Use of space technologies to forecast and monitor forest fires in Greece
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http://beyond-eocenter.eu
Click the FireHUB Button to visit the 24/7 Real-Time Fire Monitoring service

Click the FireHUB Button to visit the Diachronic Burnt Scar Mapping

Click the FireHUB Button to visit the Forest Fire Information System in Europe, N. Africa, Middle East, Balkans, Black Sea

Click the FireHUB Button to visit the Smoke Dispersion Service
24/7 Real-Time Fire Monitoring service

- Active fire detection by **MSG SEVIRI** Instrument (IR 3.9, IR 10.8)
- 3 Classification steps:
  1. EUMETSAT Fire mapping algorithm (**FIR**) based on fixed thresholding approach, applied on the spectral bands IR 3.9 and IR 10.8 -> dynamic
  2. Create and integrate classification evidence through geospatial ontology schemes and reasoning queries, accounting for the a) thematic consistency by eliminating false alarms and b) time persistence of the fire observations
  3. Downscaling the first classification output and calculate the fire occurrence probability in sub-areas of **500m x 500m** wide, inside the initial observation area of 3.5km x 3.5km
24/7 Real-Time Fire Monitoring service

- The downscaling process accounts for the real meteorological, physical / ecological, and morphological conditions in the affected area such as:
  a) Wind conditions (speed/direction),
  b) Fuel types and fuel type’s proneness to fire,
  c) Altitudinal zone,
  d) Slope and Aspect elements of each of the 500mx500m area.
24/7 Real-Time Fire Monitoring service

- FireHub continuously ingesting real time satellite acquisitions every 5 minutes
This screen shows the first alert that was sent by the FireHub system of BEYOND at 17:05 local time, that is 5-7 minutes later than the official start of the fire (between 16:55-17:00). The FireHub web site is open and accessible at that time by all and the authorities of Fire Brigades at http://195.251.203.238/seviri/.

The system provided the starting area (red rectangle - 500mx500m wide) at 17:05 local time and was updating the situational picture every five minutes. The more reddish the cell the higher the active fire occurrence in it. The masked out area is what FireHub considers as urban. FireHub does not update the fire occurrence picture inside the urban zones. The urban area fringe is also apparent by looking at the background Google Earth map.
• 25-30% of the detected fires are reported 10 -15 minutes earlier than Fire Brigades logs
• 60% of the detected fires, are reported in the first ~15 minutes after the ignition timestamp reported in the Fire Brigade logs
• All the fires larger than the 112ha are completely detected without any omission
• Smaller fires, that are in the range of [4.7ha - 112 ha] are 50% detected
• The smallest detected fire has been of the order of 4.7 ha
• The omitted fire detections, are summing up to the 5,8% of the total Burned Area.
• Omissions are caused mainly due to a) cloud cover, b) fire intensity (e.g. small fires – small burned areas), c) area topography, and d) fuel characteristics (e.g. less vegetative areas, pasture lands, sparse vegetation resulting in low fire intensities)
• The 82-85% of the 500mx500m cells which are assigned a high fire occurrence probability that is in the range of [6, 10], are located in the Burned Area Polygons

24/7 Real-Time Fire Monitoring service
Diachronic Burnt Scar Mapping

1984-2020, Greece, ~1100 satellite images LANDSAT TM, SPOT, IKONOS, SENTINEL-2
Diachronic Burnt Scar Mapping

The Burn Scar Mapping (BSM) data layers depict:

a. The burned areas (fire polygons) per year. The year of interest is selected using the sliding selector function.
b. Areas which have been burned more times through the studied years. Different colors are used to depict the number of times a fire has occurred in the same area (Fire Frequency Layer).
c. All fire polygons mapped through the years over Greece - Diachronic BSM Layer.

