



UNITED NATIONS
Office for Outer Space Affairs

UN-SPIDER



UN-SPIDER / ZFL Regional Virtual Expert Meeting for Southern Africa "Space-based Solutions for Disaster Risk Management and Emergency Response" 13-15 July 2021

The FloodHub and FireHub systems for early warning and crisis management

Haris Kontoes, Alexia Tsouni, Stella Girtsou

National Observatory of Athens – IAASARS – BEYOND Center of Excellence

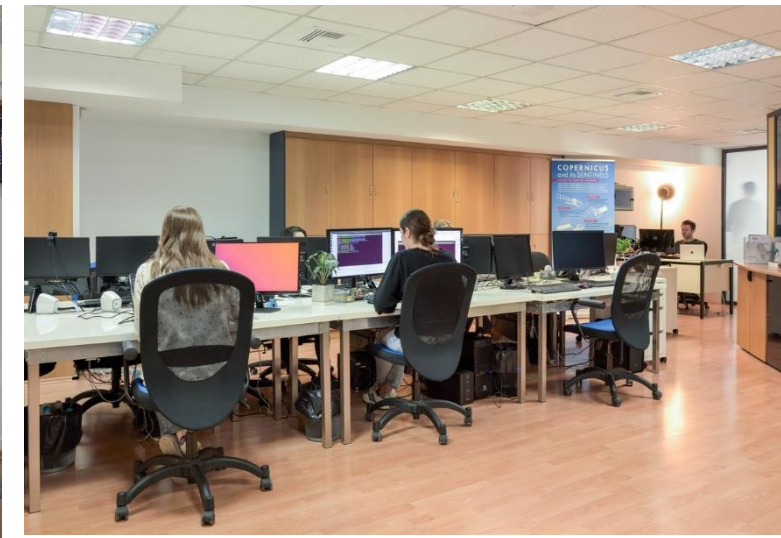


BEYOND
Centre of EO Research & Satellite Remote Sensing

<http://beyond-eocenter.eu>



The BEYOND Center of EO Research & Satellite Remote Sensing



The services of the BEYOND Center

FireHUB

**24/7 Real-Time Forest Fire Monitoring service - Diachronic Burnt Scar Mapping (> 35 years)
- Fire Risk assessment (<http://beyond-eocenter.eu/index.php/web-services/firehub>)**

DustHUB

**Detection and diffusion of desert dust, dust, volcanic ash and toxic gases
(<http://beyond-eocenter.eu/index.php/web-services/dusthub>)**

FloodHUB

**Rapid Flood Mapping - Diachronic Flood Mapping - Flood monitoring and early warning
(<http://beyond-eocenter.eu/index.php/web-services/floodhub>)**

GeoHUB

**Early warning and monitoring of geophysical disasters (earthquakes, landslides, volcanic eruptions)
- Ground Displacement Mapping (<http://beyond-eocenter.eu/index.php/web-services/geohub>)**

SolarHUB

**Solar Atlas Service - Solar Energy Nowcasting Service - Short-term Forecasting System
(<http://beyond-eocenter.eu/index.php/web-services/solarhub>)**

ClimaHUB

**Data Extraction Application for Regional Climate
(<http://beyond-eocenter.eu/index.php/web-services/climahub>)**

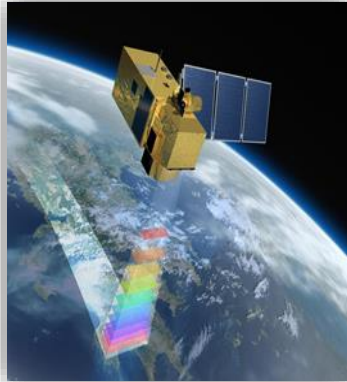
EYWA

**Early Warning System for Mosquito Borne Diseases
(<http://beyond-eocenter.eu/index.php/web-services/eywa>)**

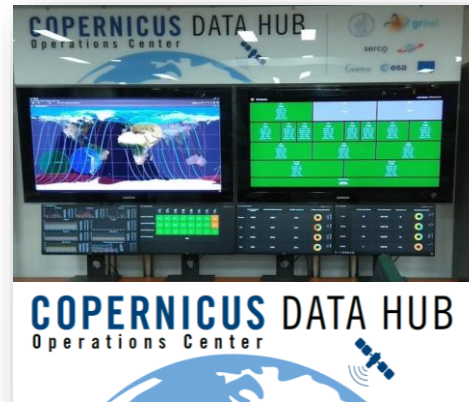
COVID - 19

**Global spread monitoring of the COVID-19 pandemic
(<http://beyond-eocenter.eu/index.php/web-services/covid-19>)**

The monitoring systems of the BEYOND Center



Satellites Polar Orbit
X-/L-band Station
Sentinel Mirror Site



Satellites
Geostationary
Orbit
MSG SEVIRI



Ελληνικό Mirror Site
(Copernicus satellite
missions)

<http://beyond-eocenter.eu/index.php/web-services/hellenic-mirror-site>)



Sentinels GreekHUB

(<http://beyond-eocenter.eu/index.php/web-services/sentinels-greekhub>)



Manned &
Unmanned
Aerial
Vehicles



In-situ networks and
crowdsourcing



Διανέμει 55 TB/80K εικόνες δορυφόρων /Ημέρα
Λειτουργεί Αδιάλειπτα 24/7
Ταχύτητα Δικτύου GEANT 350-500 Mbps

Flood was the most frequent type of disaster in 2020

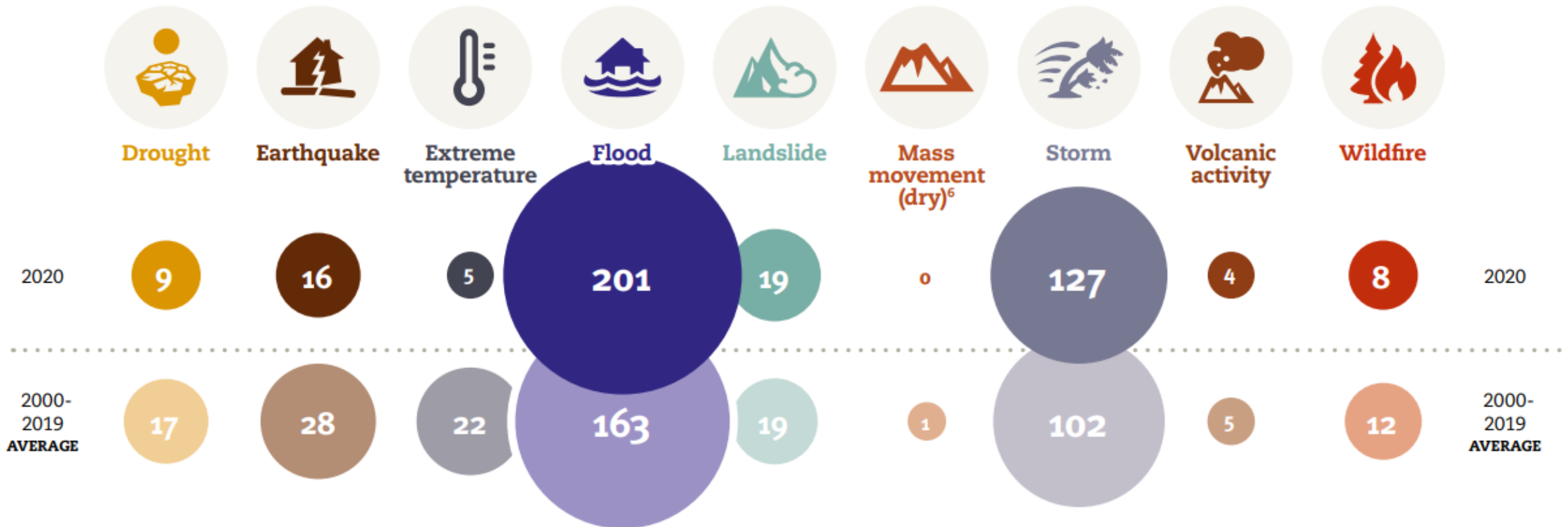
Figure 2

Occurrence by disaster type: 2020 compared to 2000-2019 annual average

368
2000 to 2019

<

389
in 2020



Flood was the only type of disaster increasingly deadly in 2020

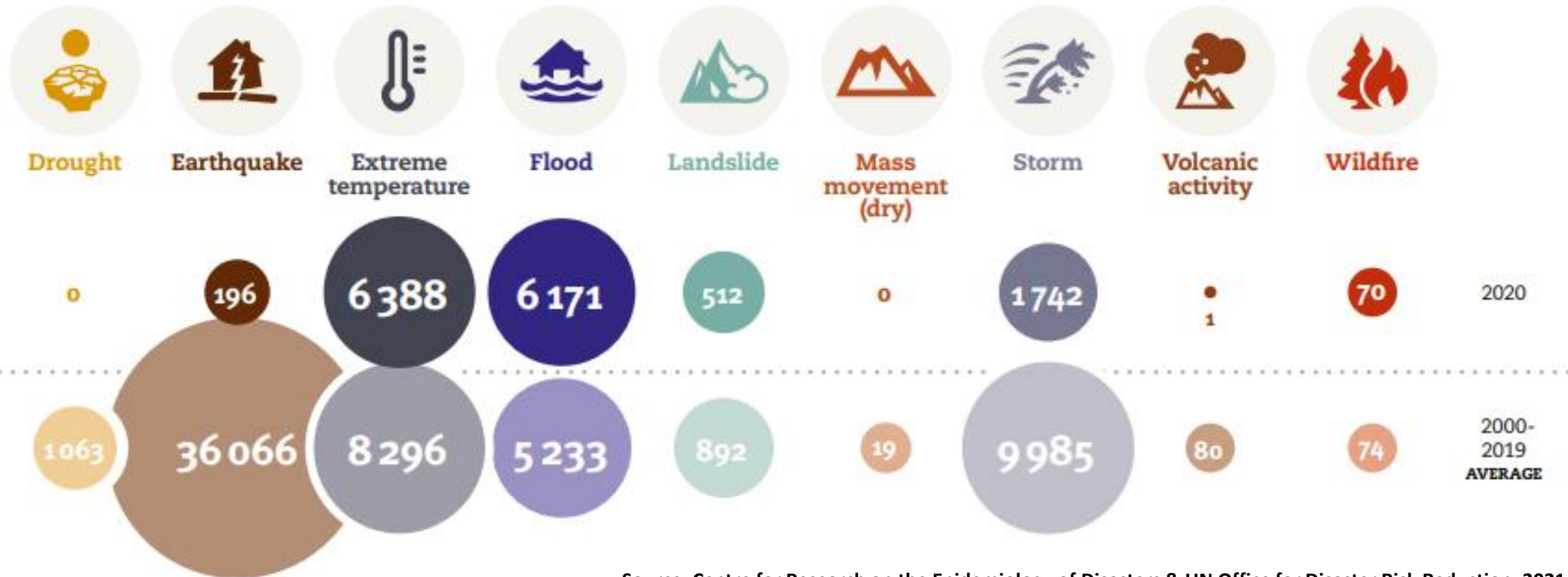
Figure 4

Number of deaths by disaster type: 2020 compared to 2000-2019 annual average

61,709
2000 to 2019

>

15,080
in 2020



Mandra flood 2017: Setup of an integrated web GIS platform



Analysis of the flood in west Attica on 15/11/2017

Ποταμός και ηγ. Παράρτημα 1, 2, 3, 4 & 5 Δλ. Απορρόσες: For the Instructions and the References 1, 2, 3, 4 & 5 see Details

Υποστήρικτα Απορρόσες

Κρίσιμα σημεία - Critical points

- Ασυνάρμοστη διατομή - Inadequacy of cross section
- Επαρκής διατομή - Adequacy of cross section

Τοποθεσίες - Locations



Φωτογραφίες - Photos

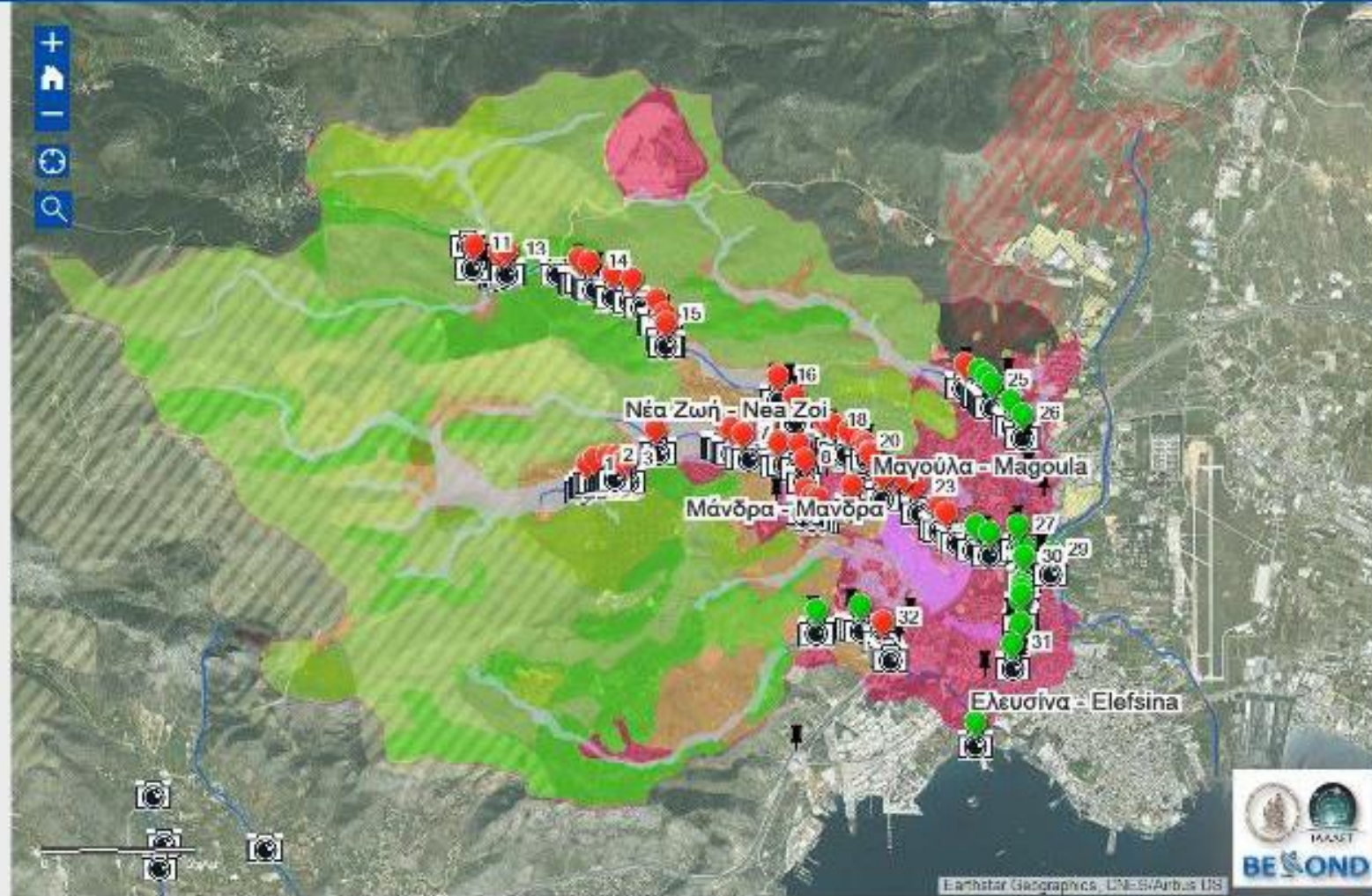


Ευκατασκευασμένο υδρολογικό δίκτυο - Updated hydrographic network (1)

