HS4.4 - 'Operational forecasting and warning systems for natural hazards: challenges and innovations'
Thursday 29 April 2021

# The innovation of the FloodHub system for a reliable flood early warning and crisis management

Alexia Tsouni , Haris Kontoes, Themistocles Herekakis, Stavroula Sigourou, Theodora Perrou

National Observatory of Athens – IAASARS – BEYOND Center

EuroGEO

Disaster Resilience Action Group

BEYOND Centre of EO Research & Satellite Remote Sensing

http://beyond-eocenter.eu

FloodHUB

SMURBS ERA-PLANET

EXCELSIOR

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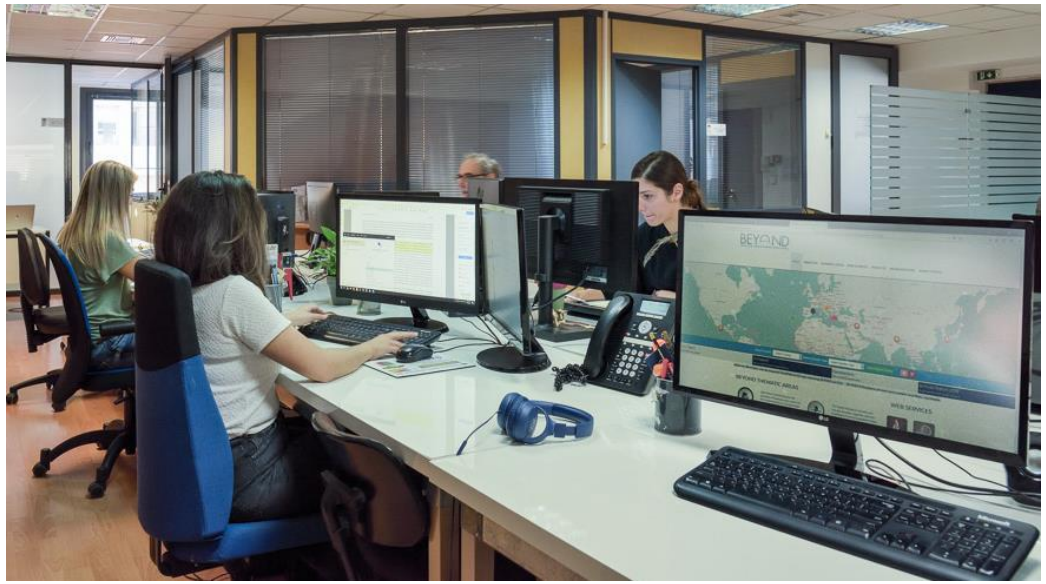
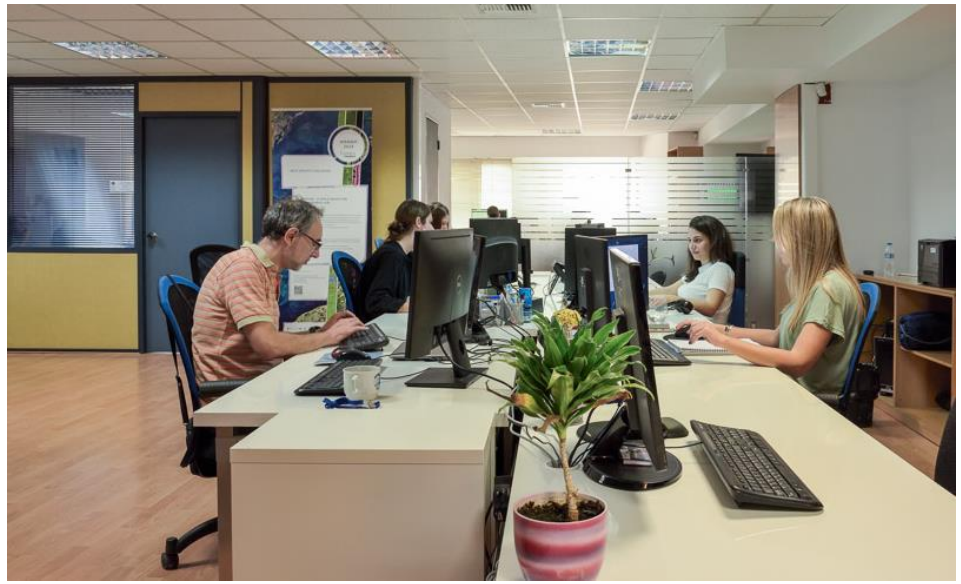
# The BEYOND Center of EO Research & Satellite Remote Sensing

BEYOND Centre of EO Research & Satellite Remote Sensing

FloodHUB





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# The services of the BEYOND Center

BEYOND Centre of EO Research & Satellite Remote Sensing
National Observatory of Athens

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

**Early warning and monitoring of flood events - Diachronic Flood Extent Mapping**
**(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)**

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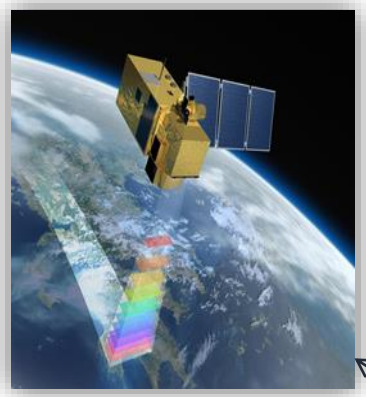
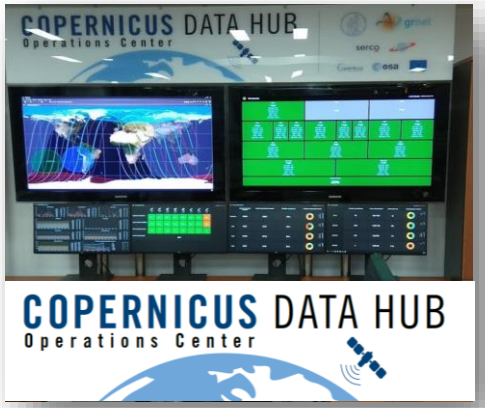
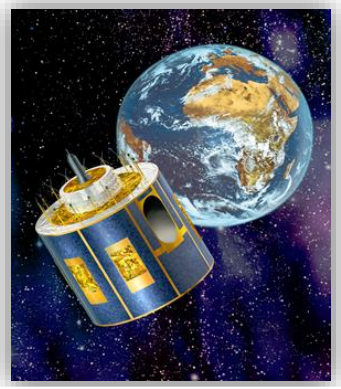
# The monitoring systems of the BEYOND Center



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



Satellites
Geostationary
Orbit
MSG SEVIRI

HELLENIC MirrorSite

**Ελληνικό Mirror Site (Copernicus satellite missions)**
http://beyond-eocenter.eu/index.php/web-services/hellenic-mirror-site)

GreekHUB

**Sentinels GreekHUB**
(http://beyond-eocenter.eu/index.php/web-services/sentinels-greekhub)

Manned &
Unmanned
Aerial
Vehicles

In-situ networks and crowdsourcing

in-situ

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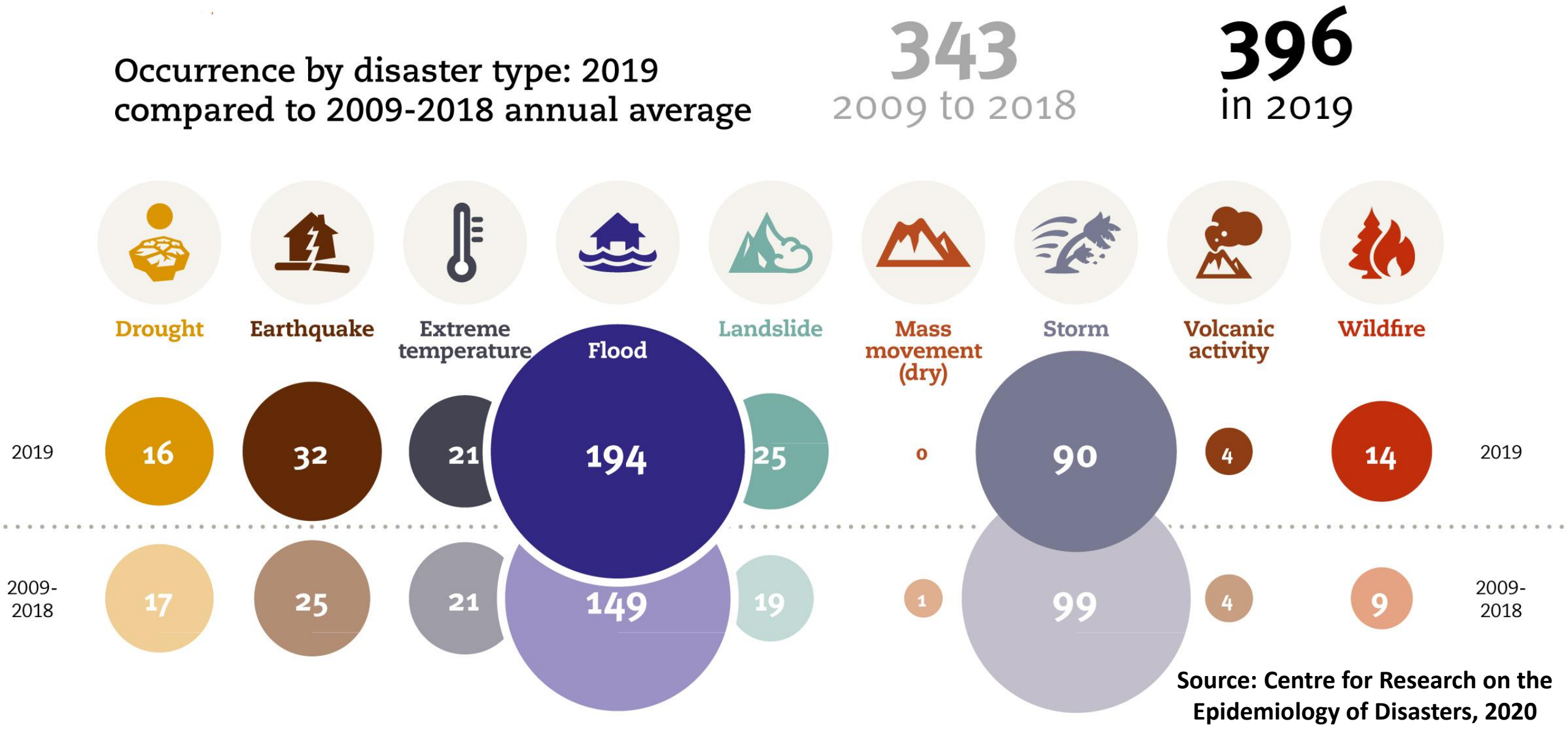
# Floods: the deadliest type of disaster
## 43.5% of deaths in 2019 (CRED 2020)




