FLOOD RISK ASSESSMENT IN THE REGION OF ATTICA

In the framework of the **Programming Agreement** of 03/03/2021 between the **Prefecture of Attica** and the **National Observatory of Athens – Part A:** «***Earthquake, fire and flood risk assessment in the region of Attica***»

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ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
ΠΕΡΙΦΕΡΕΙΑ ΑΤΤΙΚΗΣ

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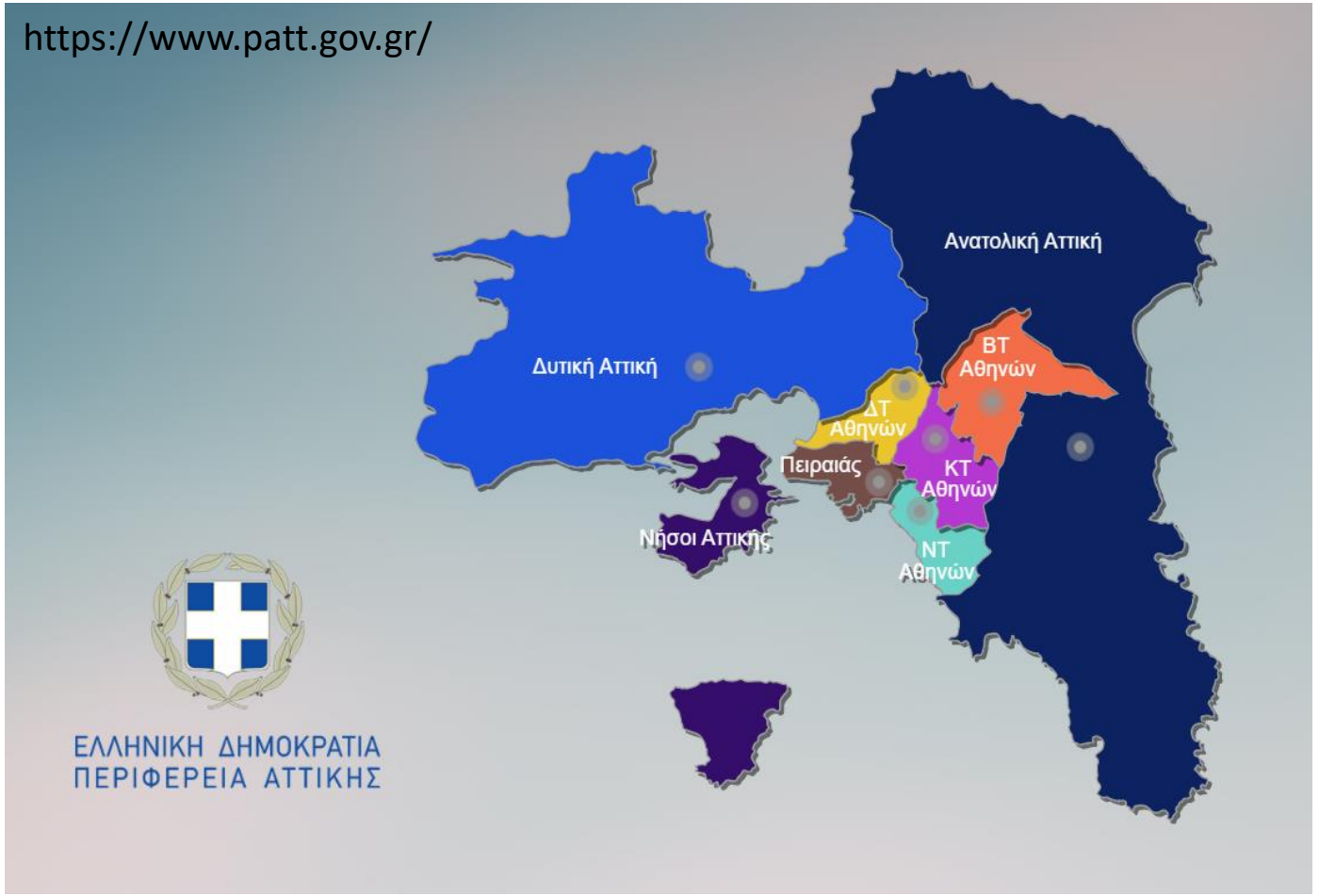
1. INTRODUCTION

- The Prefecture of Attica constitutes a region with special features, such as **long coastline**, **large inland area**, **various geoenvironmental units**, **high population density** (3.792.469 residents, 36,4% of the country's population according to the Hellenic Statistical Authority [1], **critical infrastructures** and **social economic activities**.



[1] Hellenic statistical Authority. (2021, November 5). 2021 Population-Housing Census. https://www.statistics.gr/2021-census-pop-hous

1. INTRODUCTION

- In March 2021, a **Programming Agreement** was signed between the **Prefecture of Attica and the NOA** – Part A – to conduct the study entitled «**Earthquake, fire and flood risk assessment in the region of Attica**» funded by the Prefecture of Attica [2].

- A **new methodology for flood risk assessment** is introduced and implemented at **the most high-risk river basins** in Attica, by analyzing the **vulnerability** and the **exposure** of the river basin to **flood risk**, in conjunction with the actual physical and socioeconomic parameters in order to propose mitigation measures

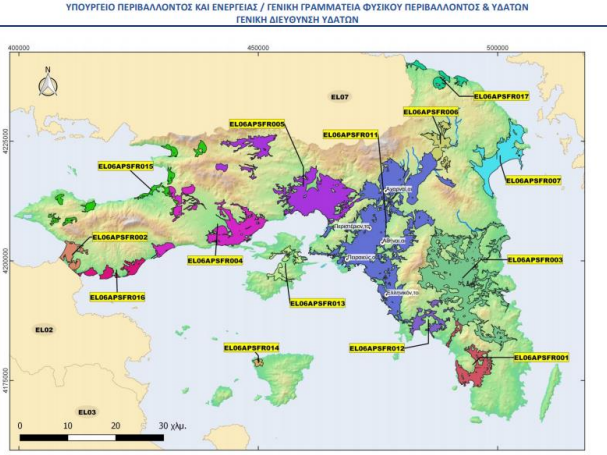
[2] Operational Unit "BEYOND Centre of EO Research & Remote Sensing" / IAASARS / NOA. (2021, March 2). A Programming Agreement was signed with the Prefecture of Attica. http://beyond-eocenter.eu/index.php/news-events/375-ypografi-trimeris-programmatikis-symvasis-me-tin-periferia-attikis

2. METHOD AND DATA

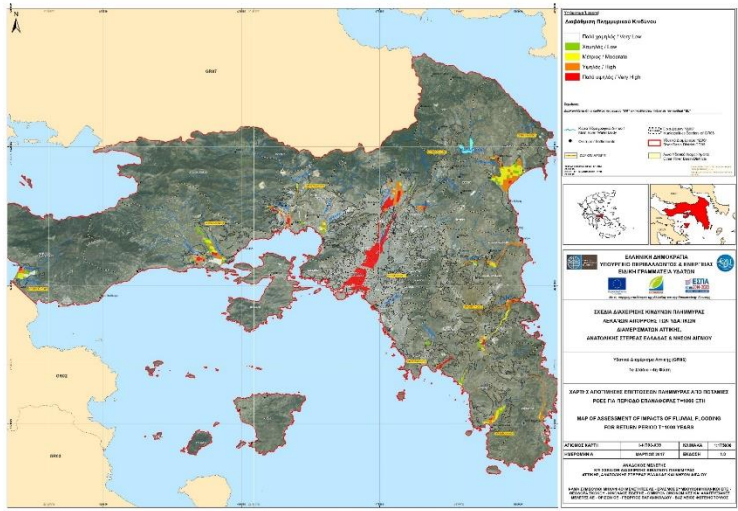
2.1. Selection of the study areas

Aiming to select the study areas, the following spatial information were taken under consideration:

- the **Areas of Potentially Significant Flood Risk** in the Water Department of Attica according to the 1st Revision of the Preliminary Flood Risk Assessment [3];
- the **Spatial Distribution of Flood Risk from fluvial flows in Attica for return period T=1000 years** [4] according to the Approved Flood Risk Management Plan in the Water Department of Attica for the implementation of the EU Floods Directive [5].



