

## FloodHub; An Integrated Near-Real-Time Flood Monitoring System in support of the decision makers based on Modeling, Multi-source EO and Crowdsourced data

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National Observatory of Athens - BEYOND Center - FloodHUB



Disaster Resilience  
Action Group



<http://beyond-eocenter.eu>



# The BEYOND Center of EO Research & Satellite Remote Sensing



**BEYOND**  
Centre 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

**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>)**

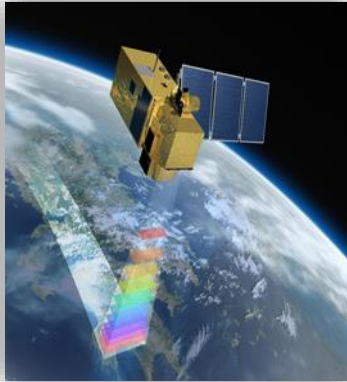
ClimaHUB

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

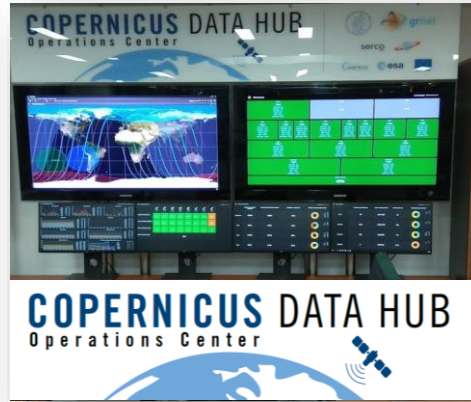
# The monitoring systems of the BEYOND Center



**BEYOND**  
 Centre of EO Research & Satellite Remote Sensing



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



Satellites  
 Geostationary Orbit  
 MSG SEVIRI



Manned &  
 Unmanned  
 Aerial  
 Vehicles



In-situ networks and  
 crowdsourcing



**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>)



**COPERNICUS DATA HUB**  
 Operations Center

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

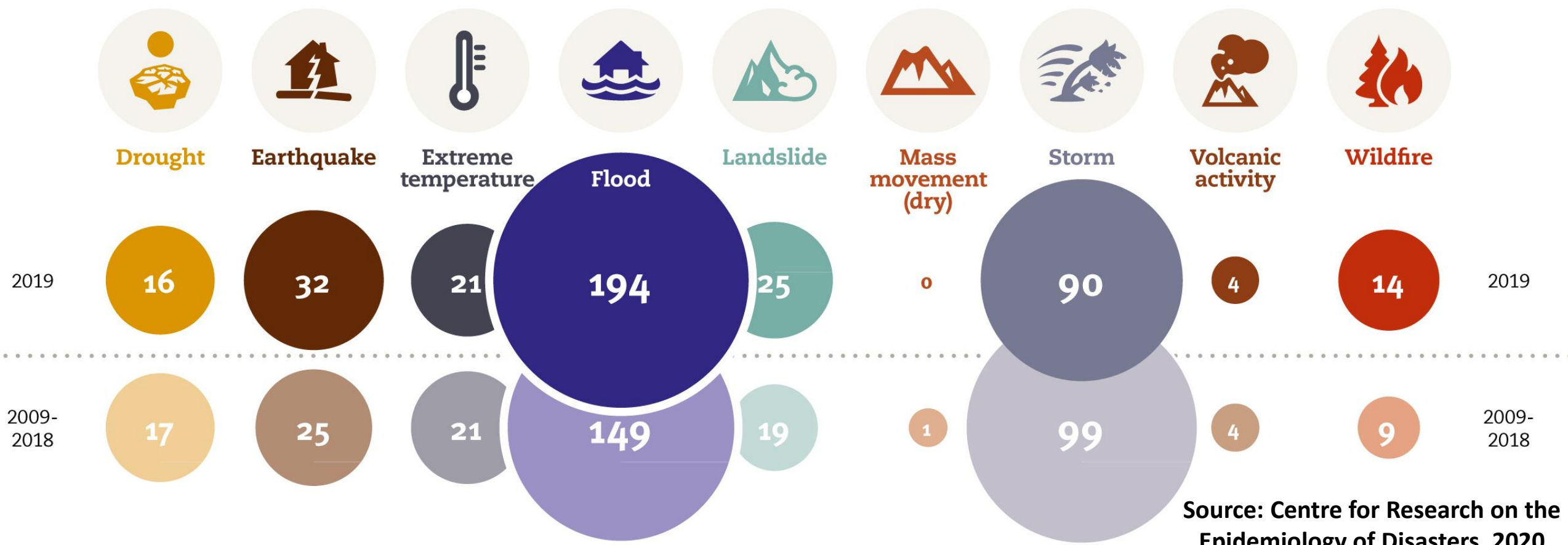
# Floods: the deadliest type of disaster 43.5% of deaths in 2019 (CRED 2020)



Occurrence by disaster type: 2019  
 compared to 2009-2018 annual average

**343**  
 2009 to 2018

**396**  
 in 2019

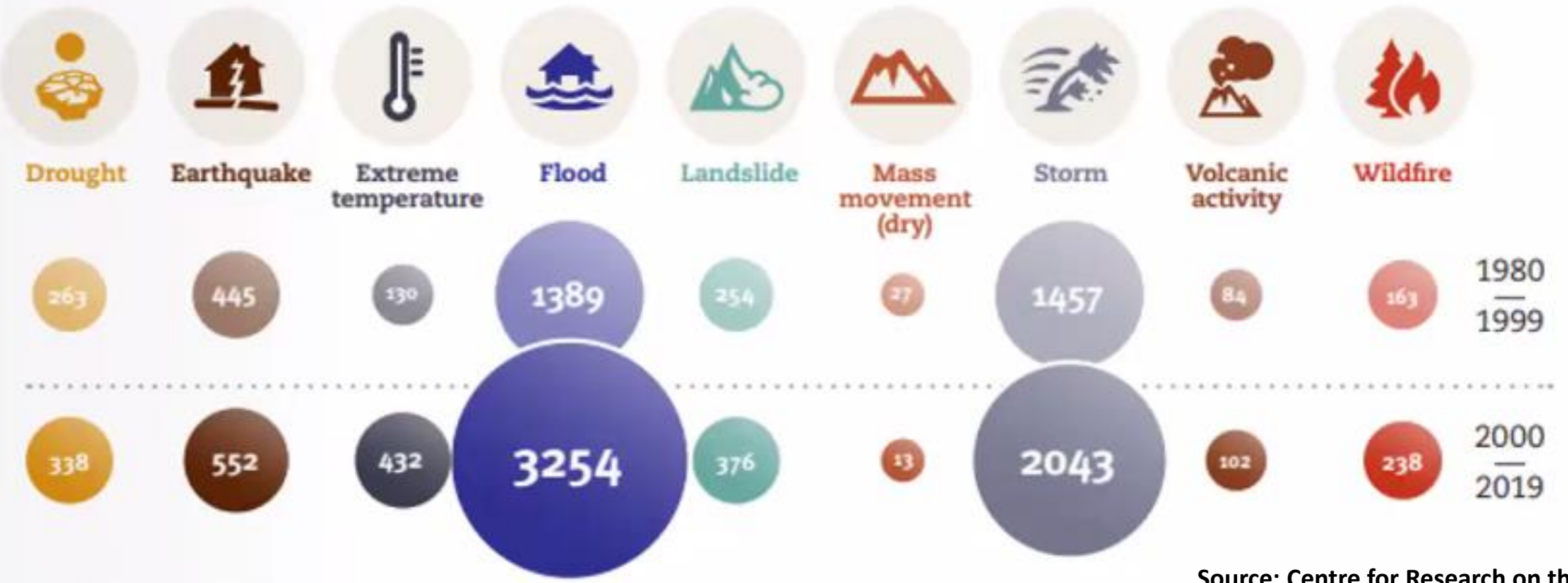


Source: Centre for Research on the Epidemiology of Disasters, 2020

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



Total disaster events by type: 1980-1999 vs. 2000-2019



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



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

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

**Κρίσιμα σημεία - Critical points**

- Ασπάρταση διατομής - Adequacy of cross section (Red dot)
- Επάρκεια διατομής - Adequacy of cross section (Green dot)