Source: Centre for Research on the Epidemiology of Disasters, 2020

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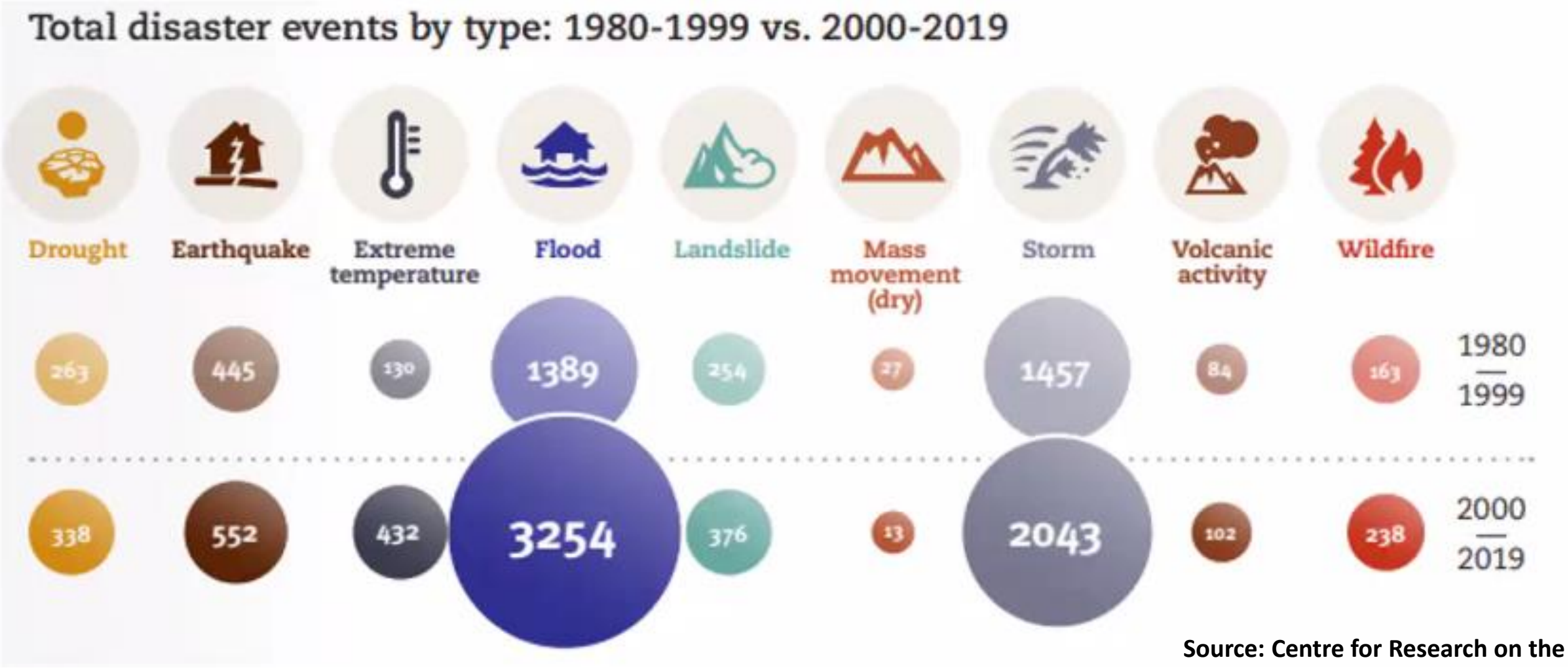


Source: Centre for Research on the Epidemiology of Disasters, 2020

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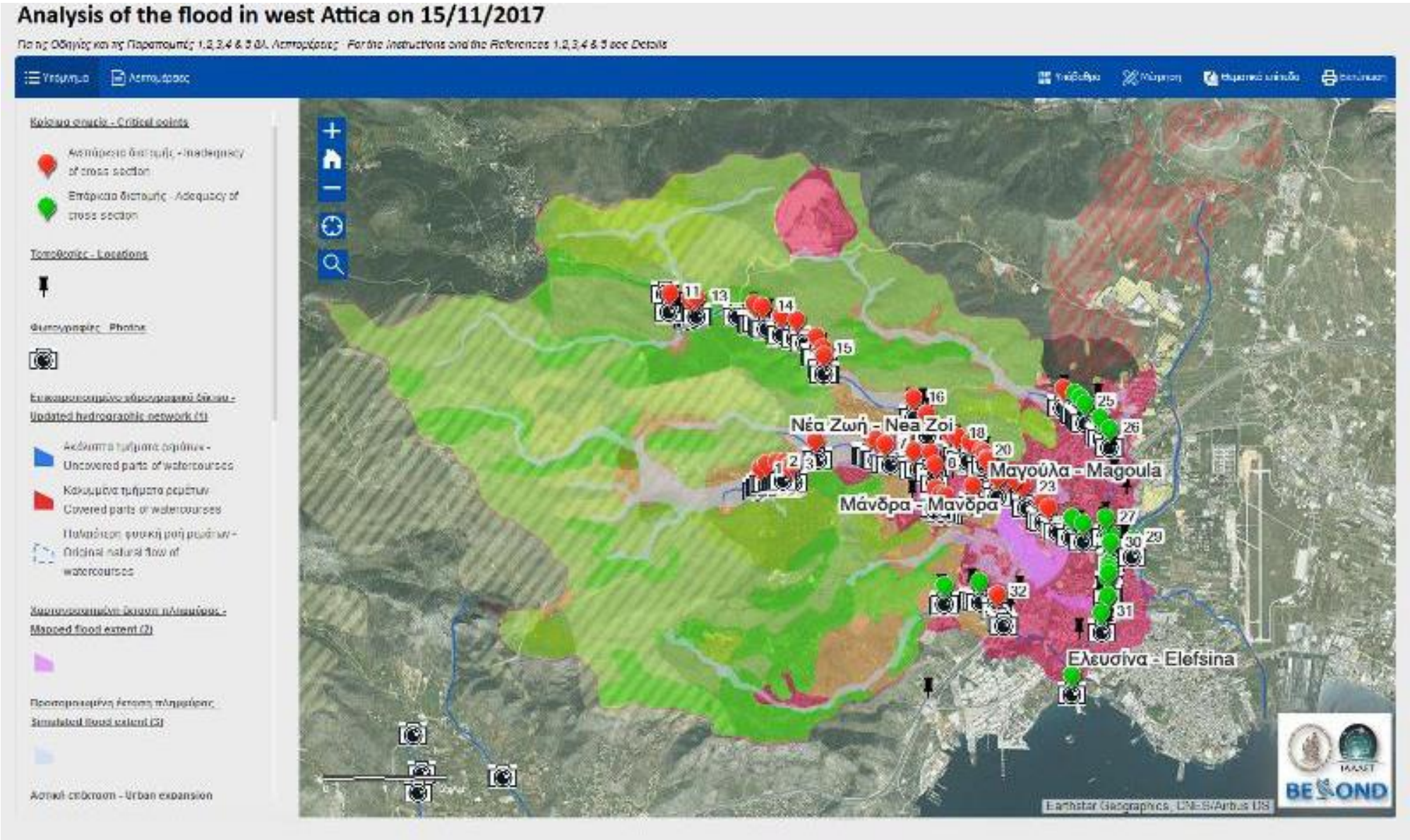
# Mandra flood 2017: Setup of an integrated web GIS platform

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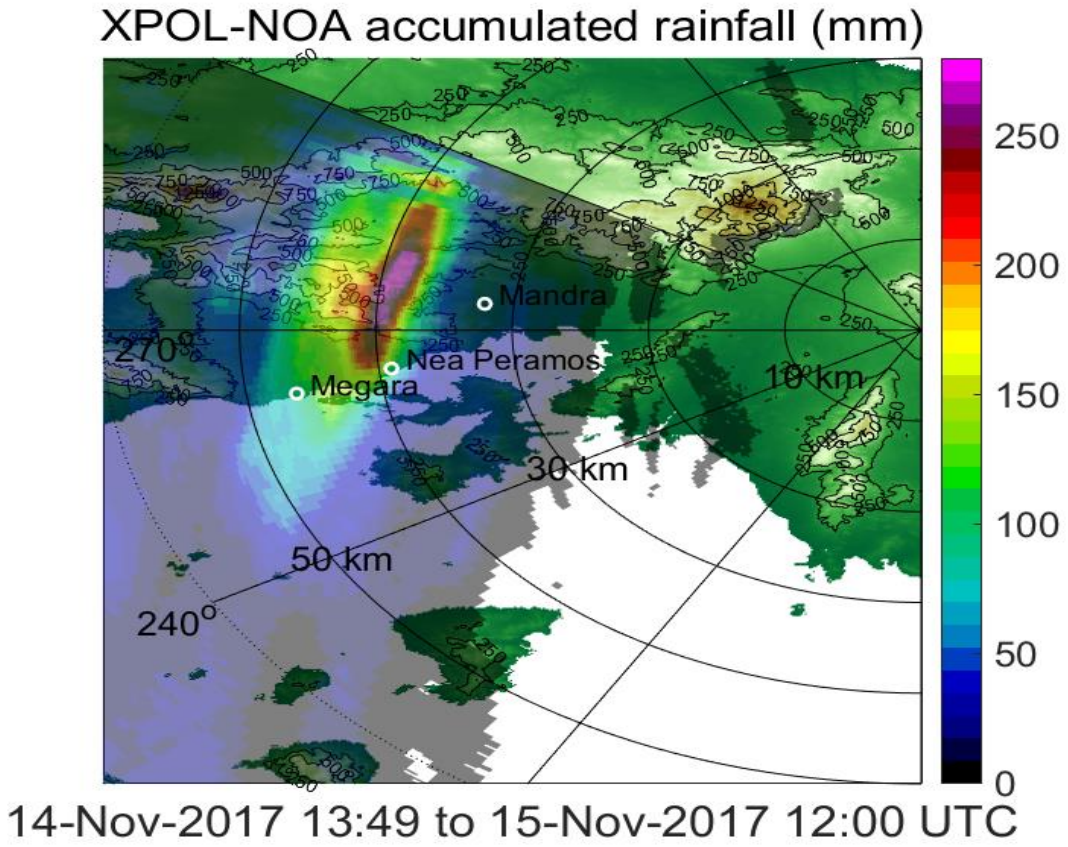
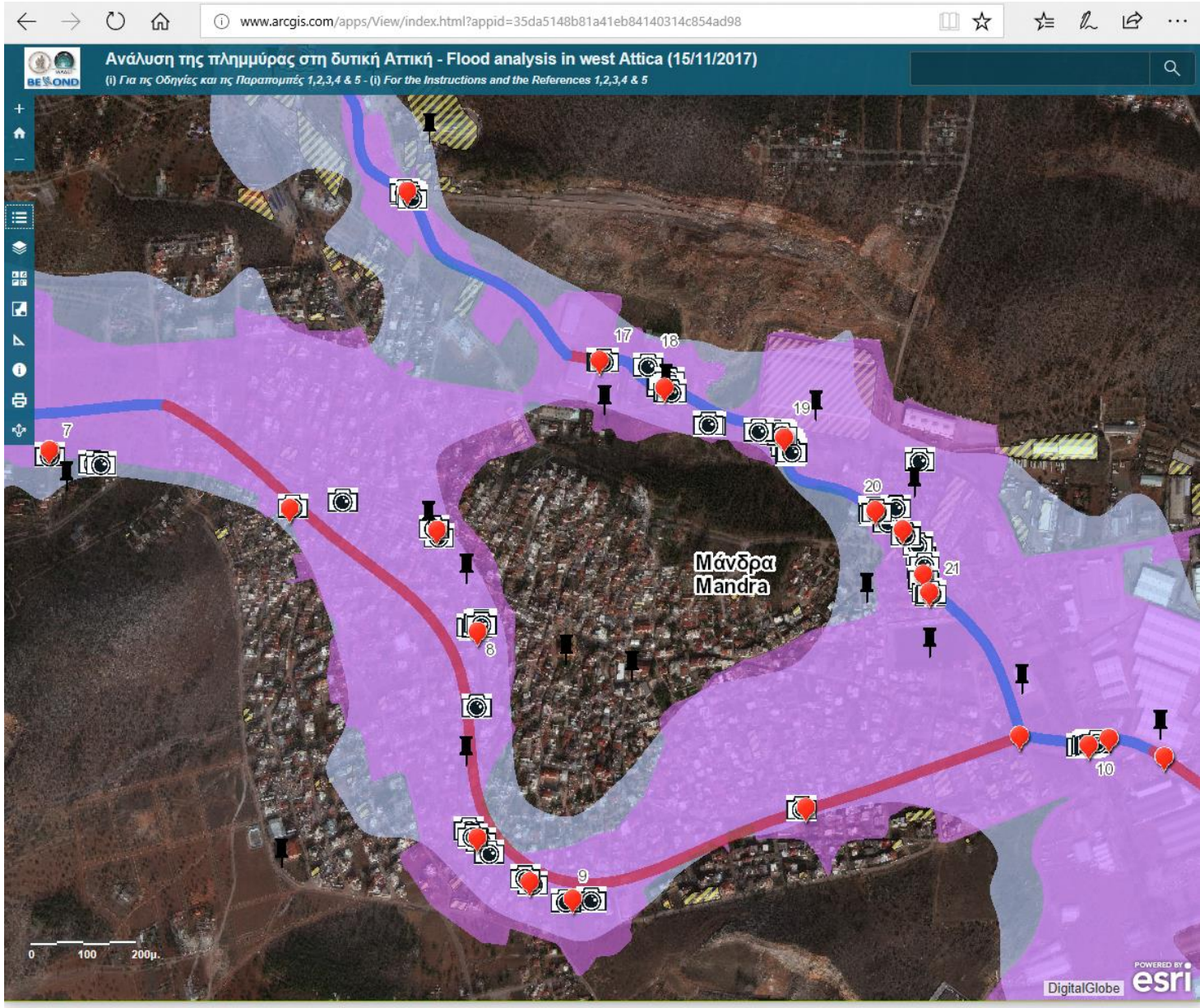
# Mandra flood 2017: modelling (blue) vs EO mapping (pink)

