

GIS and Water resources management and GIS (part 3)

Application of GIS on the EU's Flood Directives.

The INSPIRE Directive.

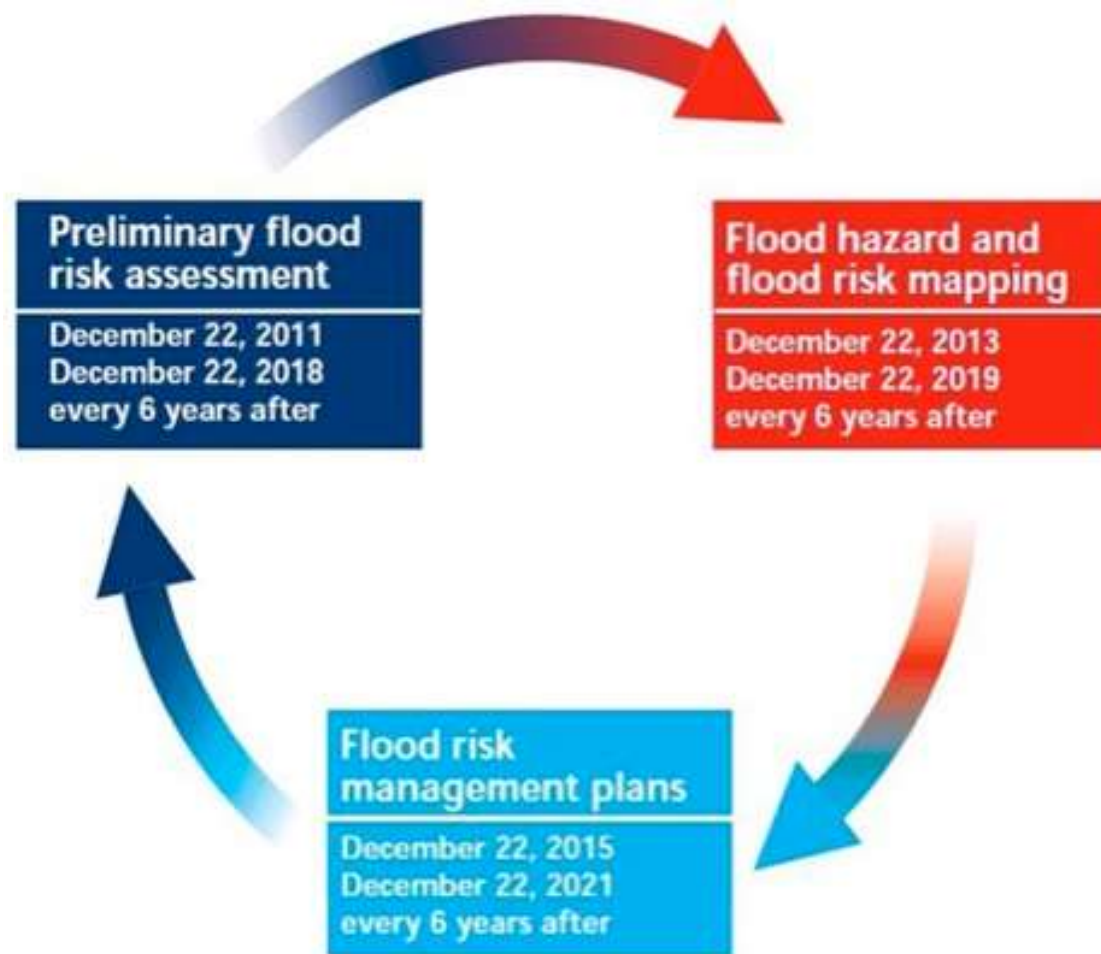
By

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hskoulik@civil.auth.gr

April 2022

Application in EU's Floods Directive

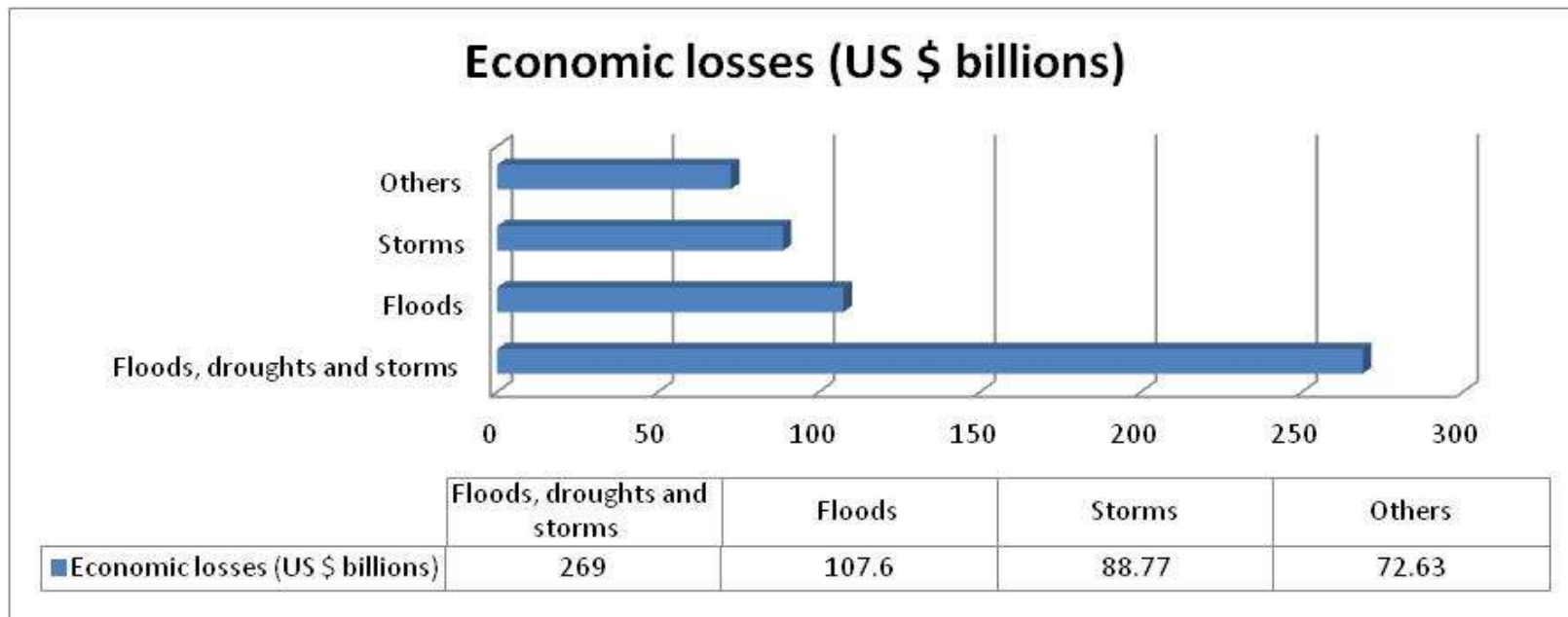