Auxiliary Layers: The auxiliary information layers, namely

a. The CORINE Land Cover
b. A heatmap layer, which at the same time thematically depicts the size, the location and the density of the fire events per year.
c. A “mask out” layer depicting areas that were not studied due to the omission of satellite data in the USGS archives.
A new service has been developed, known as **Forest Fire Information System** in Europe, N. Africa, Middle East, Balkans, Black Sea and provides daily near real time information on active fires and burned areas, as well as statistics on the affected areas per time period and country over the large area covering Europe, North Africa, Middle East, Balkans, and Black Sea.

http://ffis.beyond-eocenter.eu/

MODIS, VIIRS

Sentinel-2

Processing in Real Time of SUOMI-NPP, NOAA-20, MODIS, and S2 data
Forest Fire Information System

http://ffis.beyond-eocenter.eu/
3 steps prototype Algorithm for Burnt Scar Mapping (BSM)

- Basic preprocess of the acquired images
- Generation of cloud and sea masks and enhanced histogram matching of pre and post fire images.
- Temporal changes detection by the analysis of numerous diverse spectral features for base and reference image.
- Custom spatial database post-processing chain stores, attributes, validates and keeps track of the BSM polygons that are about to be published in the WebGIS platform.
**First fire detection in 10’**

Detection of active sources of fire from FireHUB

**Day #1**
- NPP-VIIRS
- MR=375m
- 20170817 11:14

**Day #2**
- MODIS-Terra
- MR=250m
- 20170818_1055

**Day #3**
- NPP-VIIRS
- MR=375m
- 20170819_1057

Detection - Fire Monitoring - Resolution 500 m/5 minute

Rapid daily Mapping at Medium Resolution - 2-3 times/day

Rapid Mapping at High Resolution/ 5 days

**KALAMOS**
- 13/08/2017
- 2953 hectares

**Day #4 Sentinel-2 HR-10 m**

Burned area extent
- Medium resolution (250m)

Burned area extent
- High resolution (10m)

**T0**
- 10 minutes

**T1**
- Day
- Medium resolution (250m)

**T2**
- Day
- Medium resolution (375m)

**T3**
- Day
- Burned area extent
- Medium resolution (375m)

**T4**
- Day
- Burned area extent
- Medium resolution (375m)
Forest Fire Prediction System

- Theoretical models (i.e. FWI) are entirely based on equations that describe the physics of the related to the fire ignition physical phenomena.

- Machine Learning algorithms are designed to automatically formulate the complex mathematical relations between the input parameters.

![Diagram of Forest Fire Prediction System with nodes labeled as: NOA – Beyond FireHub (BSM), FFIS, NOA – Beyond FireHub Active Fires, NASA FIRMS, and a Fire Inventory 2010-2018 at 500m grid resolution for ML training.](Image)
Forest Fire Prediction System

- MODIS ndvi, evi, LST
- Temperature
- Wind
- Precipitation
- Topography
- CORINE

Fire/ no-fire repository

Datacube

Feature extraction
- Daily max/dominant wind speed/direction
- Daily max/min/mean temperature
- 7 day accumulated precipitation
- NDVI, EVI, LST
- CORINE, DEM, aspect, slope, curvature

ML algorithms

Time series analysis
Forest Fire Prediction for 03/07/2021

Cephalonia island

Fire ignition

UN-SPIDER
Fire in Cephalonia – 03/07/2021

24/7 Real-Time Fire Monitoring service
Fire in Cephalonia – 03/07/2021

Forest Fire Information System – Active Fires
Fire in Cephalonia – 03/07/2021

Forest Fire Information System – VIIRS Burned Scar Map
Forest Fire Information System – Sentinel-2 burned Scar Map

Fire in Cephalonia – 03/07/2021

Map showing burned areas in Cephalonia on 03/07/2021.
Ημερήσιος χάρτης πρόβλεψης κινδύνου πυρκαγιάς - 03/08/2021

Πληροφορίες χάρτη
Ο χάρτης είχε δημιουργηθεί από το Κέντρο Παρατήρησης της Ελλάδας και Δυτικής Τηλεπικοινωνίας Beyond (www.beyond-eocenter.eu) του Εθνικού Αστεροσκοπείου Αθηνών. Βασίζεται σε συνδυασμό τεχνολογιών και μοντέλων Μηχανικής Μάθησης, που αξιοποιούν γνώση αναφορικά με την συμπεριφορά της πυρκαγιάς στην Ελλάδα τις τελευταίες δεκαετίες, προγνώσεις και και καθοδηγούν την επόμενη ημέρα, καθώς και δυναμική εκτίμηση περιβαλλοντικών παραμέτρων. Ο χάρτης απεικονίζει τον κίνδυνο έναρξης πυρκαγιάς στην χωρική ανάλυση των 500 μέτρων.