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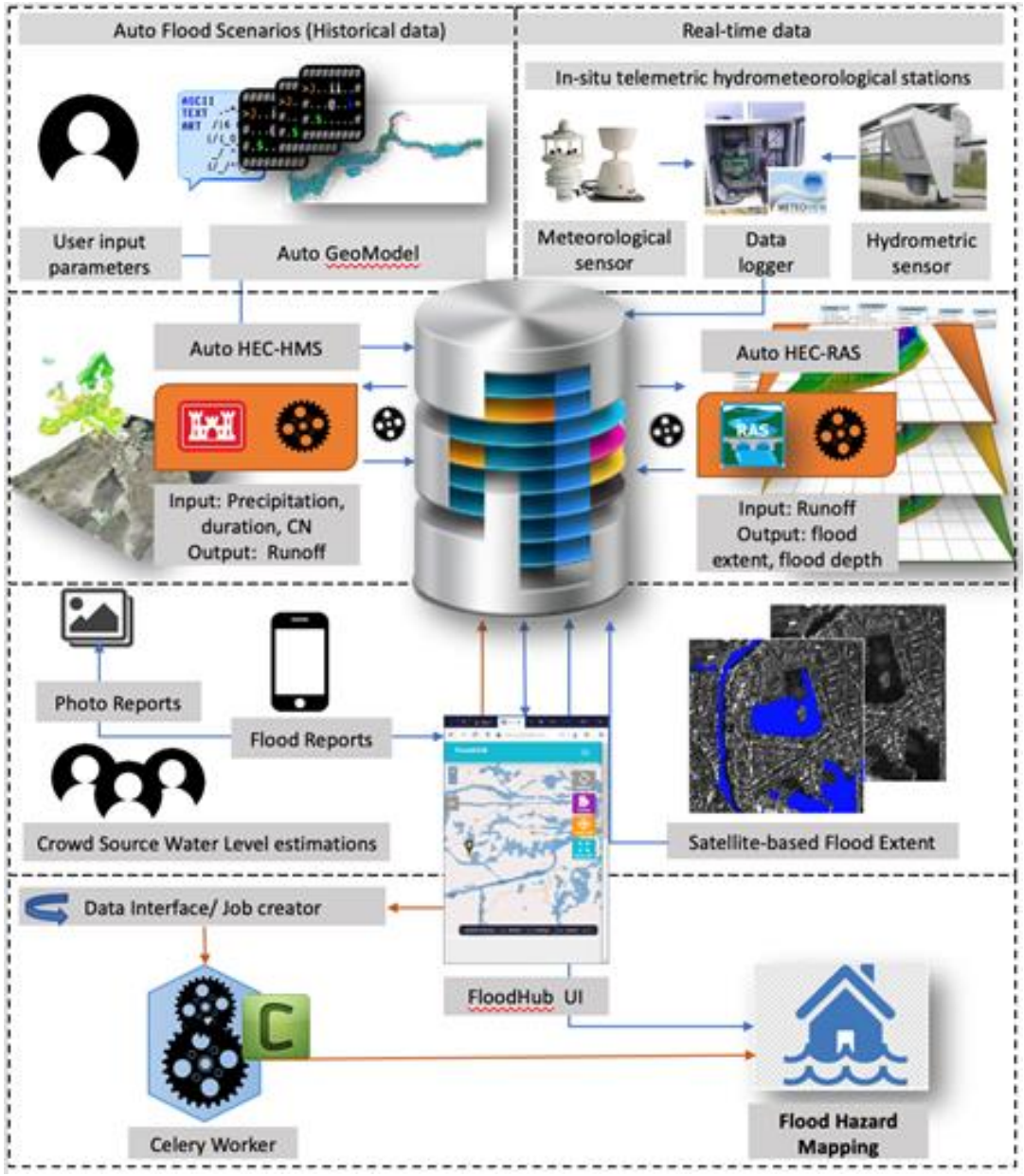
# Mandra 2020: Architecture of the FloodHUB system

## 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).

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# Mandra 2020: Development of the operational FloodHUB system

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NATIONAL OBSERVATORY OF ATHENS
1842
BEYOND
Centre of EO Research & Satellite Remote Sensing
FloodHUB

HELLENIC PETROLEUM

**Procurement and installation of 3 telemetric hydrometeorological stations with co-funding by the Hellenic Petroleum S.A. and the SMURBS/ERA-PLANET project, in collaboration with the Attica Region**

SMURBS
ERA-PLANET

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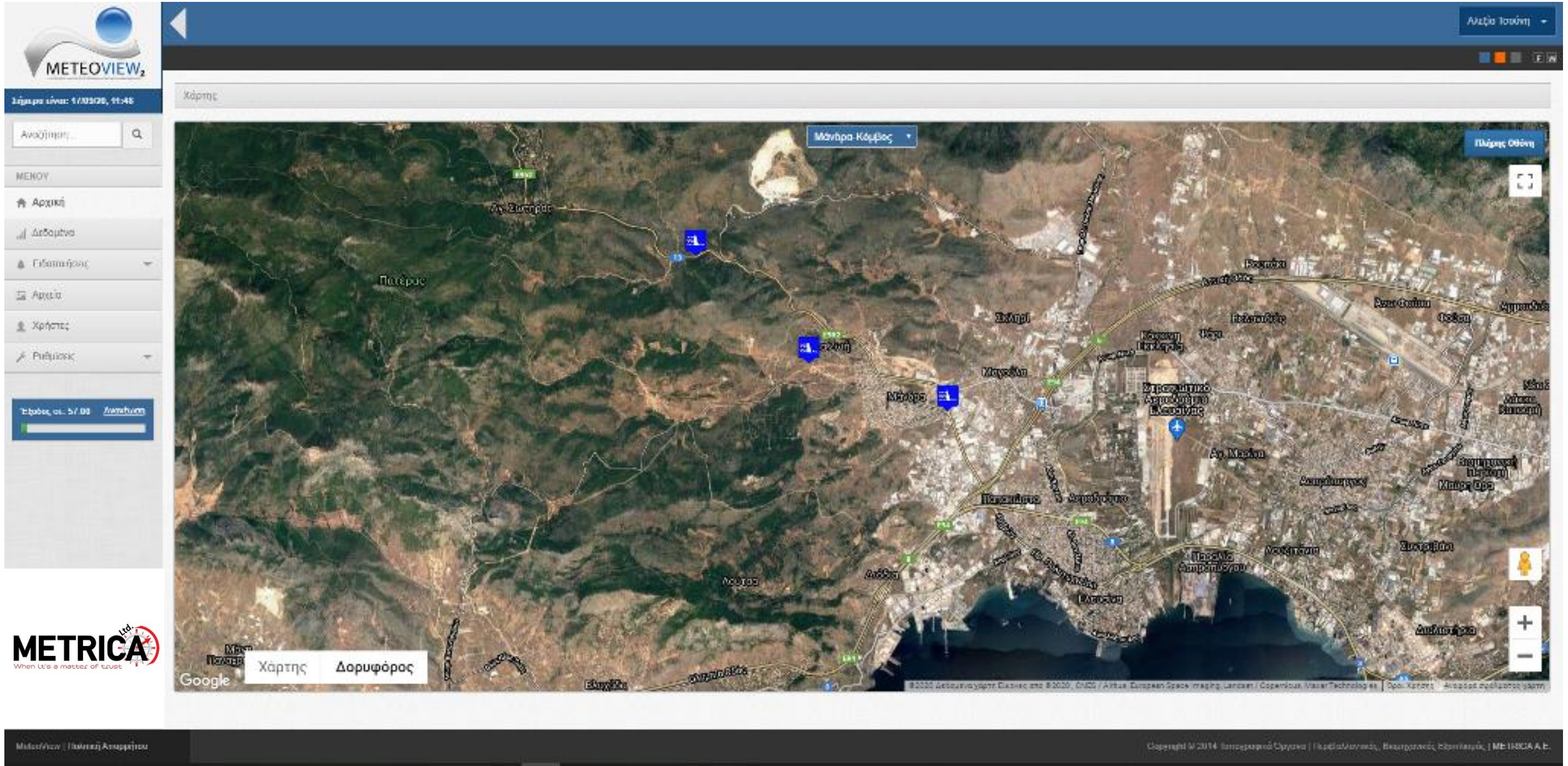
# Web platform of the 3 telemetric hydrometeorological stations




METRICA Ltd
When it's a matter of trust

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# Web platform of the 3 telemetric hydrometeorological stations

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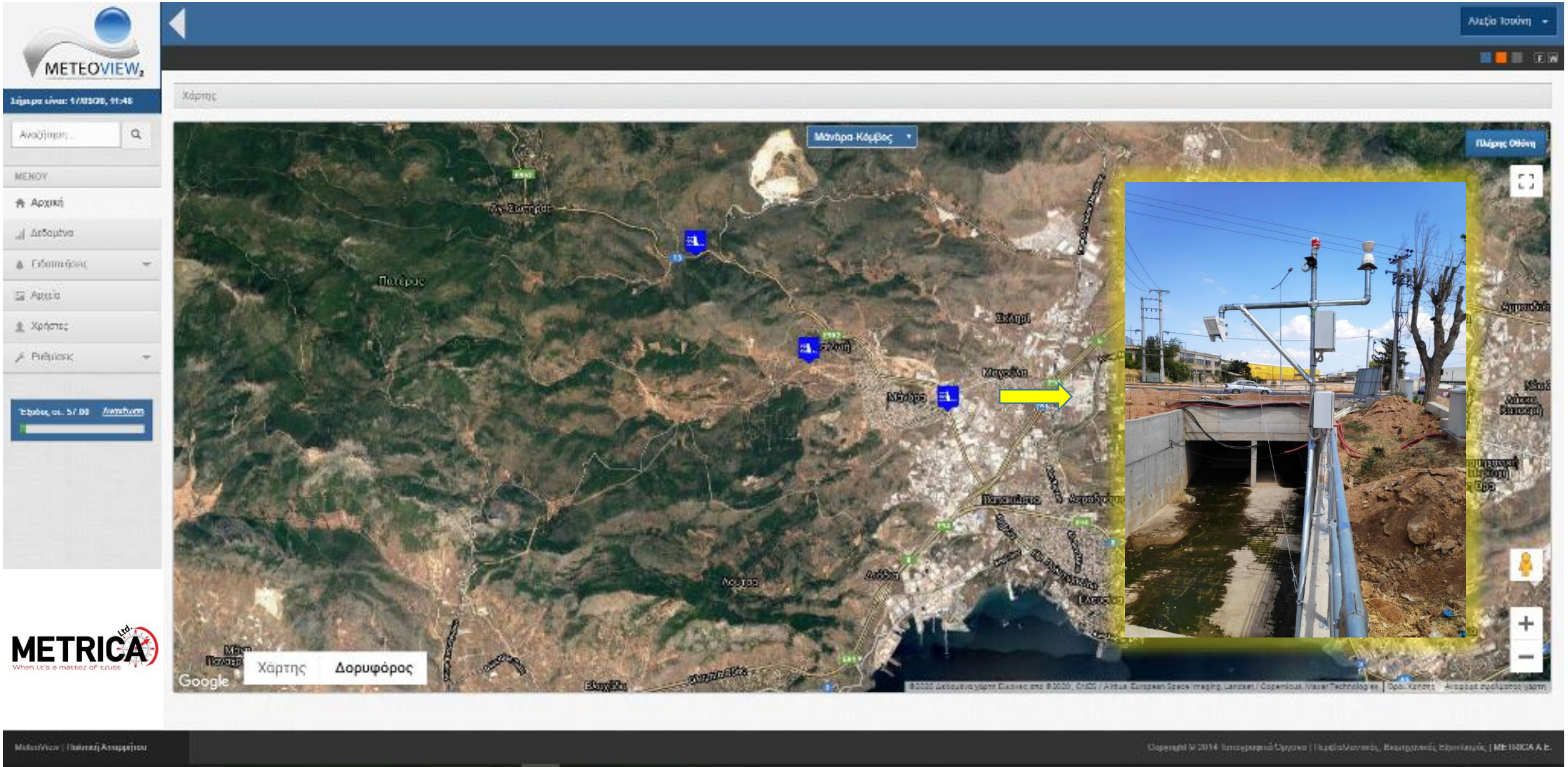
Centre of EO Research & Satellite Remote Sensing
FloodHUB



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# Web platform of the 3 telemetric hydrometeorological stations

ΕΘΝΙΚΟΝ ΑΣΤΕΡΟΣΚΟΠΕΙΟΝ ΑΘΗΝΩΝ
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# Web platform of the 3 telemetric hydrometeorological stations

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# Web platform of the 3 telemetric hydrometeorological stations

BEYOND Centre of EO Research & Satellite Remote Sensing
FloodHUB

METEOVIEW2

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

Search here...