Floods in Europe? Impacts?

Floods and storms in Europe account respectively for 40 % and 33% of the total economic damages for the period 1989-2008.

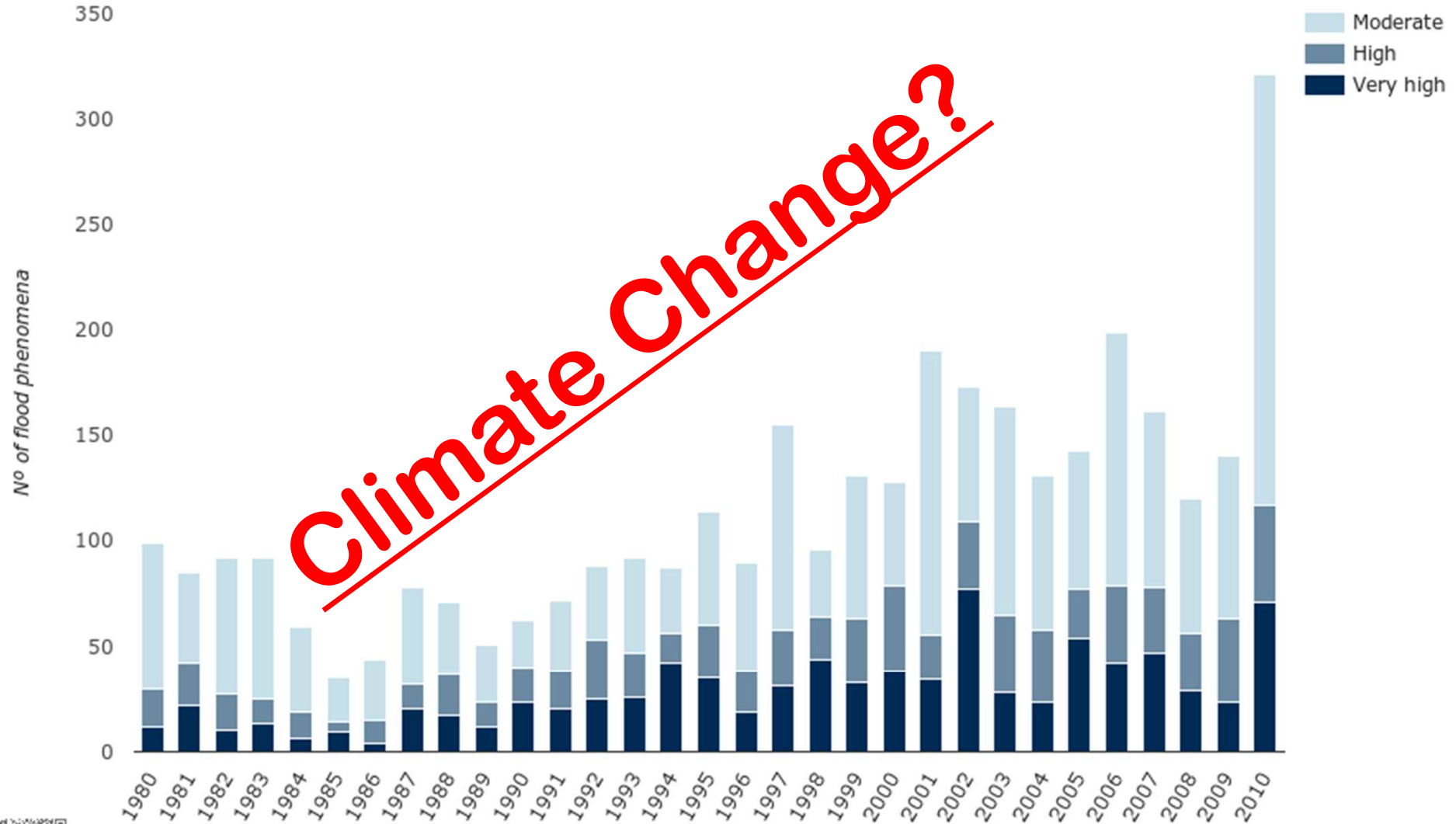
The trend will probably continue to rise as floods and storms are expected to become more frequent and severe in the future in Europe. (source: UNISDR)

