Flood Risk Assessment using the CLIMAAX framework

The September 2023 Storm Daniel in Thessaly's Plain (Greece)

Team Talos: Amalia, Carola, Mikaela & Pinelopi
Instructor: Aristeidis (Aris) Koutroulis

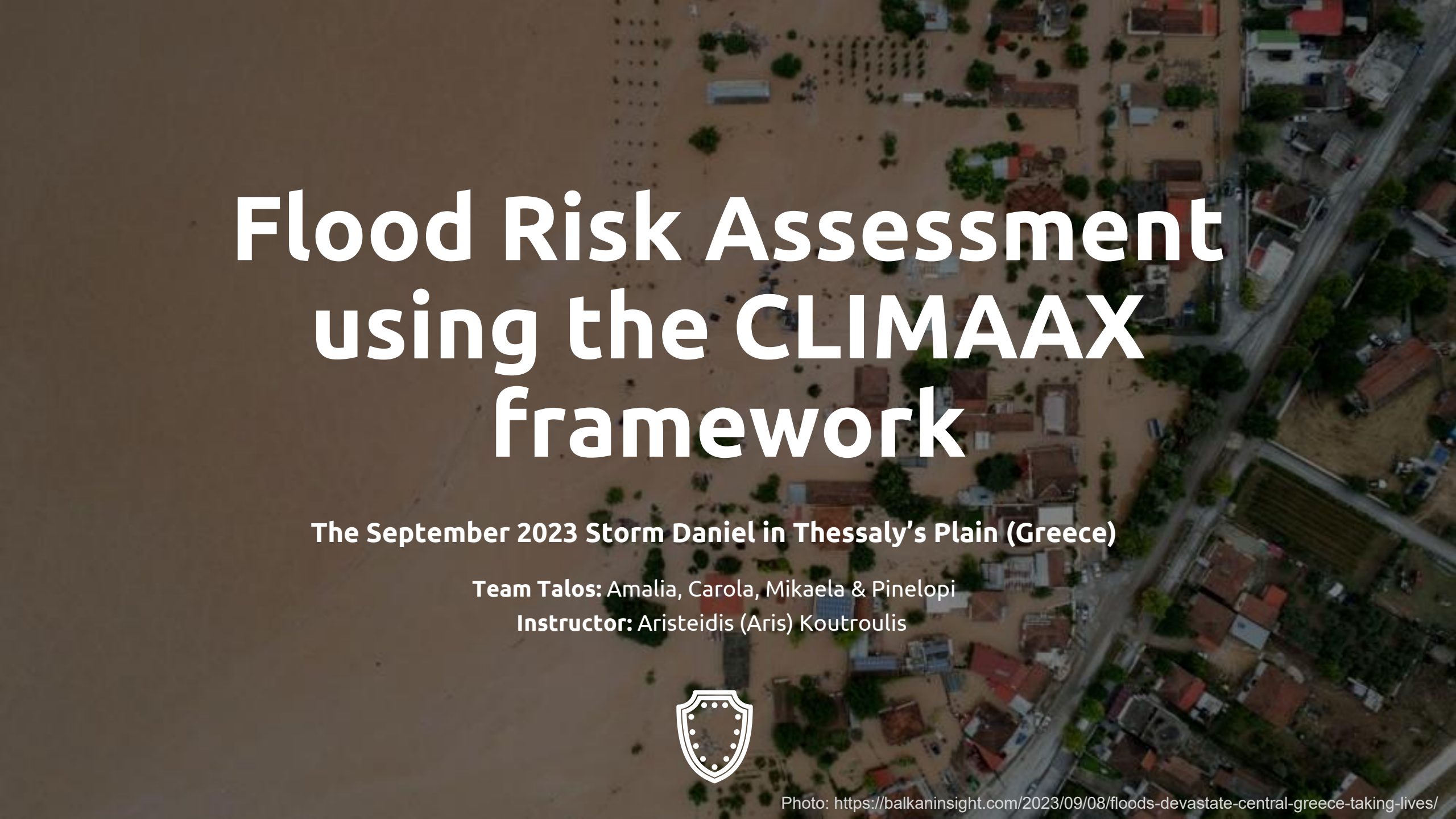
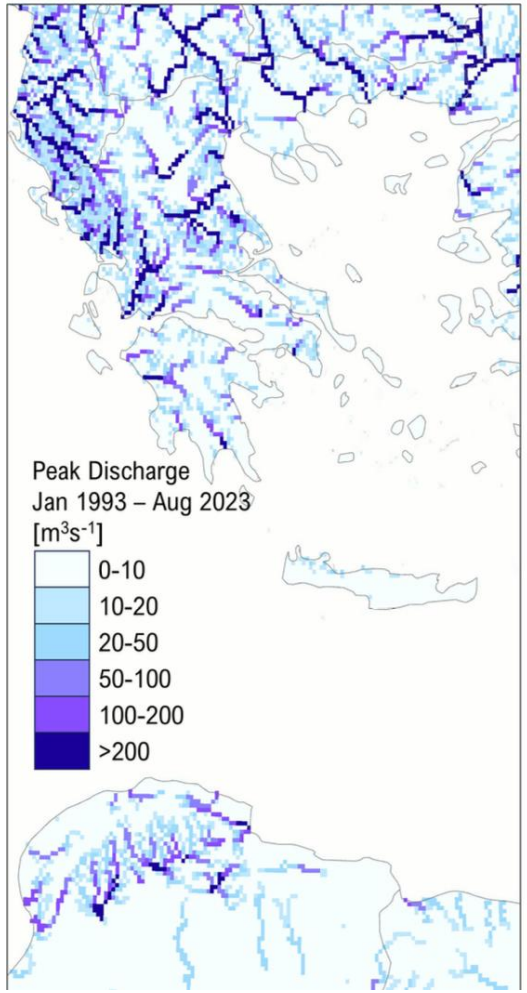
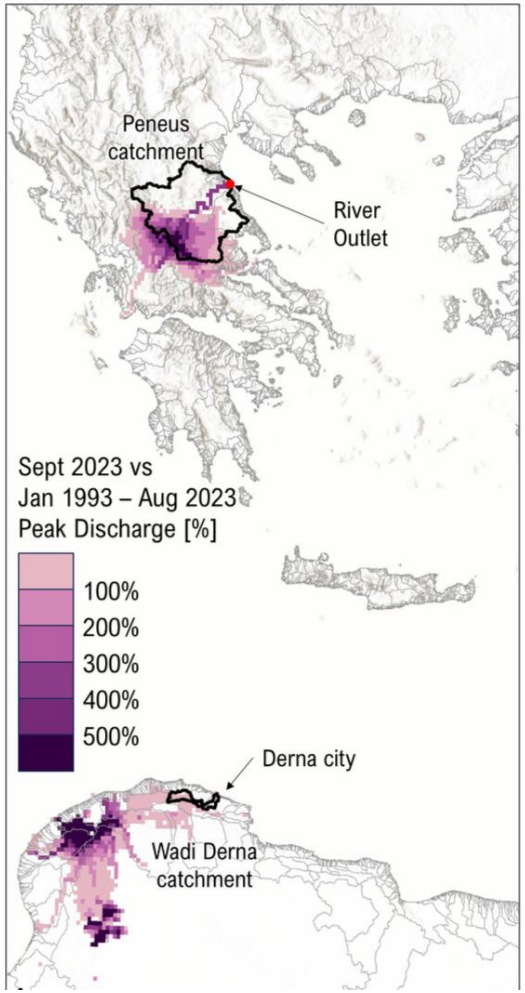