MAIN NAVIGATION

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

Sign out in: 59:21 Refresh

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Home / View Data

Ν Πέρρου

Άγιος Αθανάσιος
Μάνδρα-Εκτροπή
Μάνδρα-Κόμβος

ΆΓΙΟΣ ΑΘΑΝΆΣΙΟΣ

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

Live Photos

SELECTION FILTERS FOR DATA VIEW

Date Interval: Choose Interval
Date From* Time from 00:00
Date To* Time to 23:59

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:
Select one or more stations to compare

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.

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# Real-time crowdsourcing platform for staff and volunteers

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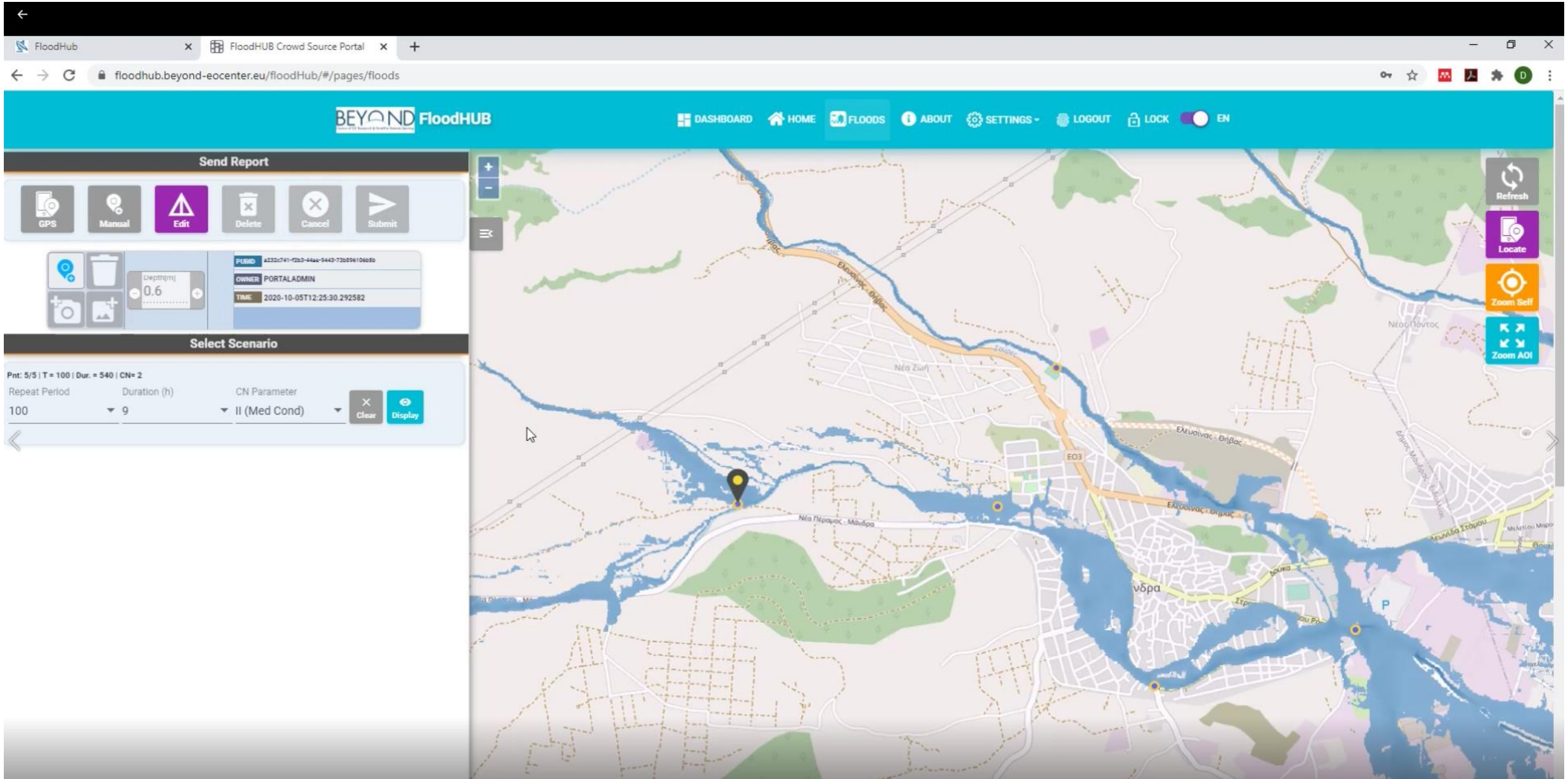

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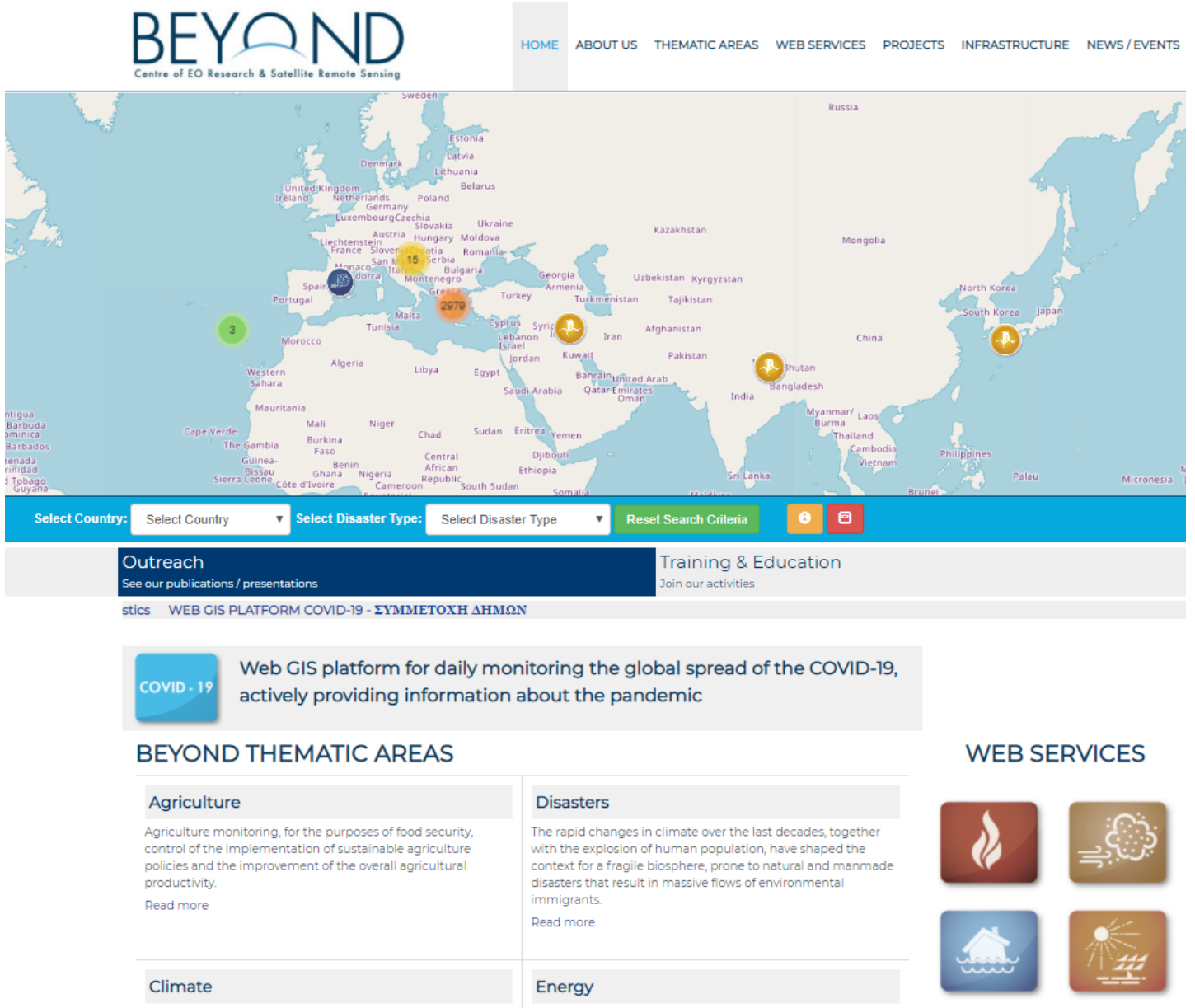
# Integrated near-real-time flood monitoring system



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# Integrated near-real-time flood monitoring system

National Observatory of Athens
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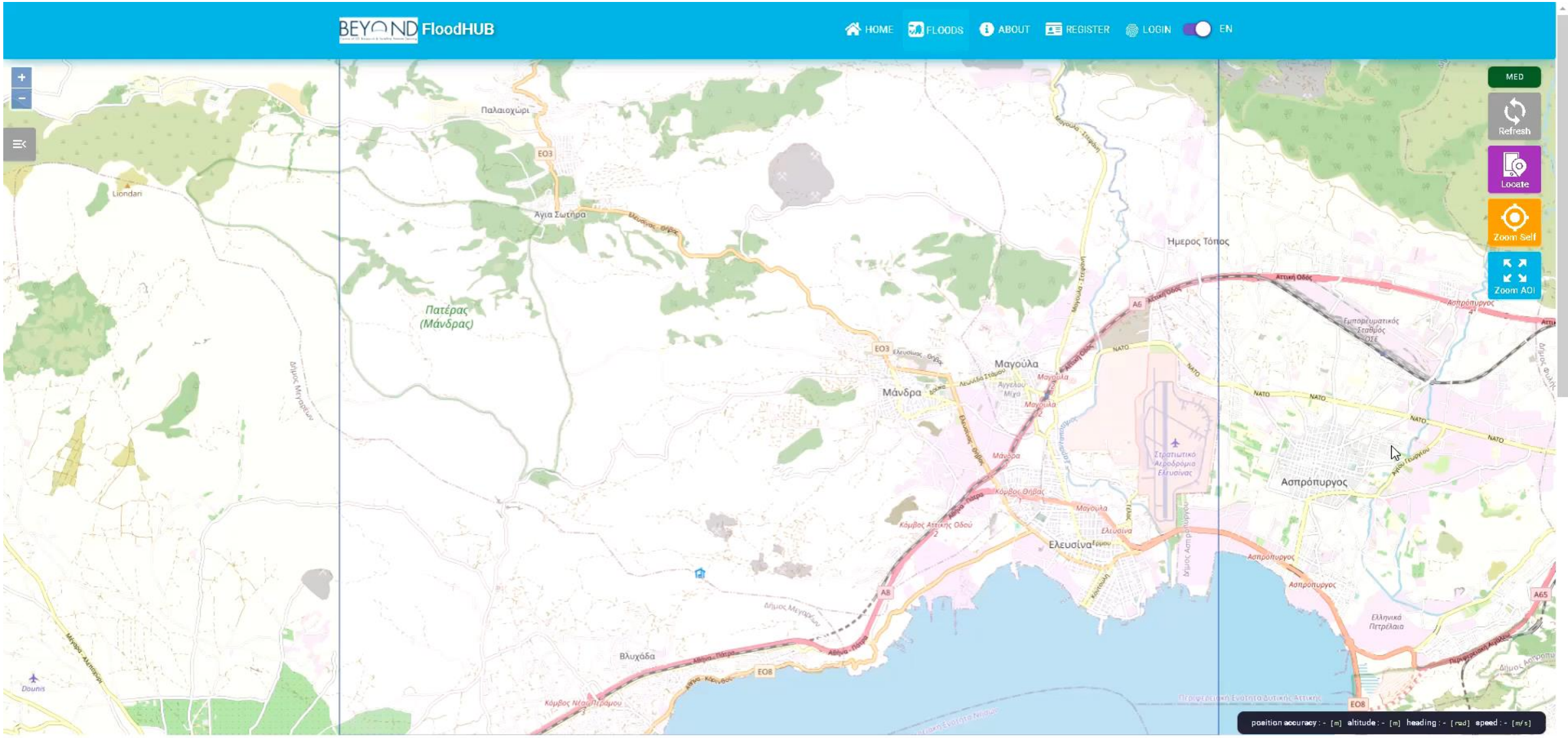