Εικόνα 7-7: Υδατικό Διαμέρισμα Αττικής (EL06)
Ζώνες Δυνητικά Υψηλού Κινδύνου Πλημμύρας (Οκτώβριος 2019)



[3] Special Secretariat for Water. (2019). 1st Revision of the Preliminary Flood Risk Assessment of Attica (EL06). Ministry of Environment and climate change. https://floods.ypeka.gr/index.php?option=com_content&view=article&id=1113&Itemid=1154

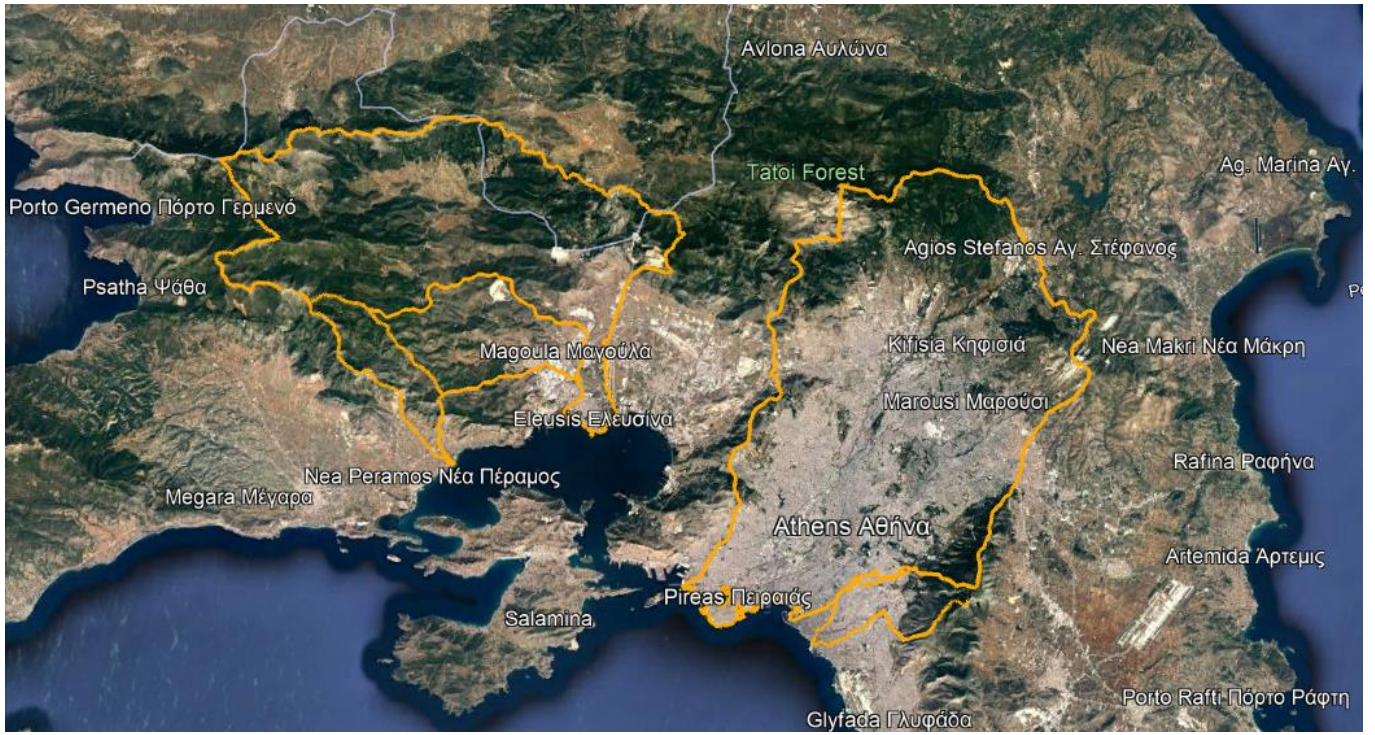
[4] Special Secretariat for Water. (2018). Flood Risk Management Plans of Attica (EL06). Ministry of Environment and climate change. https://floods.ypeka.gr/index.php?option=com_content&view=article&id=272&Itemid=782

[5] Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks (Text with EEA relevance) OJ L 288, 06/11/2007, p. 27–34.

2. METHOD AND DATA

2.1. Selection of the study areas

Given the above, the **Operational Unit BEYOND / IAASARS / NOA** in cooperation with the **Research Group ITIA/ School of Civil Engineering/ NTUA** study **five river basins (**Pikrodafni, Giorgis, Sourres and Agia Aikaterini streams and Sarantapotamos and Kifisos rivers) in the Region of Attica, which are included in **23 Municipalities**.