In the past 20 years, 953 disasters killed nearly 88,671 people in Europe, affected more than 29 million others



Floods in Europe? Impacts?

Chart – Reported flood phenomena



Floods in Europe? Impacts?



European flood risk directive 2007/60

The European "Directive on the assessment and management of flood risks", endorsed in 18 September 2007, aims to reduce the adverse consequences on human health, the environment, cultural heritage and economic activity associated with floods in the Community.

Article 6 of the Floods Directive requires Member States to prepare

- 1. flood hazard and**
- 2. flood risk maps**

(at the river basin level and at the most appropriate scale) for the areas of potential significant flood risk identified under Article 5 or 13.1(a), or for the areas for which Member States decided to prepare flood maps according to Article 13.1(b).

Definitions adopted in the EFD 2007/60

Flood: is a temporary covering by water of land normally not covered by water. This shall include floods from rivers, mountain torrents, Mediterranean ephemeral water courses, and floods from the sea in coastal areas, and may exclude floods from sewerage systems

Flood risk: is the combination of the probability of a flood event and of the potential adverse consequences to human health, the environment and economic activity associated with a flood event

Flood hazard maps: demonstrate areas which could be flooded according to three probabilities (low, medium high) complemented with: type of flood, the flood extent; water depths or water level as appropriate; where appropriate, flow velocity or the relevant water flow direction

Flood risk maps: indicate the potential adverse consequences associated with floods under several probabilities, expressed in terms of: the indicative number of inhabitants potentially affected; type of economic activity of the area potentially affected; installation which might cause accidental pollution in case of flooding

Requirements for Member States

- Preliminary flood risk assessment: the aim of this step is to evaluate the level of flood risk in each river basin district or unit of management and to select those areas on which to undertake flood mapping and flood risk management plans.
- Flood mapping comprising of flood hazard maps and flood risk maps: the flood hazard maps should cover the geographical areas which could be flooded according to different scenarios; the flood risk maps shall show the potential adverse consequences associated with floods under those scenarios.
- Flood risk management plans: on the basis of the previous maps, the flood risk management plans shall indicate the objectives of the flood risk management in the concerned areas, and the measures that aim to achieve these objectives.