- Ακάλυπτα τμήματα ποταμών - Uncovered parts of watercourses
- Καλυμμένα τμήματα ποταμών - Covered parts of watercourses
- Πρωτότυπη φυσική ροή ποταμών - Original natural flow of watercourses

Χαρτογραφημένο έδαφος πλημμύρας - Mapped flood extent (2)

- Προσимуνημένη έκταση πλημμύρας - Simulated flood extent (3)
- Αστική επέκταση - Urban expansion

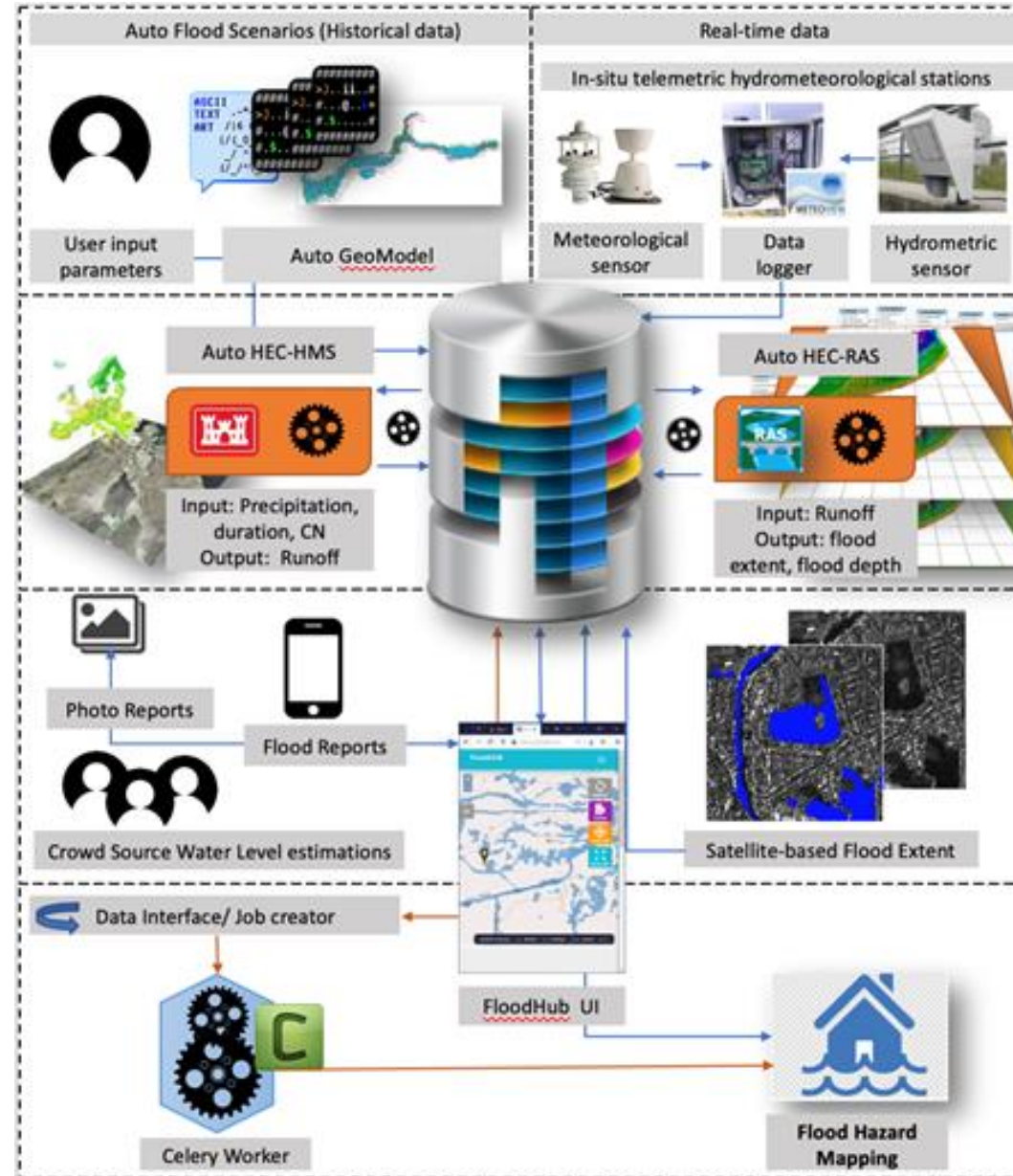


Mandra 2020:

Architecture of the FloodHUB system

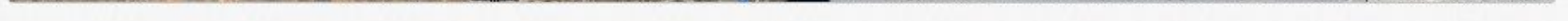
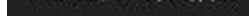
An integrated near-real-time flood monitoring system:

- based on modeling, multi-source EO and crowdsourced data
- with a fully scalable and transferable modular architecture
- delivering a reliable operational awareness picture of the crisis every 5-15 minutes to all the relevant authorities



Near-real-time ingestion and assimilation of:

- hydrometeorological parameters measured at 3 in-situ telemetric stations (installed at 3 critical locations)
- satellite data (e.g. from high resolution Sentinels collected from the Hellenic Mirror Site)
- crowdsourced data (collected via the dedicated crowdsourcing platform).



Matsufuku / Hatanaka / Anagnostou

Web platform of the 3 telemetric hydrometeorological stations

ΜΕΤΕΟVIEW₂

Σήμερα είναι: 1/10/2020, 11:45

Αναζήτηση...

MENΟΥ

- Αρχική
- Δεδομένα
- Εξοπλισμός
- Αρχείο
- Χρήστες
- Ρυθμίσεις

Είσοδος, εκ: 5/00 / Ανεγγραφή

HELLENIC PETROLEUM

SMURBS
ERA-PLANET

CLIMPACT

Χάρτης

Μάνηρα Κόμβος

Πύργος Οθόνης

Χάρτης Δορυφόρος

Google

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Web platform of the 3 telemetric hydrometeorological stations

METEVIEW₂

Σήμερα είναι: 1/10/2020, 11:45

Αναζήτηση...

MENΟΥ

- Αρχική
- Δεδομένα
- Εξοπλισμός
- Αρχείο
- Χρήστες
- Ρυθμίσεις

Είδηση, 01.10.2020 / Αναχώρηση

HELLENIC PETROLEUM

SMURBS
ERA-PLANET

CLIMPACT

Κάρτης

Μάνηρα Κάμπος

Ποταμός

Μάνηρα

Χάρτης Δορυφόρος


Google

Πήληγες Οθόνη

Αναχώρηση

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Web platform of the 3 telemetric hydrometeorological stations




Today is: 11/05/20, 16:22

MAIN NAVIGATION

- Home
- Data
- Notifications
- Files
- Users
- Settings

Sign out in: 59:21 [Refresh](#)




Home / View Data

Ν Πέρρου

Αγιος Αθανάσιος

Μάνδρα-Εκτροπή

Μάνδρα-Κόμβος



Perfecture: ΑΤΤΙΚΗΣ
City: Μάνδρα
Territory: Μάνδρα
Installation Time: 07/24/20

[Live Photos](#)

SELECTION FILTERS FOR DATA VIEW

Date Interval:

Date From*:
Time from:
Date To*:
Time to:

Sensors*

average surface velocity	Water level	Discharge	Barometric Pressure
Air temp	Relative humidity	Ηλιακή ακτινοβολία	Wind direction
Wind speed	Rainfall	Battery supply	

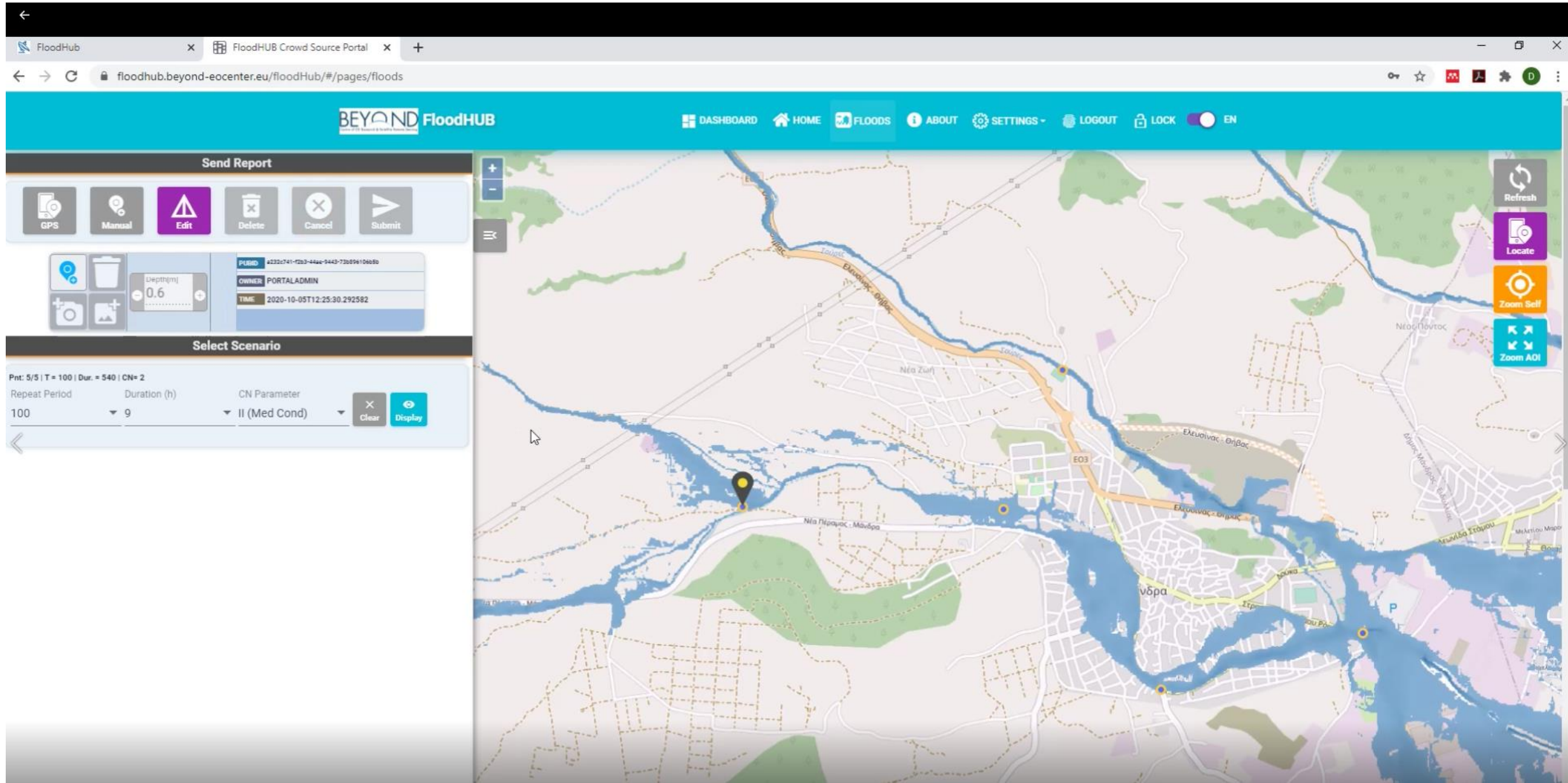
☐ Single Y Axis

Compare to sensors of other stations:

View per: [Total](#) [Minutes](#) [Hour](#) [Day](#) [Week](#) [Month](#) [Year](#) [Chart](#)

The BEYOND Center of Excellence can now provide **to the relevant operational bodies (e.g. civil protection and local authorities)** every **5-15 minutes** measurements for **10 parameters**: rainfall, water level, discharge, average surface water velocity, wind direction, wind speed, air temperature, barometric pressure, relative humidity and solar radiation.

Real-time crowdsourcing platform for staff and volunteers



The screenshot displays the FloodHUB Crowd Source Portal interface. The top navigation bar includes links for DASHBOARD, HOME, FLOODS, ABOUT, SETTINGS, LOGOUT, LOCK, and a language toggle set to EN. On the left, the 'Send Report' section contains buttons for GPS, Manual, Edit, Delete, Cancel, and Submit. Below these are input fields for Depth (m) set to 0.6, and a table showing report details: PUID: 4232c741-72b3-44aa-9443-72b59e104680, OWNER: PORTALADMIN, and TIME: 2020-10-05T12:25:30.292582. The 'Select Scenario' section shows parameters: Pnt: 5/5 | T = 100 | Dur. = 540 | CN = 2, Repeat Period: 100, Duration (h): 9, and CN Parameter: II (Med Cond), with Clear and Display buttons. The main area is a map of a river network with flood simulation overlays in blue and orange. A yellow location pin is placed on the map. On the right side of the map, there are controls for Refresh, Locate, Zoom Self, and Zoom AOI.

Integrated near-real-time flood monitoring system



Centre of EO Research & Satellite Remote Sensing

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[WEB SERVICES](#)
[PROJECTS](#)
[INFRASTRUCTURE](#)
[NEWS / EVENTS](#)



Select Country: Select Disaster Type: [Reset Search Criteria](#)

[Outreach](#)
See our publications / presentations

[Training & Education](#)
Join our activities

[Statistics](#)
[WEB GIS PLATFORM COVID-19 - ΣΥΜΜΕΤΟΧΗ ΔΗΜΩΝ](#)

COVID - 19 Web GIS platform for daily monitoring the global spread of the COVID-19, actively providing information about the pandemic

BEYOND THEMATIC AREAS

Agriculture

Agriculture monitoring, for the purposes of food security, control of the implementation of sustainable agriculture policies and the improvement of the overall agricultural productivity.

[Read more](#)

Climate

Disasters

The rapid changes in climate over the last decades, together with the explosion of human population, have shaped the context for a fragile biosphere, prone to natural and manmade disasters that result in massive flows of environmental immigrants.