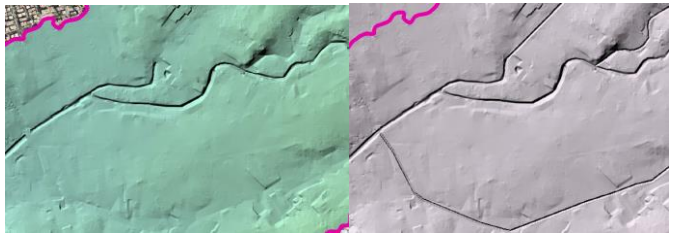


The five river basins in the Region of Attica

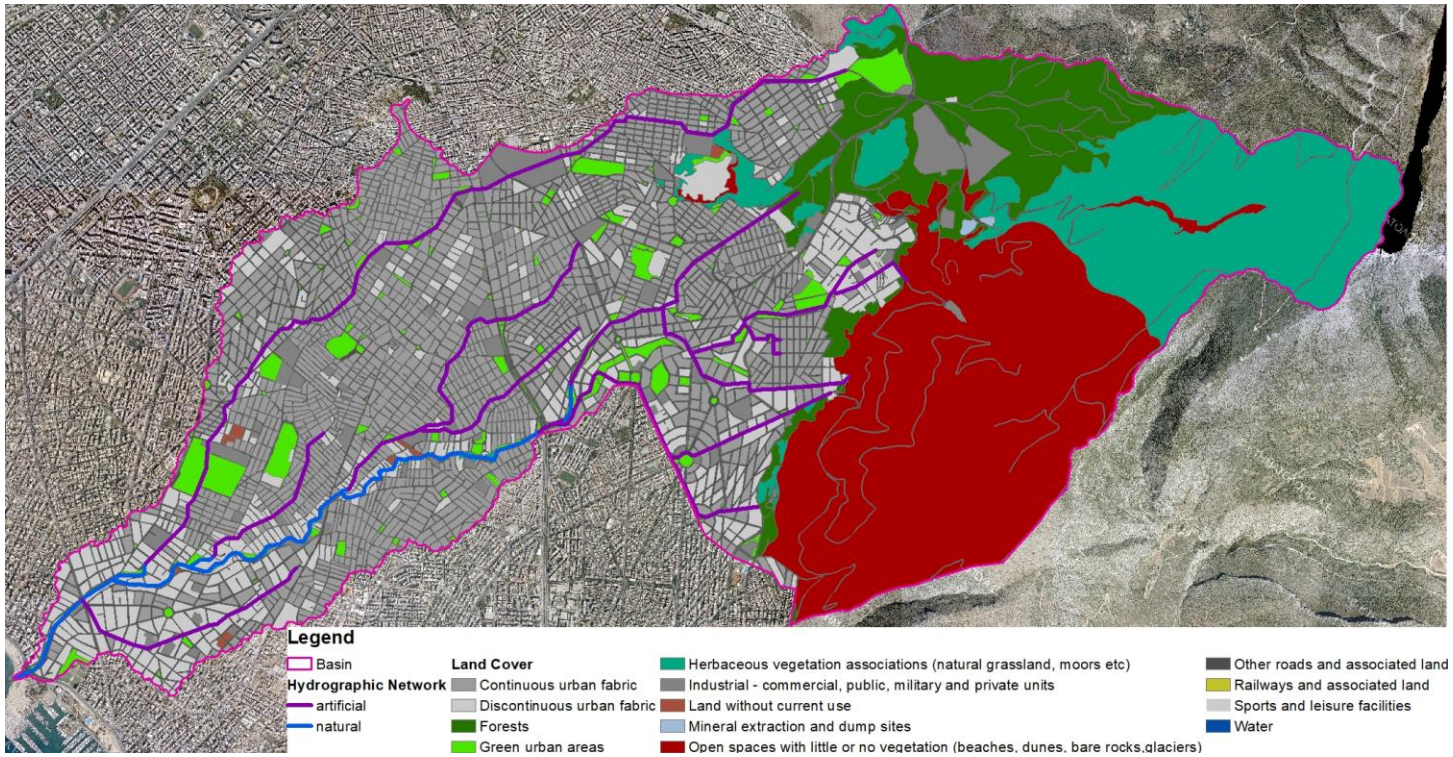
2. METHOD AND DATA

2.2. Data collection & modifications

- relevant studies from competent services & historic floods;
- terrain modification (DEM 2m provided by Hellenic Cadastre) with buried substreams and hydraulic works;
- land cover layer based on Urban Atlas [6] & burnt scar mapping from 1958-2021 provided by FireHub Service of the BEYOND Centre of IAASARS/NOA [7] using Sentinel-2 satellite images;
- population data [1], building type [1], land values [8]



Terrain modifications with buried substreams in Pikrodafni's river basin



[6] Urban Atlas (2018). Copernicus Land monitoring services. https://land.copernicus.eu/local/urban-atlas

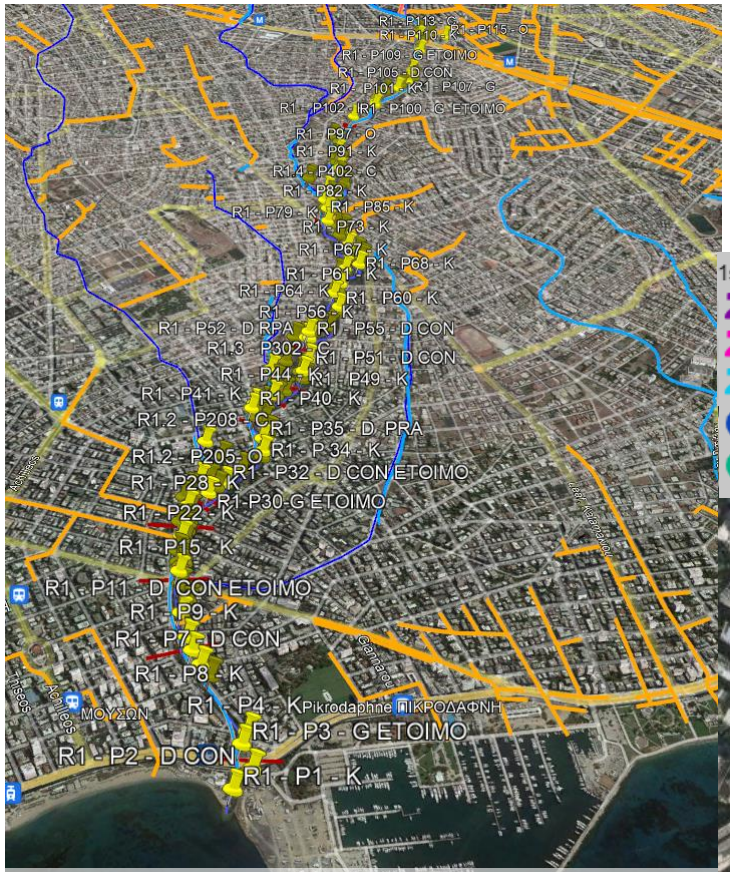
[7] Operational Unit "BEYOND Centre of EO Research & Remote Sensing" / IAASARS / NOA. (2022). FireHub A Space based Fire Management Hub. IAASARS/NOA http://beyond-eocenter.eu/images/docs/publications/other/NOA-FireHub.pdf

[8] Ministry of Finance. (2021, November 5). 2021

2. METHOD AND DATA

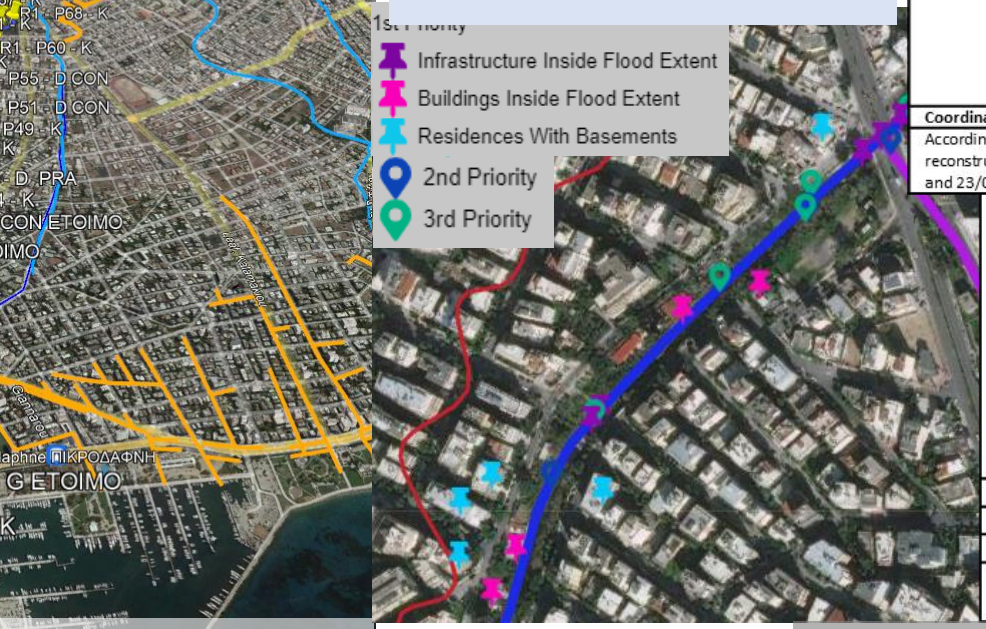
2.3. Methodology of field visits

- Detailed technical report for each critical point;
- Classification of critical points according to the prioritization level



Pre-process

Many high-risk points in residential areas, road networks and other critical infrastructure



R1-P10-G: Footbridge #1	
Coordinates (GGRS87)	473955.4742, 4197089.083
According to a resident's witness, the stream had flooded in this area destroying part of the left wall, which was reconstructed locally. Next to the footbridge five calls for flooding to the Fire Brigate were recorded (22/03/2013 and 23/03/2013).	

