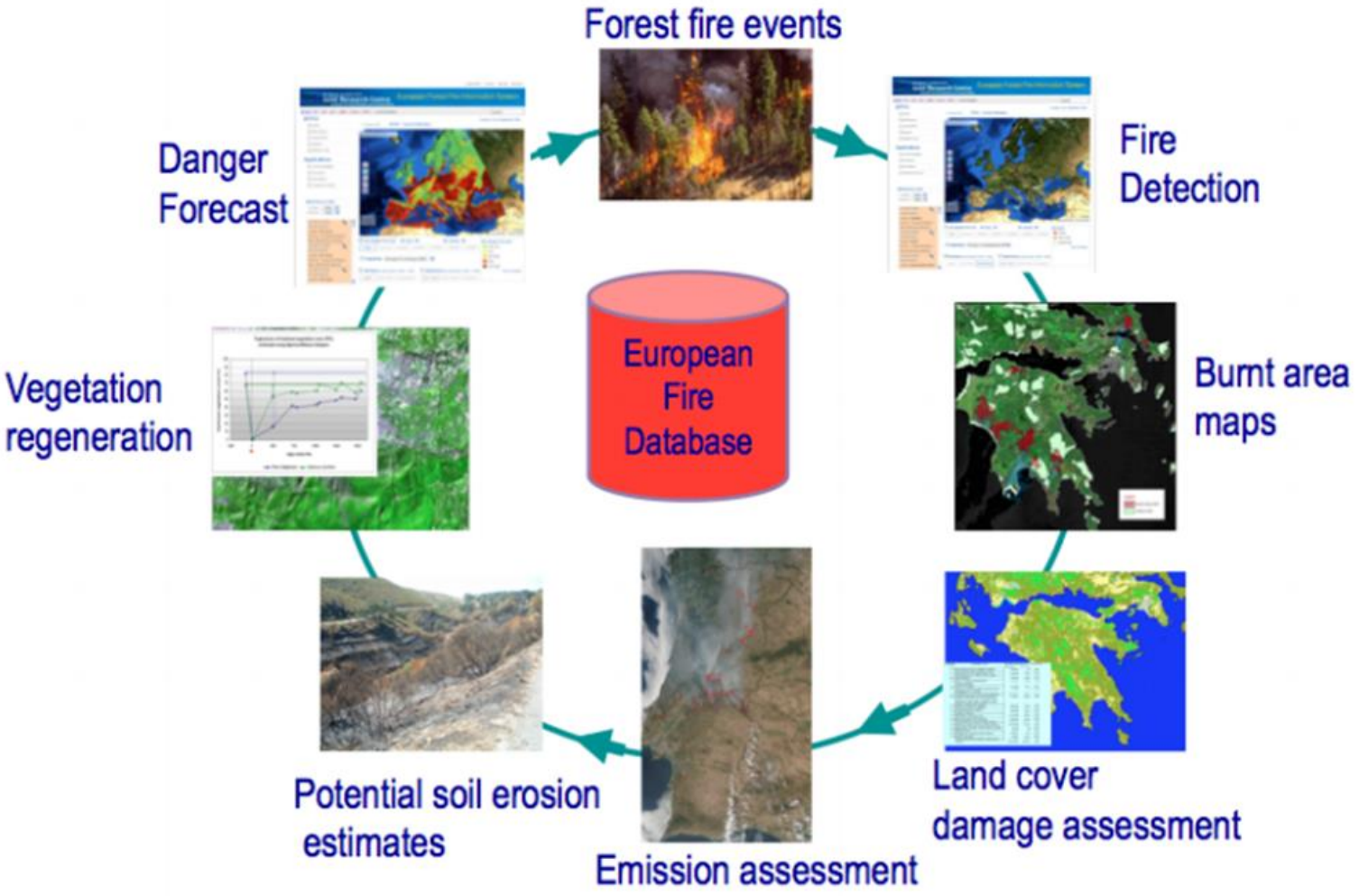
- ✓ Examples



The NOFFi fire danger index (example)