Photo: https://balkaninsight.com/2023/09/08/floods-devastate-central-greece-taking-lives/

September 2023: Storm Daniel hits Greece



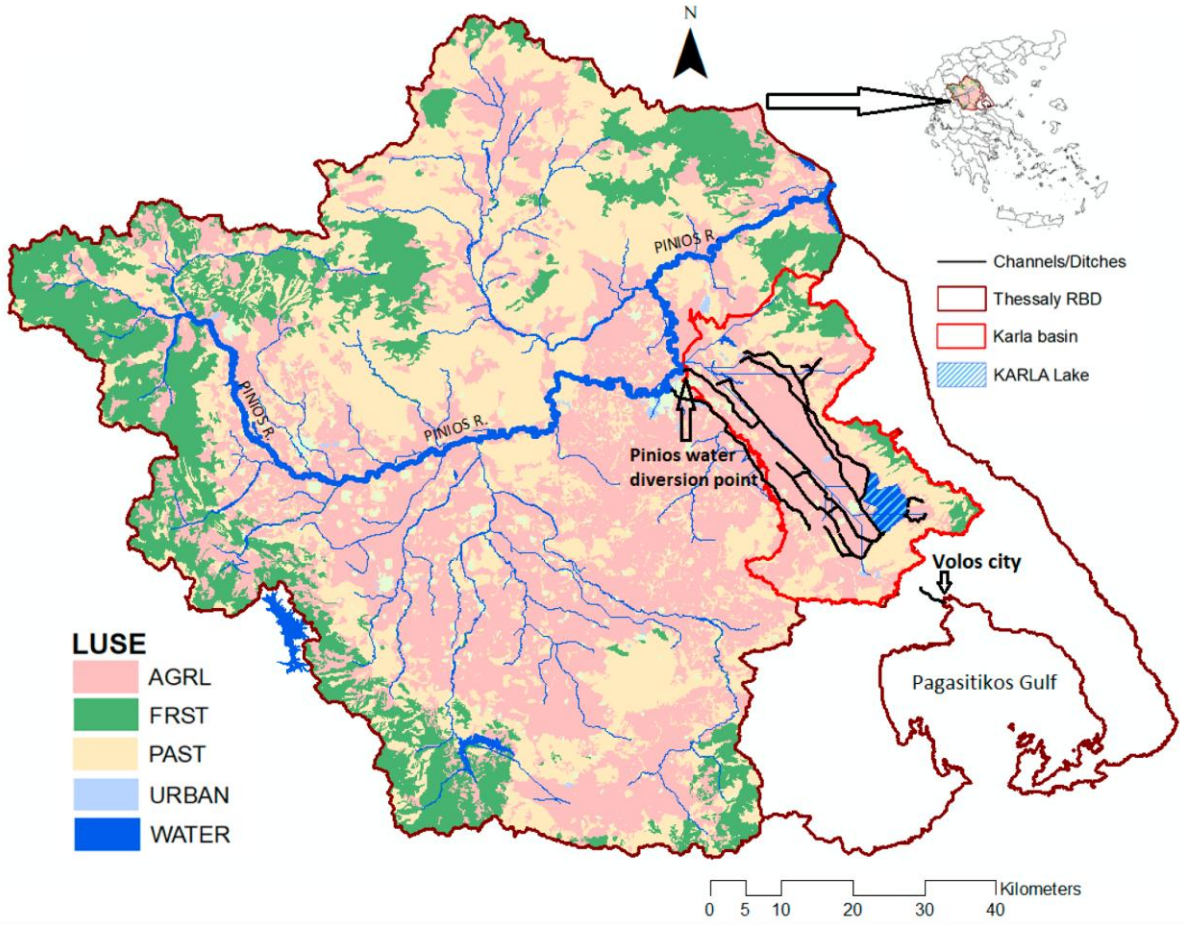


3-8 September 2023

Most intense and costly recorded storm event for the country in the 21st century

During the storm event, the basin received about 47% of its mean annual precipitation (780 mm)

Pineios River basin



Panagopoulos & Dimitriou, 2020

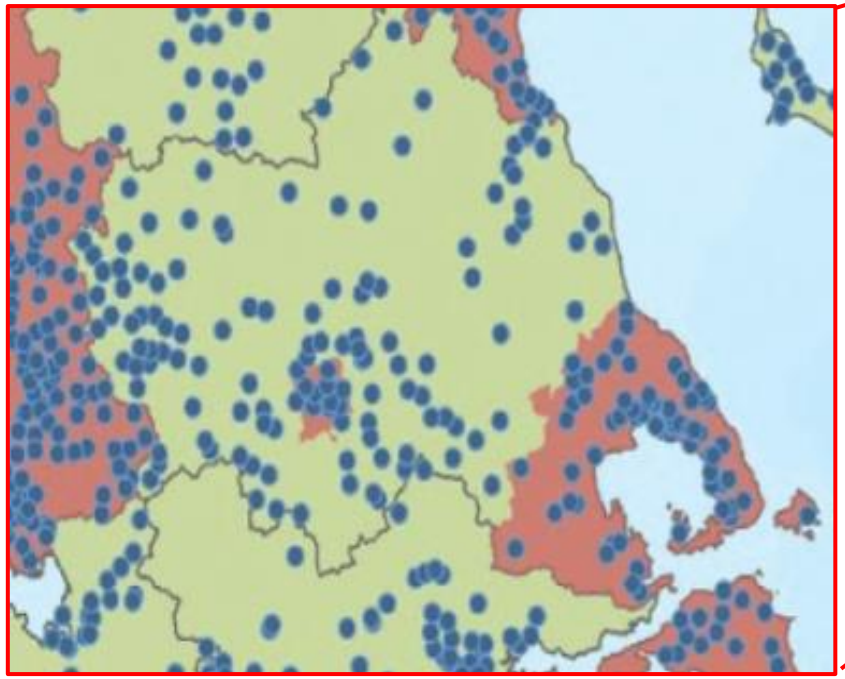
Pineios, located in the Thessaly plain, is the third-longest river in Greece (total length ~ 260 km), with a basin area of 11,063 km^2