R1-P46-G: Private Footbridge	
Coordinates (GGRS87)	474968.3287, 4197482.714
Construction material MAT	MAT=f,w
Shape and dimensions of bridge DIM	DIM=o, h=1, d=0.3, l=7.5(6)ground
dominant substrate of river bed MANb and left MANl and right river bank MANr	MANb = g, MANl= p, MANr=p

After the field visits

2. METHOD AND DATA

2.4. Precipitation from ombrian curves

Precipitation derived from **ombrian curves** [9] for **50, 100, 1000 years return periods** according to the EU Flood Directive [10] using rainfall data from meteorological stations

General equation of ombrian curves,
rainfall intensity x (mm/h) for time scale k (h) and return period T (years):

$$x = \lambda \frac{(T/\beta)^{\xi} - 1}{(1 + k/\alpha)^{\eta}}, \qquad \xi > 0$$

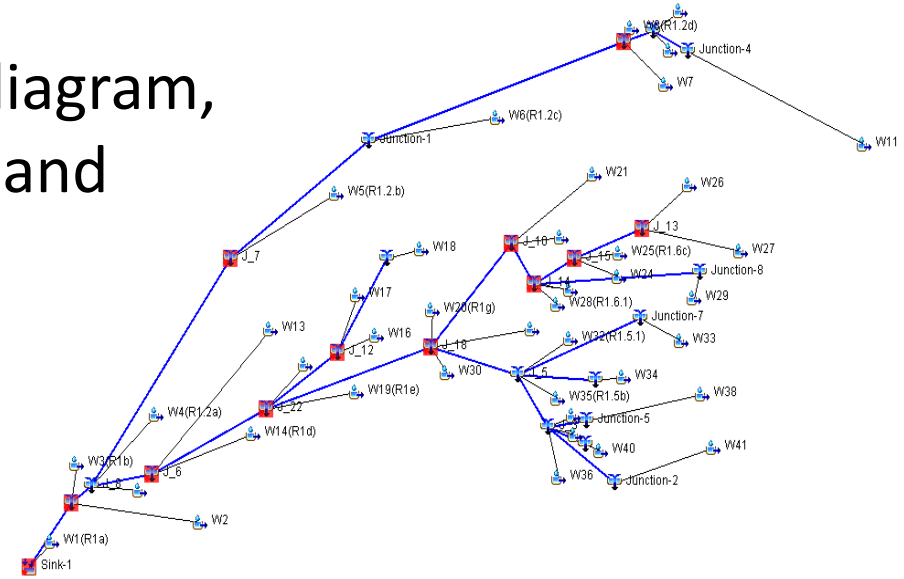
The parameters α (h), η (-), ξ (-) and β (years) are estimated for Attica, while the scale parameter λ (mm/h) is estimated based on the spatial distribution of elevation in the river basin

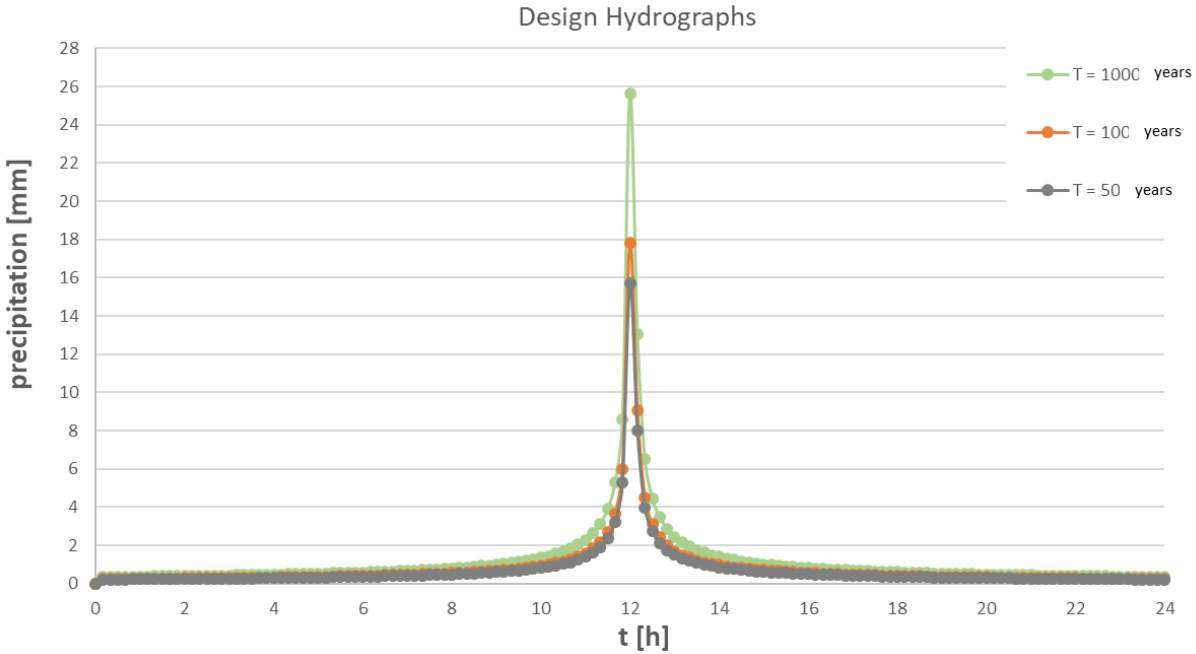
[9] D. Koutsoyiannis (2021). Stochastics of Hydroclimatic Extremes - A Cool Look at Risk, ISBN: 978-618-85370-0-2, Kallipos, Athens
[10] Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks. (2007). OJ L 288, 06/11/2007.

2. METHOD AND DATA

2.5. Hydrologic analysis of river basin-Rainfall-runoff model (HEC-HMS)

✓ Schematic diagram, substreams and subbasins





1. Estimation of precipitation excess

Soil Conservation Service (SCS) Curve Number (CN) [11]

2. "Transformation" of precipitation excess into runoff

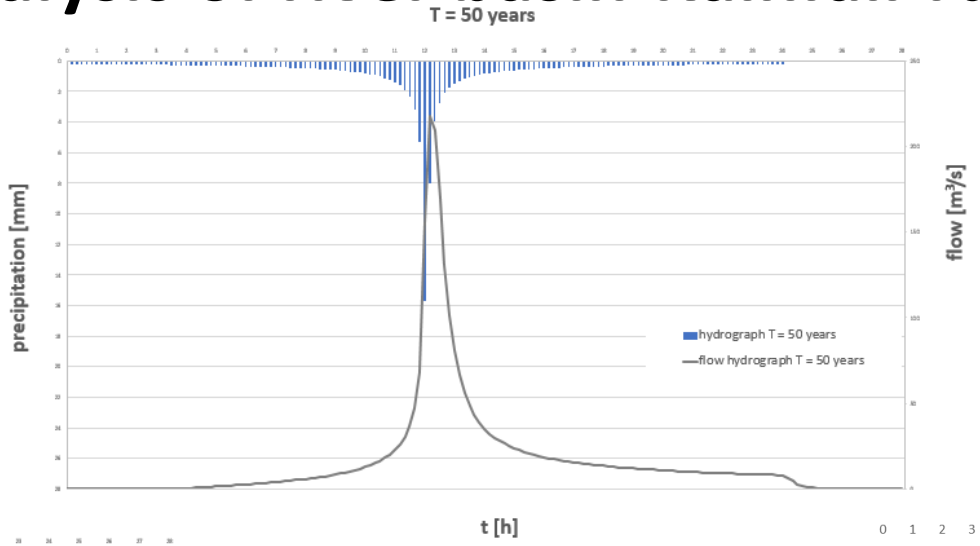
Unit Hydrograph method of Soil Conservation Service [11]