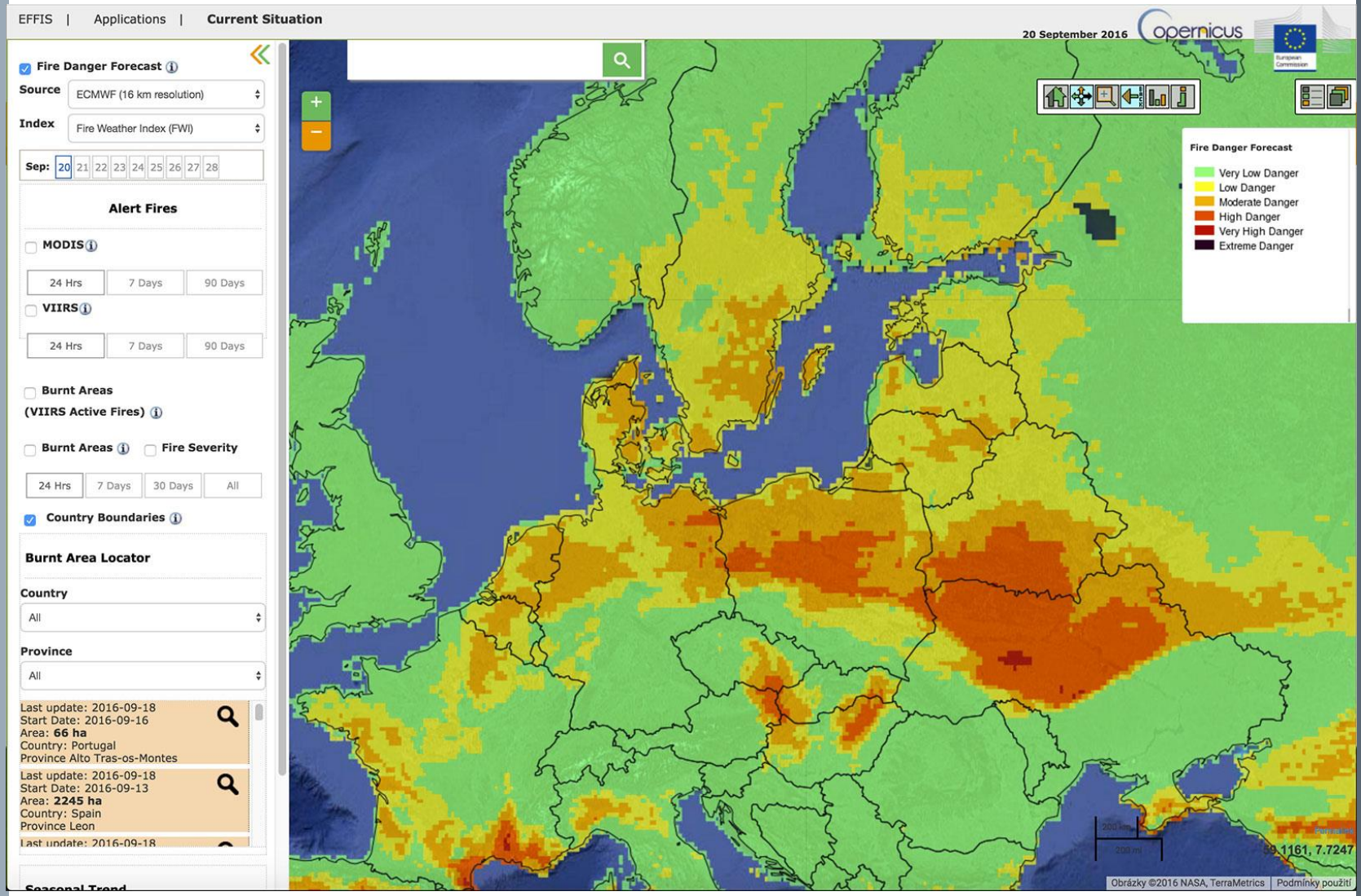


European Forest Fire Information System (EFFIS) - Overview



FMRS

European Forest Fire Information System (EFFIS)