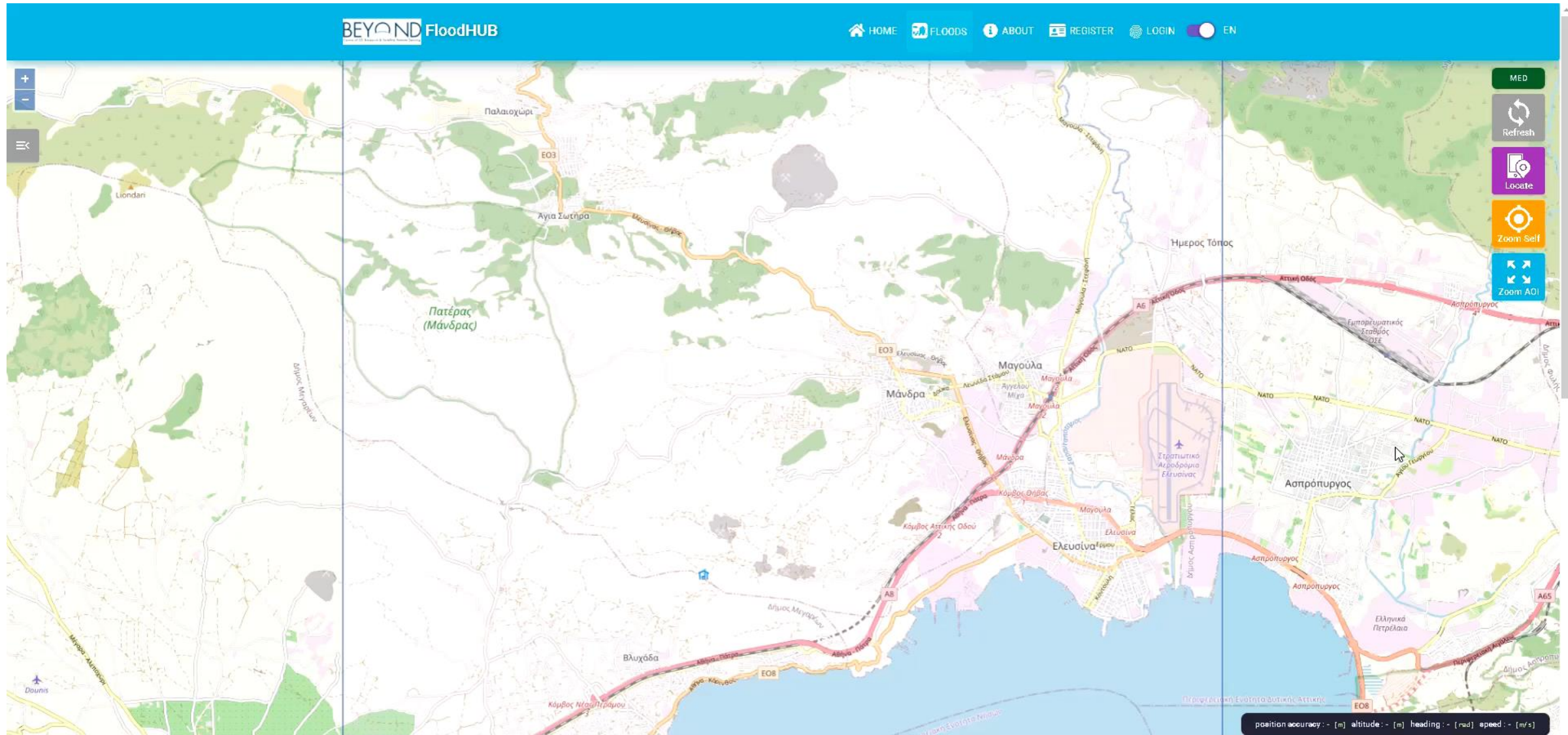
[Read more](#)

Energy

WEB SERVICES



Integrated near-real-time flood monitoring system



Integrated near-real-time flood monitoring system

BEYOND FloodHUB

DASHBOARD HOME FLOODS ABOUT SETTINGS LOGOUT LOCK EN

Send Report

GPS Manual Edit Delete Cancel Submit

Depth(m) 0 PUBID OWNER TIME

Select Scenario

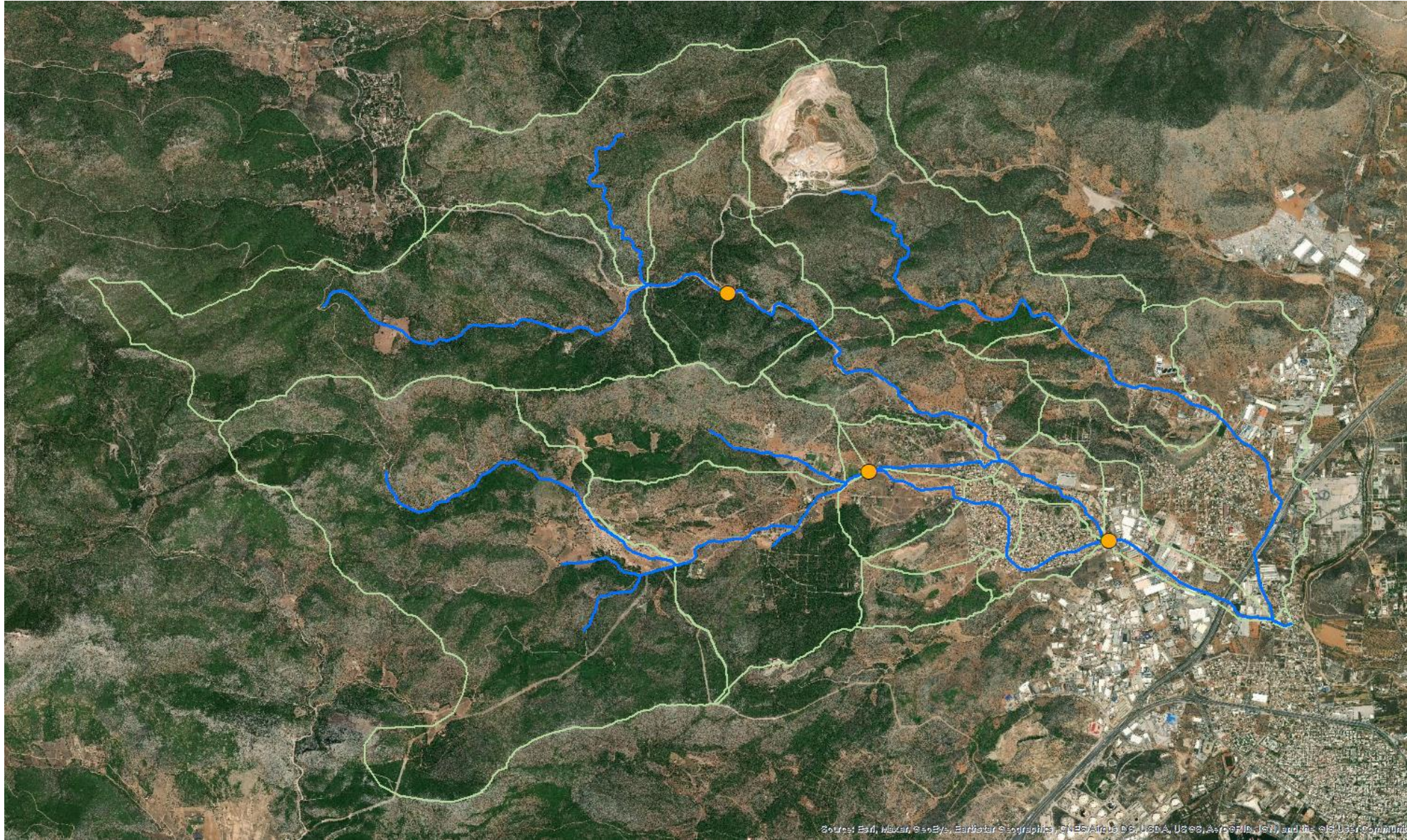
Print: crowd, stations=[0/0],[0/0] | T=1 Dur.=1 CN=2

Repeat Period Duration (h) CN Parameter II (Med Cond) Clear Display

Map showing flood monitoring data for the area around Mandra, Greece. The map displays various geographical features, including roads, rivers, and urban areas. A red line indicates a specific path or boundary. The map is overlaid with a grid and various data points.

position accuracy: - [m] altitude: - [m] heading: - [rad] speed: - [m/s]

Hydrologic & hydraulic simulation



RIVER BASIN
57 km²

SUBBASINS
19

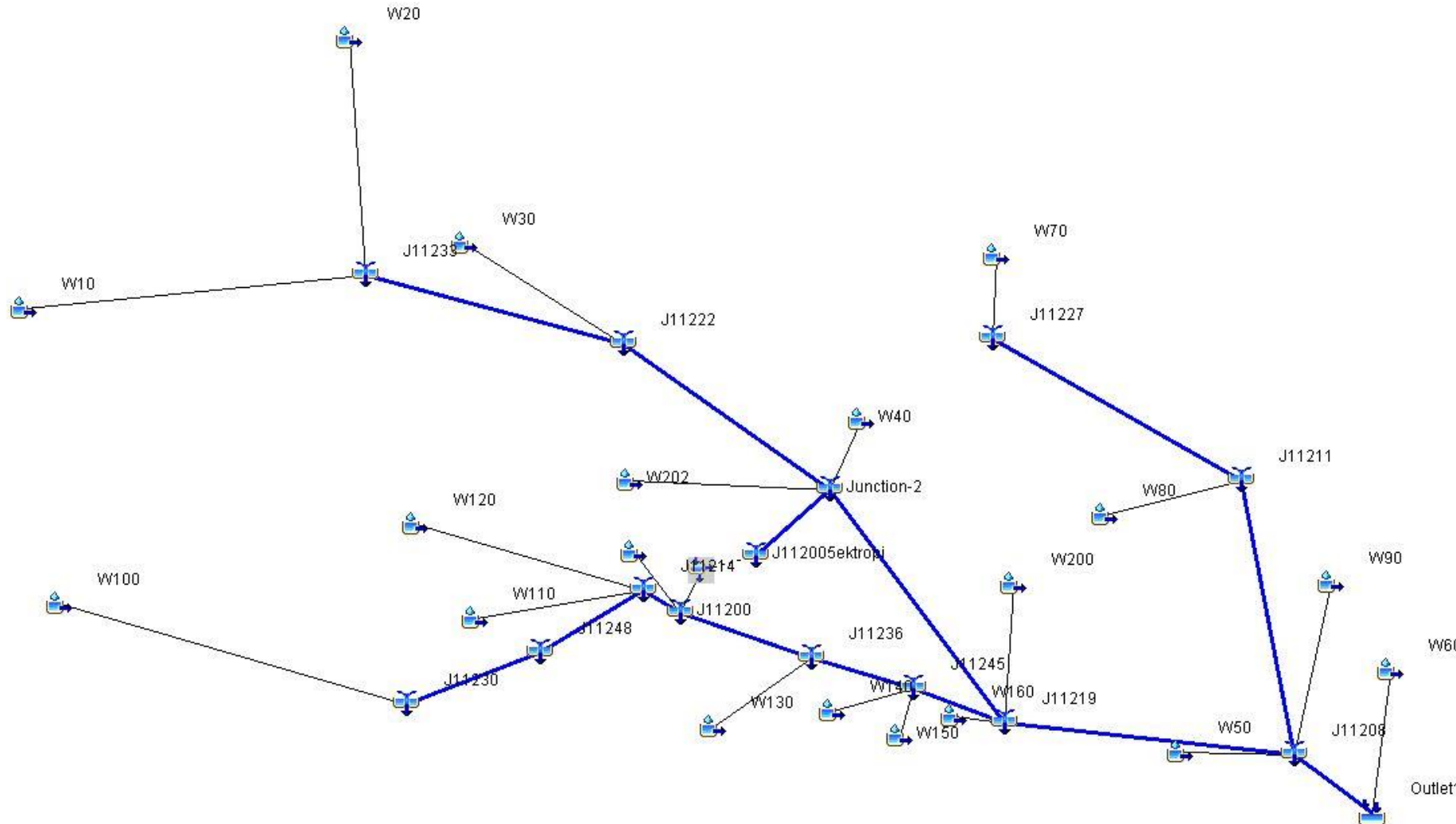
RAINFALL IDF CURVE
Koutsoyiannis &
Baloutsos, 2000

$$i(d,T) = 40.6 (T^{0.185} - 0.45) / (d + 0.189)^{0.796}$$

DISTRIBUTION
Worst profile method

TIME OF
CONCENTRATION
Kirpich (SCS) method

Hydrologic & hydraulic simulation



HYDROLOGIC MODELING:
HEC-HMS
(free & open access)

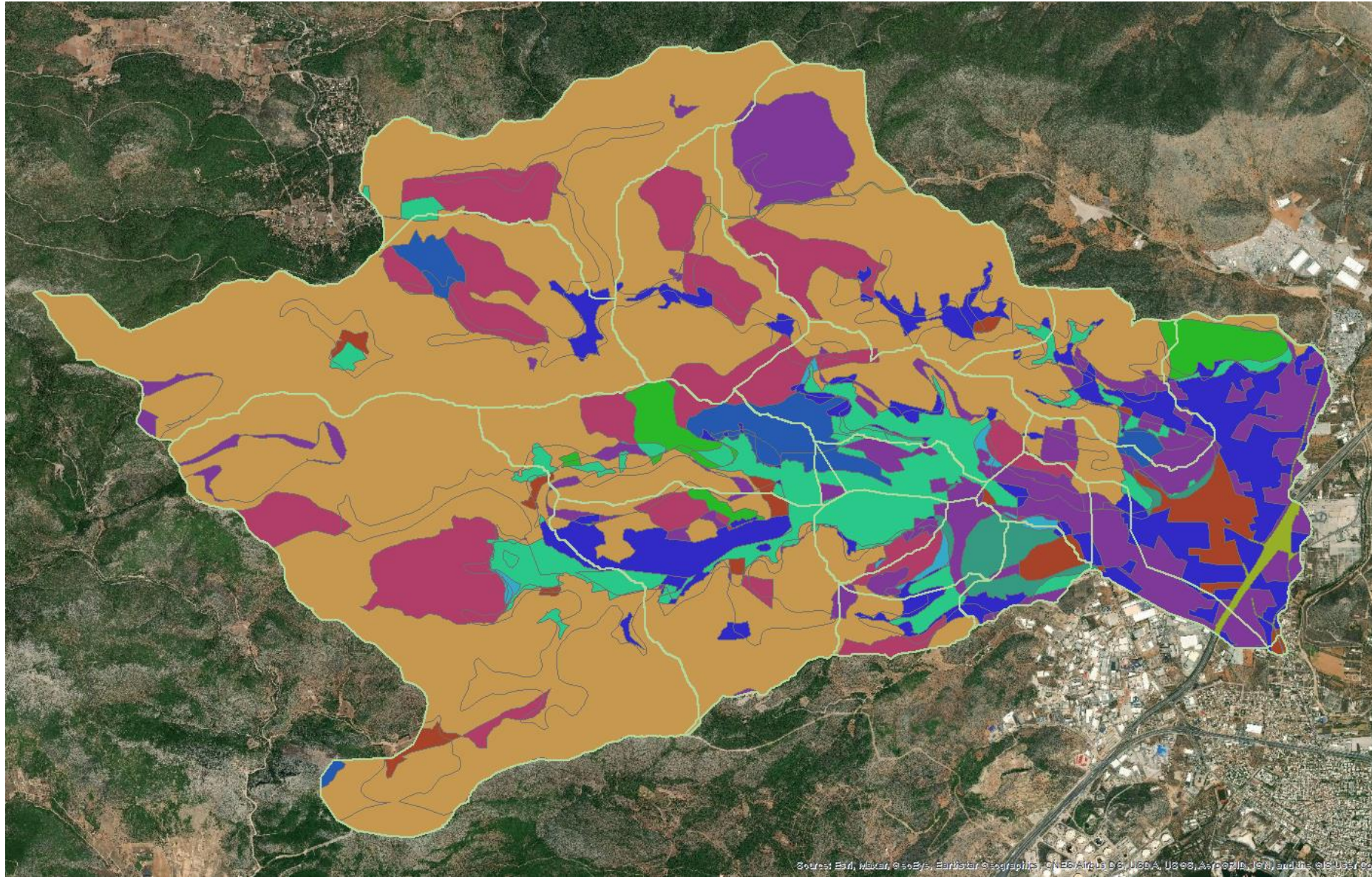
Input: rainfall data through
HEC-DSS for various
combinations of return
periods T (years) and rainfall
duration d (hours)

SCS-CN (Curve Number)
method for extracting the
excess from the gross rainfall,
and the unit hydrograph, for
propagating the surface
runoff to the basin outlet

Run: all scenarios

Output: flow hydrographs

Hydrologic & hydraulic simulation



HYDROLOGIC MODELING:

HEC-HMS

(free & open access)

Input: rainfall data through HEC-DSS for various combinations of return periods T (years) and rainfall duration d (hours)

SCS-CN (Curve Number) method for extracting the excess from the gross rainfall, and the unit hydrograph, for propagating the surface runoff to the basin outlet