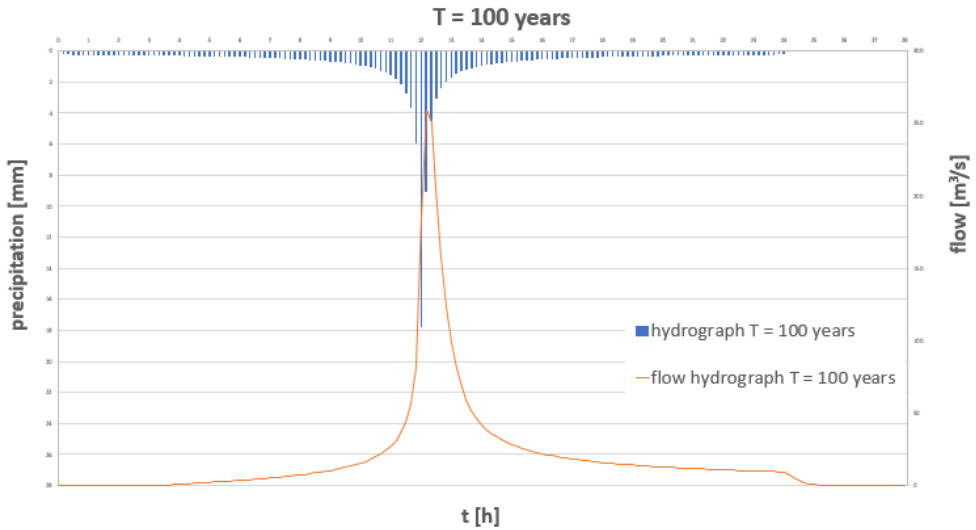
[11] Soil Conservation Service (SCS) (1972). National Engineering Handbook, Section 4: Hydrology. Department of Agriculture, Washington DC.,

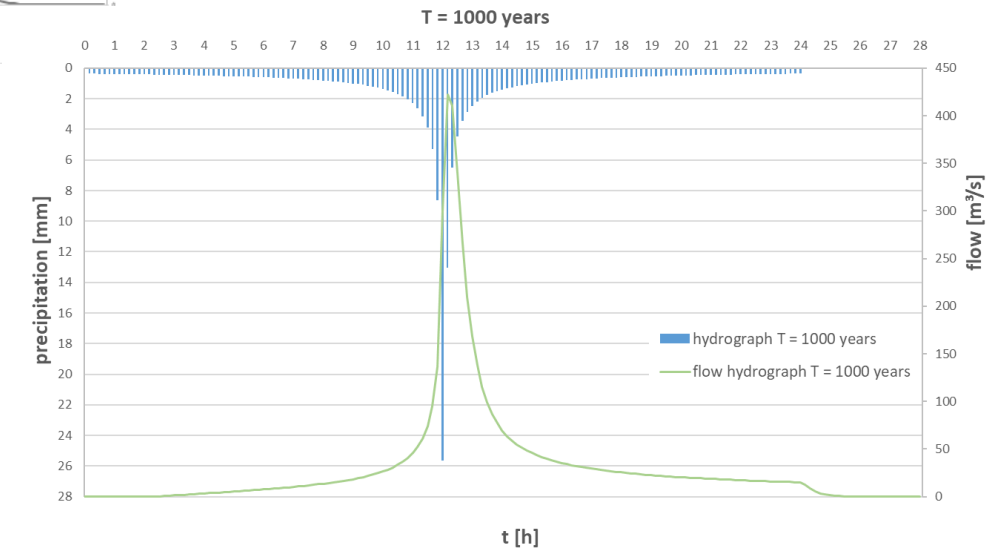
2. METHOD AND DATA

2.5. Hydrologic analysis of river basin-Rainfall-runoff model (HEC-HMS)

Outlet of basin







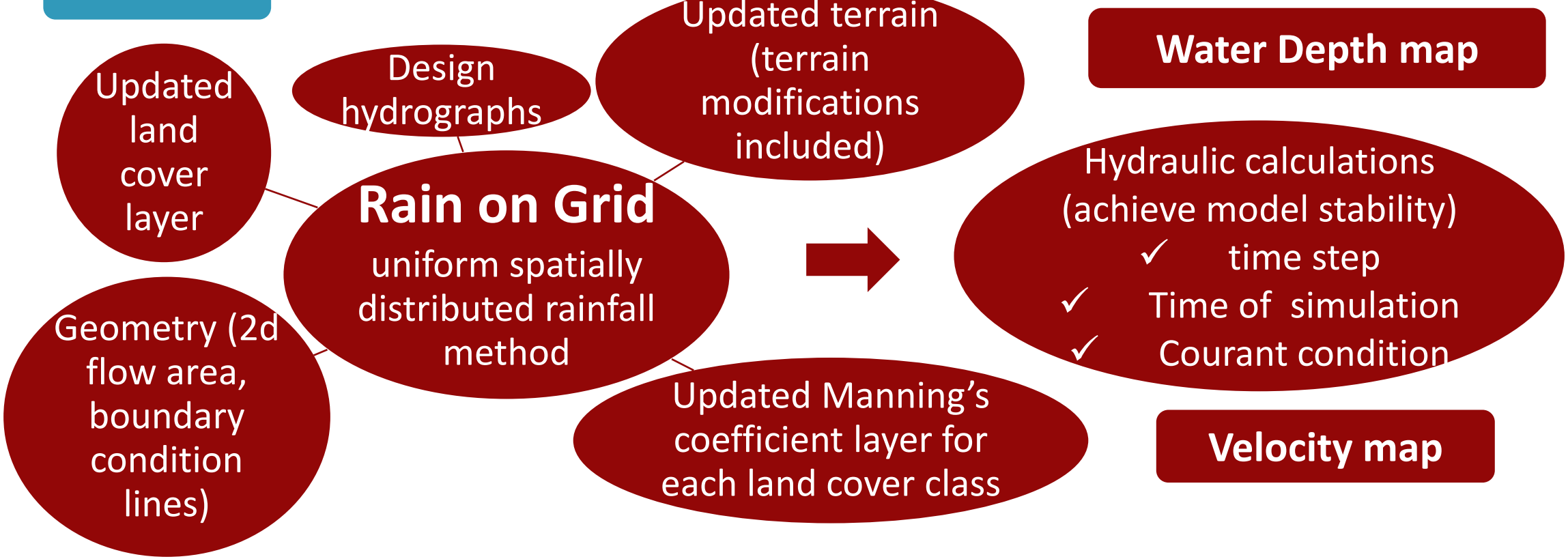
2. METHOD AND DATA

2.6. Hazard – 2D Hydraulic models

LISFLOOD – FP

- quasi-2D
- kinematic wave
- Courant condition

HEC-RAS



2. METHOD AND DATA

2.7. Risk assessment

Vulnerability

- Age;
- Population Density;
- Building Type (construction materials and the presence of pilotis)

Exposure

- Land values

Vulnerability (Age, Population Density and Buiding type)	Flood Hazard				
	1	2	3	4	5
1	1	1	1	2	3
2	1	2	2	3	4
3	1	2	4	4	5
4	2	3	4	5	5
5	3	4	5	5	5

Vulnerability & Flood Hazard	Exposure				
	1	2	3	4	5
1	1	1	1	1	1
2	2	2	2	2	3
3	3	3	3	4	4
4	4	4	5	5	5
5	5	5	5	5	5

3. RESULTS

Flood modelling
(maximum water depth map)