Υπόμνημα

Fire in Acharnes

Fire events recorded by Fire Brigade log files on 03/08/2021

<table>
<thead>
<tr>
<th>Ενισχύσεις ρίσκου</th>
<th>Αποκόρυφα</th>
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<tbody>
<tr>
<td>No risk</td>
<td></td>
</tr>
<tr>
<td>Low risk</td>
<td></td>
</tr>
<tr>
<td>Medium risk</td>
<td></td>
</tr>
<tr>
<td>High risk</td>
<td></td>
</tr>
<tr>
<td>Very high risk</td>
<td></td>
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</tbody>
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Mercator, ESPG:3857
Fire in Acharnes – 03/08/2021

24/7 Real-Time Fire Monitoring service

<table>
<thead>
<tr>
<th>ID</th>
<th>AREA (ha)</th>
<th>Sensor</th>
<th>Municipality</th>
<th>Beginning Time</th>
<th>End Time</th>
<th>Duration</th>
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<tbody>
<tr>
<td>S7007</td>
<td>78.92</td>
<td>SEVRI</td>
<td>Πύλος-Μαχαίρι</td>
<td>2021-08-03 10:10</td>
<td>2021-08-03 19:30</td>
<td>9:42</td>
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<tr>
<td>S7010</td>
<td>23.75</td>
<td>SEVRI</td>
<td>Δ. Αργυρίων</td>
<td>2021-08-03 10:35</td>
<td>2021-08-04 01:45</td>
<td>15:25</td>
</tr>
</tbody>
</table>
Fire in Acharnes – 03/08/2021

Forest Fire Information System – Active Fires
Fire in Acharnes – 03/08/2021

Forest Fire Information System – VIIRS Burned Scar Map
Fire in Acharnes – 03/08/2021

Forest Fire Information System – Burned Scar Map – Sentinel-2
Ημερήσιος χάρτης πρόβλεψης κίνδυνου πυρκαγιάς - 03/08/2021
Ημερομηνία παραγωγής 02/08/2021

Πληροφορίες χάρτη
Ο χάρτης έχει δημιουργηθεί από το Κέντρο Παρατήρησης της Εθ. Διαιτησίας και Θερμοκηπικής Διεύθυνσης Beyond (www.beyond-eocenter.eu) του Εθνικού Αστεροσκοπείου Αθηνών. Βασίζεται σε συνδυασμό τεχνολογιών και μοντέλων Μηχανικής Μάθησης, που αξιοποιούν γνώση αναφορικά με την συμπεριφορά της πυρκαγιάς στην Ελλάδα τις τελευταίες δεκαετίες, προγνώσεις και δικτύωση της ελληνικής χώρας, καθώς και δυναμική εκτίμηση των περιβαλλοντικών παραμέτρων. Ο χάρτης απεικονίζει τον κίνδυνο ενάρξεως πυρκαγιάς στην χωρική ανάλυση των 500 μέτρων.

Υπόμνημα
Fire events recorded by Fire Brigade log files on 03/08/2021

Ενδείκνυση ρίσκου:
- No risk
- Low risk
- Medium risk
- High risk
- Very high risk
Mercator, ESPG:3857

Fire in Evoia
Fire risk for 03/08/2021
Production date: 02/08/2021
Fire in Evia – 03/08/2021

24/7 Real-Time Fire Monitoring service
Fire in Evoia – 03/08/2021

Forest Fire Information System – Active Fires
Fire in Evoia – 03/08/2021

Forest Fire Information System – VIIRS Burned Scar Map
Fire in Evoia – 03/08/2021

Forest Fire Information System – Burned Scar Map – Sentinel-2
Thank you!