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# Integrated near-real-time flood monitoring system

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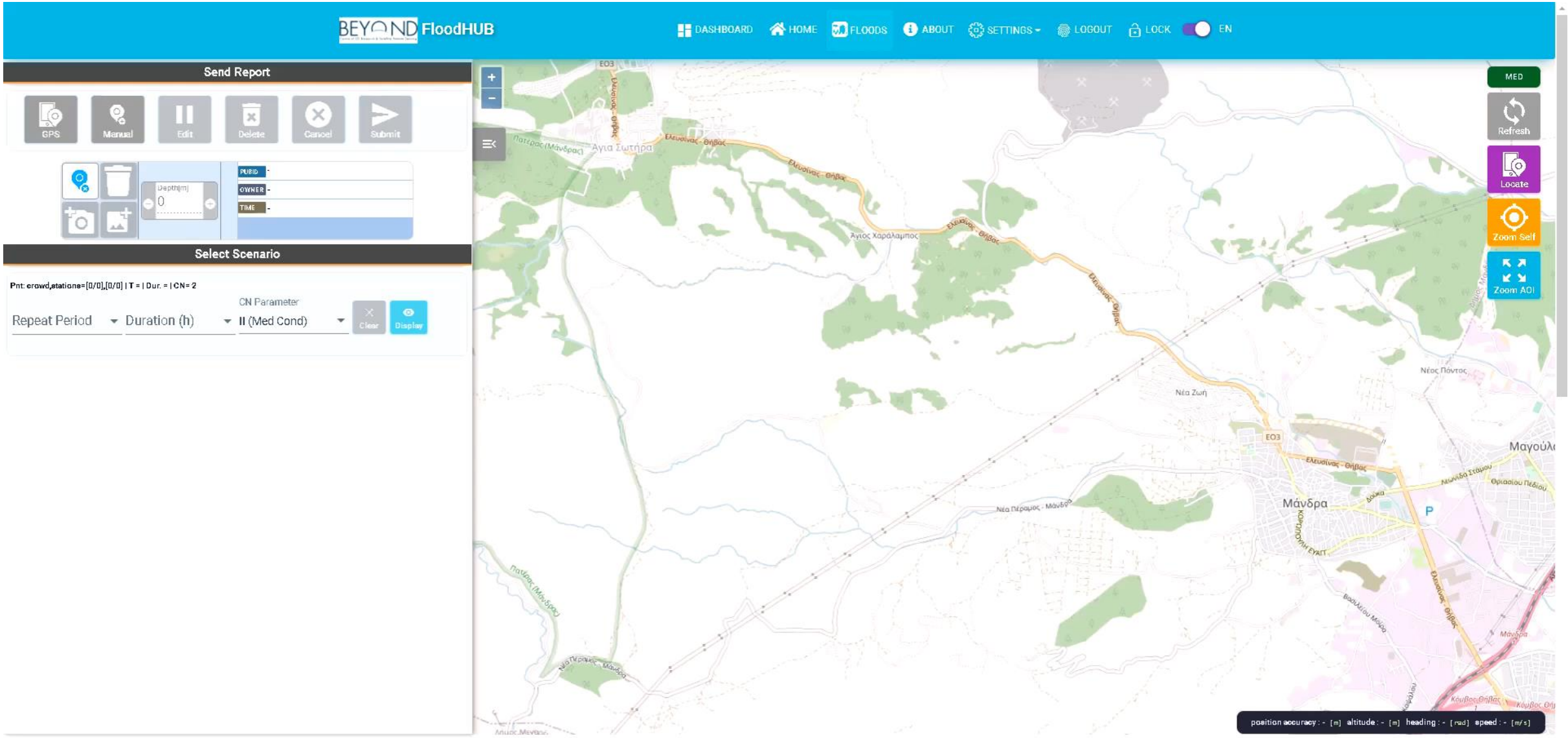

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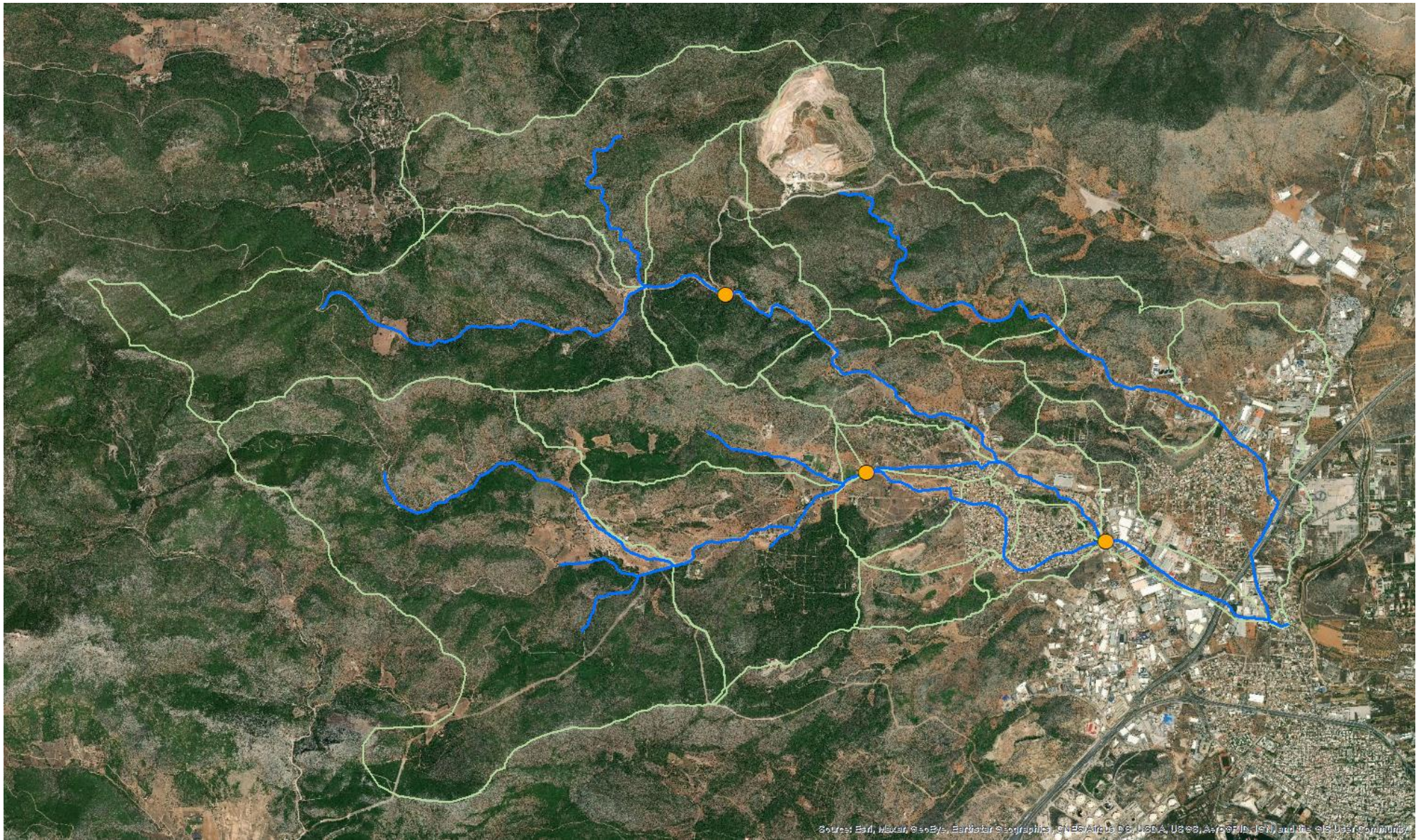
# Hydrologic & hydraulic simulation




RIVER BASIN
57 km$^2$

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

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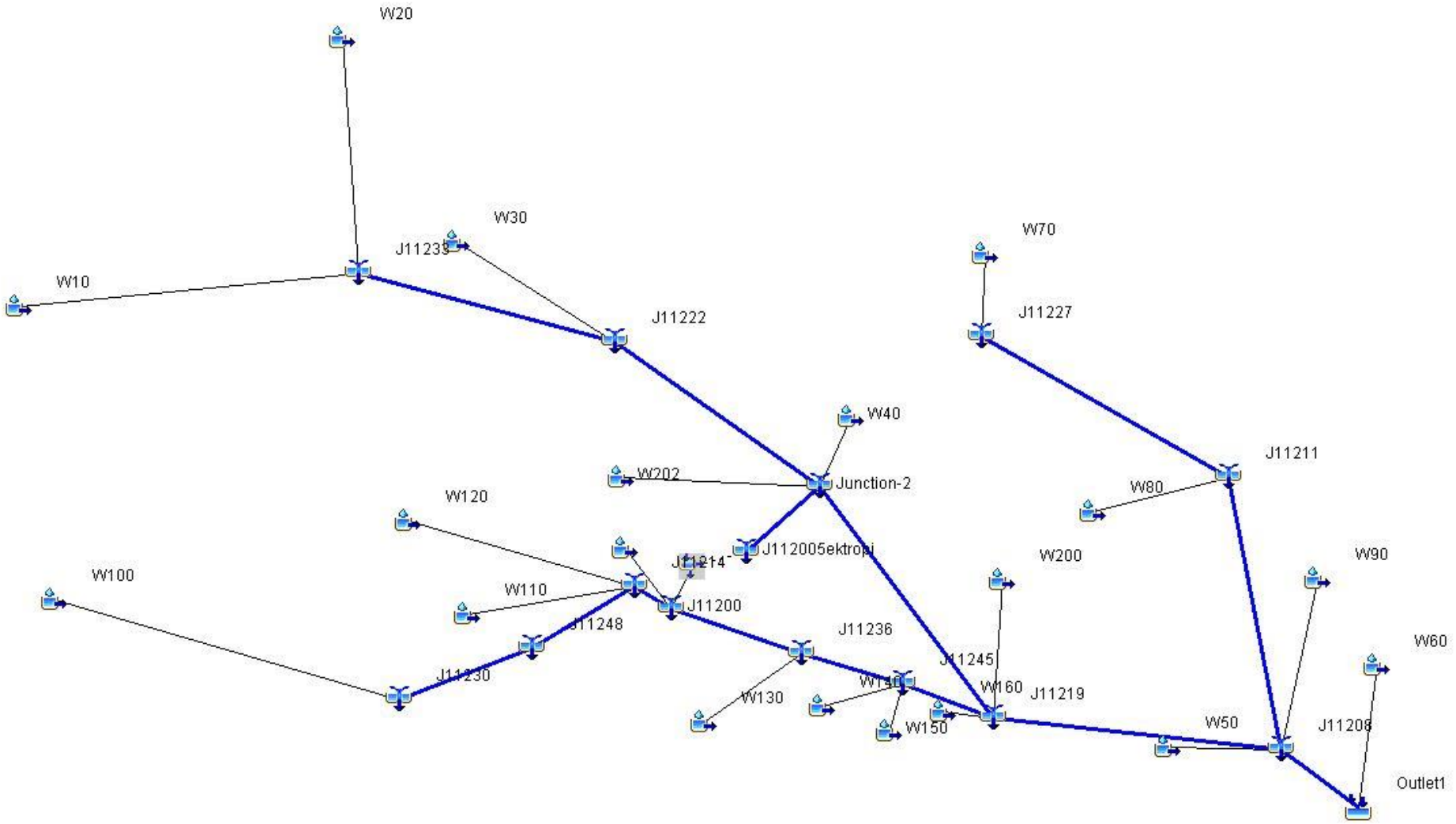
# Hydrologic & hydraulic simulation