Critical points in Pikrodafni's river basin			
1st	2nd	3rd	ALL
79	50	90	219

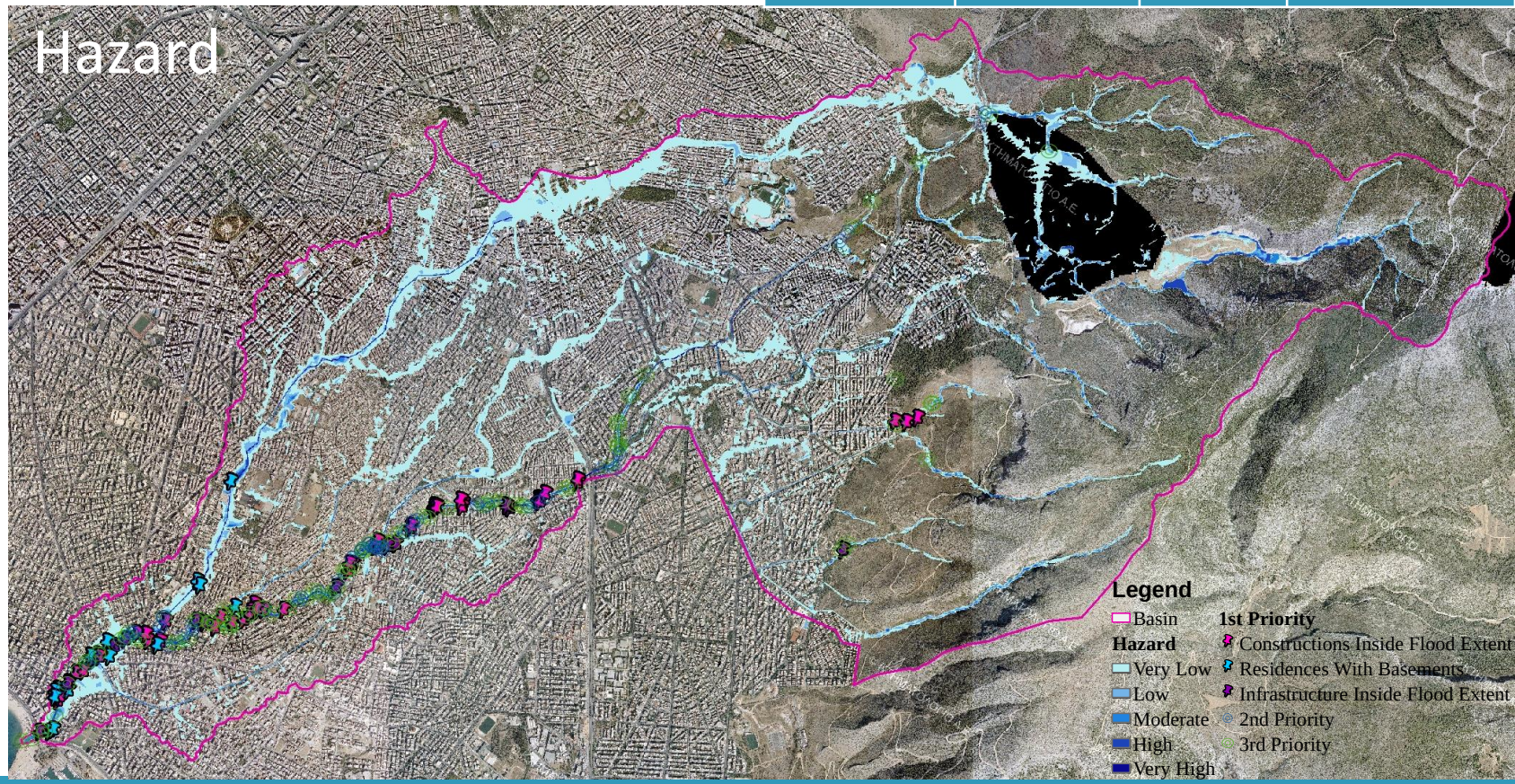
Legend
- Basin

Depth (scenario T 50 LISFLOOD)
- Very Low
- Low
- Moderate
- High
- Very High

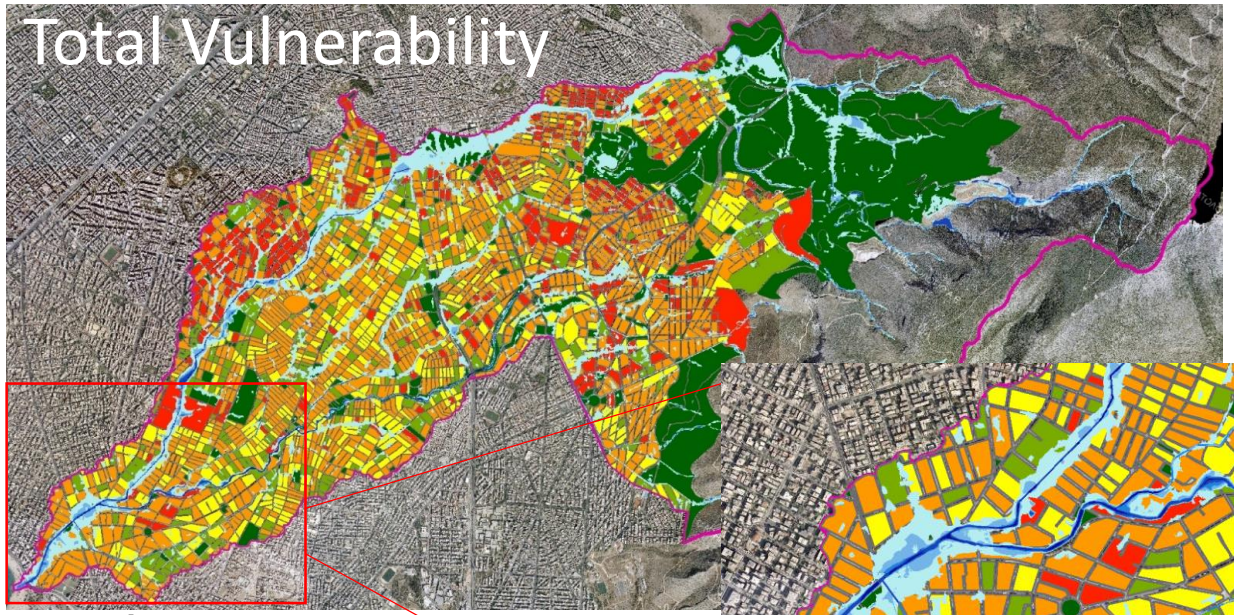
Depth (scenario T 100 LISFLOOD)
- Very Low
- Low
- Moderate
- High
- Very High