Run: all scenarios

Output: flow hydrographs

Hydrologic & hydraulic simulation

Antecedent Soil Moisture Conditions	T = 50 years	T = 100 years	T = 200 years	T = 500 years	T = 1000 years
CN I Dry conditions	T50 CNI D3	T100 CNI D3	T200 CNI D3	T500 CNI D3	T1000 CNI D3
	T50 CNI D6	T100 CNI D6	T200 CNI D6	T500 CNI D6	T1000 CNI D6
	T50 CNI D9	T100 CNI D9	T200 CNI D9	T500 CNI D9	T1000 CNI D9
CN II Average conditions	T50 CNII D3	T100 CNII D3	T200 CNII D3	T500 CNII D3	T1000 CNII D3
	T50 CNII D6	T100 CNII D6	T200 CNII D6	T500 CNII D6	T1000 CNII D6
	T50 CNII D9	T100 CNII D9	T200 CNII D9	T500 CNII D9	T1000 CNII D9
CN III Wet conditions	T50 CNIII D3	T100 CNIII D3	T200 CNIII D3	T500 CNIII D3	T1000 CNIII D3
	T50 CNIII D6	T100 CNIII D6	T200 CNIII D6	T500 CNIII D6	T1000 CNIII D6
	T50 CNIII D9	T100 CNIII D9	T200 CNIII D9	T500 CNIII D9	T1000 CNIII D9

HYDRAULIC MODELING:
HEC-RAS
(free & open access)

Input:

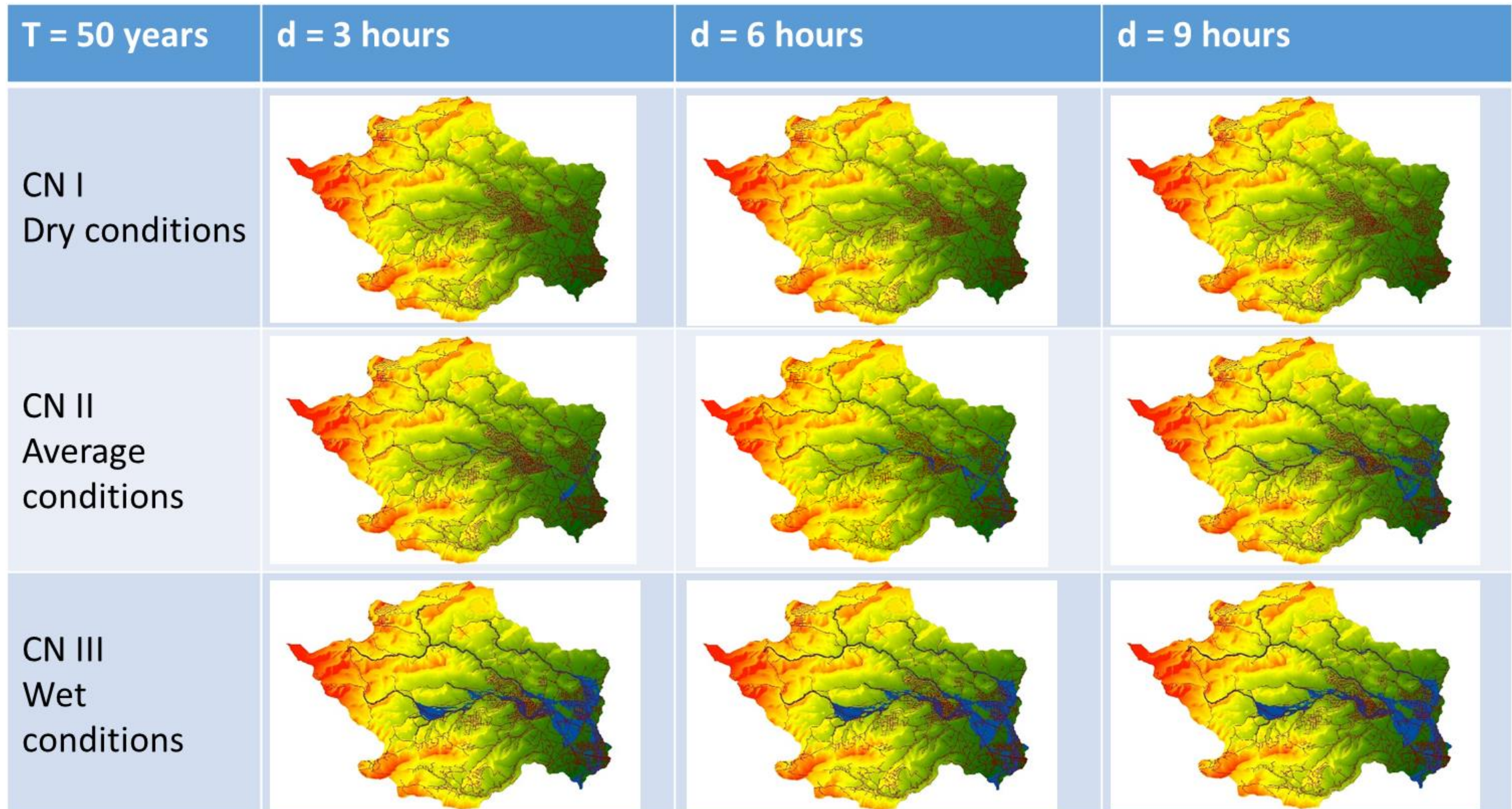
- * flow hydrographs for each stream of the hydrographic network
- * banks and road network through breaklines
- * DEM at 5m spatial resolution provided by the National Cadastre and Mapping Agency SA of Greece

Run: All scenarios at 10m spatial resolution (2D mesh)