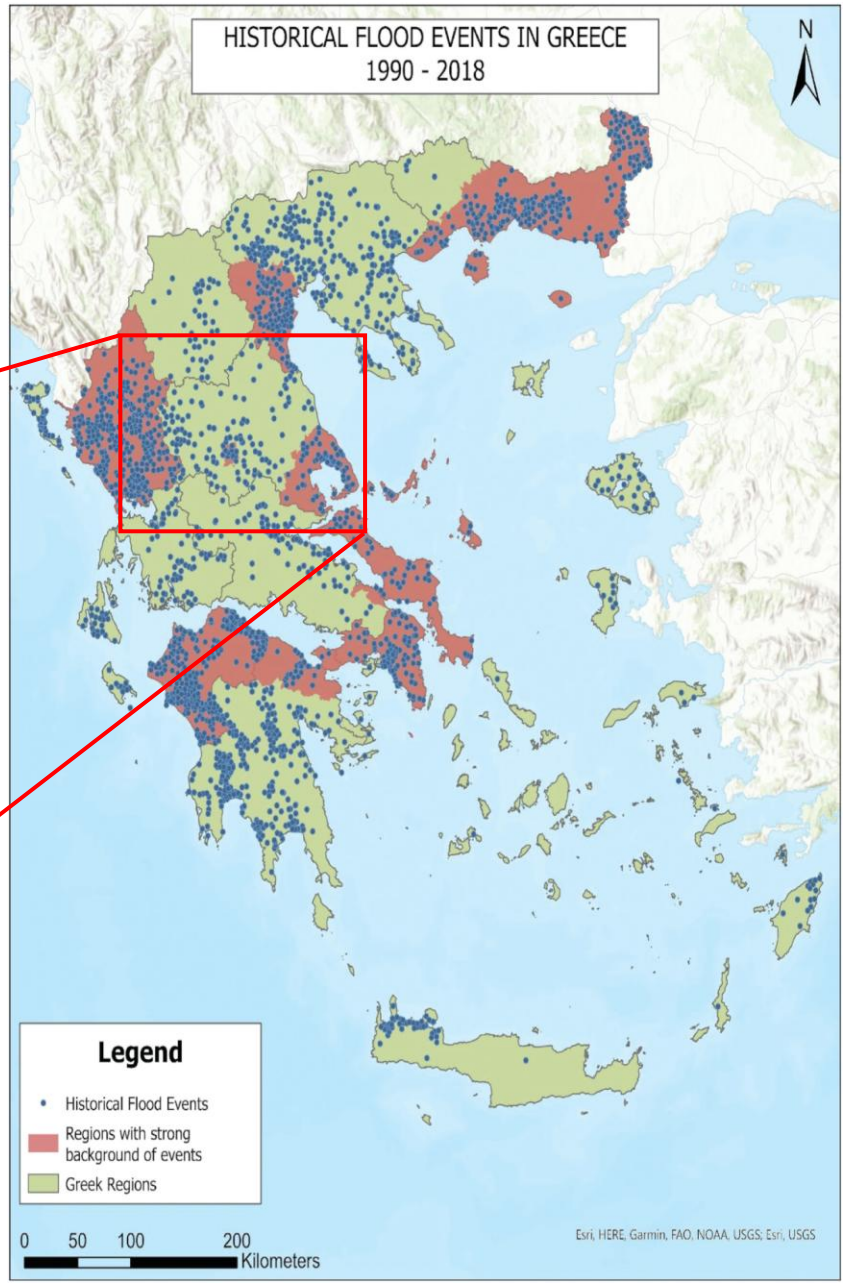
55% of the area is rural/semi-urban
56% of cultivated land is irrigated

Major producer of cotton, wheat, maize, livestock
~12% of Greece's agricultural GDP

Floods are a recurring phenomenon in Thessaly

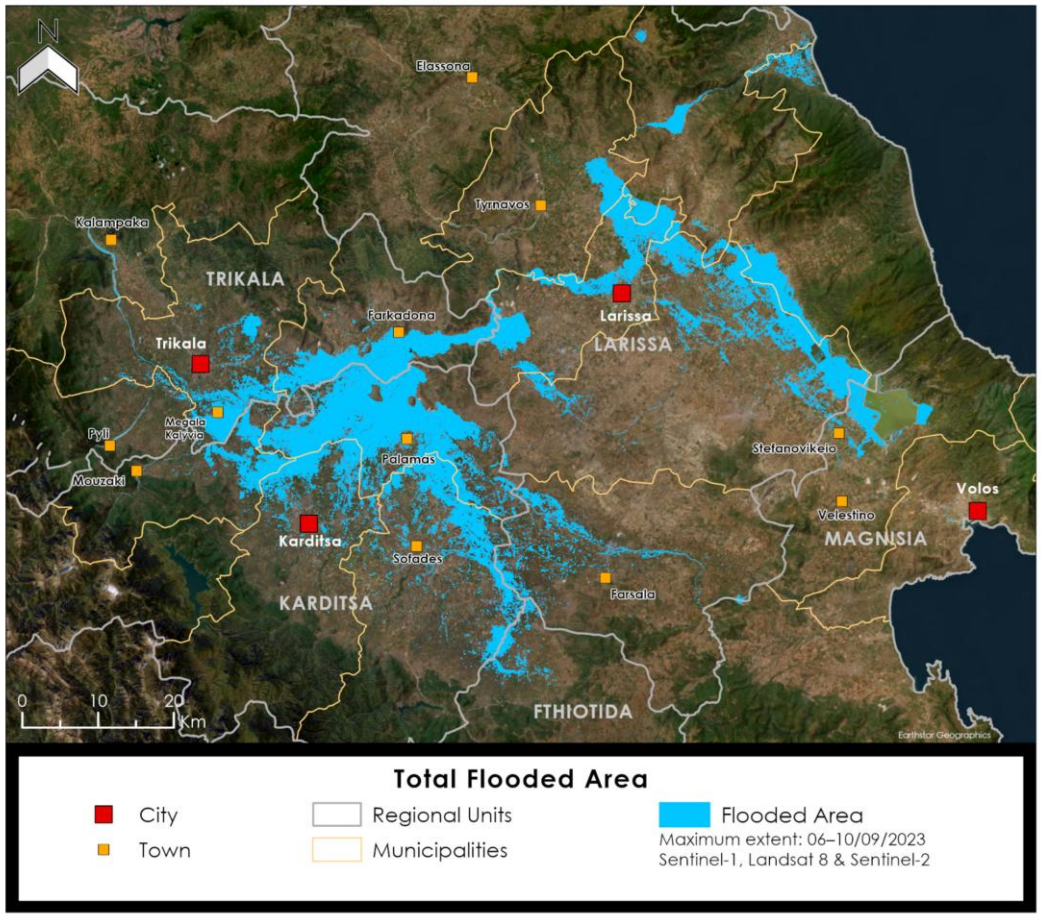
Historical flood events (1990–2018) and hot-spot zones for flood hazard and exposure in Greece.