International Service

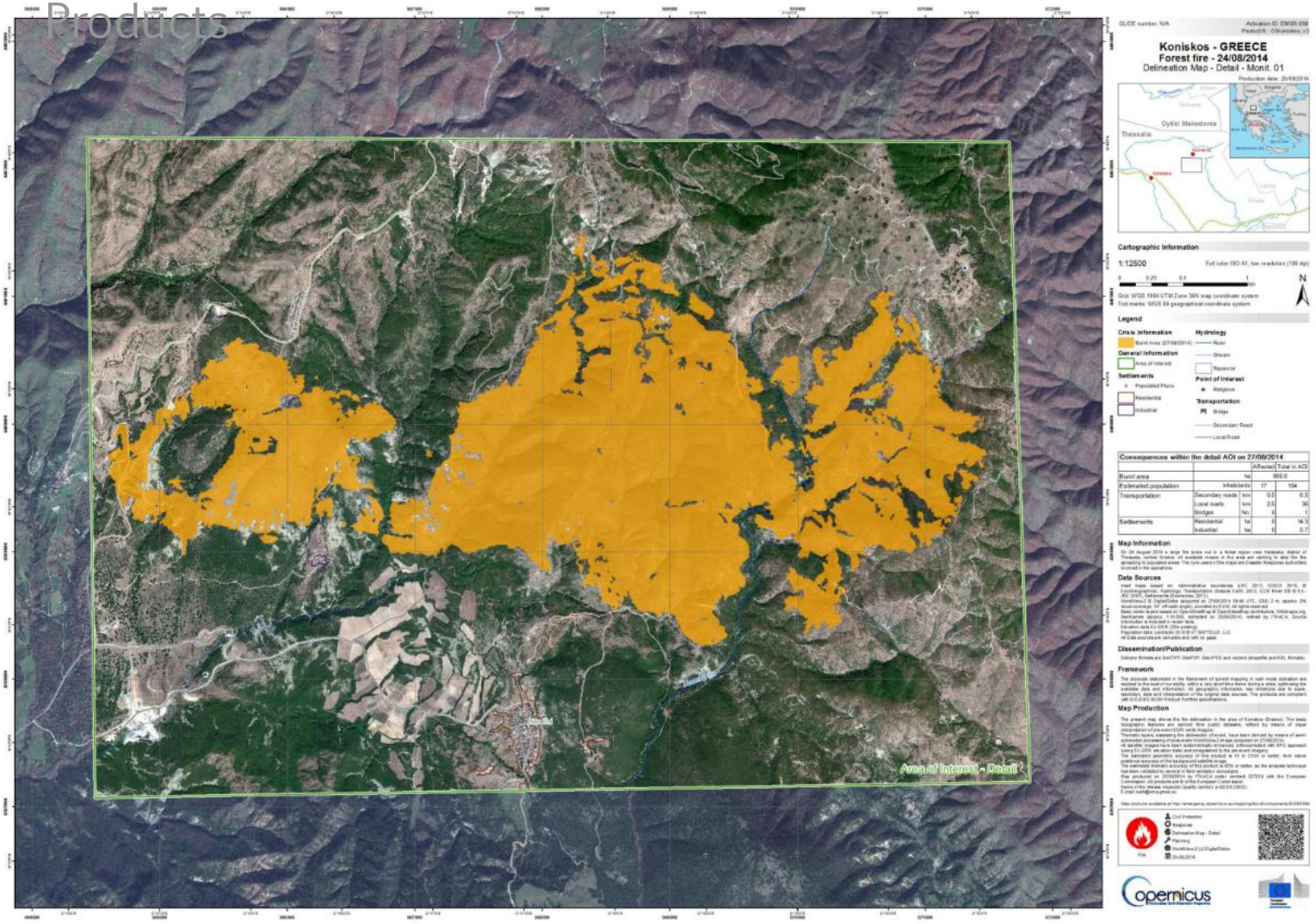
Copernicus Emergency Management Service - EMS

Latest Copernicus EMS - Mapping Activations

Act. Code	Title	Event Date	Type	Country/Terr.	Feed
EMSR203	Floods in Central US	2017-04-27	Flood (Riverin...	United States	
EMSR200	Tropical cyclone Debbie in Australia	2017-03-27	Wind storm	Australia	
EMSR199	Floods in Peru	2017-03-22	Flood	Peru	
EMSR198	EU RICHTER-CARAIBES 2017 Exercise	2017-03-21	Earthquake	Guadeloupe, Martinique	
EMSR197	Tropical Cyclone ENAWO-17 in Madagascar	2017-03-07	Wind storm	Madagascar	

Copernicus Emergency Management Service - EMS

- ✓Example of EMS Rapid Mapping Products



11th EARSeL Forest Fires SIG Workshop

New Trends in Forest Fire Research Incorporating Big Data and Climate Change Modeling

25-27 SEPTEMBER 2017, CHANIA, GREECE

Important dates

Submission deadlines extended!

1-page abstract submission:
28th May 2017
Notification of acceptance:
19th June 2017
Full paper submission:
30th July 2017
Early bird registration:
30th August 2017

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Thank you very much for your attention