Output: flood extent

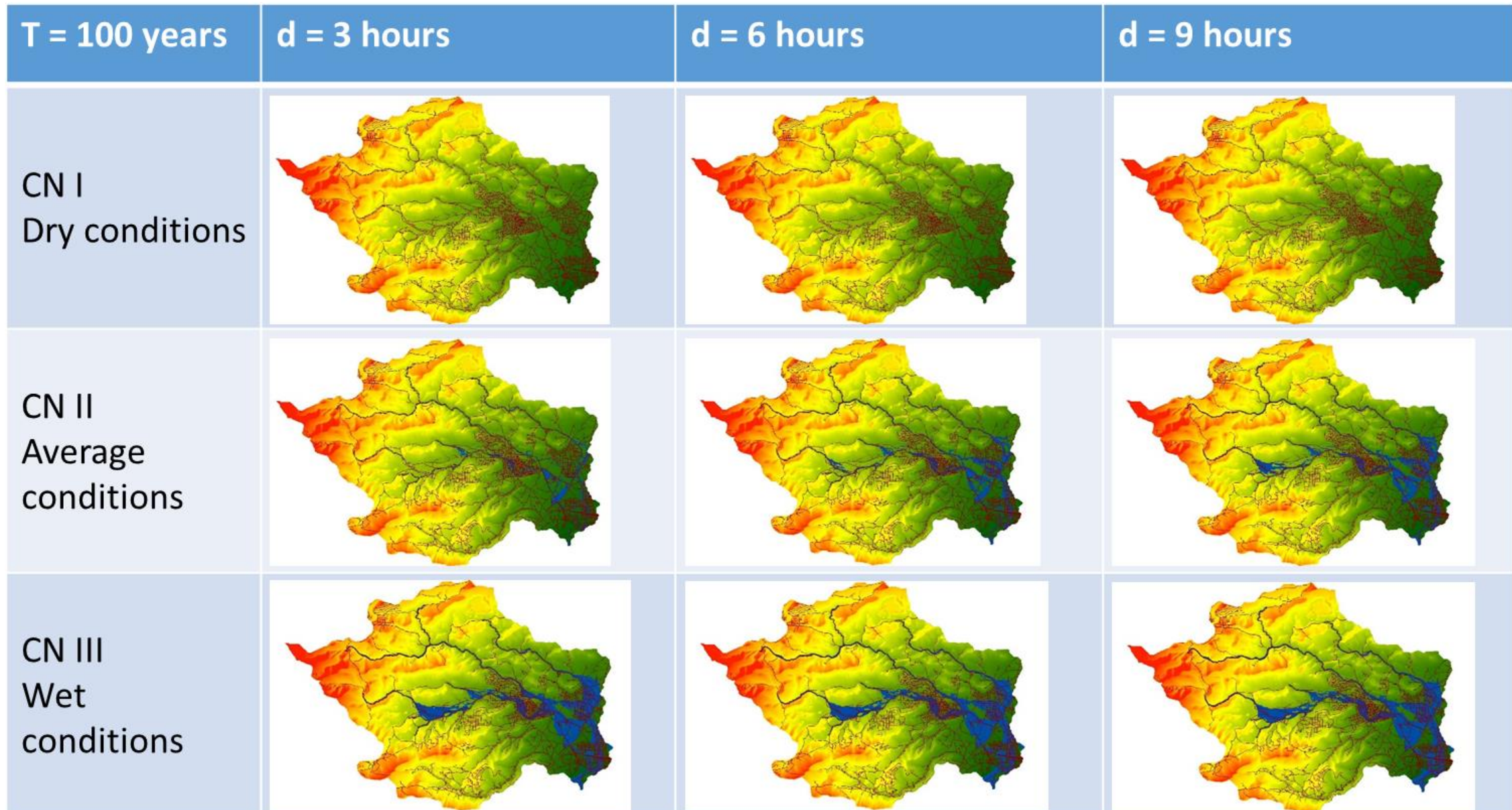
Flood mapping results

T = 50 years



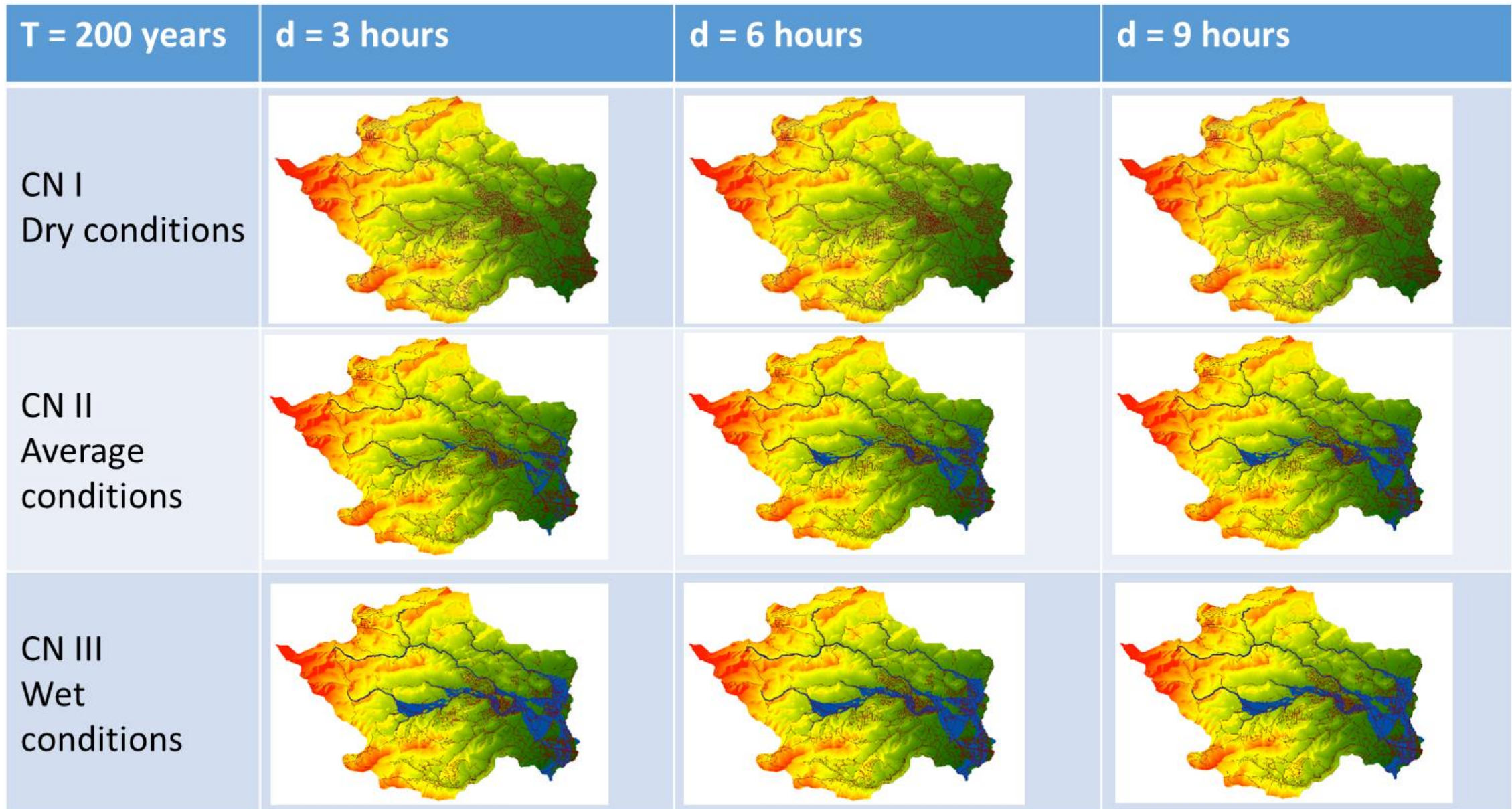
Flood mapping results

T = 100 years



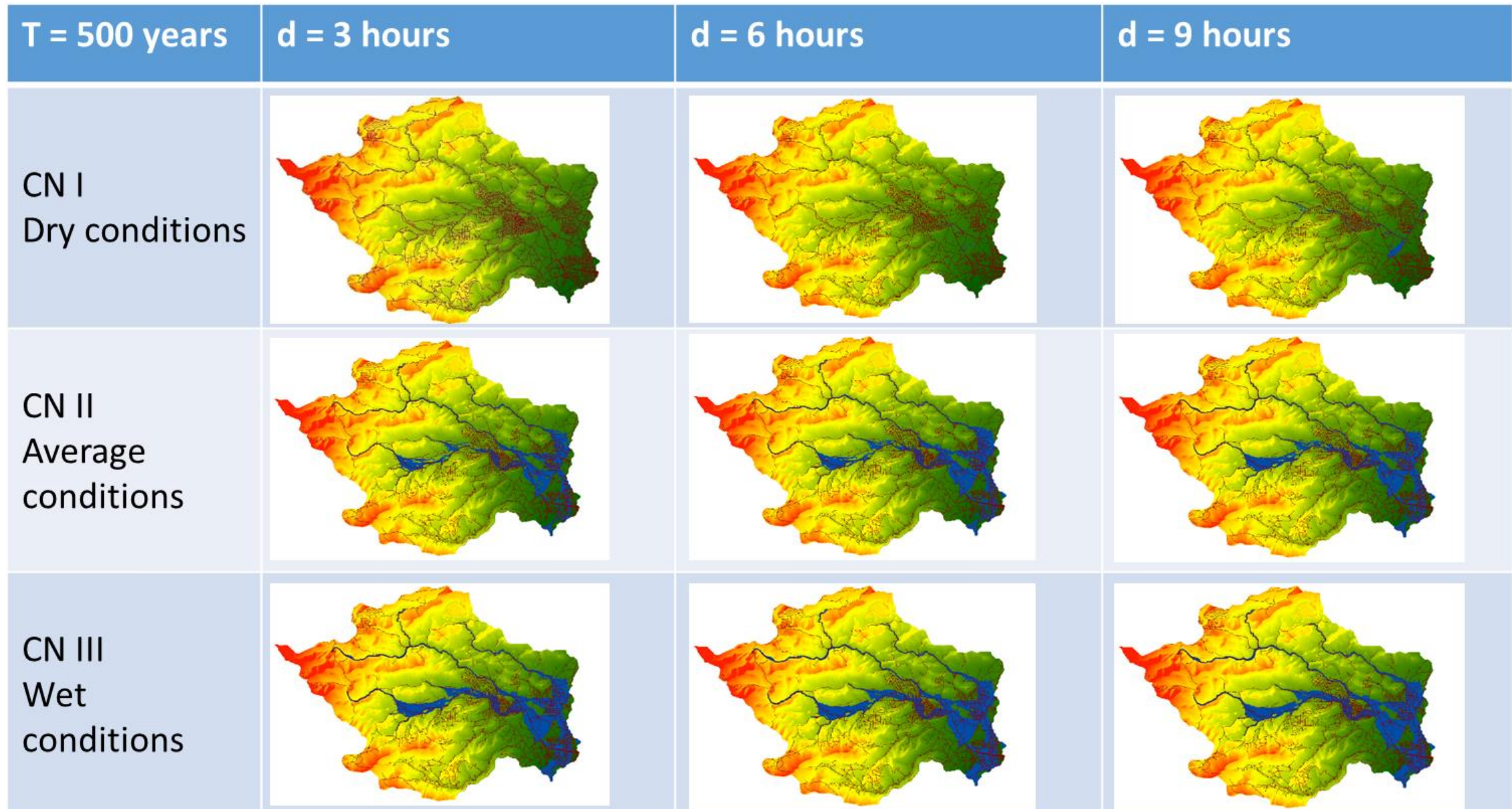
Flood mapping results

T = 200 years



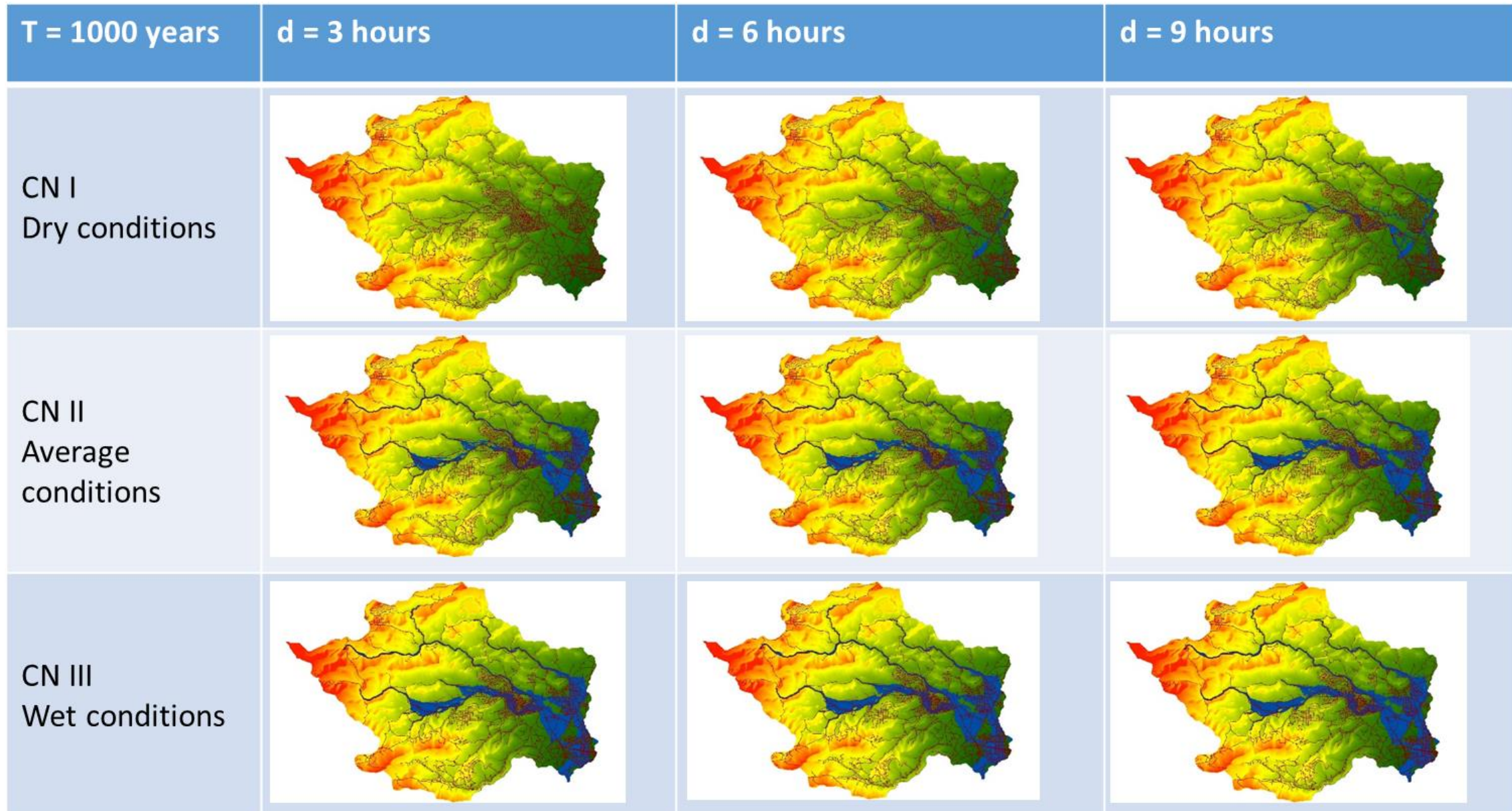
Flood mapping results

T = 500 years



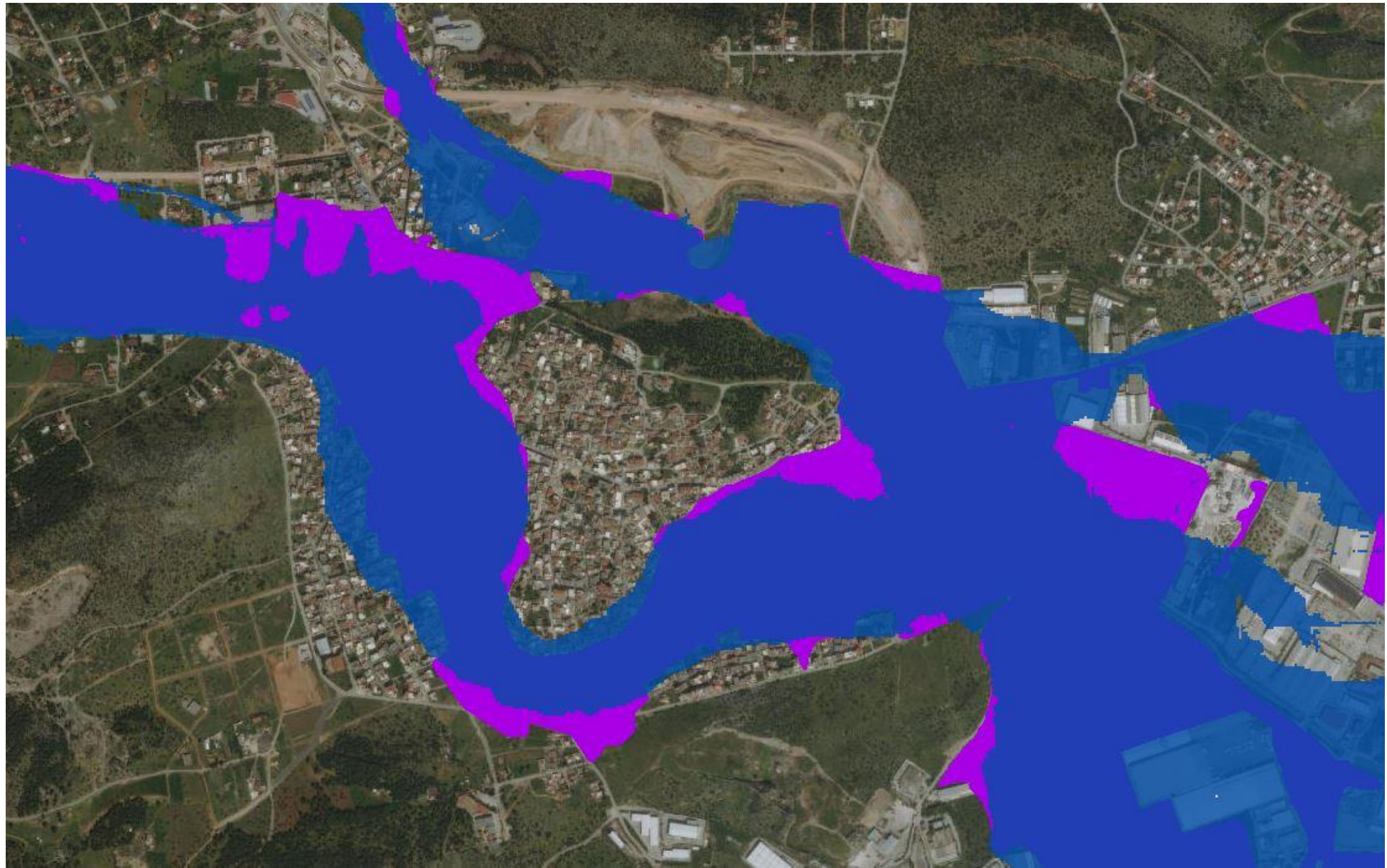
Flood mapping results

T = 1000 years



Mandra flood 2017: modelling (blue) vs EO mapping (pink)

Blue:
Simulation
of flood
scenario
T1000
CNIII
d6



Pink:
VHR
satellite-
based
mapping
(Meteoview)

FloodHUB system in support of the decision makers

In line with the requirements for the implementation of the:

- ✓ EU Floods Directive 2007/60/EC “on the assessment and management of flood risks”
- ✓ Sendai Framework for Disaster Risk Reduction
- ✓ UN SDGs:



- ✓ GEO's Societal Benefit Areas:



Disaster Resilience



Sustainable Urban Development



Water Resources Management



Public Health Surveillance



Food Security and Sustainable Agriculture



Infrastructure and Transportation Management

Stakeholders' trainings in the operational FloodHUB system



FireHub

Prediction - Early detection and continuous forest fire monitoring and management service based on satellite remote sensing

FireHUB

Click the FireHUB Button to visit the [24/7 Real-Time Fire Monitoring service](#)

FireHUB

Click the FireHUB Button to visit the [Diachronic Burnt Scar Mapping](#)

FireHUB

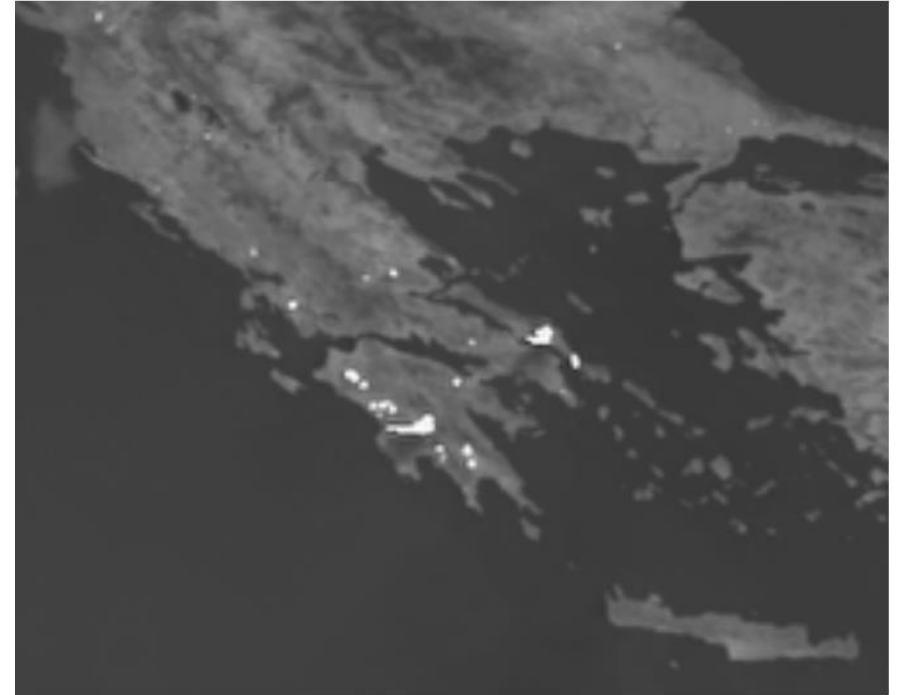
Click the FireHUB Button to visit the [Forest Fire Information System in Europe, N. Africa, Middle East, Balkans, Black Sea](#)

FireHUB

And a pilot service for fire risk prediction

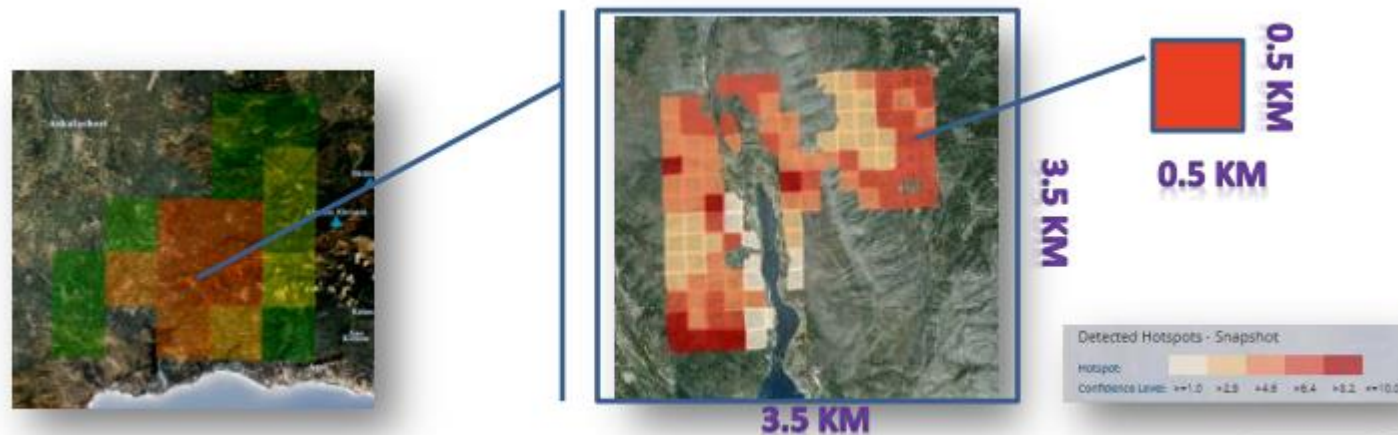
24/7 Real-Time Fire Monitoring service

- 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
 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