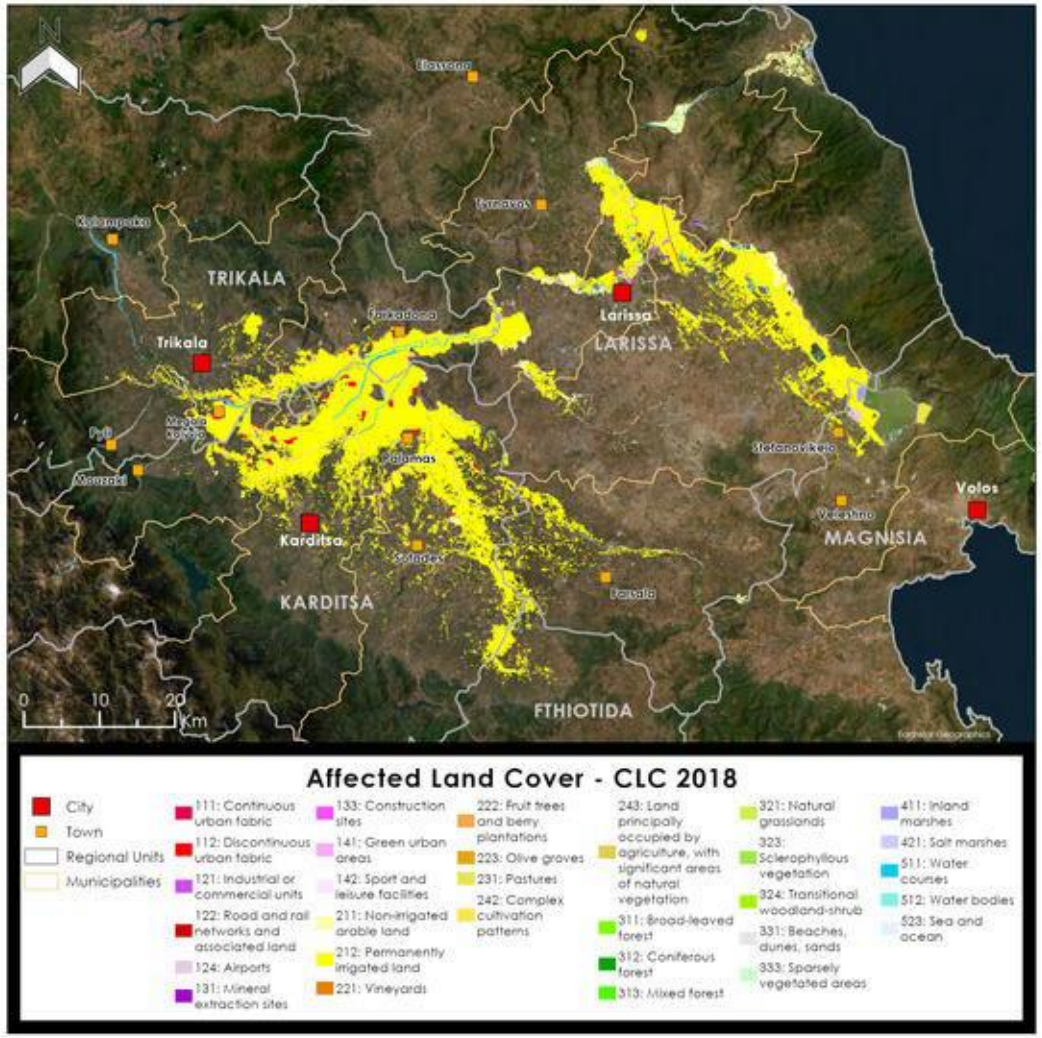




Sapountzaki & Dermosinoglou (2024)

Approximately 720,00 hectares of land were flooded





Falaras et al., 2025

Storm's aftermath

42,520 people, with 17 fatalities and 900 individuals rescued from submerged areas

13% of the cattle, 3% of the sheep and goats, 10% of the pigs and 5% of poultry were lost (more than 200,000 animals died)

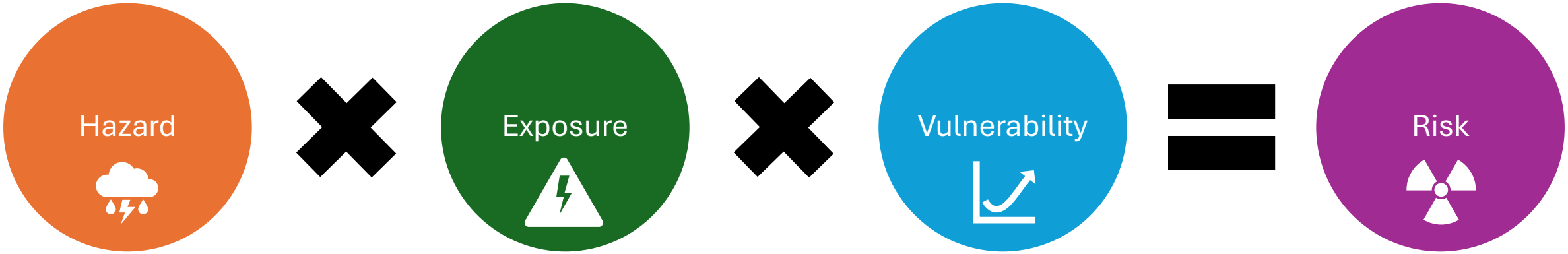
~70% of cotton crops were destroyed

449.16 km of road and rail network was affected, 260.12 km of which were tertiary

More than 2 billion € in damages

Water or electricity shortages in some areas, lasting even months

Water contamination caused by dead animals, garbage, pesticides and oil tanks->outbreaks of epidemics


Hazard
Exposure
Vulnerability
Risk

Hazard Assessment – Datasets

River Flood Hazard Maps [JRC]

- Spatial Resolution: 3 arcseconds (~ 30 - 75 m)
- Scenarios: Present-day
- Return Periods (RP): 10, 100, 500 years
- Includes River Basins > 150 km2
- Does not account for man-made protections

Obtain the flood extents under extreme events with different statistical likelihood of occurrence

Flood Hazard Projection Maps [Aqueduct Floods]

- Spatial Resolution: 30 arcseconds (~ 300 - 750 m)
- Historical (Baseline): c. 1980
- Future (Projections): 2030, 2050, 2080
- Scenarios: RCP4.5, RCP8.5
- Return Periods: 10, 100, 500, years

Estimate the effect of climate scenarios on the river flood hazard

Risk Assessment – Datasets

LUISA Base Map 2018 [JRC]

- Spatial Resolution: ~100m
- 17 Artificial Land Use/Cover Categories

Depth-Damage Curves [JRC]

- Relate the water depth during a flood event to a fraction of the building/land type that is damaged.

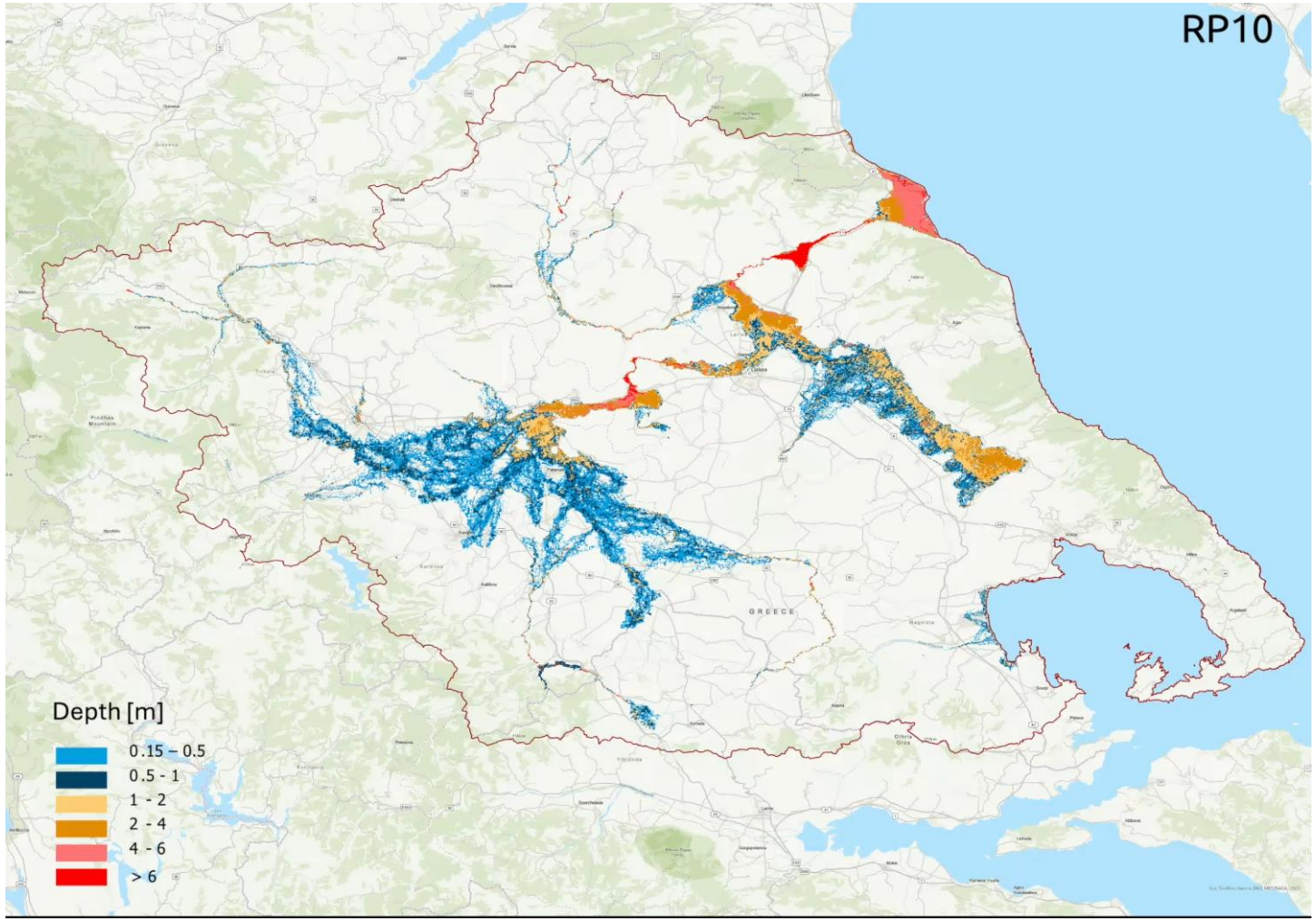
River Flood Hazard Maps [JRC]