**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

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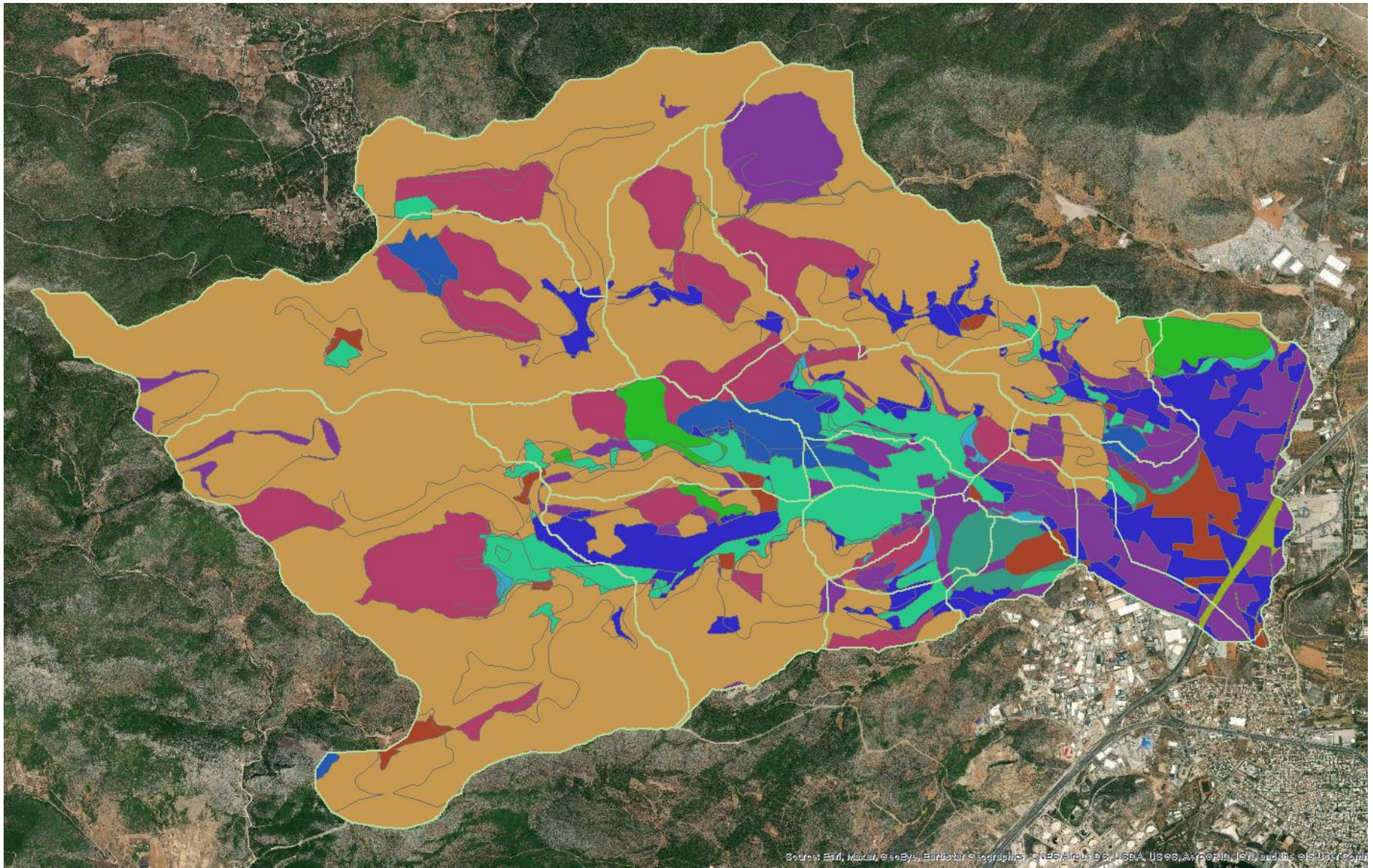
# Hydrologic & hydraulic simulation



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# 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

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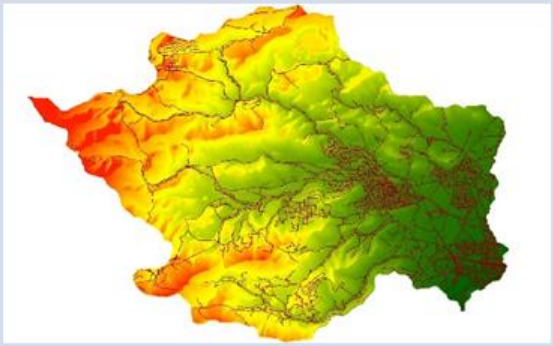
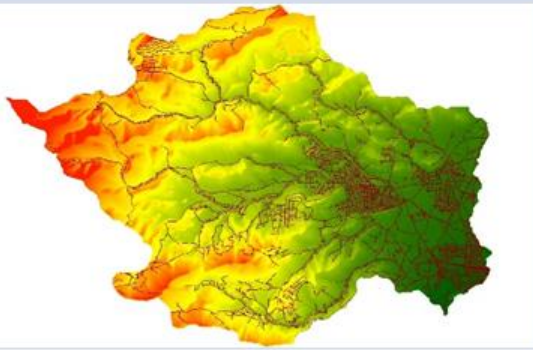
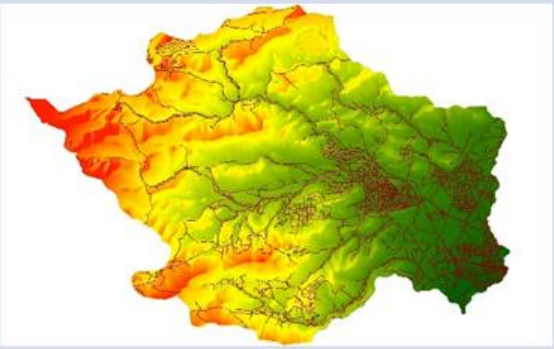
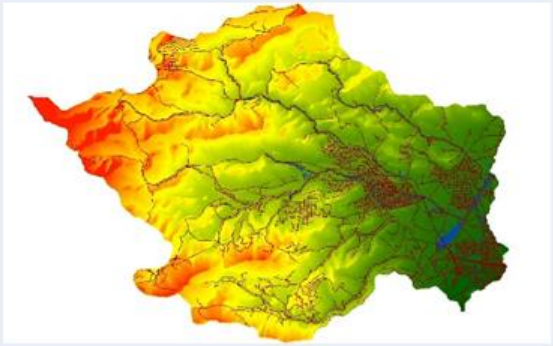
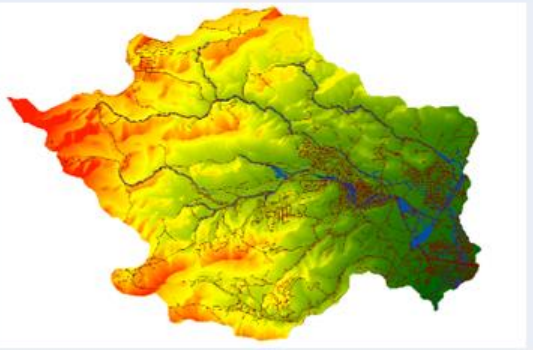
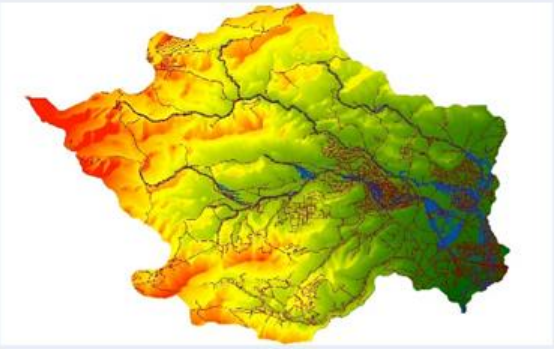
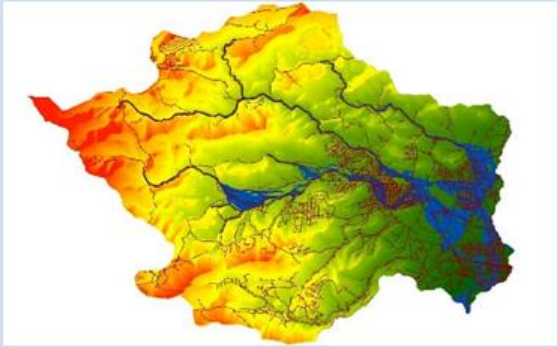
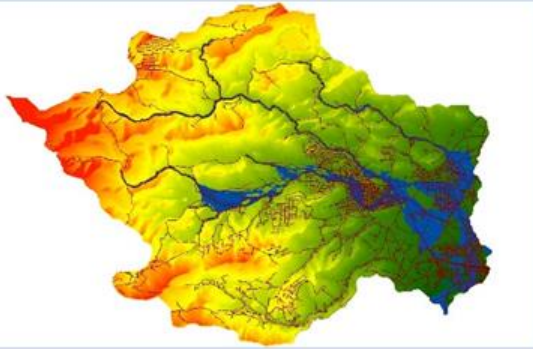
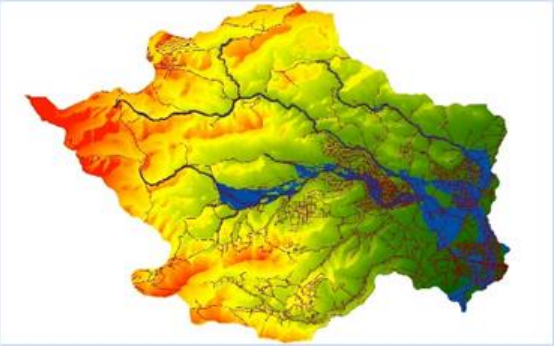
# Flood mapping results
# T = 50 years

| T = 50 years | d = 3 hours | d = 6 hours | d = 9 hours |
|---|---|---|---|
| CN I<br>Dry conditions |  |  |  |
| CN II<br>Average conditions |  |  |  |
| CN III<br>Wet conditions |  |  |  |

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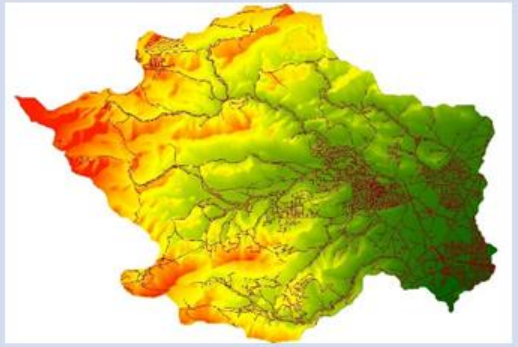
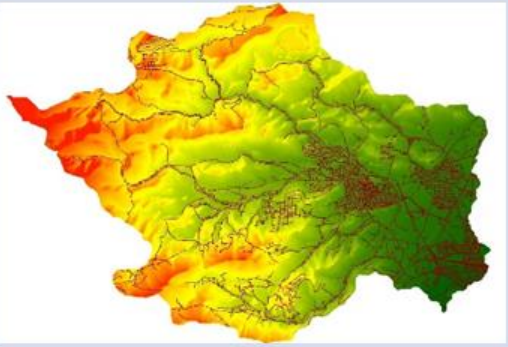
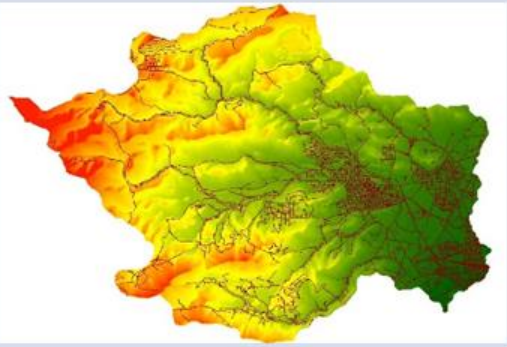
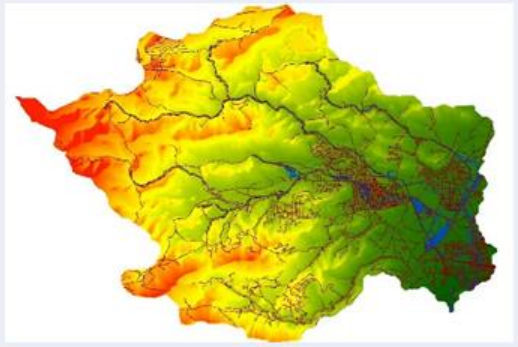
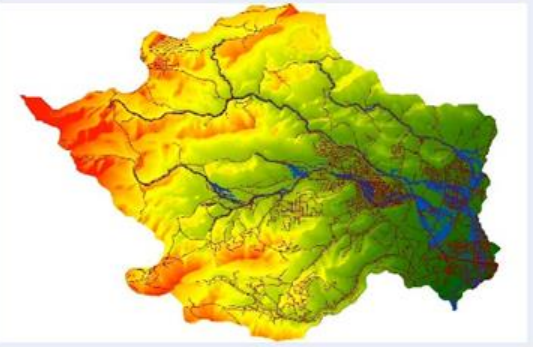
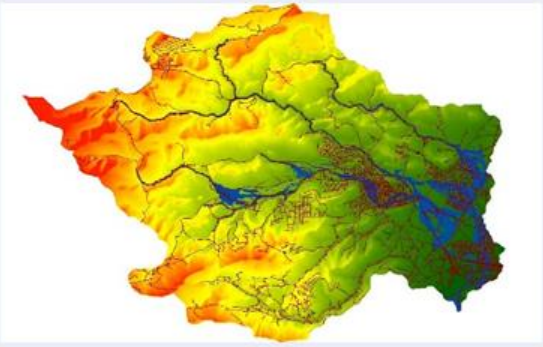
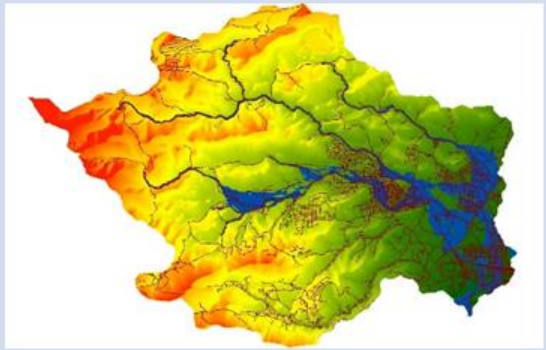
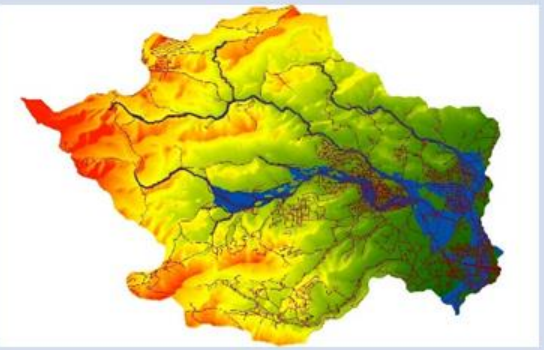
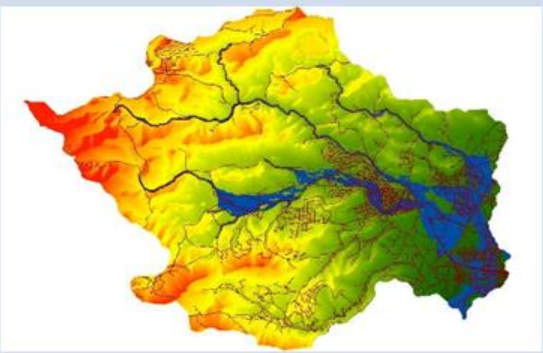
# Flood mapping results
# T = 100 years