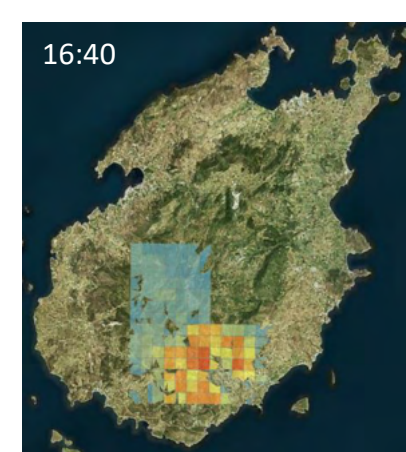
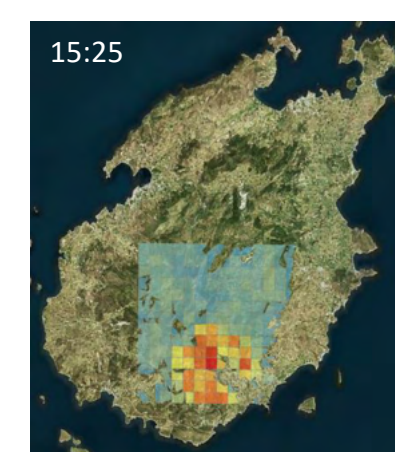
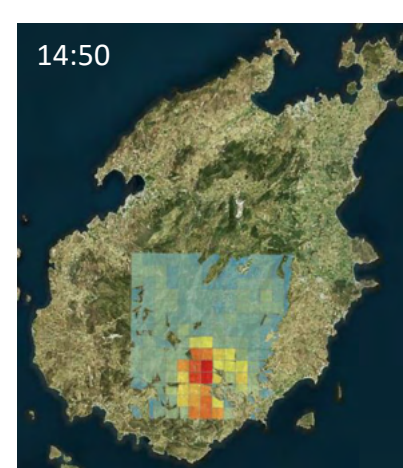
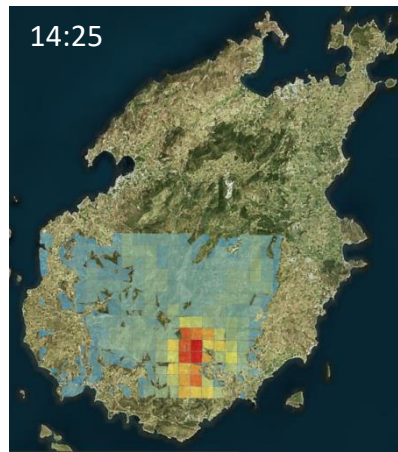
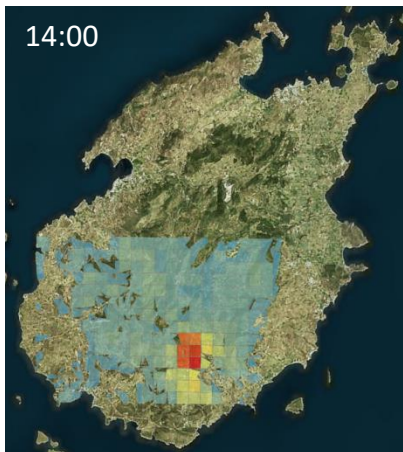
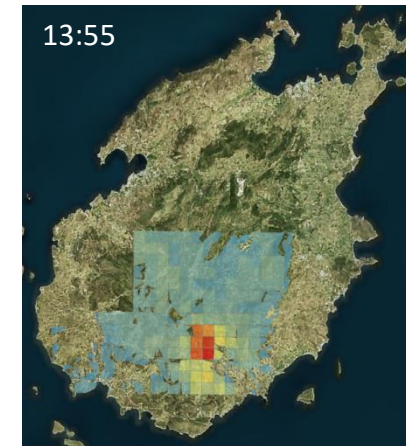
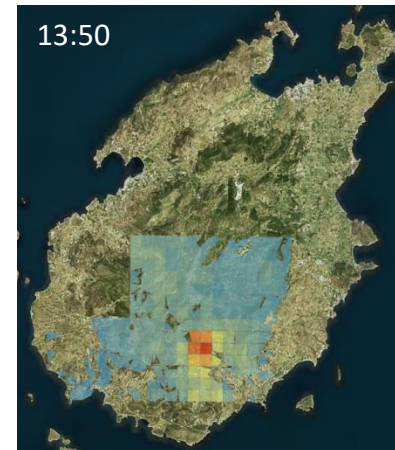
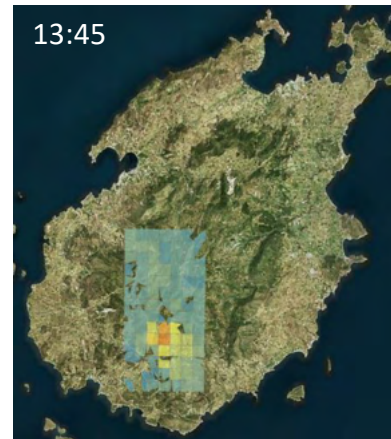
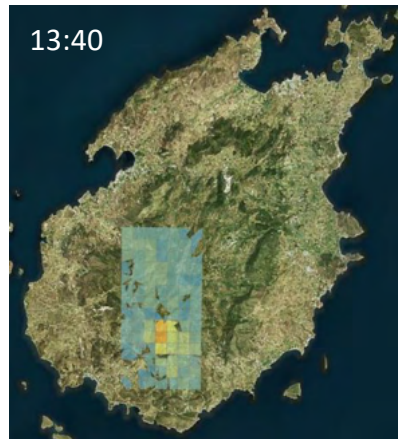
24/7 Real-Time Fire Monitoring service

- 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**



24/7 Real-Time Fire Monitoring service

Fire at Mati, Attica

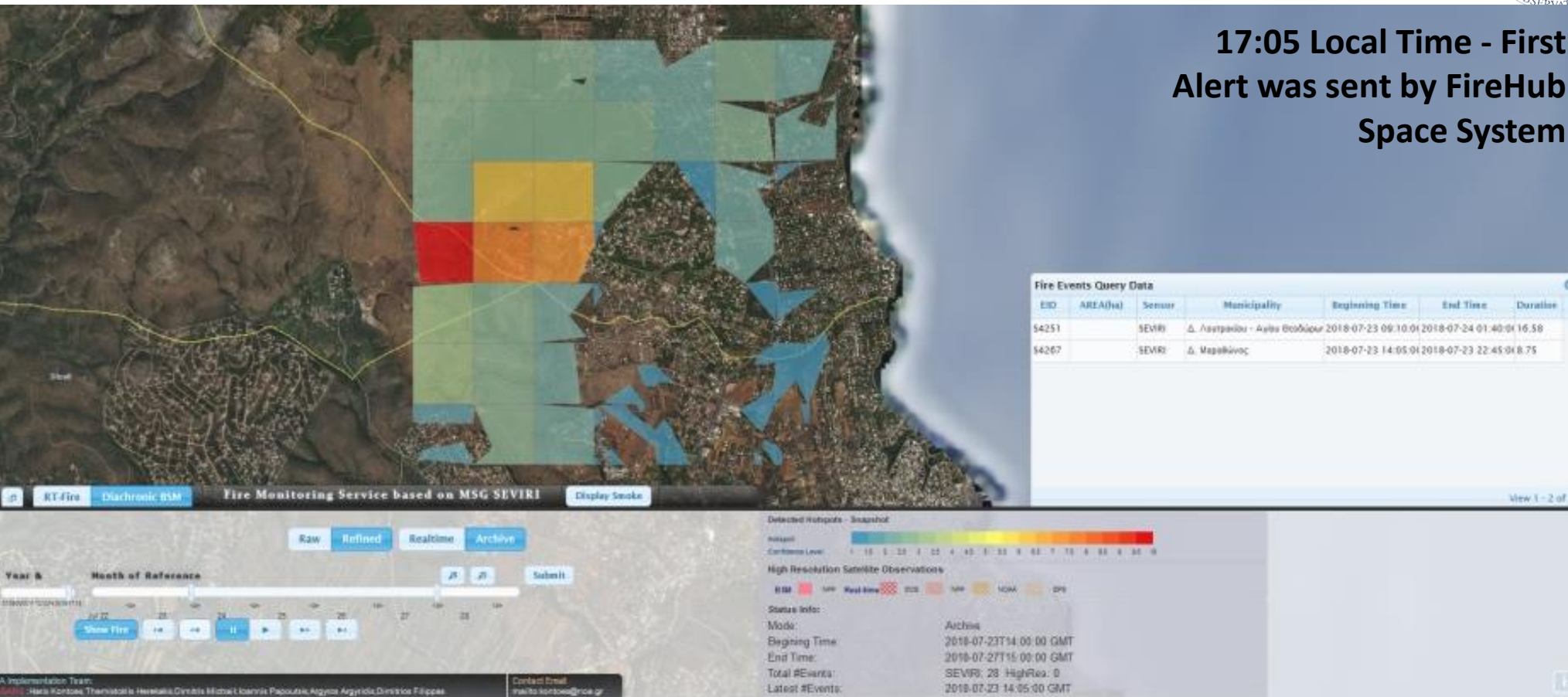


Beyond was monitoring the wildfire from the ignition and every five minutes





**17:05 Local Time - First
Alert was sent by FireHub
Space System**

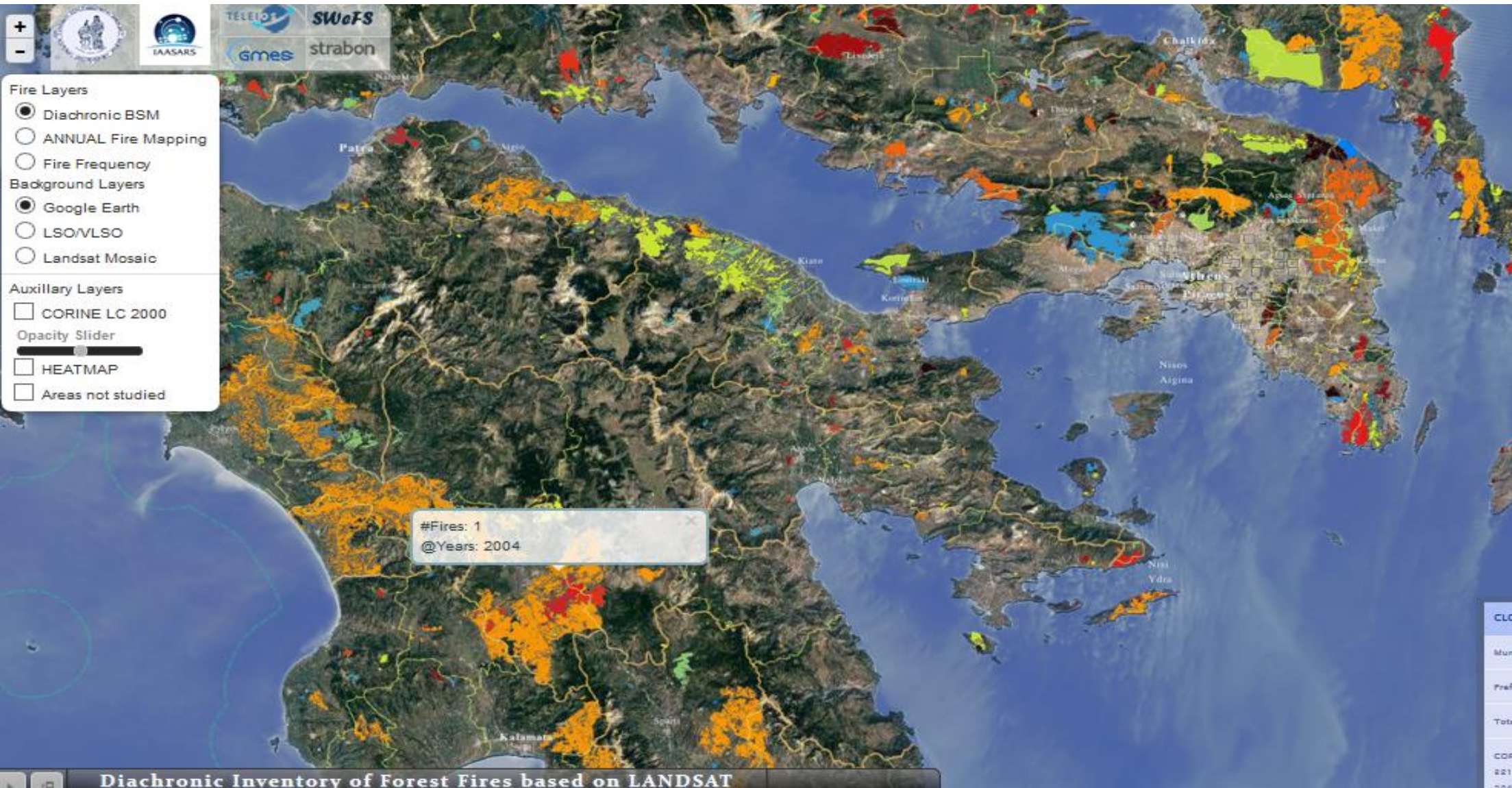


- This screen shows the first alert that was sent by the FireHub system of BEYOND at 17:05 local time, that is 5-7 minutes later than the official start of the fire (between 16.55-17:00). The FireHub web site is open and accessible at that time by all and the authorities of Fire Brigades at <http://195.251.203.238/seviri/>
- 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 is not made so as to update the fire occurrence picture inside the urban zones. The urban area fringe is also apparent by looking at the background Google Earth map.

24/7 Real-Time Fire Monitoring service

- 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 time stamp reported in the Fire Brigade logs
- All the larger fires 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

Diachronic Burnt Scar Mapping



1984-2020,
 Greece , ~1100
 satellite images
 LANDSAT TM,
 SPOT, IKONOS,
 SENTINEL-2

Diachronic Burnt Scar Mapping



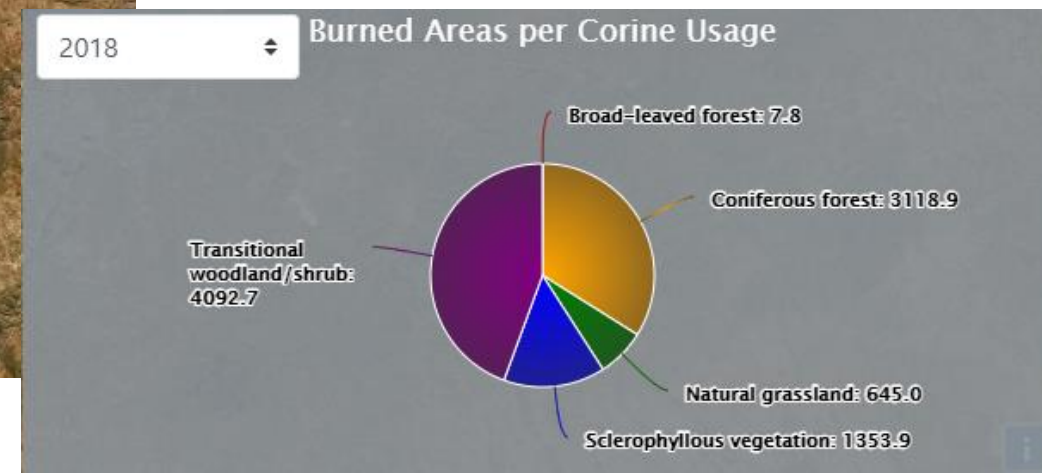
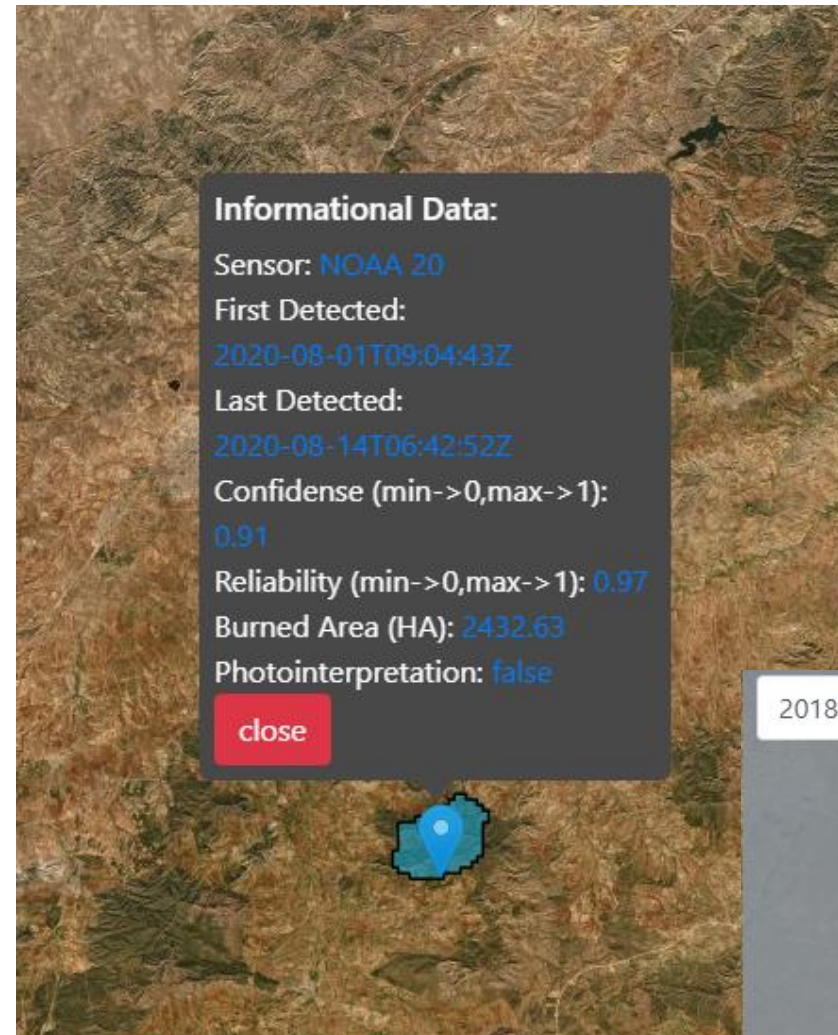
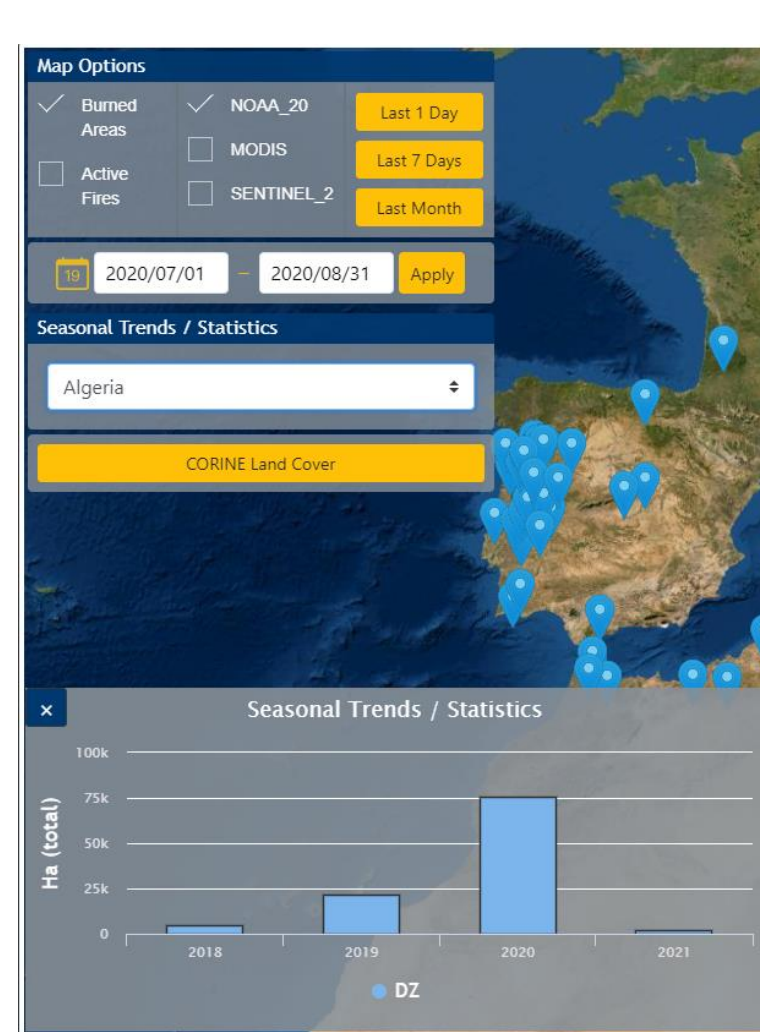
Forest Fire Information System