**Τοποθεσίες - Locations**

- Φωτογραφίες - Photos (Camera icon)

**Ευκατασκευασμένο υδρολογικό δίκτυο - Modified hydrological network (1)**

- Ακάλυπτα τμήματα υδρορρέων - Uncovered parts of watercourses (Blue)
- Καλυμμένα τμήματα υδρορρέων - Covered parts of watercourses (Red)
- Πρωτότυπη φυσική ροή υδρορρέων - Original natural flow of watercourses (Blue line)

**Χαρτογραφημένο έδαφος πλημμύρας - Mapped flood extent (2)**

- Προσπορευμένη έκταση πλημμύρας - Simulated flood extent (Pink)

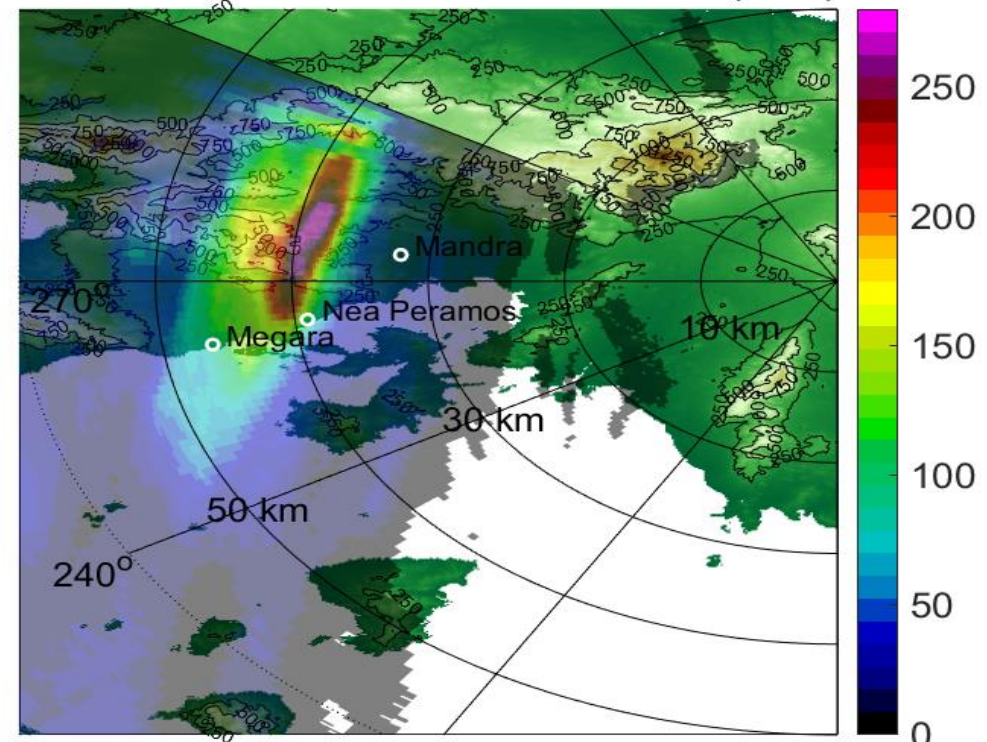
**Αστική επέκταση - Urban expansion**

Map labels: Νέα Ζωή - Nea Zoi, Μαρούδα - Maroussa, Μάνδρα - Mandra, Ελευσίνα - Elefsina

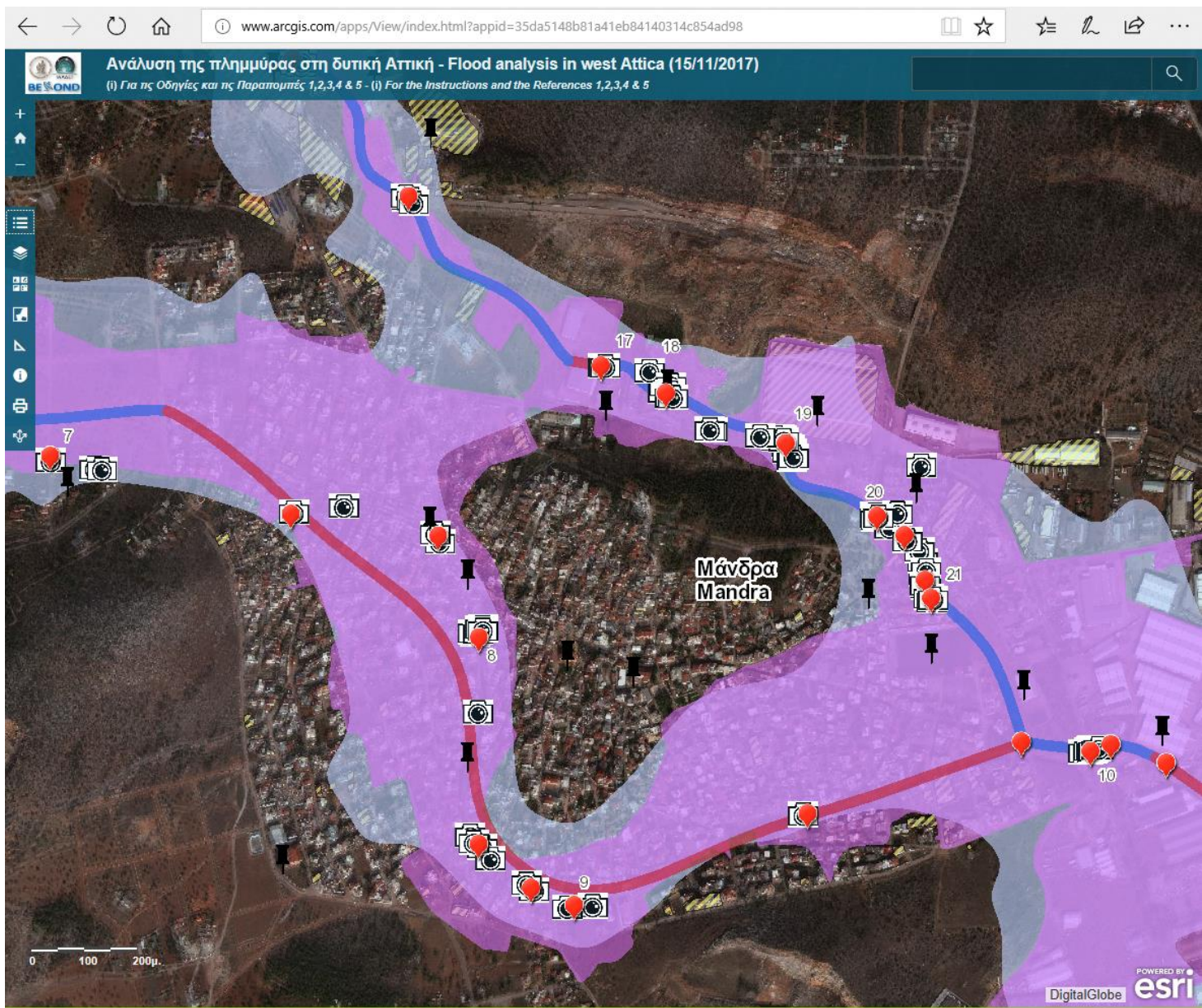
# Mandra flood 2017: modelling (blue) vs EO mapping (pink)



XPOL-NOA accumulated rainfall (mm)