| T = 100 years | d = 3 hours | d = 6 hours | d = 9 hours |
|---|---|---|---|
| CN I Dry conditions |  |  |  |
| CN II Average conditions |  |  |  |
| CN III Wet conditions |  |  |  |

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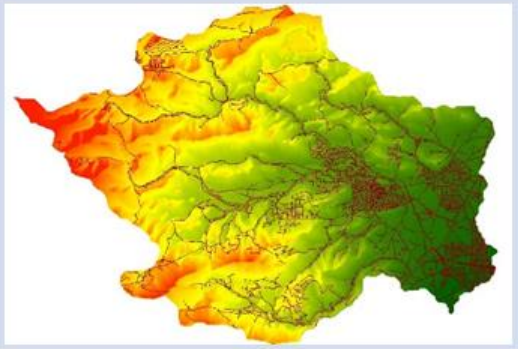
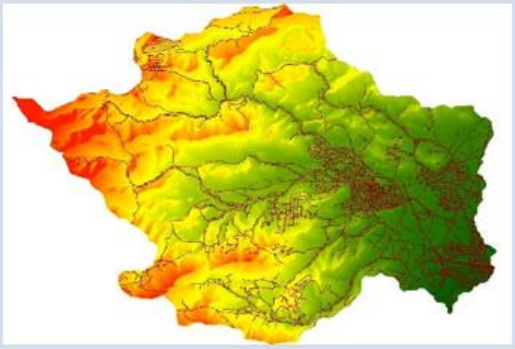
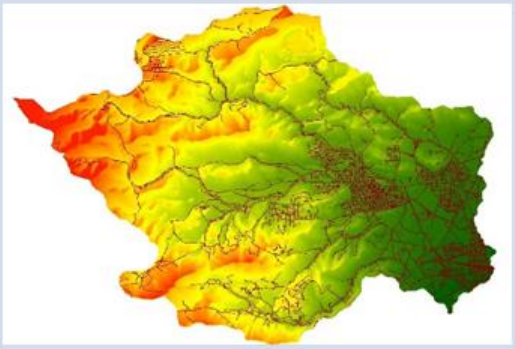
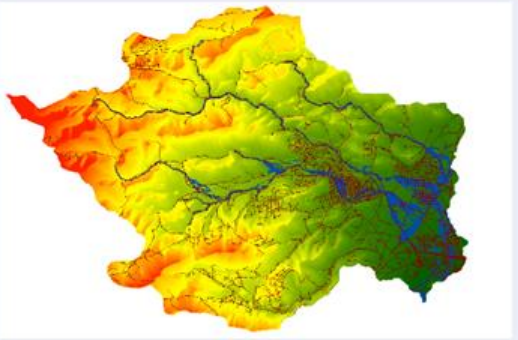
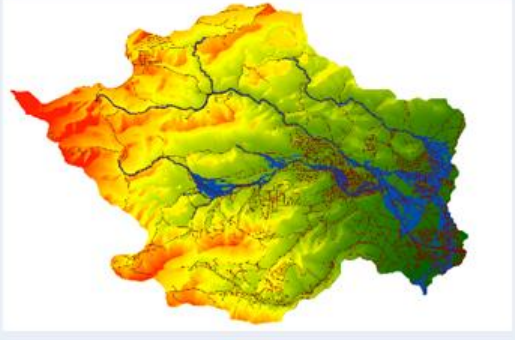
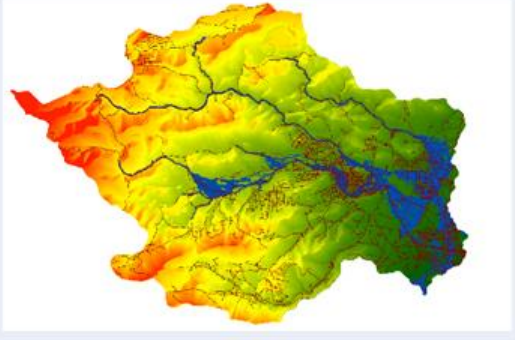
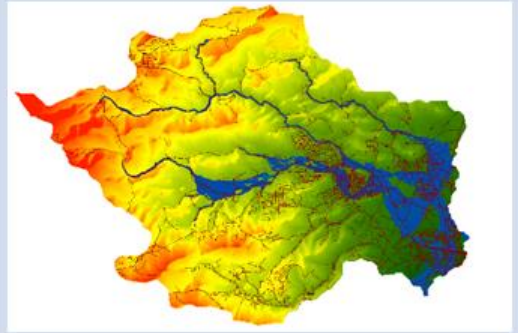
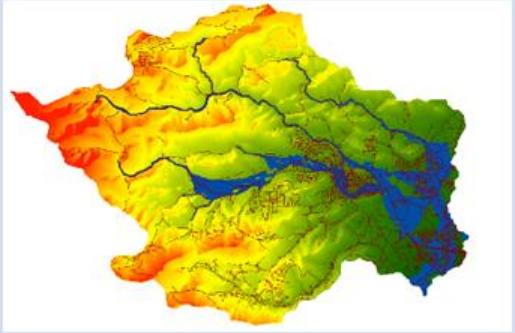
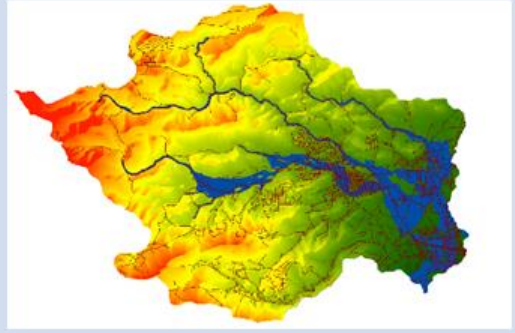
# Flood mapping results
# T = 200 years

| T = 200 years | d = 3 hours | d = 6 hours | d = 9 hours |
|---|---|---|---|
| CN I Dry conditions |  |  |  |
| CN II Average conditions |  |  |  |
| CN III Wet conditions |  |  |  |

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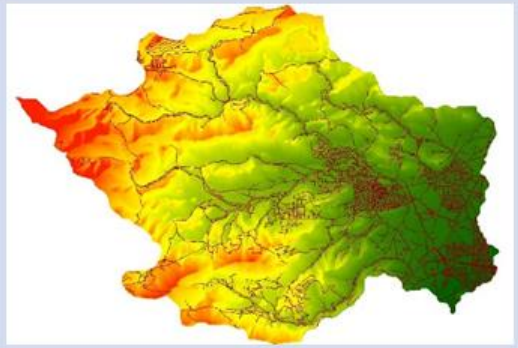
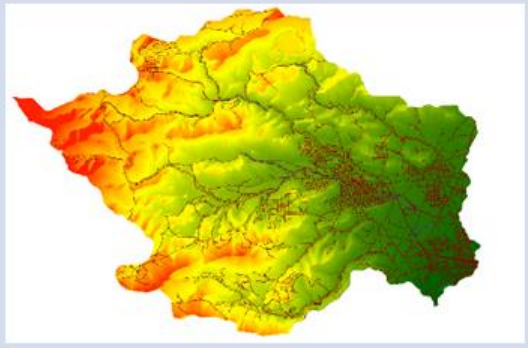
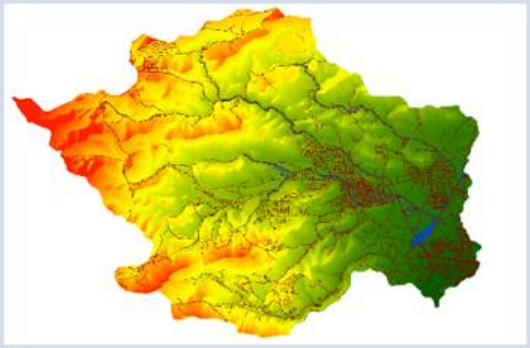
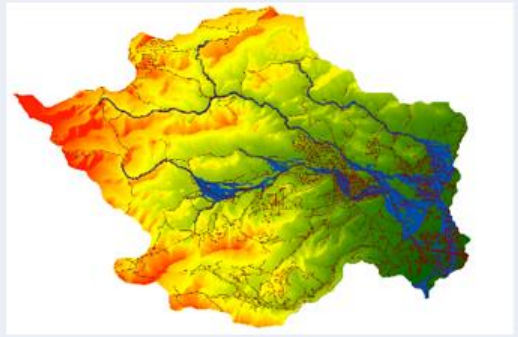
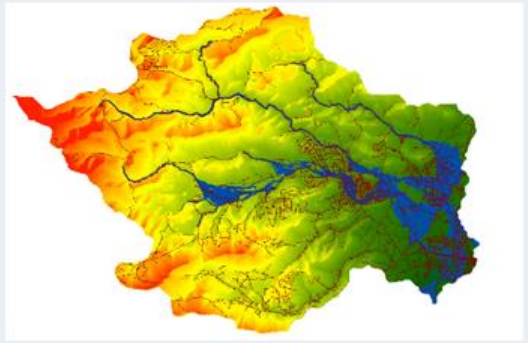
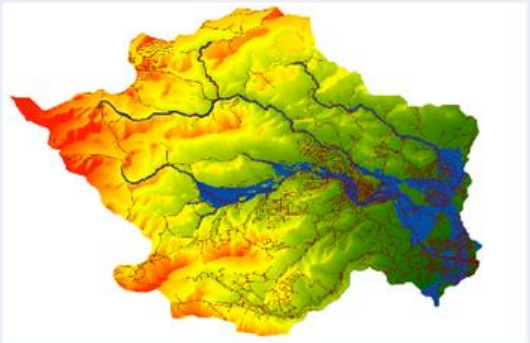
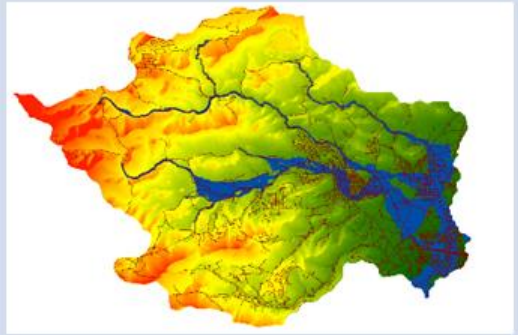
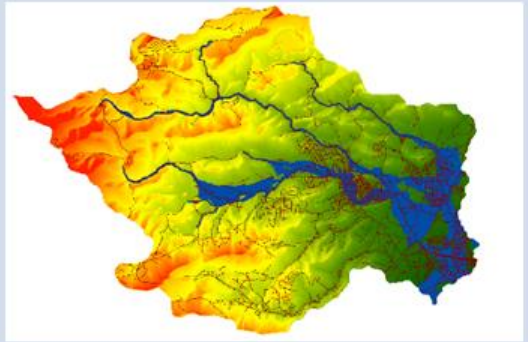
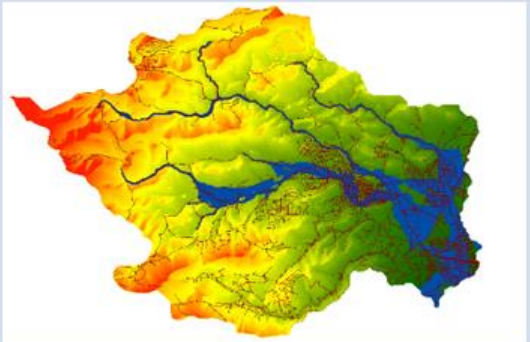
# Flood mapping results
# T = 500 years