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 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.

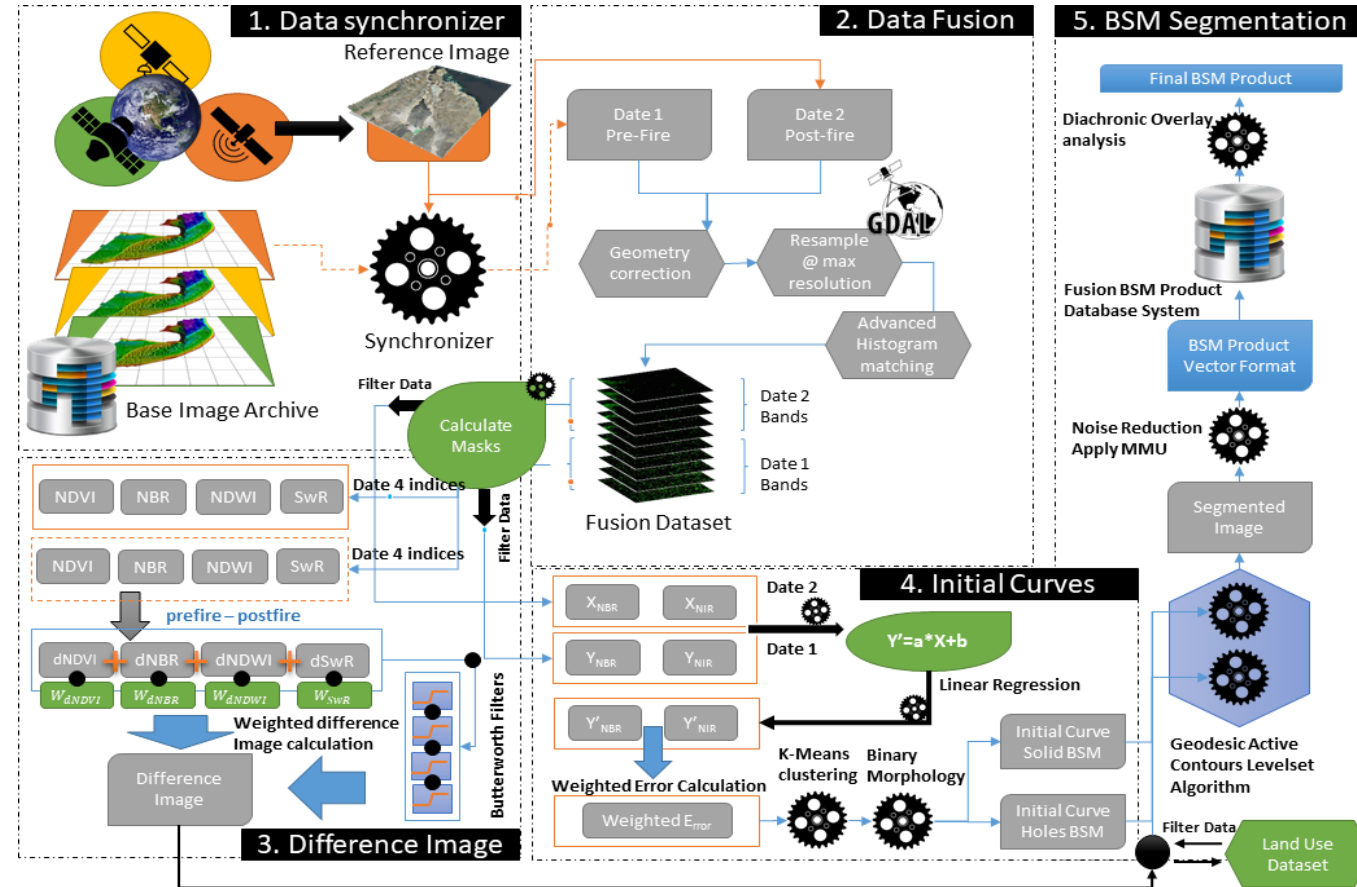


Processing in Real Time of SUOMI-NPP, NOAA-20, MODIS, and S-2 data

Forest Fire Information System



Forest Fire Information System

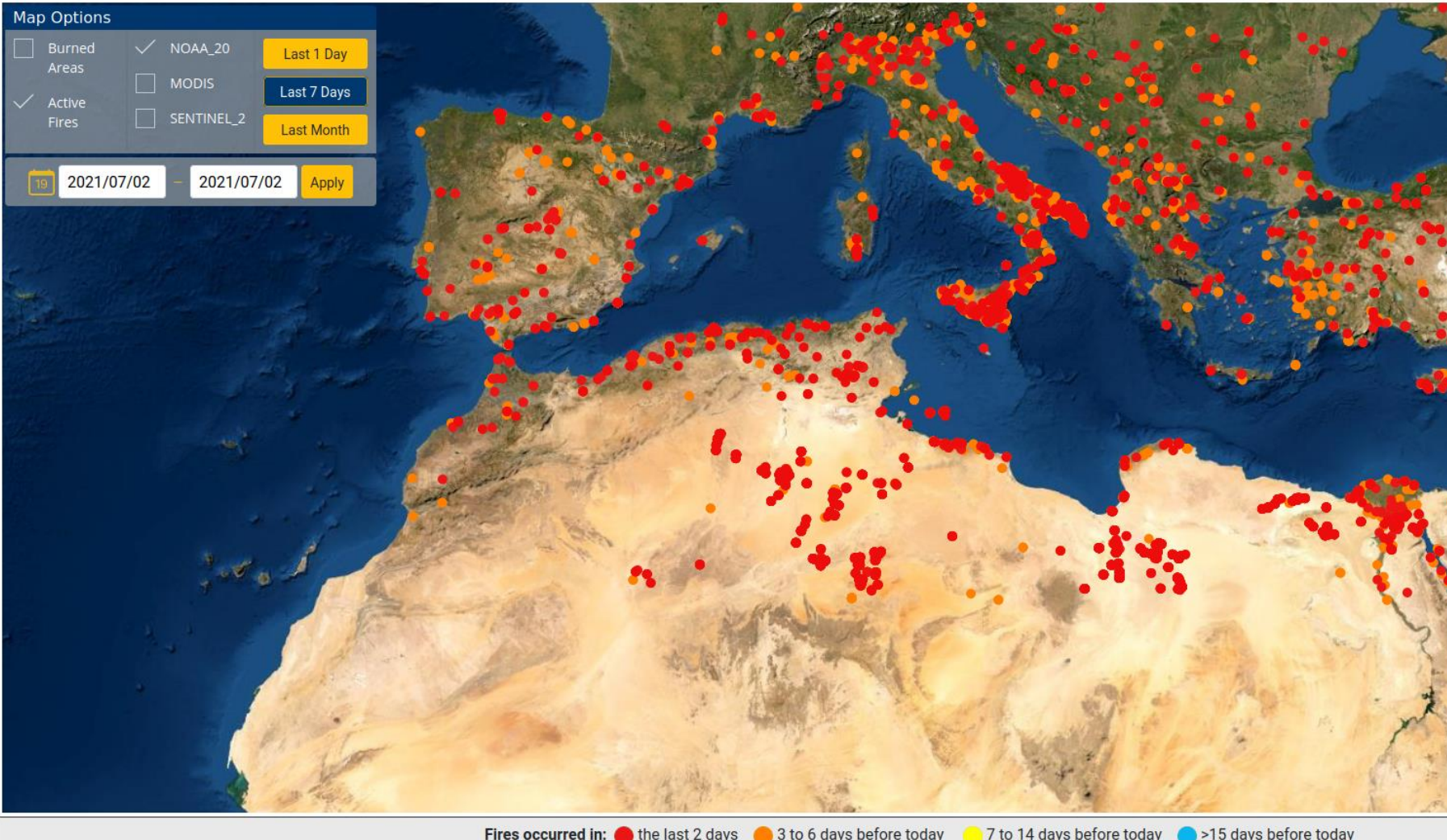


3 steps prototype Algorithm for Burnt Scar Mapping (BSM)

- 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.

Forest Fire Information System

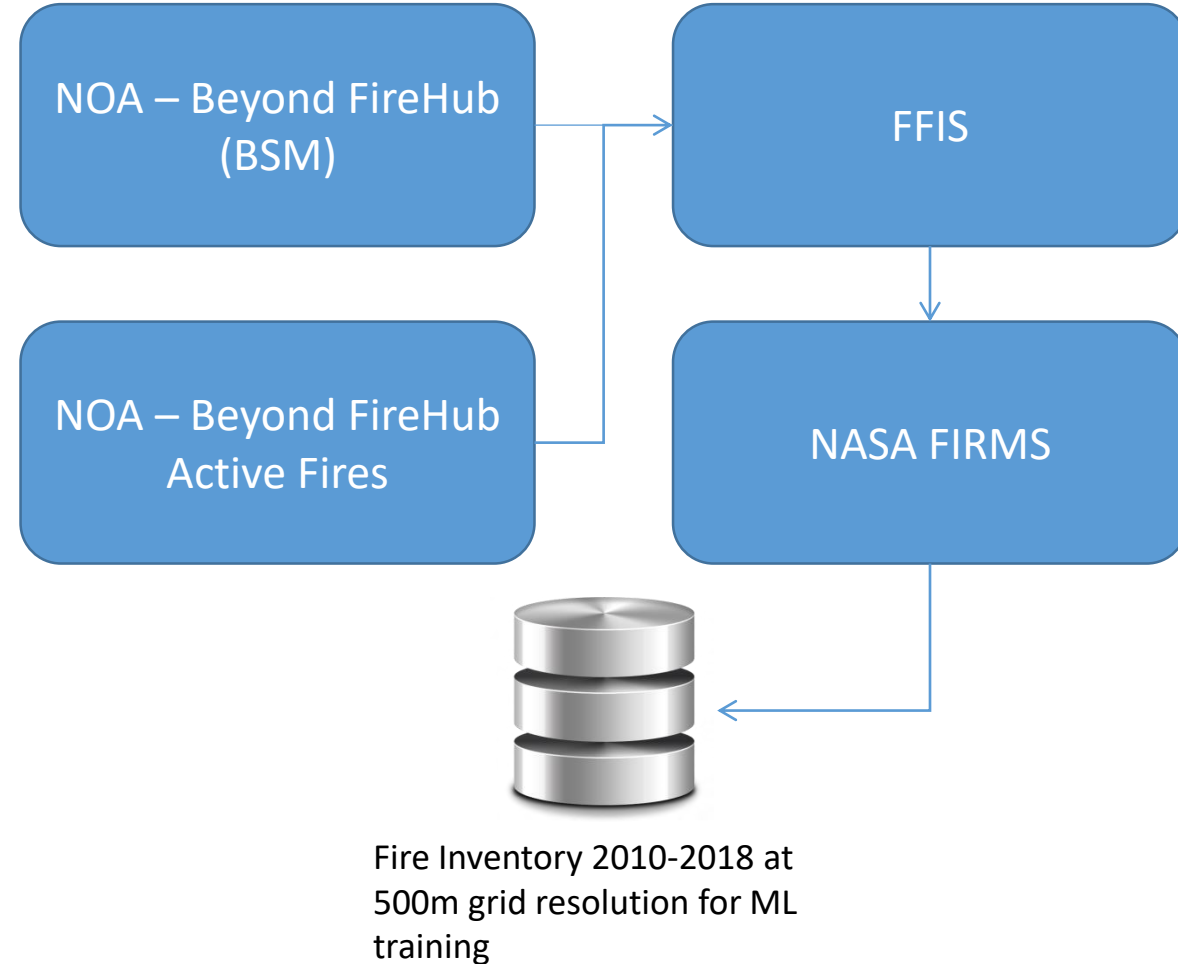
Forest Fire Information System
in Europe, N. Africa, Middle East, Balkans, Black Sea