14-Nov-2017 13:49 to 15-Nov-2017 12:00 UTC



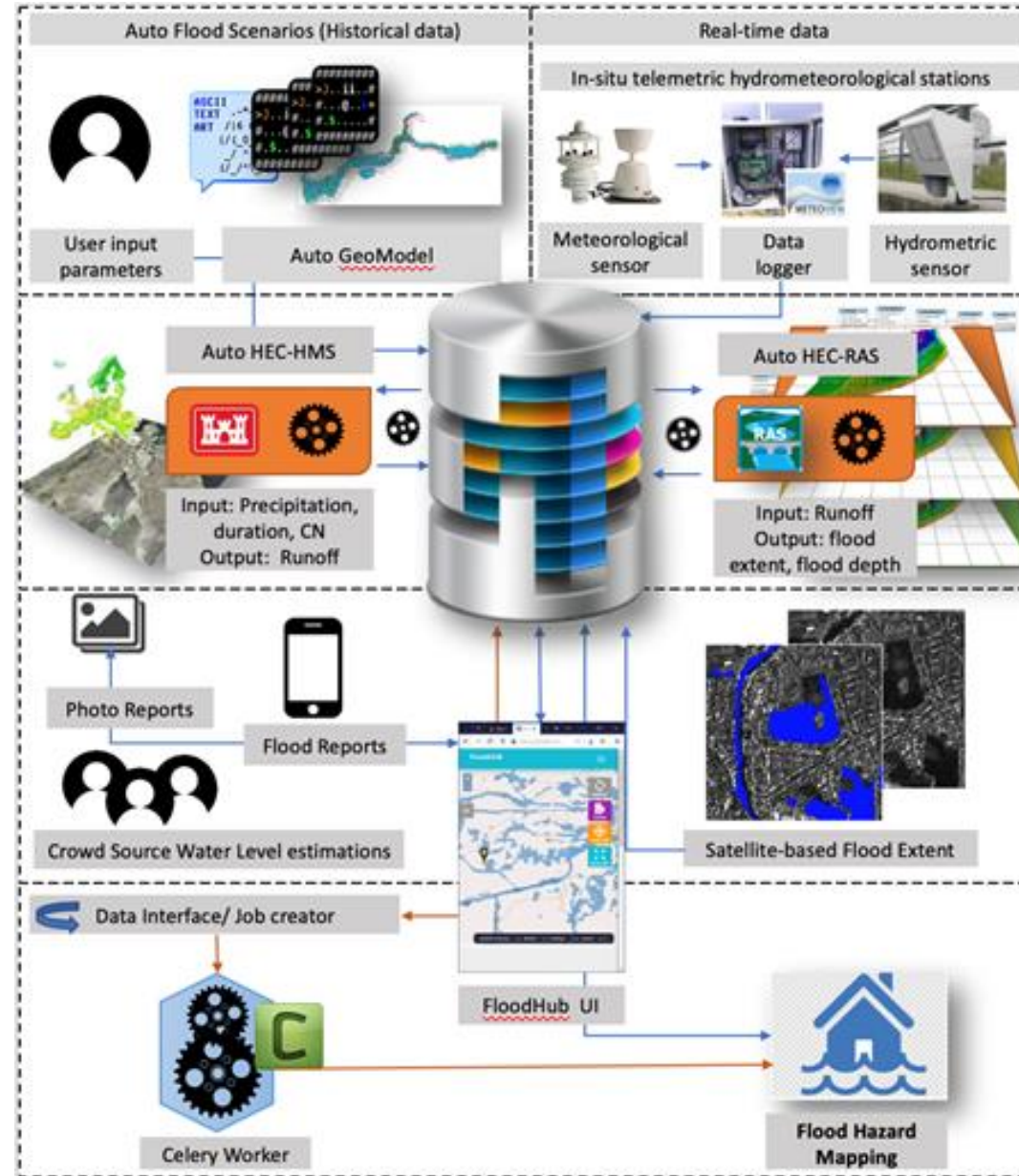
**Disaster Resilience  
 Action Group**



# 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).

# Mandra 2020: Development of the operational FloodHUB system



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



# Web platform of the 3 telemetric hydrometeorological stations



**METEOVIEW<sub>2</sub>**

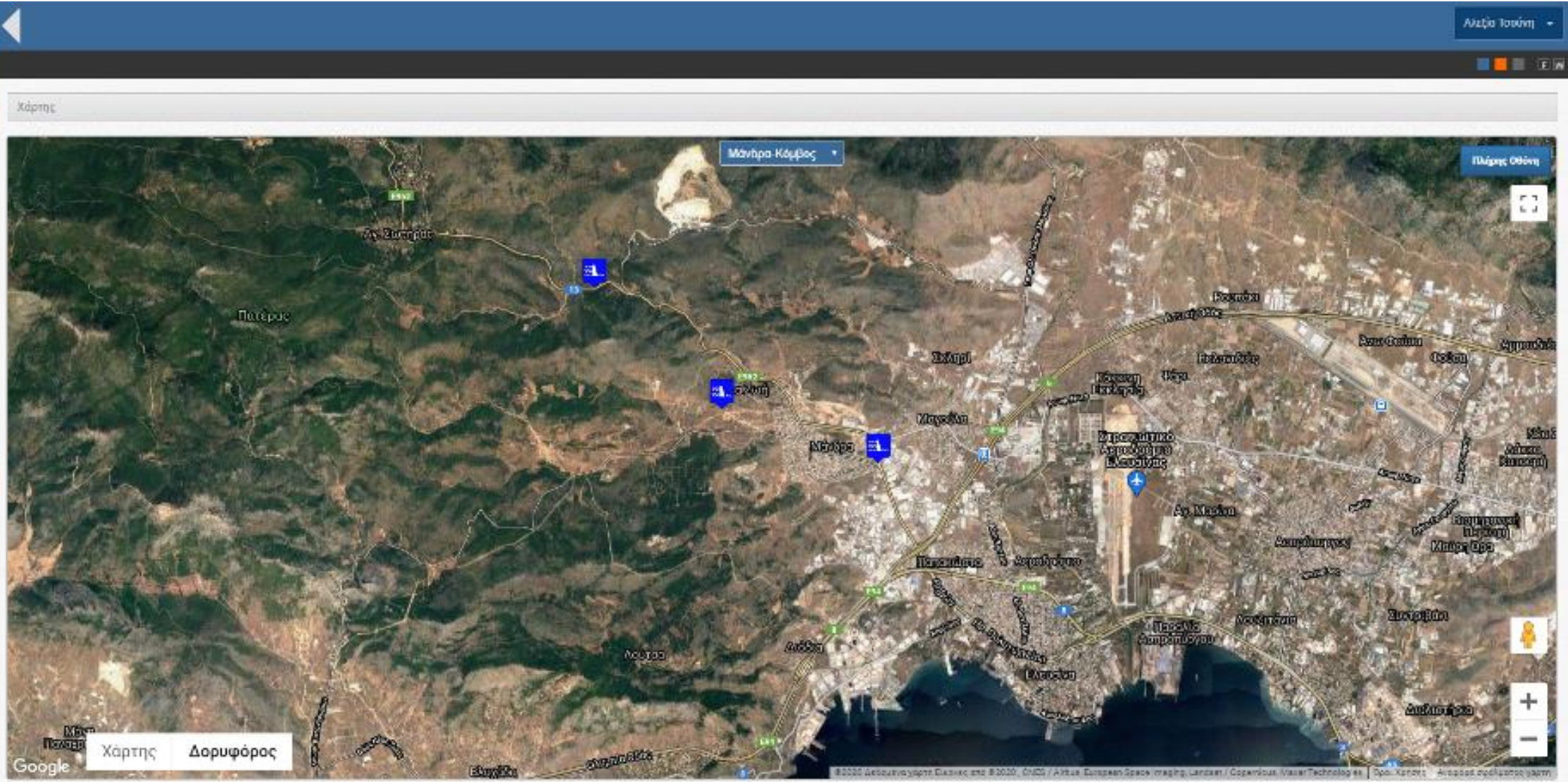
Σήμερα είναι: 1/12/20, 11:45

Αναζήτηση:

MENU

- Αρχική
- Δεδομένα
- Γεωτοπογραφία
- Αρχείο
- Χρήστες
- Ρυθμίσεις

Έπιβατα: 0.5 / 08



# Web platform of the 3 telemetric hydrometeorological stations



**METEOVIEW<sub>2</sub>**

Σήμερα είναι: 1/12/20, 11:45

Αναζήτηση:

MENU

- Αρχική
- Δεδομένα
- Γεωπηλώρας
- Αρχείο
- Χρήστες
- Ρυθμίσεις

Έπιπέδο: 0.1 / 0.0

Κάρτης

Μάνηρα Κόμβος

Πλάγιος Οθόνη

Χάρτης Δορυφόρος



# Web platform of the 3 telemetric hydrometeorological stations



**METEOVIEW<sub>2</sub>**

Σήμερα είναι: 1/12/20, 11:48

Αναζήτηση:

MENU

- Αρχική
- Δεδομένα
- Γεωγραφικός
- Αρχείο
- Χρήστες
- Ρυθμίσεις

Έπιβατα: 01 / 08

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Χάρτης Δορυφόρος



# Web platform of the 3 telemetric hydrometeorological stations



Σήμερα είναι: 1/12/20, 11:48

Αναζήτηση

MENU

- Αρχική
- Δεδομένα
- Γεωπαράμετροι
- Αρχείο
- Χρήστες
- Ρυθμίσεις

Έπιβατα: 0.5 / 08 [Αναλυτικά](#)

Κάρτης





Χάρτης Δορυφόρος

# Web platform of the 3 telemetric hydrometeorological stations



Home / View Data

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

Search here...

MAIN NAVIGATION

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

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

**METRICA**  
 When it's a matter of trust

Αγιος Αθανάσιος

Μάνδρα-Εκτροπή

Μάνδρα-Κόμβος

**ΑΓΙΟΣ ΑΘΑΝΑΣΙΟΣ**

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.

# Real-time crowdsourcing platform for staff and volunteers



**Send Report**

GPS Manual Edit Delete Cancel Submit

Depth[m] 0.6

PURID: 4232c741-72b3-44aa-9443-72b69e10668a  
OWNER: PORTALADMIN  
TIME: 2020-10-05T12:25:30.292582

**Select Scenario**

Pnt: 5/5 | T = 100 | Dur. = 540 | CN = 2

Repeat Period: 100 | Duration (h): 9 | CN Parameter: II (Med Cond)

Clear Display

Refresh Locate Zoom Self Zoom AOI



# Integrated near-real-time flood monitoring system



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HOME ABOUT US THEMATIC AREAS WEB SERVICES PROJECTS INFRASTRUCTURE NEWS / EVENTS

Select Country:  Select Disaster Type:

**Outreach**  
 See our publications / presentations

**Training & Education**  
 Join our activities

[stics](#) [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**

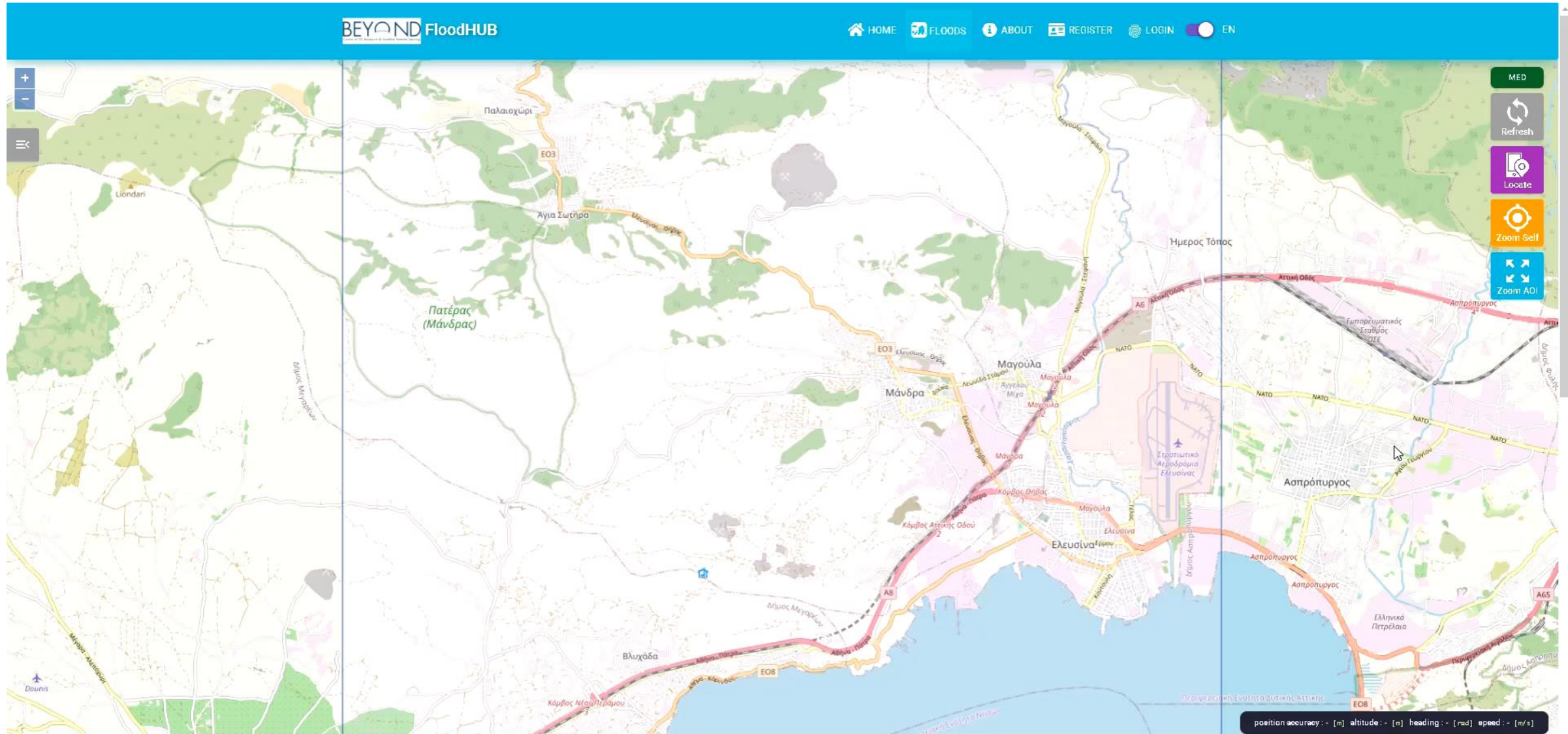
**Disasters**  
 The rapid changes in climate over the last decades, together with the explosion of human population, have shaped the context for a fragile biosphere, prone to natural and manmade disasters that result in massive flows of environmental immigrants.  
[Read more](#)