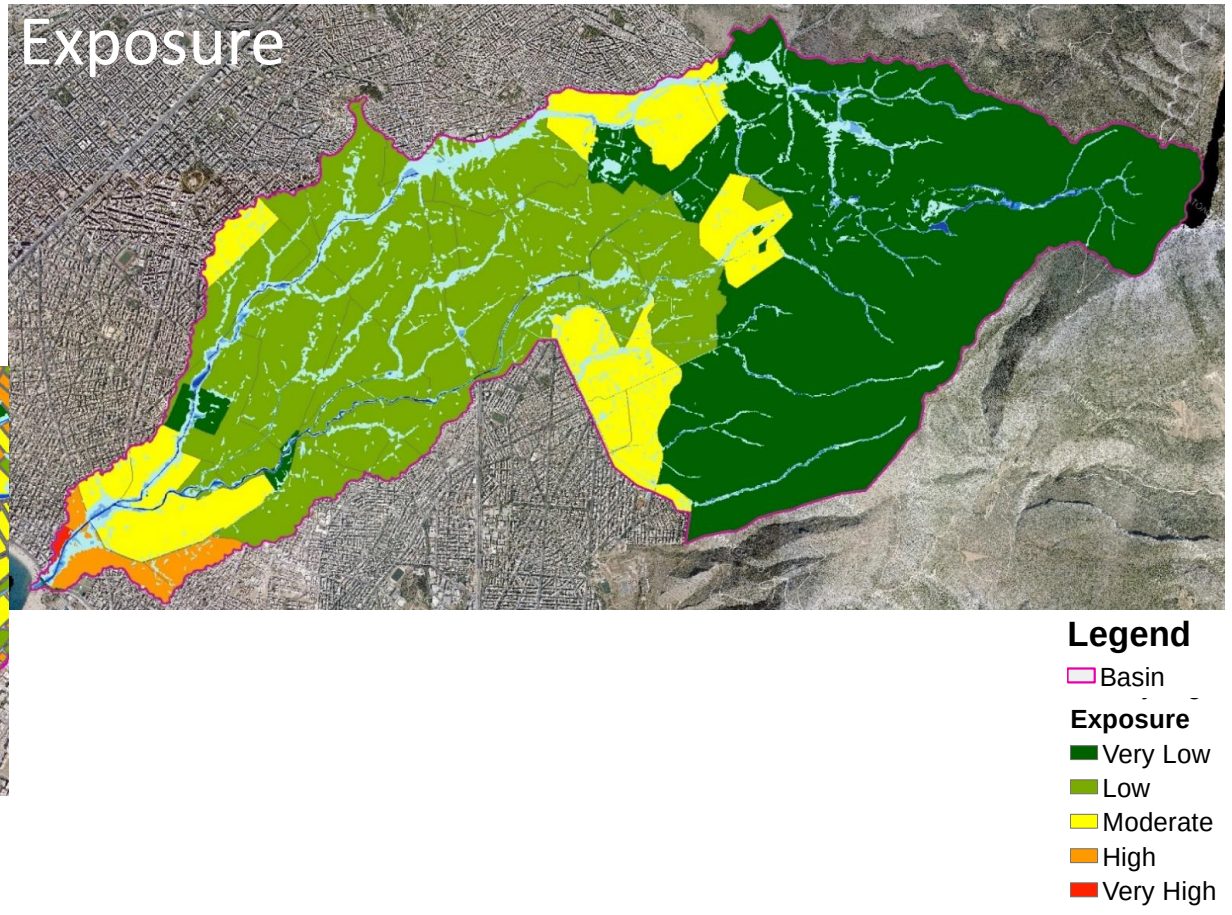
Depth (scenario T 1000 LISFLOOD)
- Very Low
- Low
- Moderate
- High
- Very High