GHSL Population Dataset [JRC]

- Spatial Distribution of Population 2025
- Spatial Resolution: 3 arcseconds

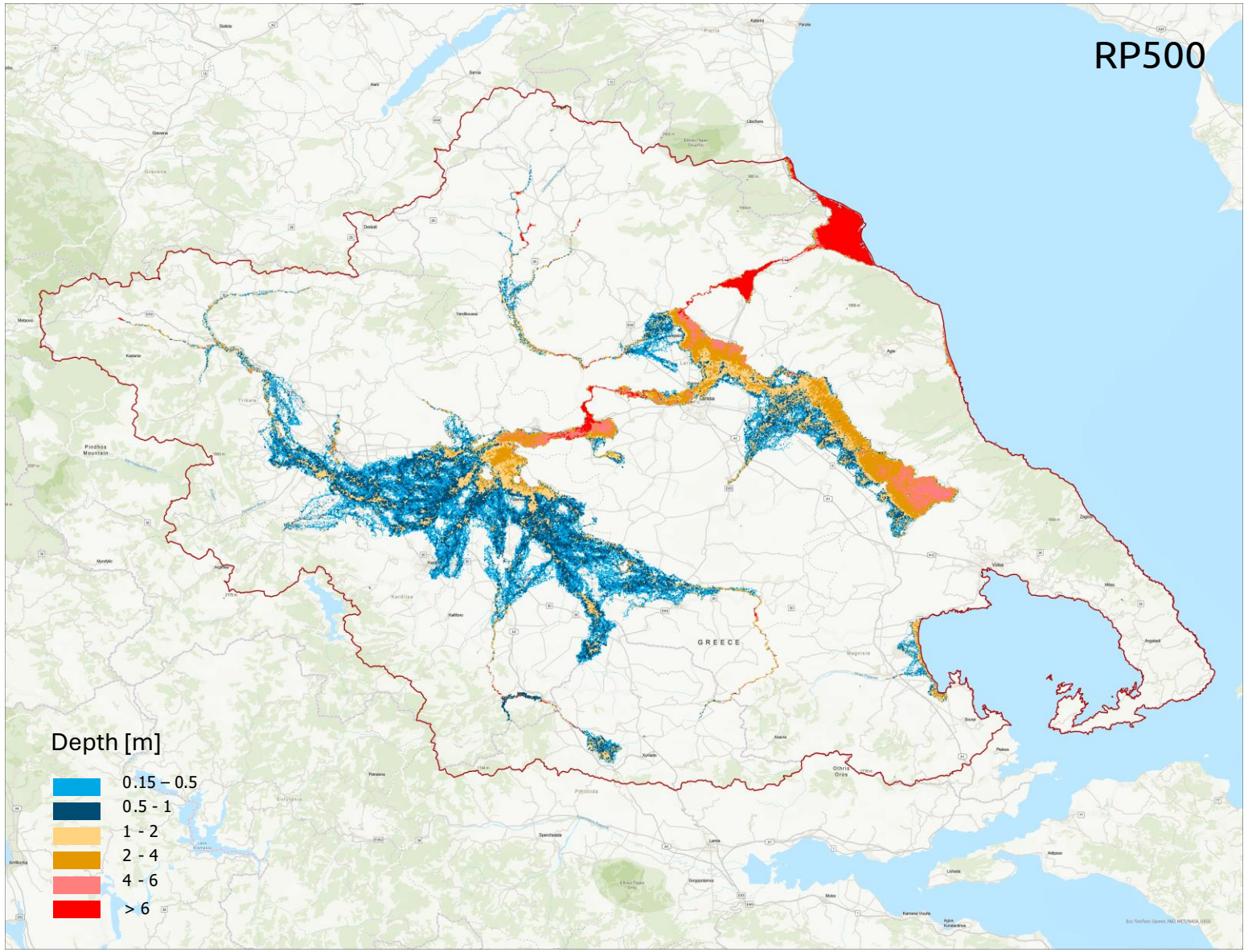
RESULTS

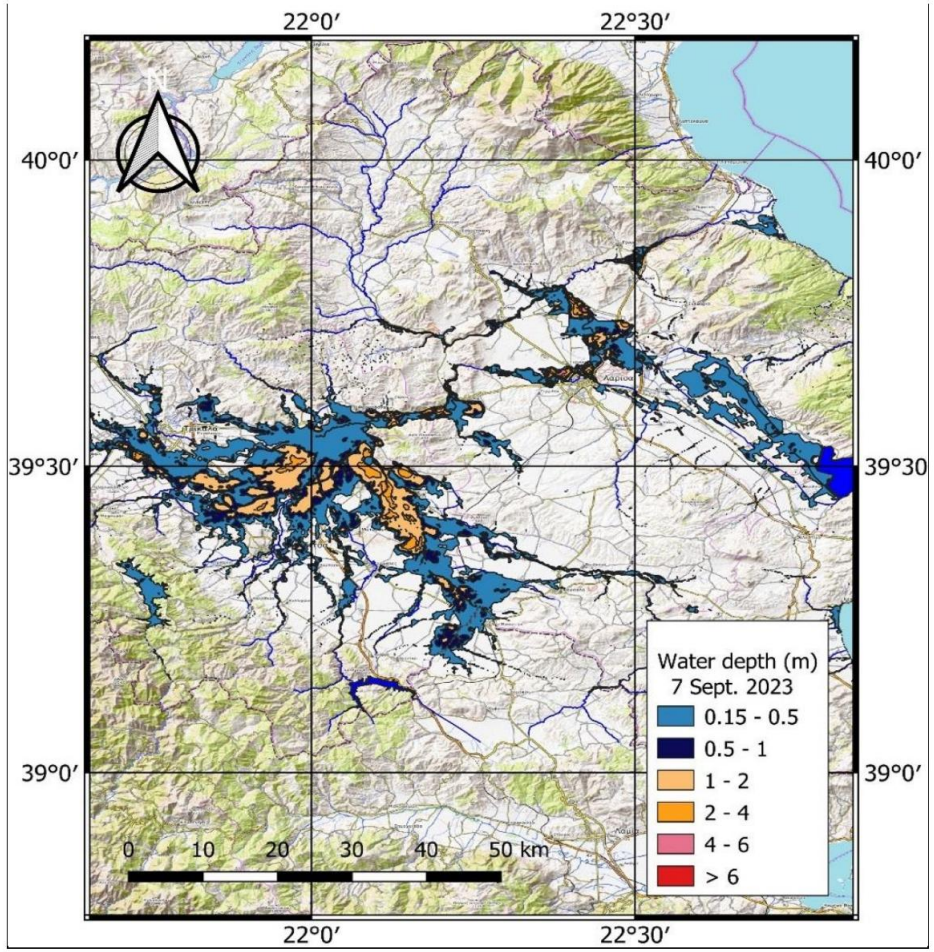
Hazard Assessment



Understanding the differences between river flood maps under extreme events with different return periods in the present-day scenario.