**Energy**

## WEB SERVICES



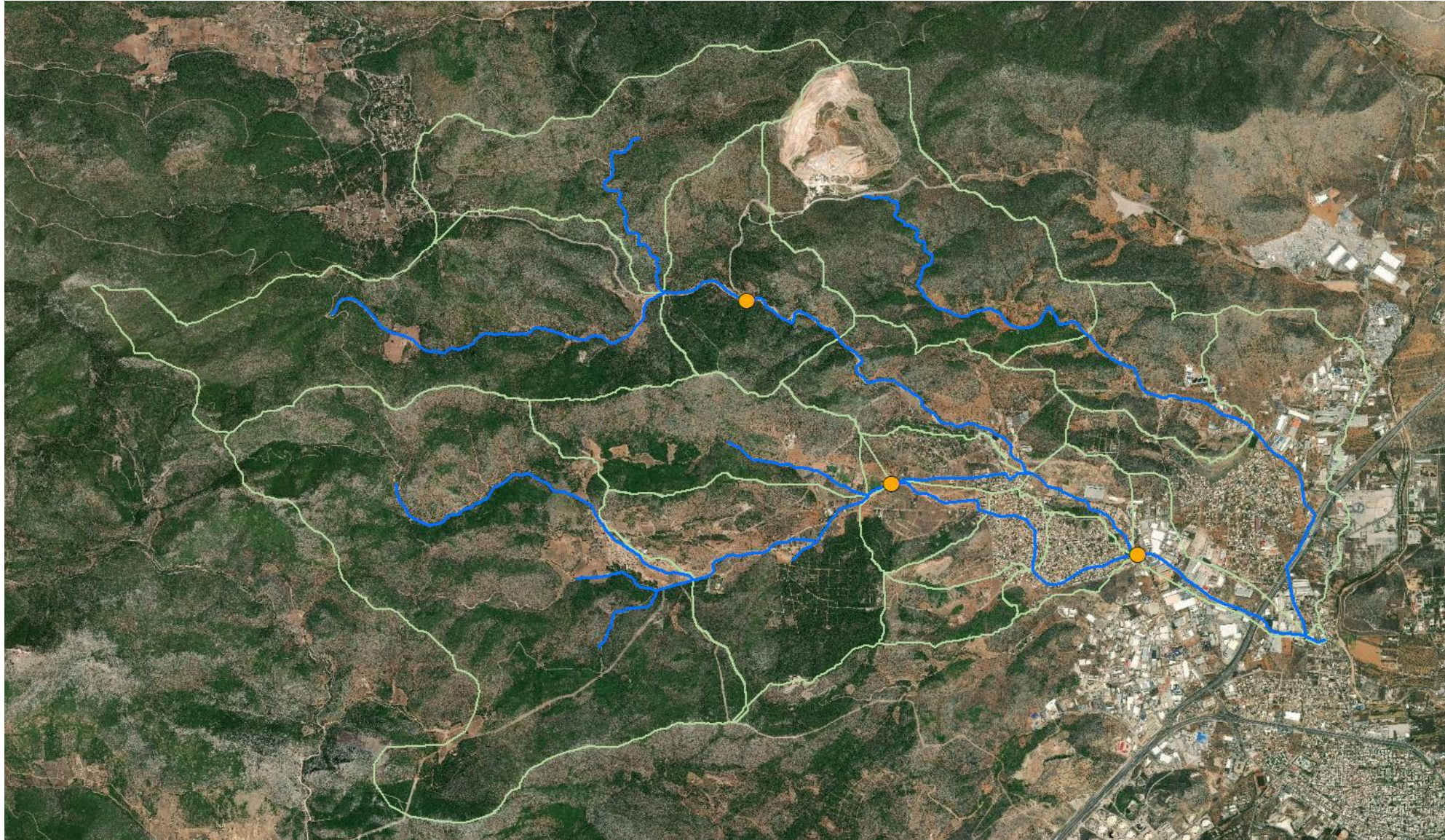
# Integrated near-real-time flood monitoring system



# Integrated near-real-time flood monitoring system



# Hydrologic & hydraulic simulation



RIVER BASIN  
57 km<sup>2</sup>

SUBBASINS  
19

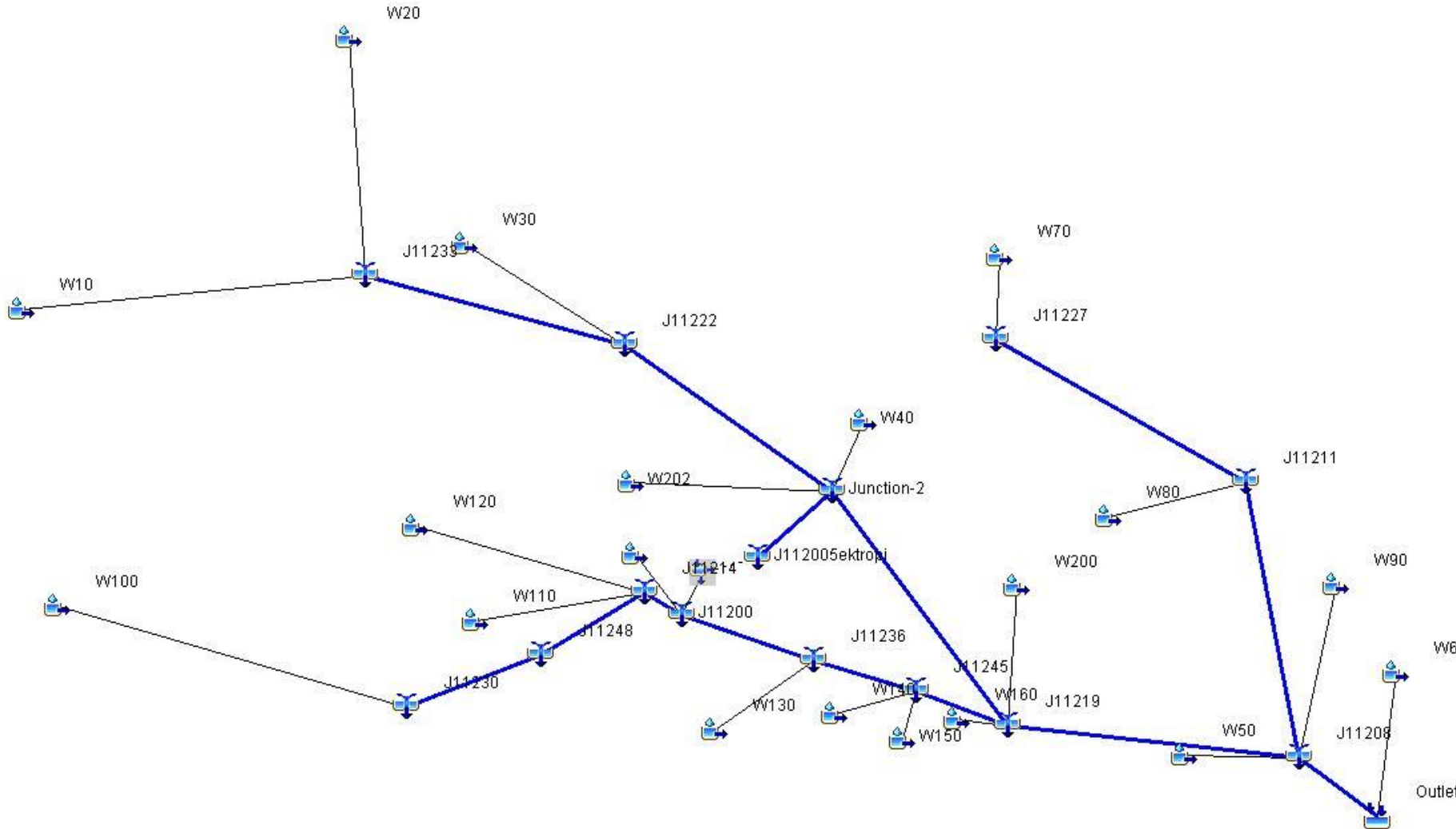
RAINFALL IDF CURVE  
Koutsoyiannis &  
Baloutsos, 2000