| T = 500 years | d = 3 hours | d = 6 hours | d = 9 hours |
|---|---|---|---|
| CN I Dry conditions |  |  |  |
| CN II Average conditions |  |  |  |
| CN III Wet conditions |  |  |  |

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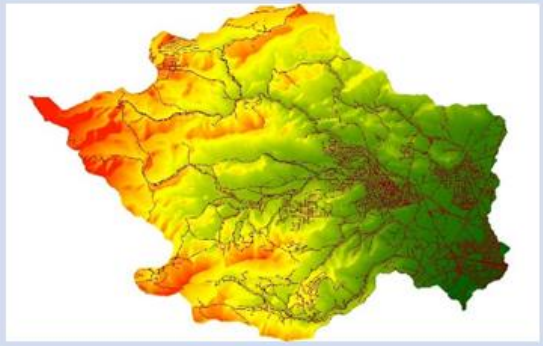
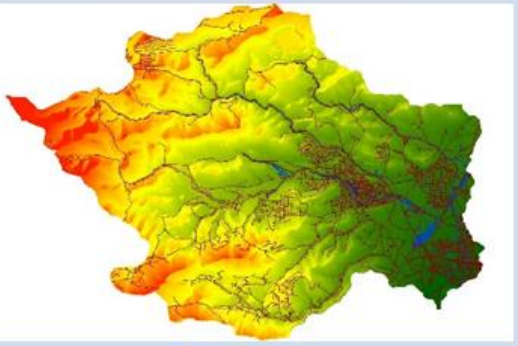
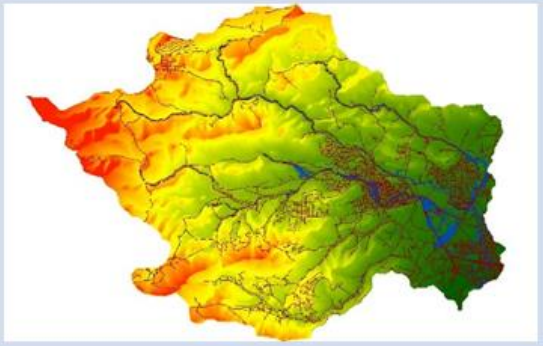
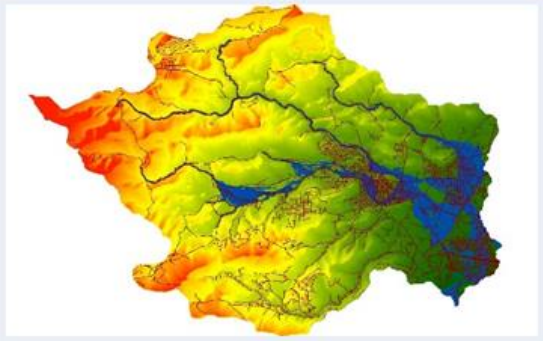
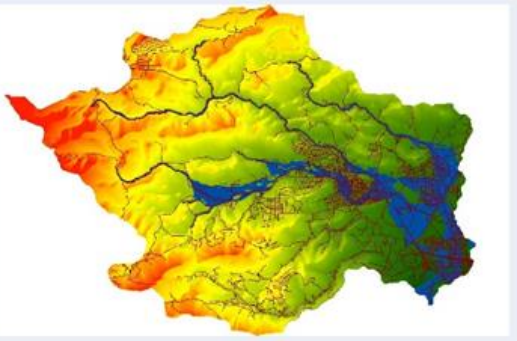
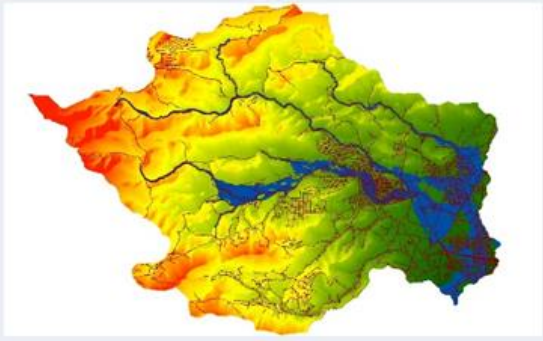
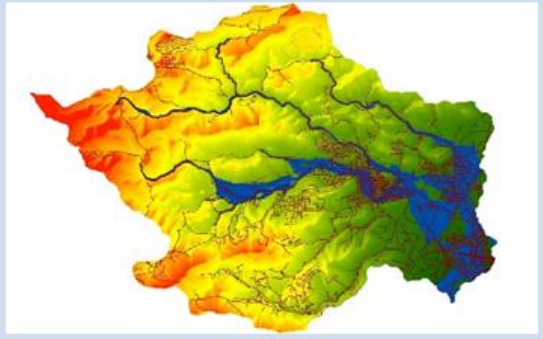
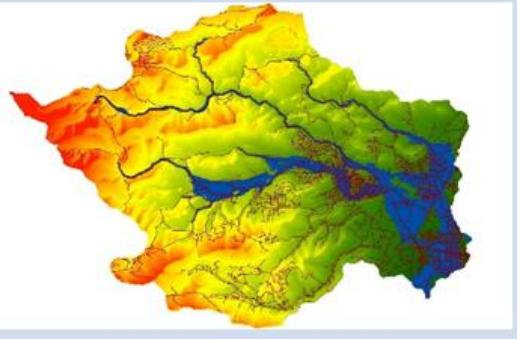
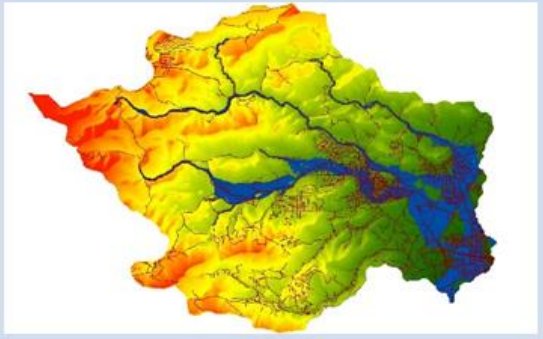
# Flood mapping results
# T = 1000 years

| T = 1000 years | d = 3 hours | d = 6 hours | d = 9 hours |
|---|---|---|---|
| CN I<br>Dry conditions |  |  |  |
| CN II<br>Average conditions |  |  |  |
| CN III<br>Wet conditions |  |  |  |

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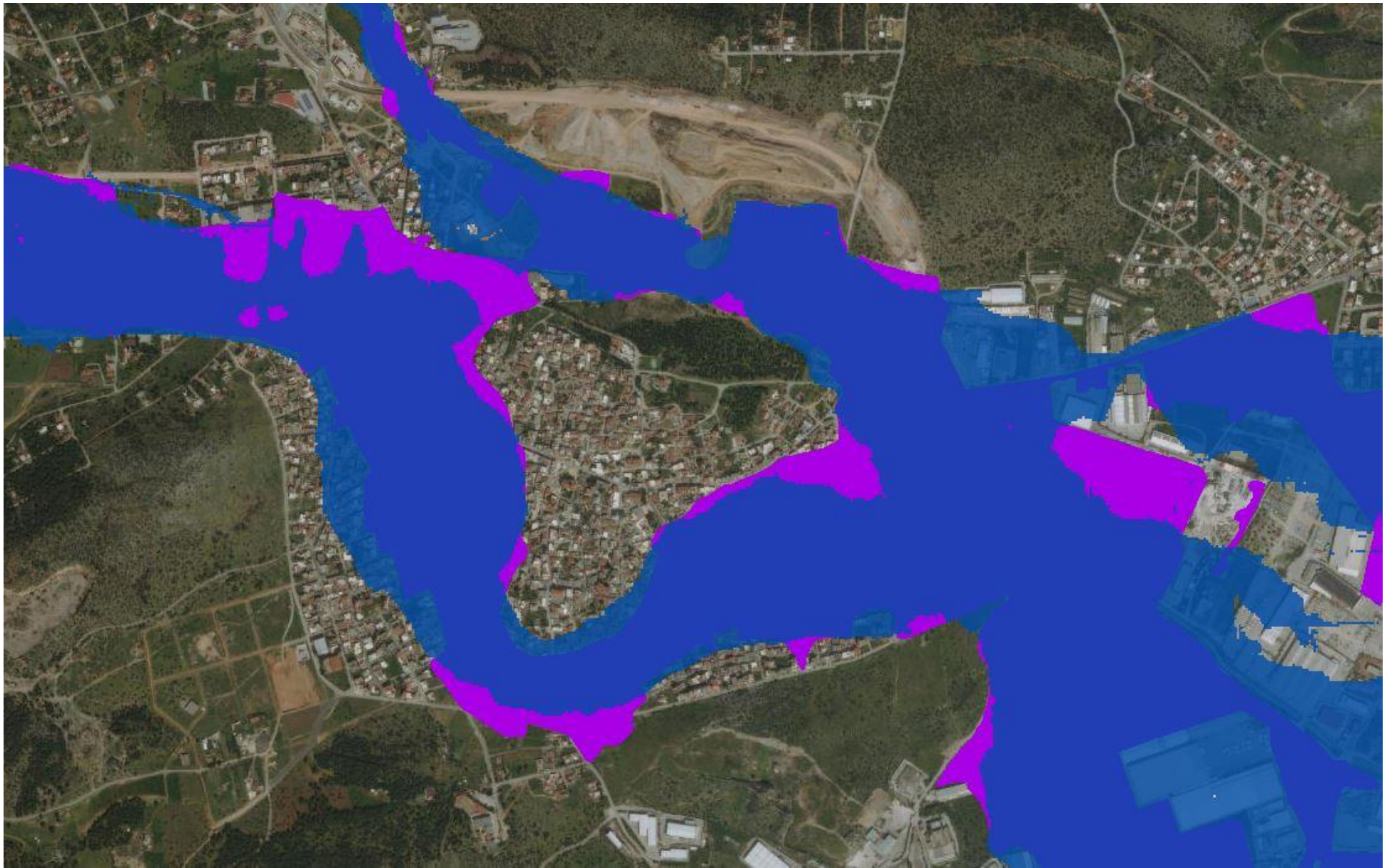
# Mandra flood 2017: modelling (blue) vs EO mapping (pink)

ΕΘΝΙΚΟΝ ΑΣΤΕΡΟΣΚΟΠΕΙΟΝ ΑΘΗΝΩΝ
NATIONAL OBSERVATORY OF ATHENS
1842
BEYOND
Centre of EO Research & Satellite Remote Sensing
FloodHUB

**Blue:**
**Simulation of flood scenario T1000 CNIII d6**



**Pink:**
**VHR satellite-based mapping (Meteoview)**

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# FloodHUB system in support of the decision makers

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**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

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# Stakeholders' trainings in the operational FloodHUB system

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**Thank you for your attention!**

**Contact me: alexiatsouni@noa.gr**