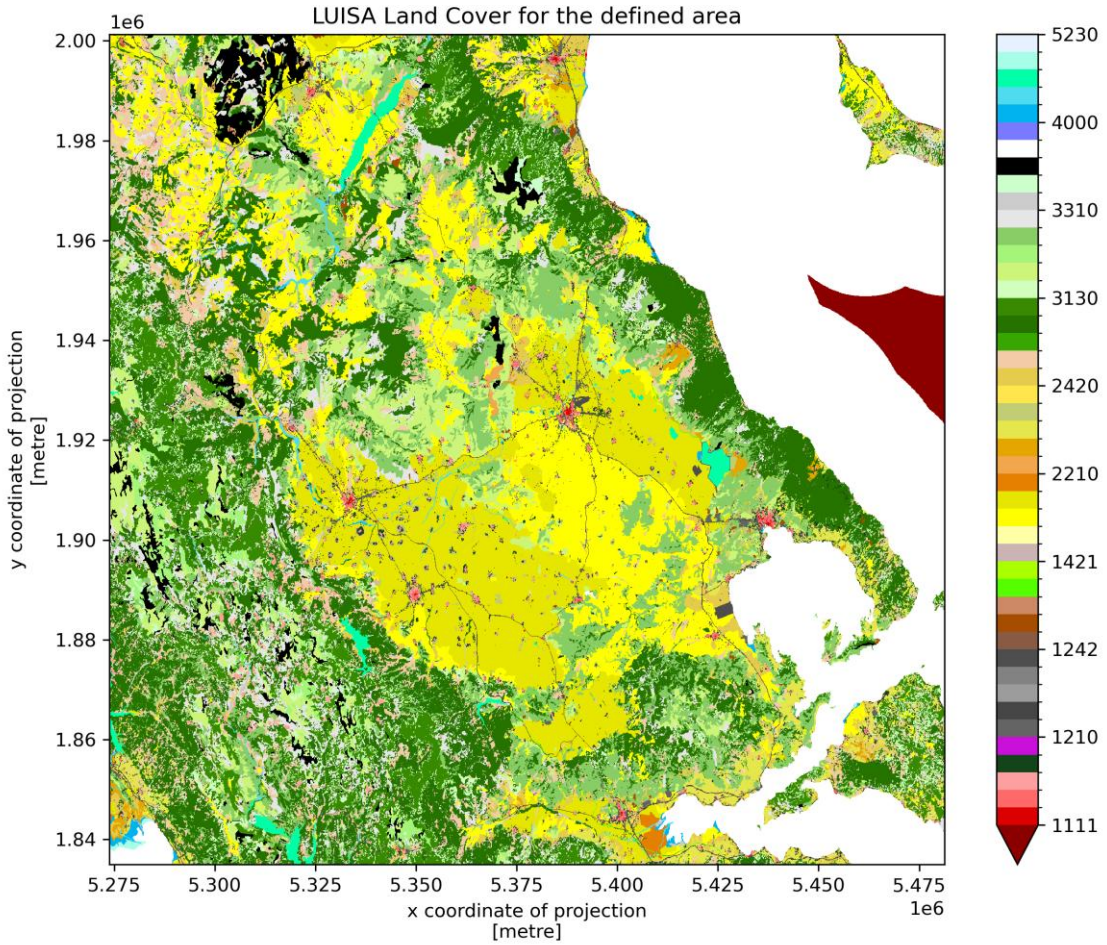
The more extreme the event, the higher inundation depth!





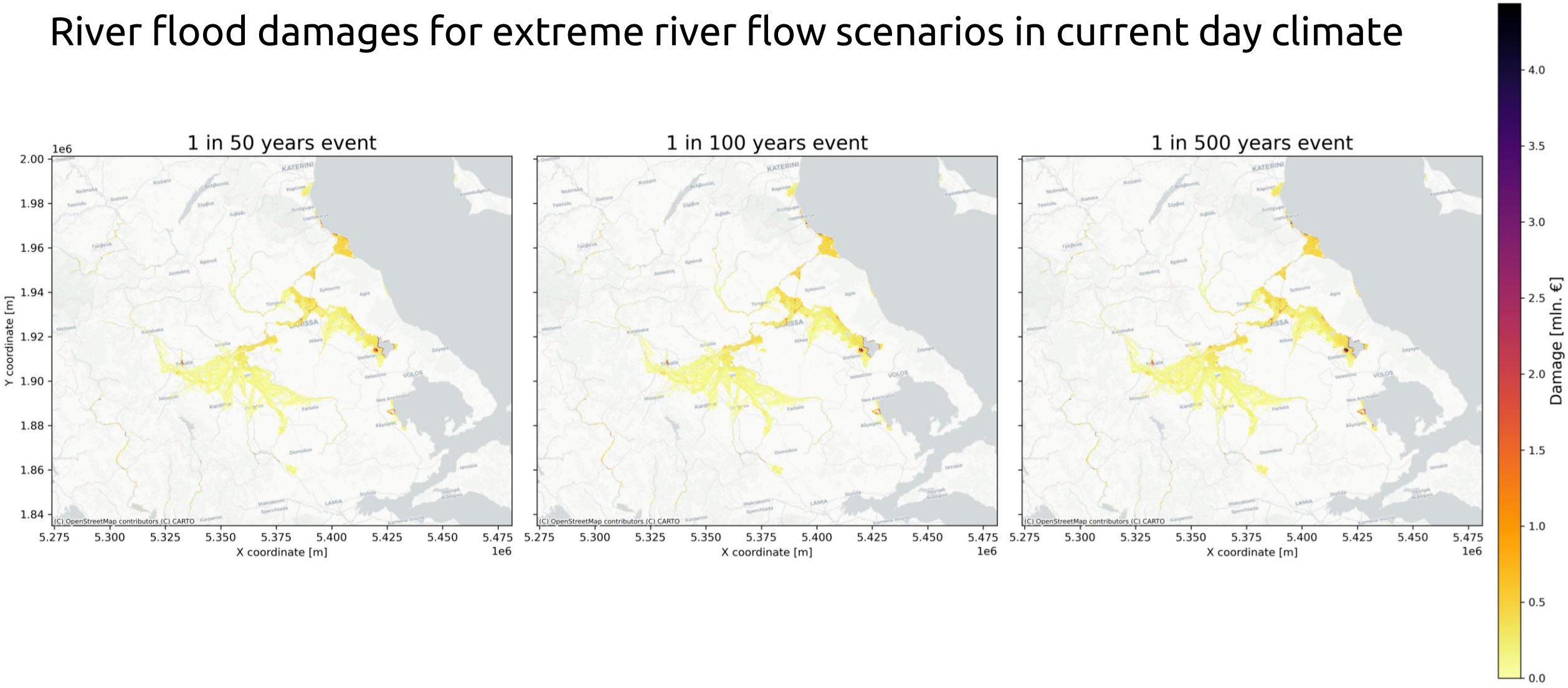
Inundation depths on September 7, 2023
HVA, 2023