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

DISTRIBUTION  
Worst profile method

TIME OF  
CONCENTRATION  
Kirpich (SCS) method

# Hydrologic & hydraulic simulation



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

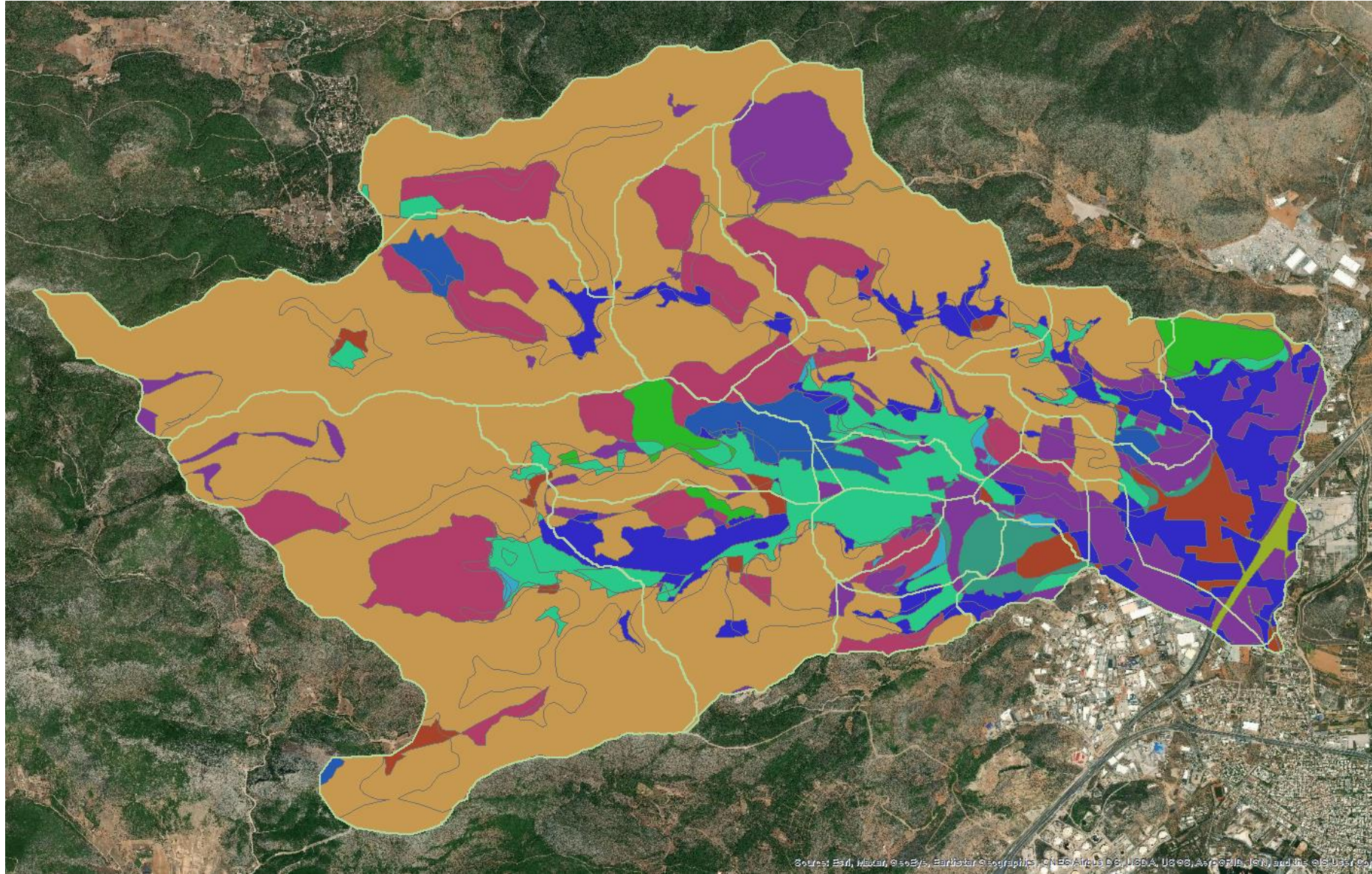
**Input:** rainfall data through HEC-DSS for various combinations of return periods  $T$  (years) and rainfall duration  $d$  (hours)

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



## 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

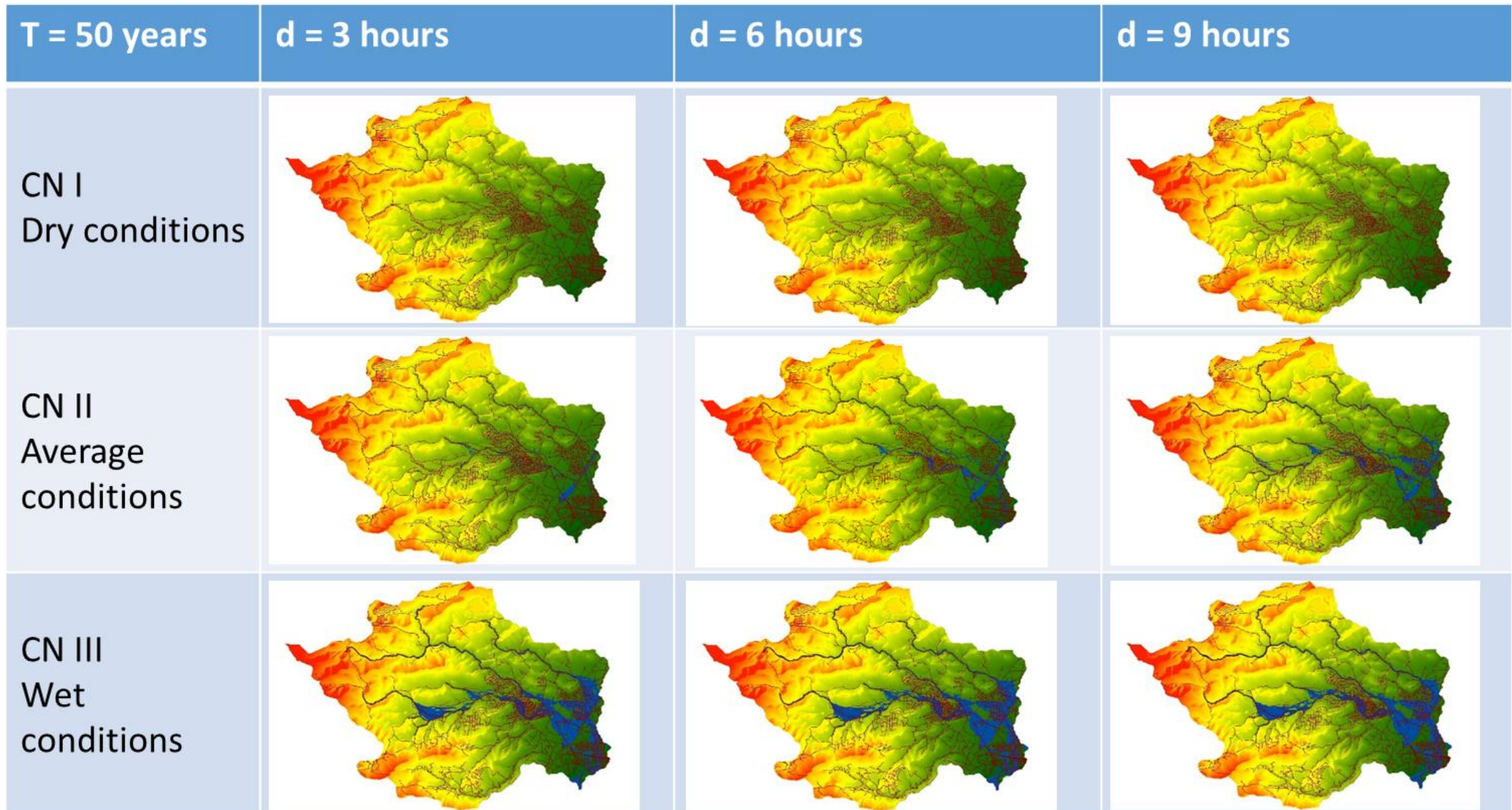
**Run:** All scenarios at 10m spatial resolution (2D mesh)