HEC-RAS scenario T 1000 years

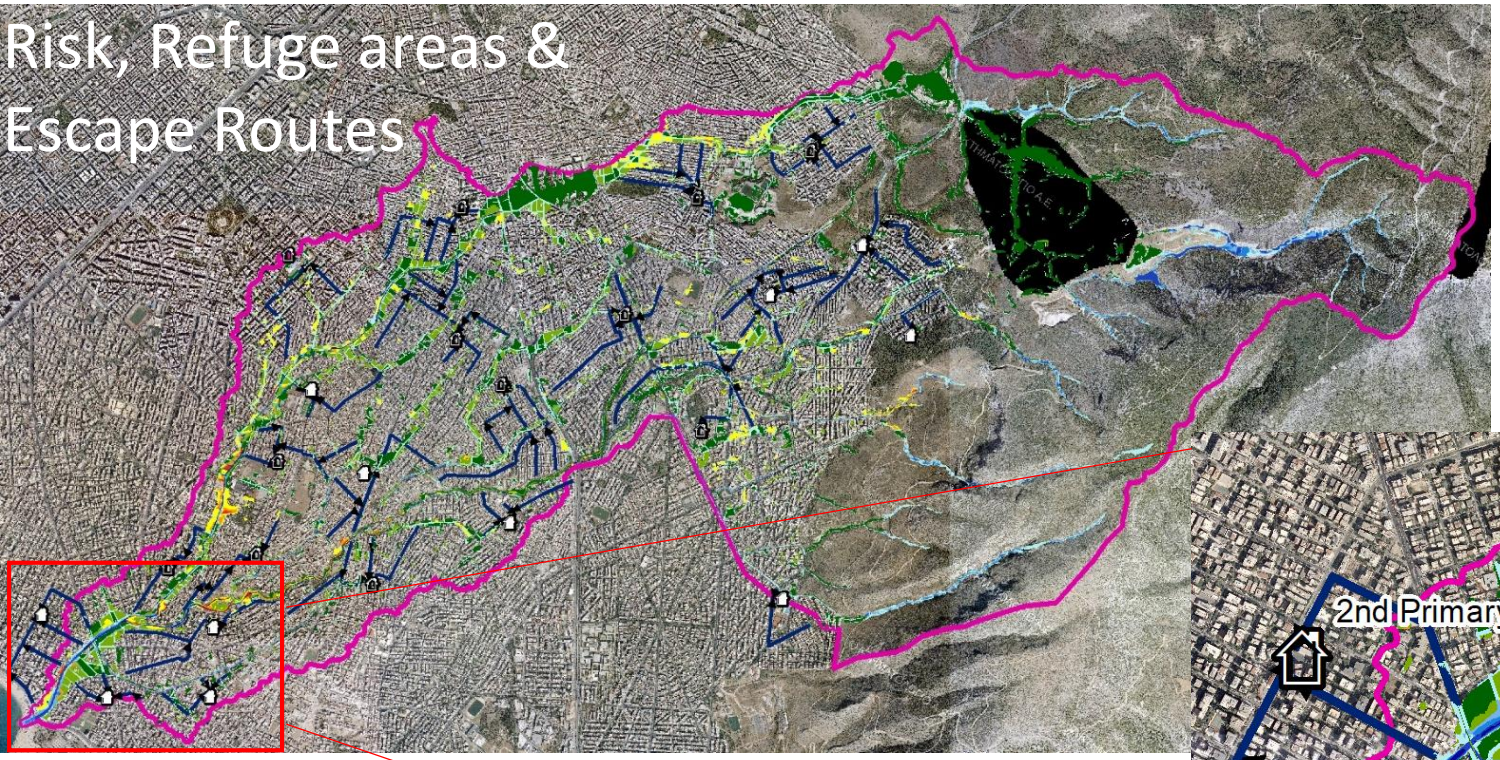


3. RESULTS

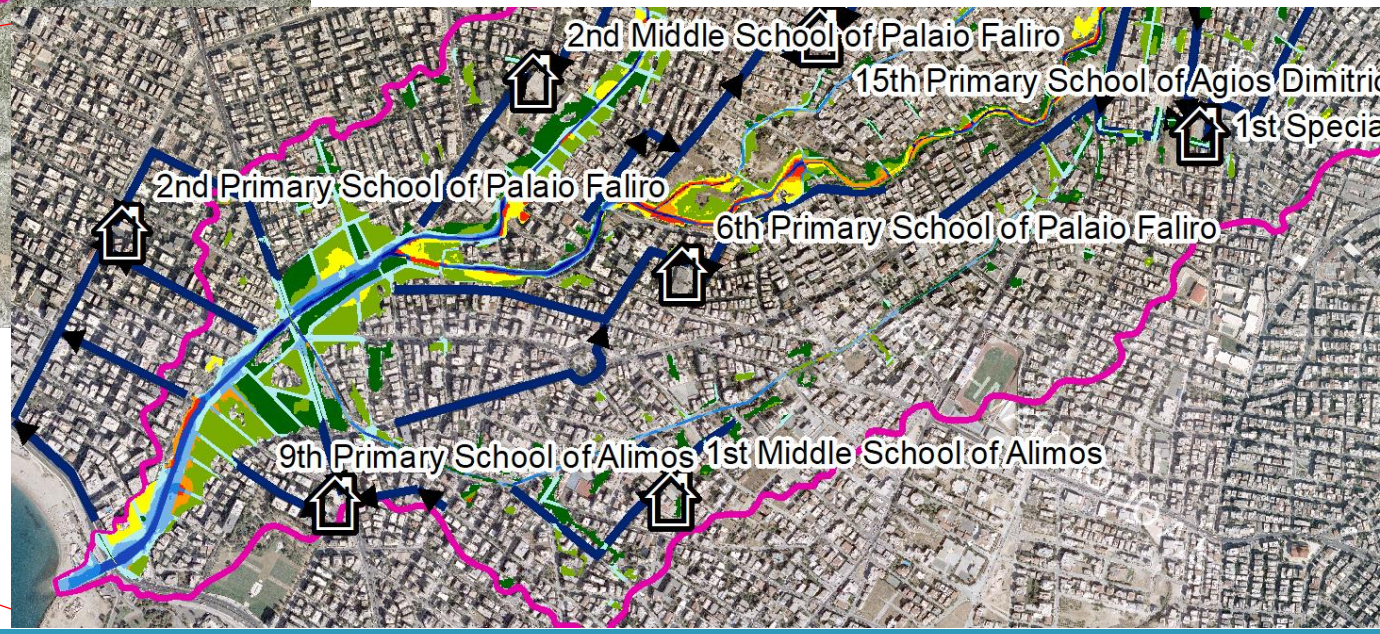

Total Vulnerability
Legend
Basin
Total Vulnerability
Very Low
Low
Moderate
High
Very High


Exposure
Legend
Basin
Exposure
Very Low
Low
Moderate
High
Very High

3. RESULTS



- ✓ Safe close refuge areas
- ✓ Design of proposed escape routes in order to evacuate the citizens safely



Legend

Basin

Risk

- Very Low
- Low
- Moderate
- High
- Very High
- Refuge Areas
- Escape Routes

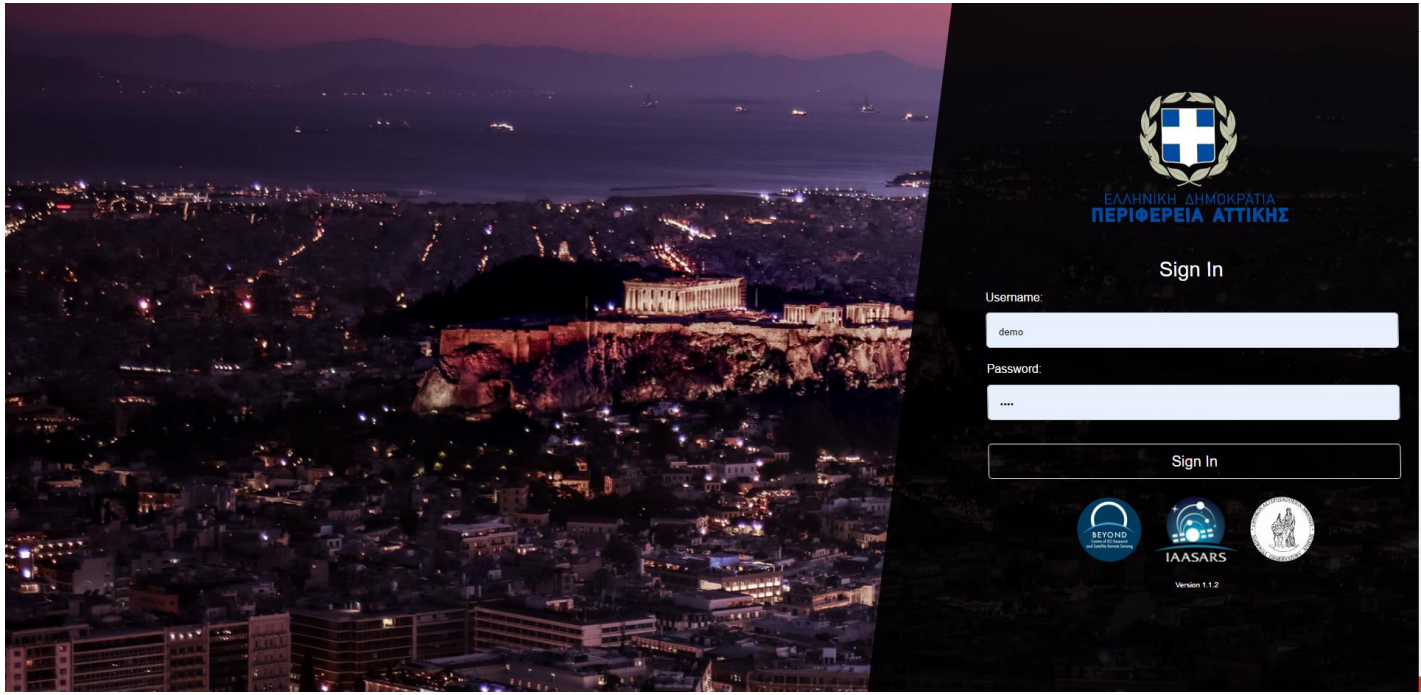
4. DİSCUSSİON

Proposed mitigations measures both short-term and long-term are:

- **structural measures**, e.g. delimitation of streams/rivers, river bed arrangement using up-to-date environmental terms, removal of constructions inside the river beds, small mountain hydro-distribution works, stream daylighting
- **non-structural measures**, e.g. special signs at high risk points, cleaning of the river bed, cleaning and maintenance of flood protection works on a regular and ad-hoc basis after each flood event, tree planting, promoting rainwater harvesting, training and raising awareness of the population, flood management exploiting the output of the projects (web platform)

5. CONCLUSİON

- First, it is very important that **for the first time all the pre-existing, collected and produced data along with the scientific analysis, are properly organised and stored on a user-friendly web platform**, becoming available to all Prefecture's and Municipalities' services.
- This supports the **operational needs** during the crisis, as well as the **preparedness** and the **strategic decision making** towards **disaster resilience**.



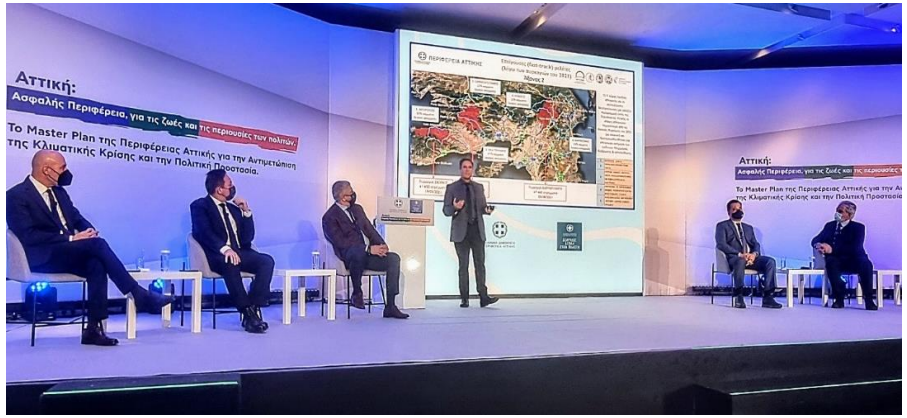
5. CONCLUSİON

Moreover, it’s the first time that such a **holistic approach** for flood risk assessment is implemented on **building block level** in Greece.

The prototype knowledge created through the project supports the Prefecture of Attica in the optimum implementation of the **National Civil Protection Plan** and the work of **Civil Protection Coordination Bodies**. This serves the operational needs during the crisis, as well as the preparedness and the strategic decision making towards disaster resilience.

5. CONCLUSİON

- All the above-mentioned were **confirmed and evaluated positively** according to the stakeholders' feedback.



Thank you for your attention

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ΠΕΡΙΦΕΡΕΙΑ ΑΤΤΙΚΗΣ

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