Risk Assessment - Exposure



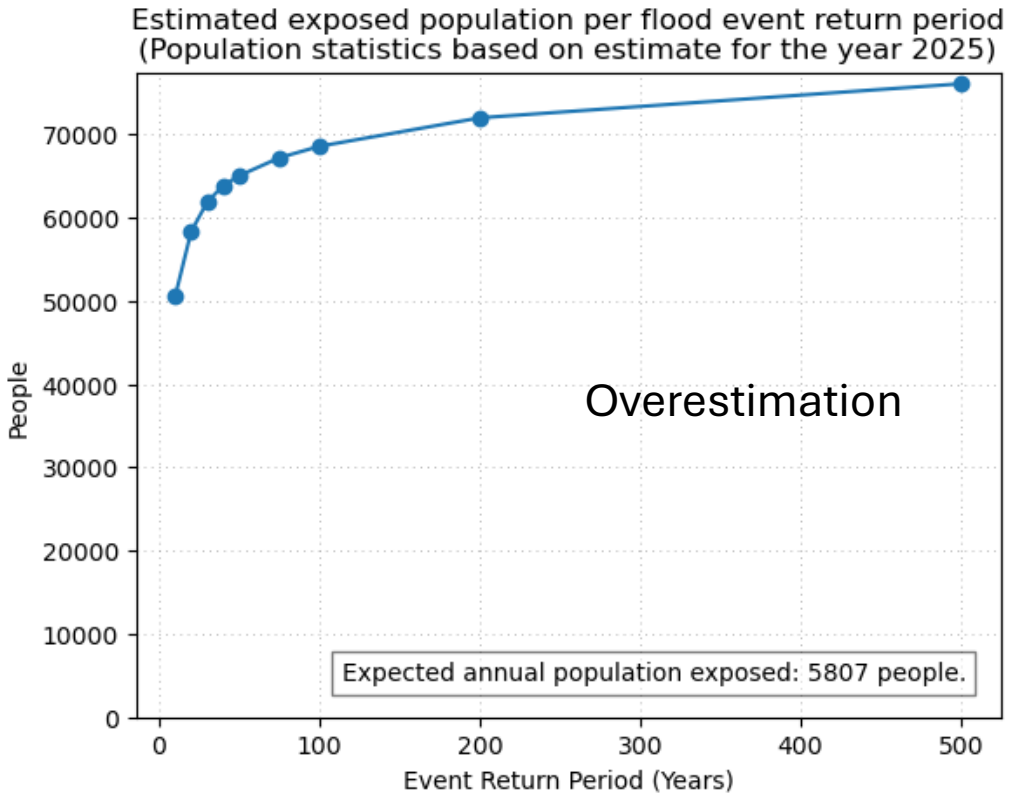
Description	Land use code	€/m²
High density urban fabric	1111	544.6068956
Major stations	1222	519.6538603
Airport areas	1241	519.6538603
Airport terminals	1242	519.6538603
Medium density urban fabric	1121	375.789054
Industrial or commercial units	1210	370.5775211
Construction sites	1330	287.0137338
Port areas	1230	222.7087973
Low density urban fabric	1122	222.3294545
Sport and leisure built-up	1422	192.1121597
Green urban areas	1410	64.03738656
Sport and leisure green	1421	64.03738656
Isolated or very low density urban fabric	1123	63.60573873
Non irrigated arable land	2110	44.92774499

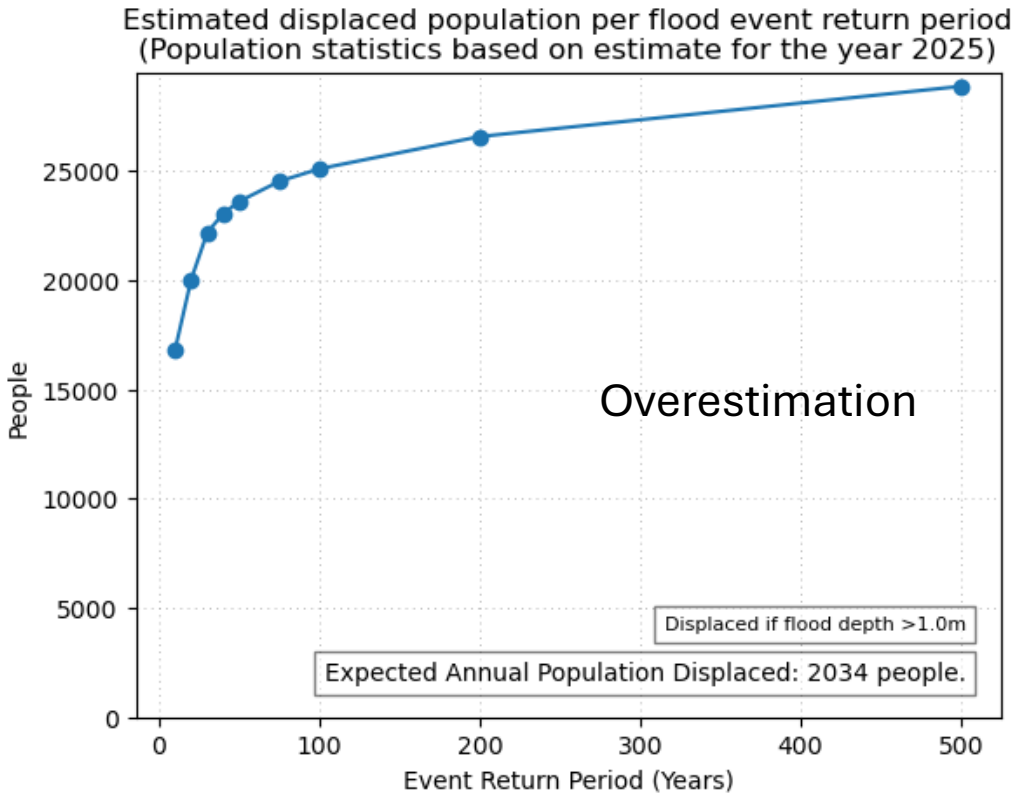
River flood damages for extreme river flow scenarios in current day climate



Comparing with the actual event

42,520 people exposed (water > 0)
900 individuals displaced (water > 1m)





PREPAREDNESS

1. PREVENTION:
Need to revise all flood defense infrastructures and other infrastructures and improve the retention capacity of the area.

Photo: https://balkaninsight.com/2023/09/08/floods-devastate-central-greece-taking-lives/

PREPAREDNESS

2. GOVERNANCE:

- Poor accuracy of previous flood management models
- Poor governance of the territory and lack of coordination
- Spatial planning: residential and industrial areas at inadequate locations
- Law enforcement: illegal dams and other structures
- Maintenance of water infrastructure