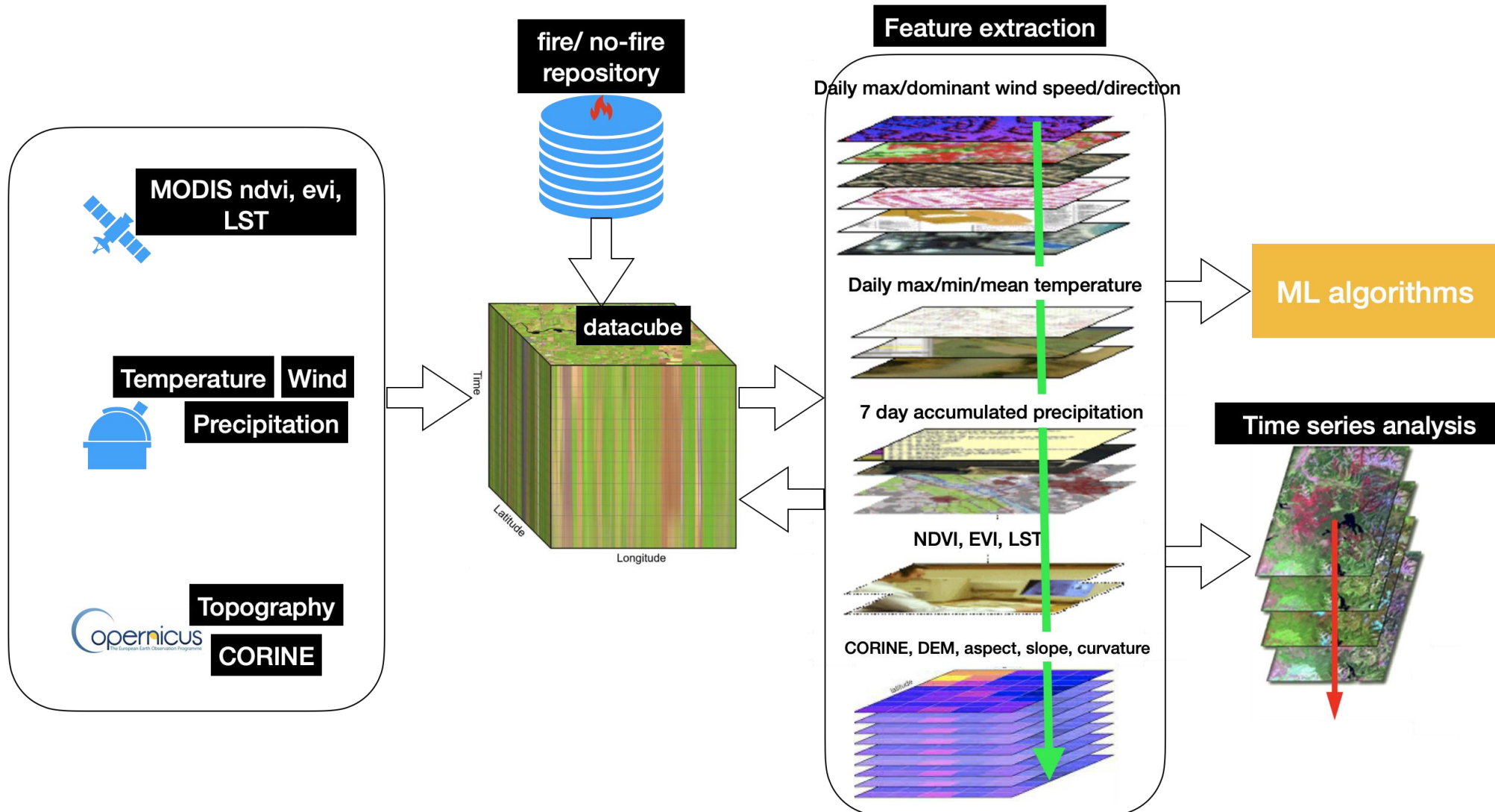
- Active fire detection from NASA-FIRMS algorithm
- Active fires integrate with burned areas to raise the confidence level
- They are produced within 2 hours from the acquisition to NOA's Ground Segment (for VIIRS and MODIS images)

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.

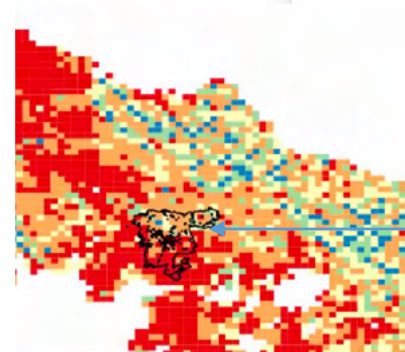
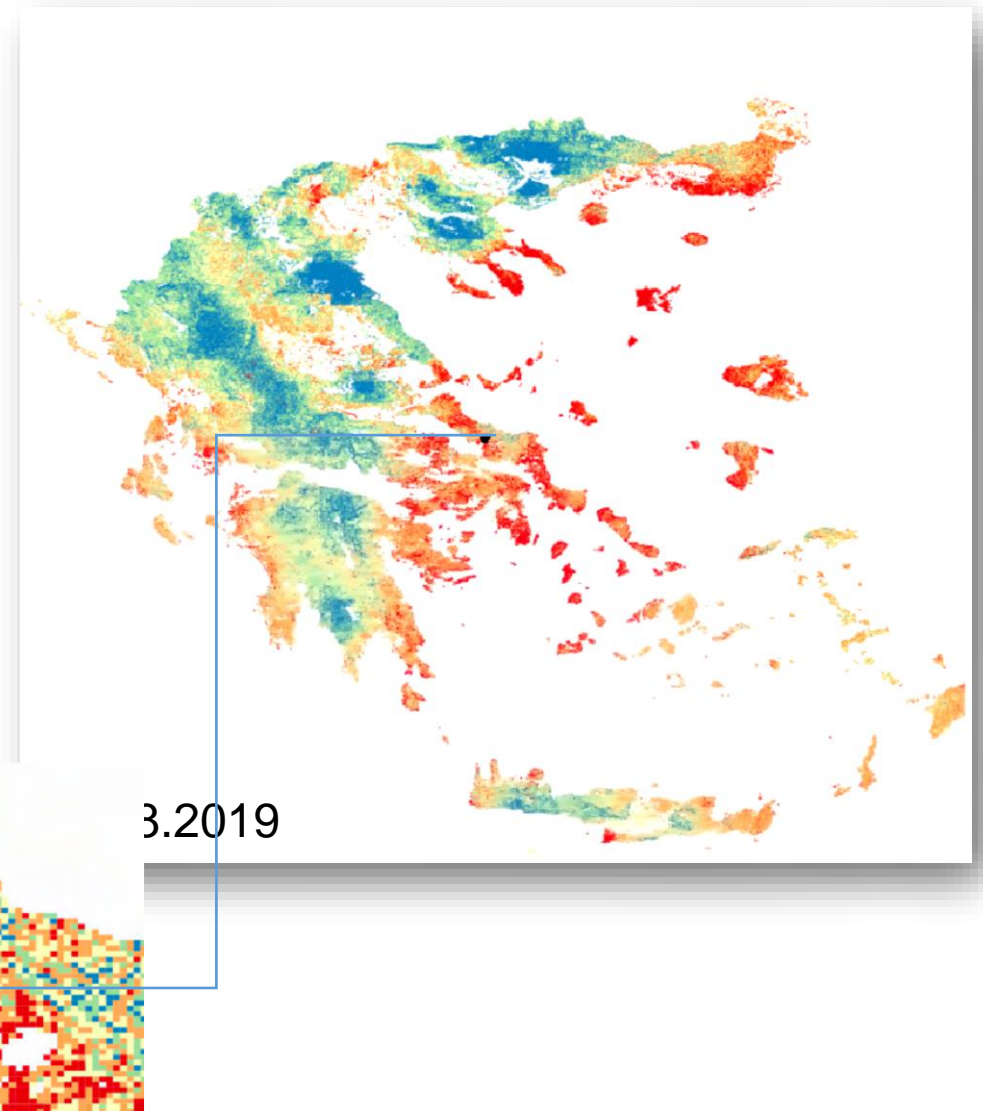
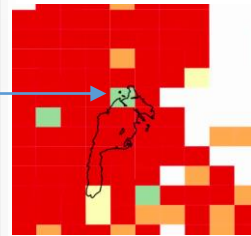
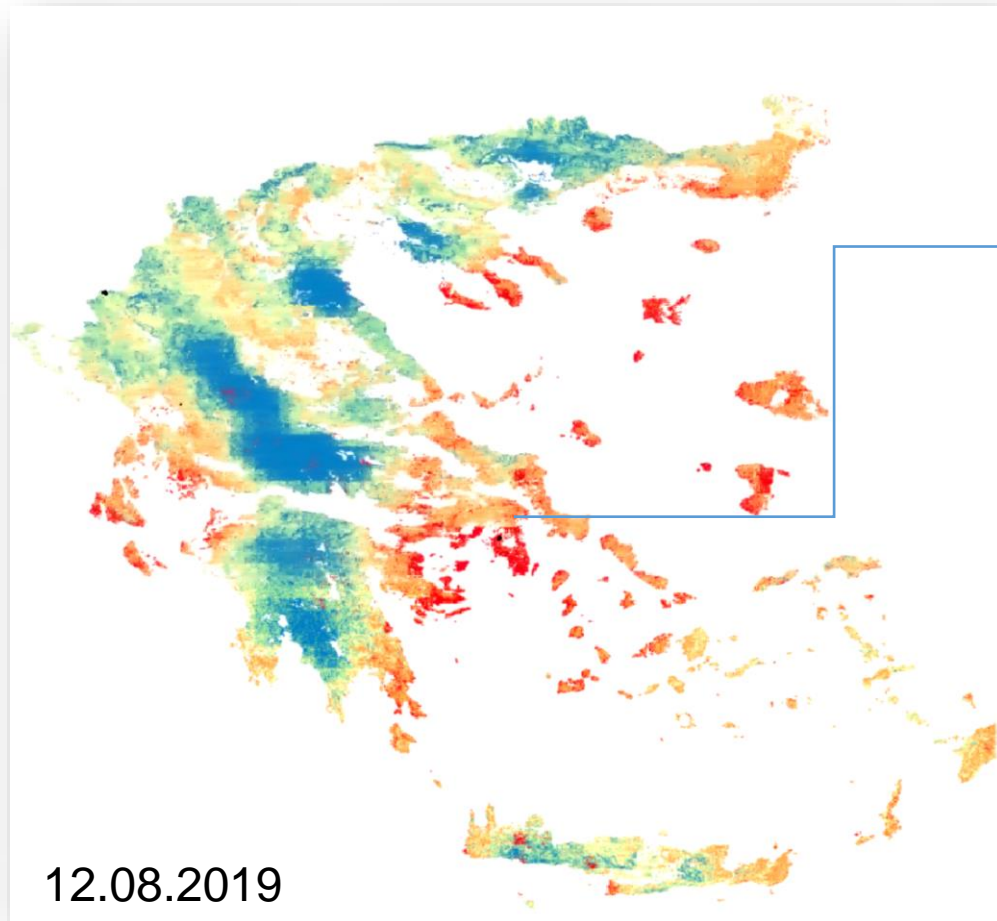


Forest Fire Prediction System

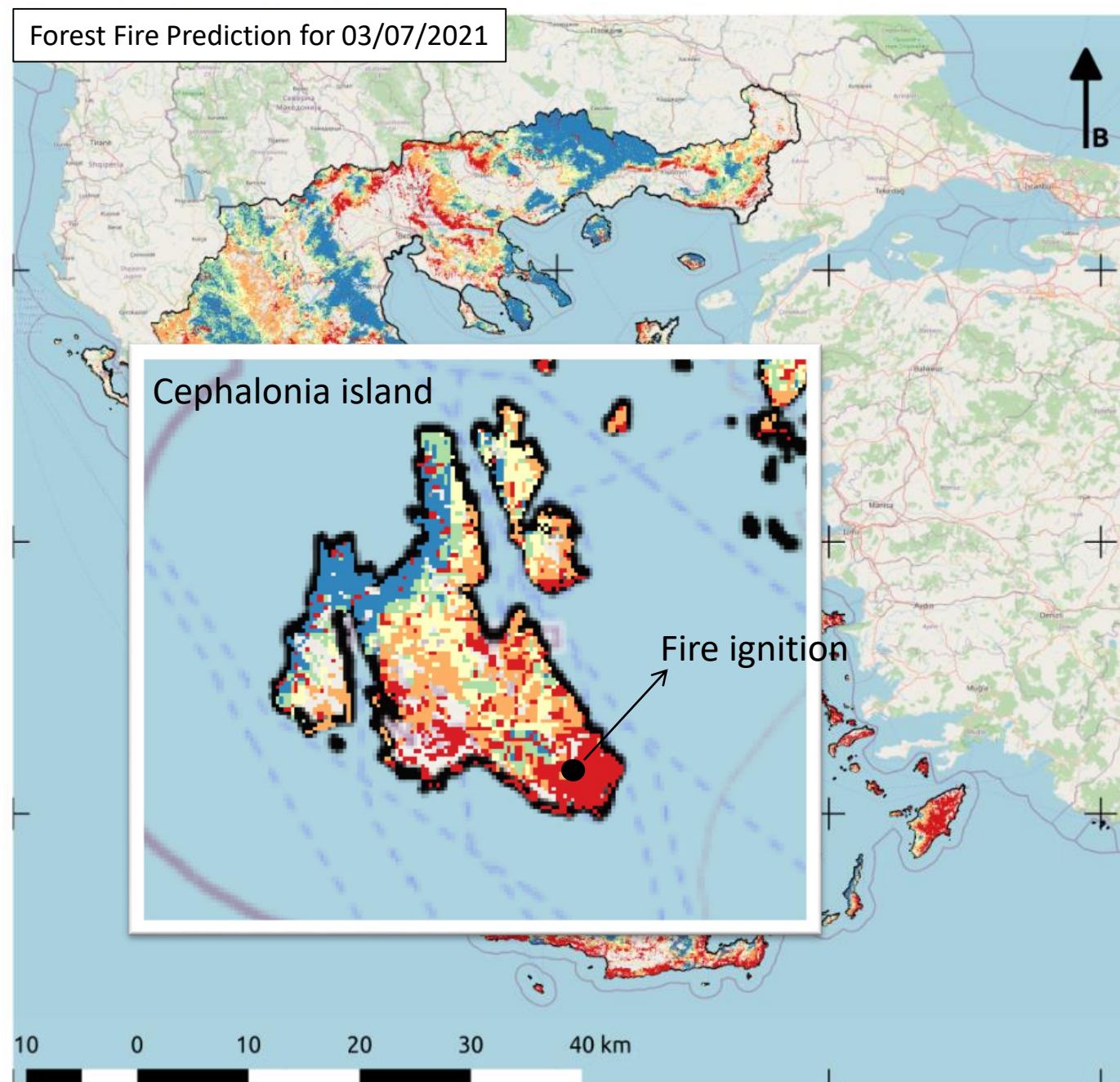


Forest Fire Prediction System

Tests on 2019



Forest Fire Prediction for 03/07/2021



Ημερήσιος χάρτης πρόβλεψης κινδύνου πυρκαγιάς

Πληροφορίες χάρτη

Ο χάρτης έχει δημιουργηθεί από το Κέντρο Παρατήρησης της Γης και Δορυφορικής Τηλεπισκόπησης 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 τέσσερις τελευταίες δεκαετίες, προγνώσεις καιρού για την επόμενη ημέρα, καθώς και δυναμική εκτίμηση περιβαλλοντικών παραμέτρων. Ο χάρτης απεικονίζει τον κίνδυνο έναρξης πυρκαγιάς στην χωρική ανάλυση των 500 μέτρων.

Υπόμνημα

— Ακτογραμμή

Επίπεδα ρίσκου

- Very high risk
- High risk
- Medium risk
- Low risk
- No risk

Χαρτογραφική προβολή: WGS 84 / Pseudo-Mercator, EPSG:3857

- The system is in a test phase
- Next day's risk maps are produced and sent to the authorities for validation
- Results are validated daily by Beyond experts as well
- Over 90% of the wildfires occur in high and very high risk areas

The BEYOND Center of EO Research & Satellite Remote Sensing



Thank you for your attention!