**Output:** flood extent

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

# Flood mapping results

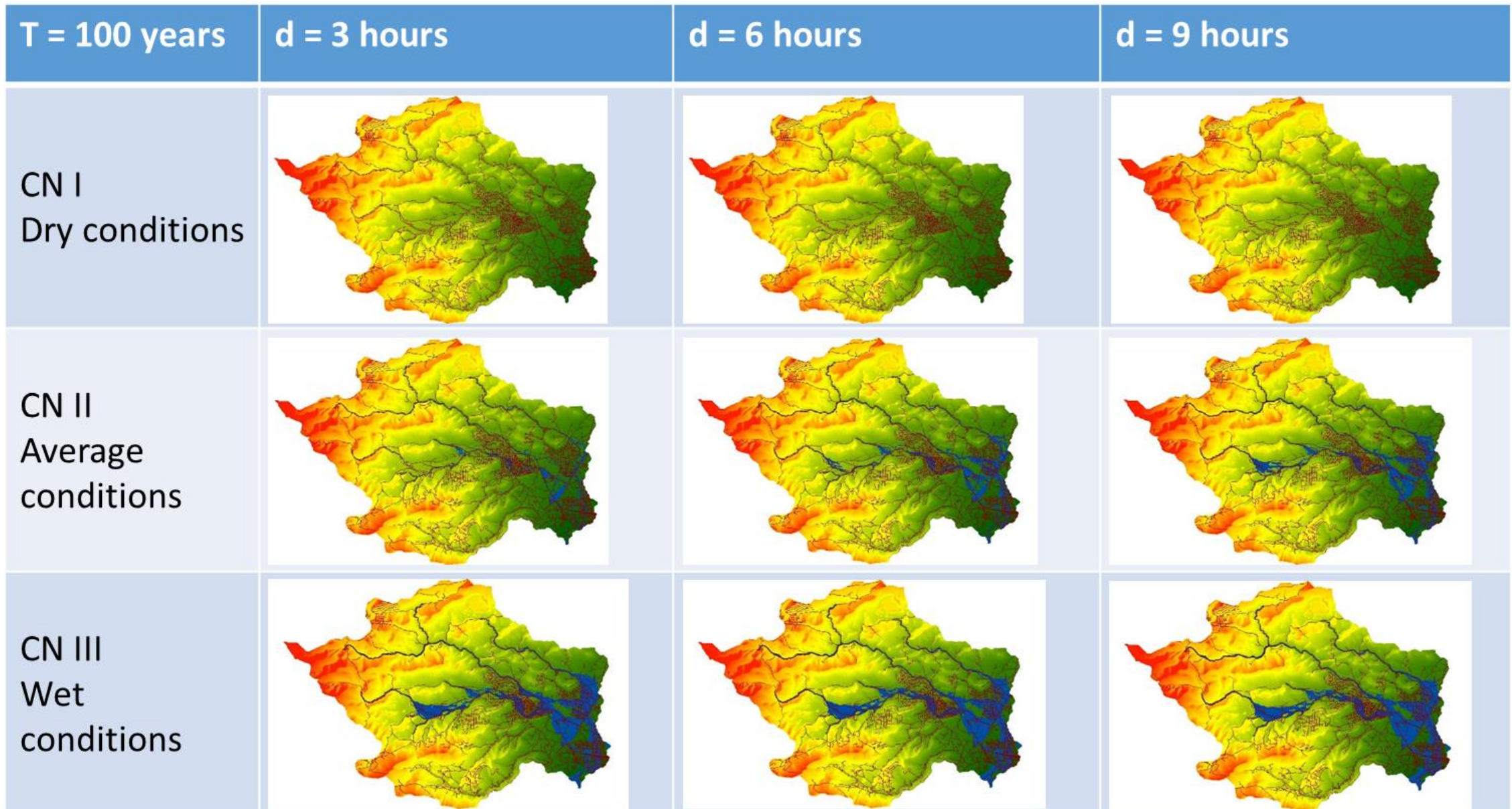
## T = 50 years





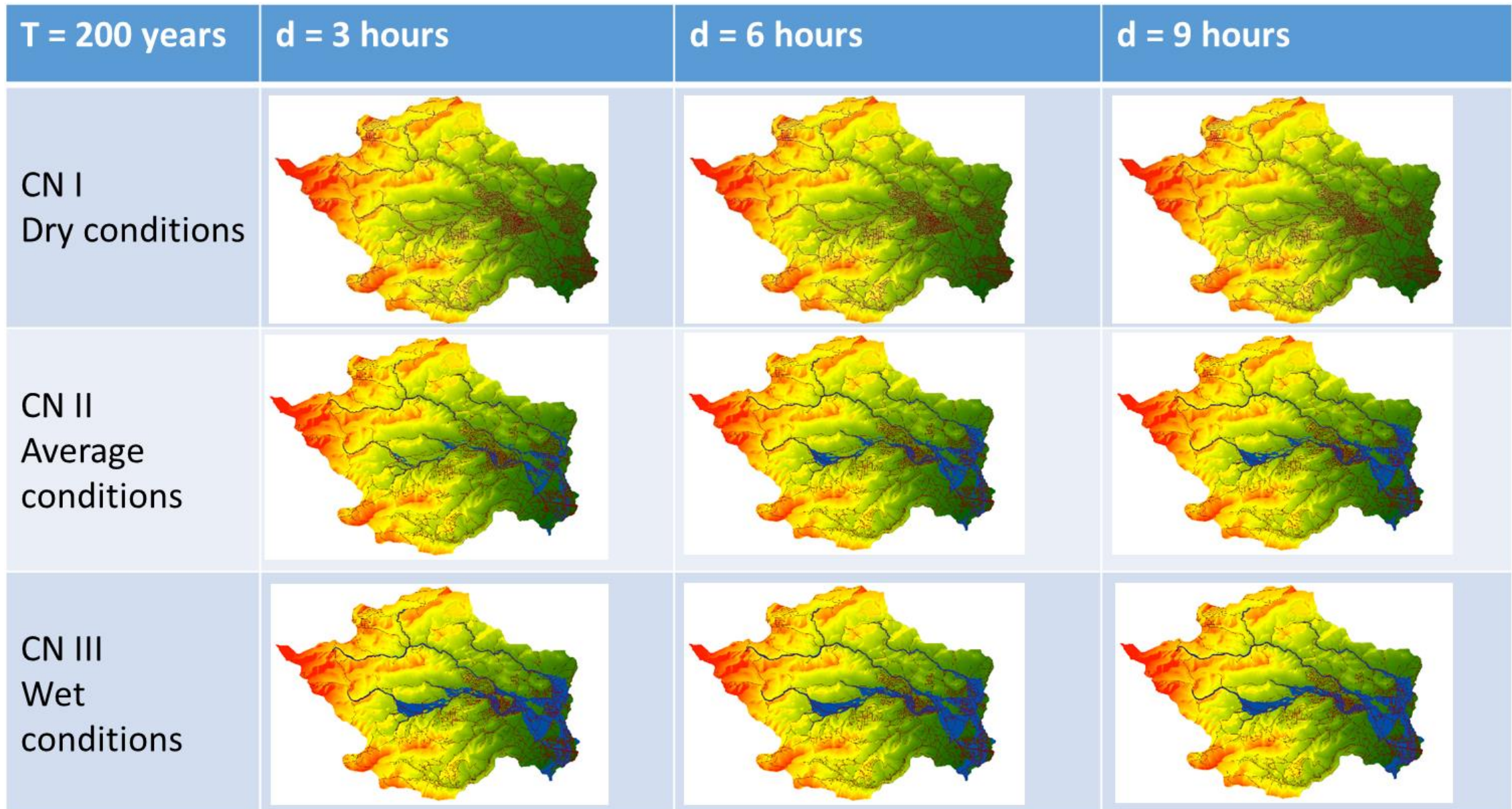
# Flood mapping results

## T = 100 years



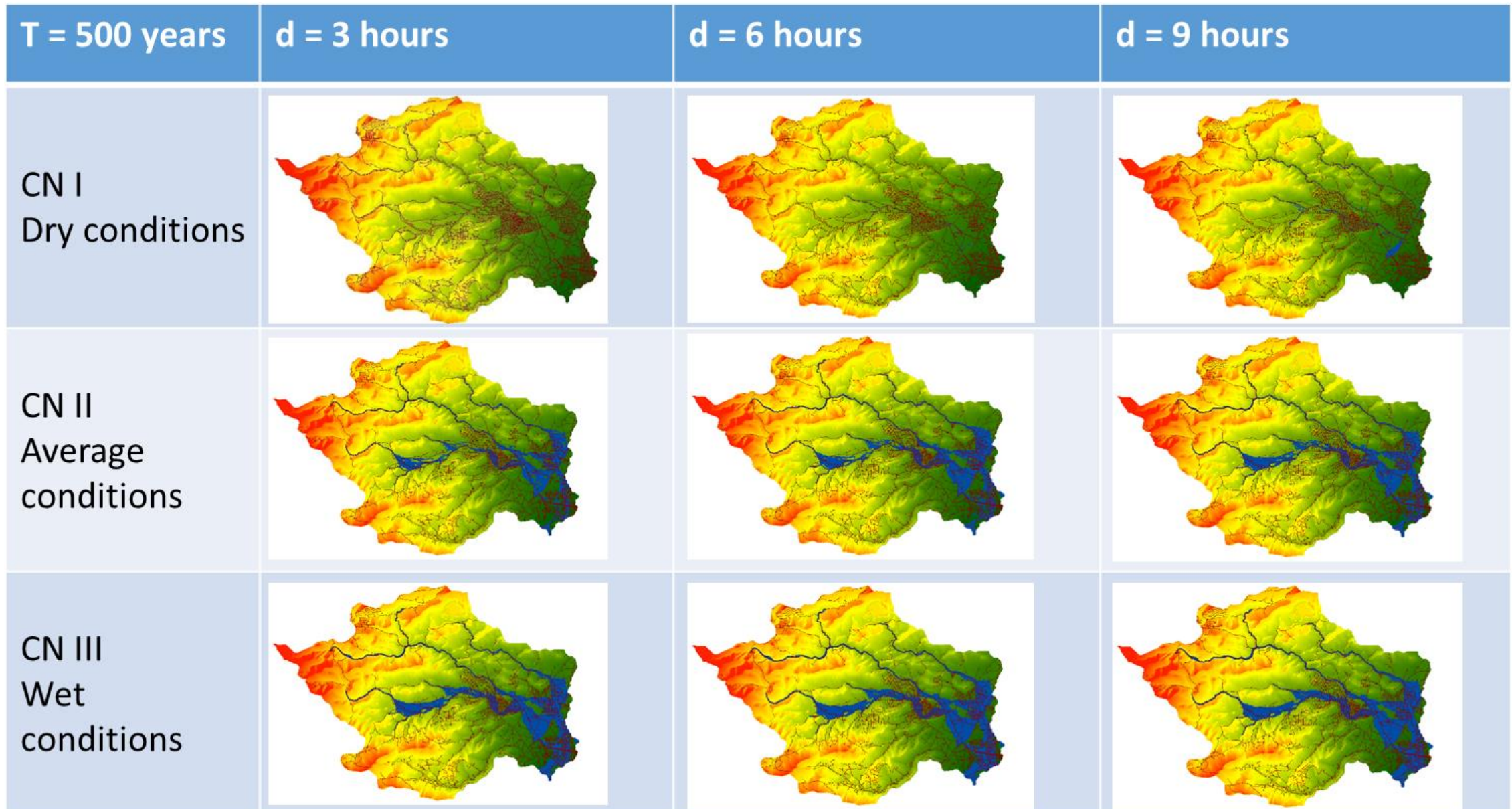
# Flood mapping results

## T = 200 years



# Flood mapping results

## T = 500 years



# Flood mapping results

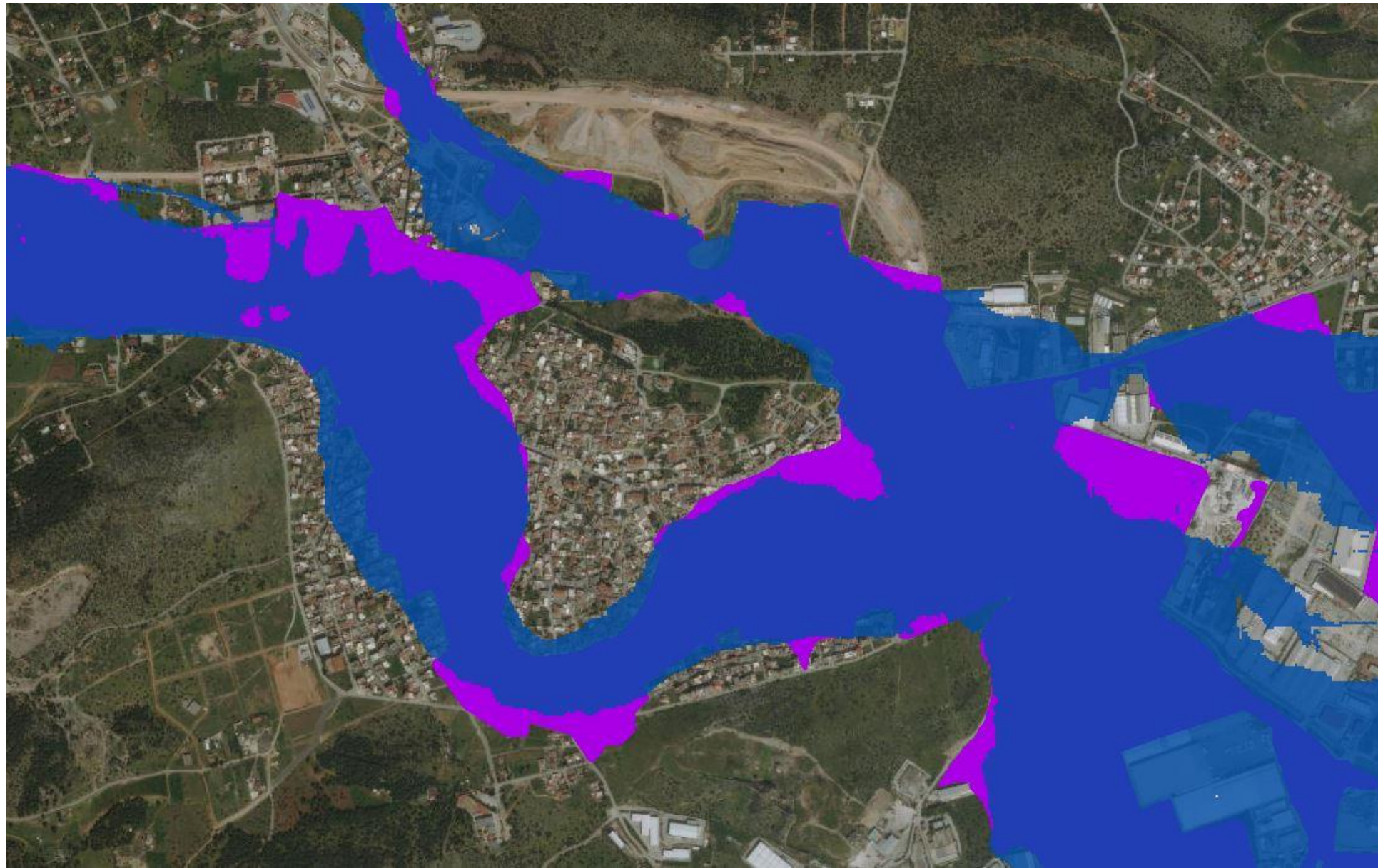
## T = 1000 years



T = 1000 years	d = 3 hours	d = 6 hours	d = 9 hours
CN I Dry conditions			
CN II Average conditions			
CN III Wet conditions			

# 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



# Stakeholders' trainings in the operational FloodHUB system





# The BEYOND Center of EO Research & Satellite Remote Sensing



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**Thank you for your attention!**

**Contact me: [alexiatsoni@noa.gr](mailto:alexiatsoni@noa.gr)**