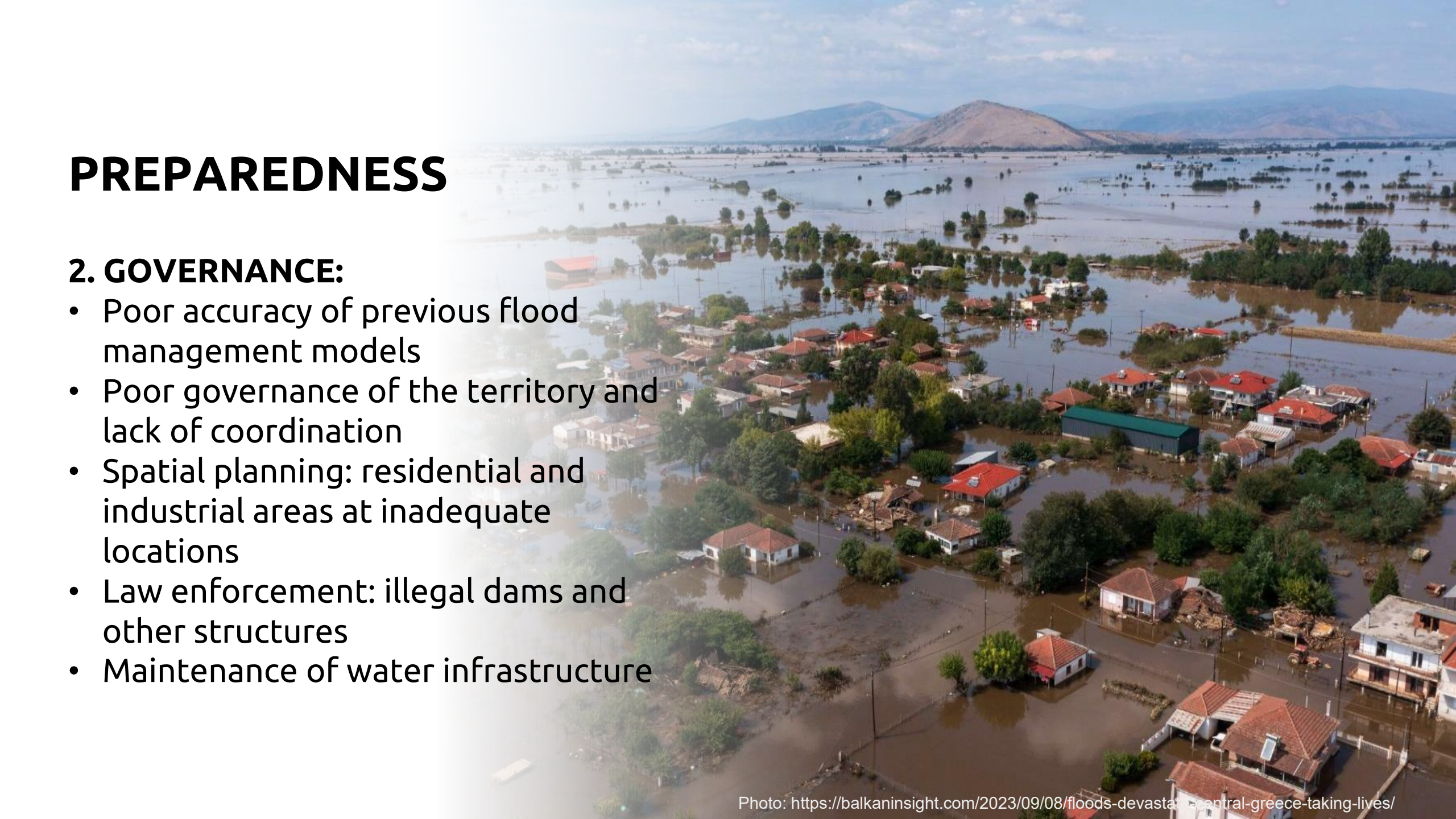


Photo: https://balkaninsight.com/2023/09/08/floods-devastate-central-greece-taking-lives/

PREPAREDNESS

3. CRISIS MANAGEMENT:
Warning system and communication with inhabitants was ineffective

Need for an early warning system and new protocols

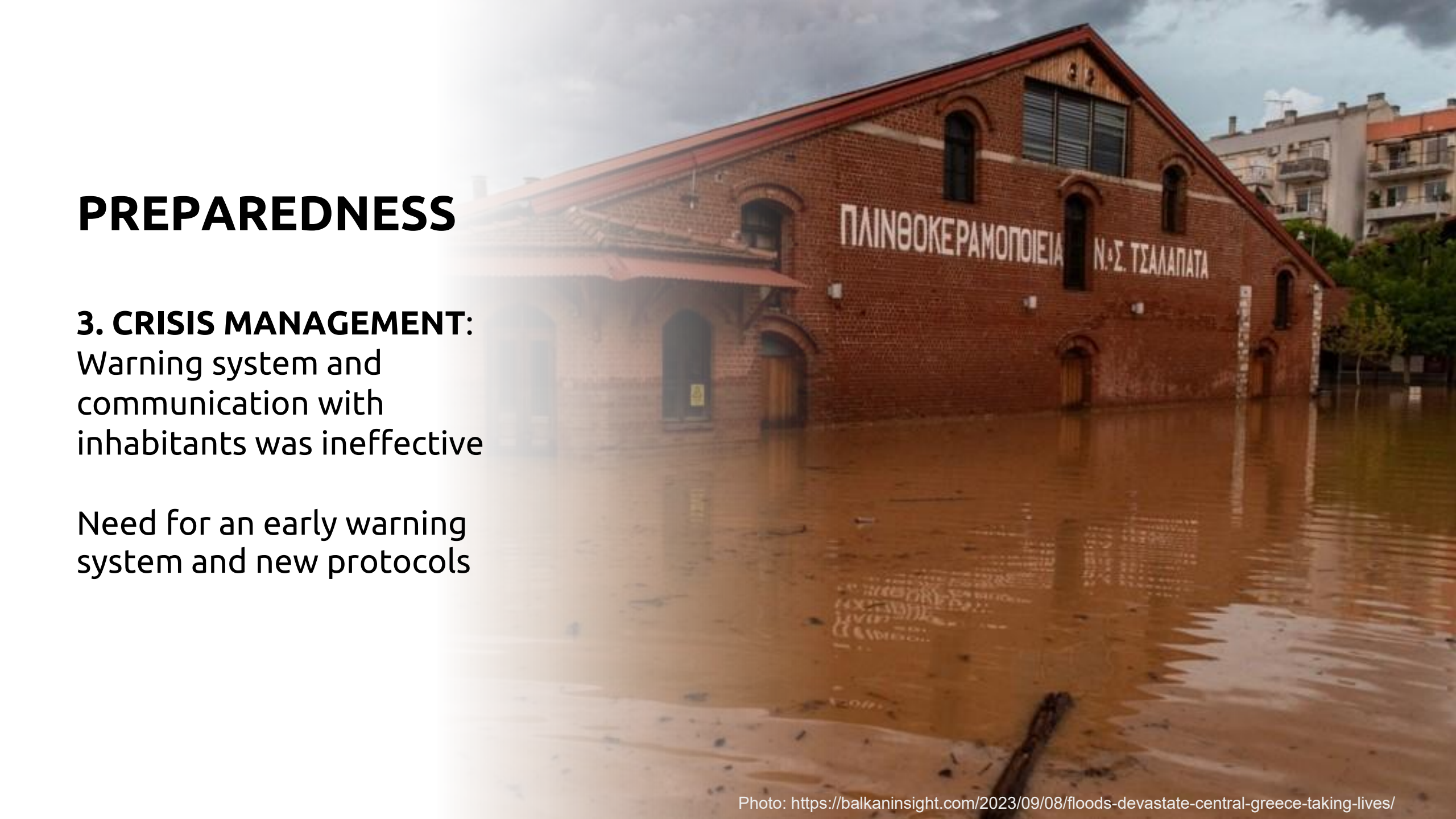


Photo: https://balkaninsight.com/2023/09/08/floods-devastate-central-greece-taking-lives/

Limitations & Future steps

- Hazard assessment:
  - Smaller basins and riverine systems are not assessed → Might overestimate results
  - Datasets with different resolution → might not capture spatial variability due to less detailed information
- Risk assessment:
  - Deficiencies, poor resolution, or inherent structure of the datasets
  - Datasets with different resolution, e.g. flood extent maps [30-75 m] Vs land use data [50 or 100 m]
  - Coarse statistical representation of population distribution

Promoting Nature-based Solutions (NbS) introduces a new approach to flood risk governance. Deep institutional reforms, public engagement, and financial realignment are essential for Greece to mainstream NbS in flood governance.

With the hope of building back better...
Thanks!

Photo: https://balkaninsight.com/2023/09/08/floods-devastate-central-greece-taking-lives/