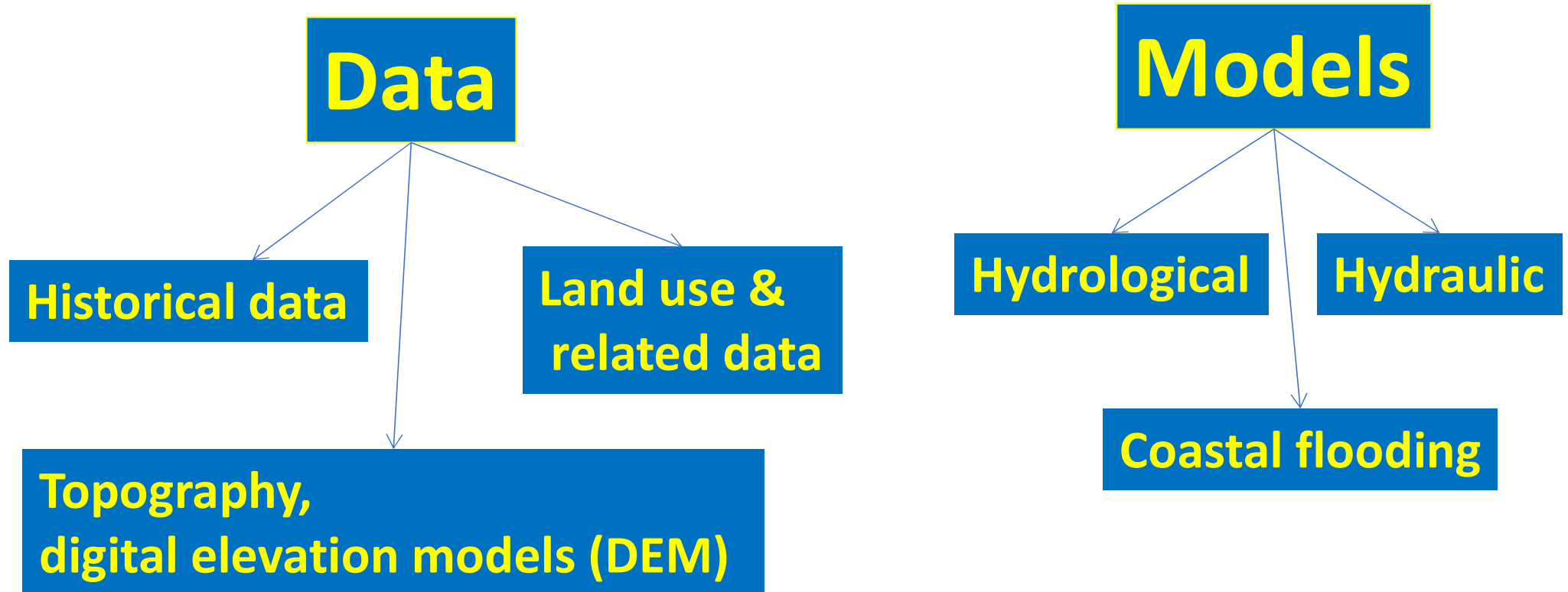
To be completed by 2011

To be completed by 2013

To be completed by 2015

Production of flood maps

To produce the maps data and models are required



Data requirements

Topography, digital elevation models (DEM)

To enable accuracy of inundation modelling as well as to secure the identification of the endangered properties, detailed and accurate digital maps and digital elevation models (DEM) are required. Taking into consideration the most flat character and the very slight slope of the floodplain as well as that of the river flood surface, appropriate selection of horizontal and vertical accuracy of the maps/DEM has significant impact on the reliability and accuracy of the end product.

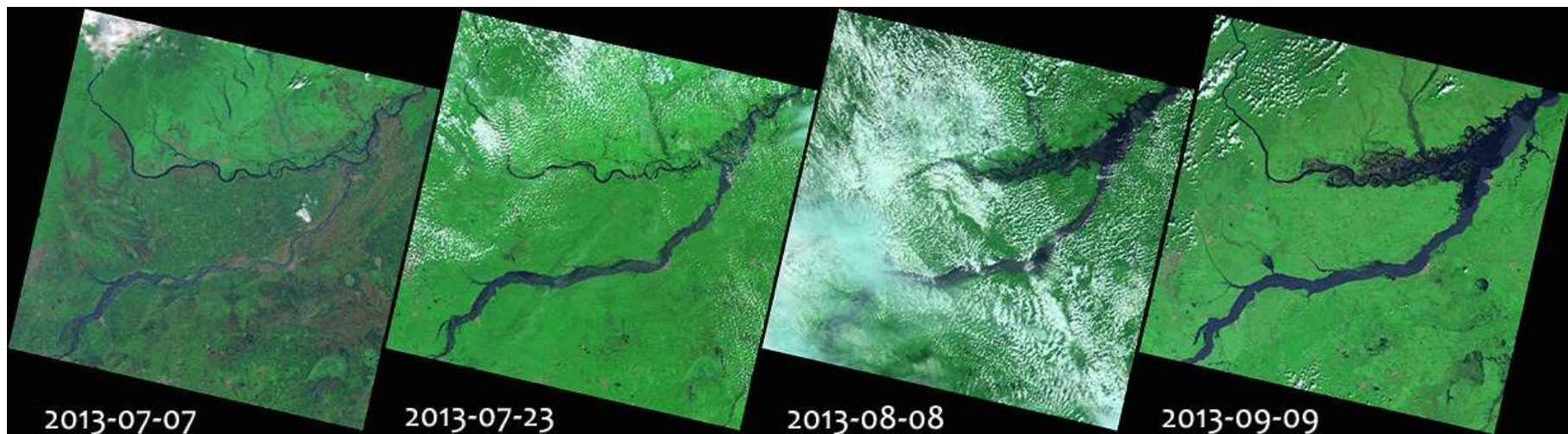
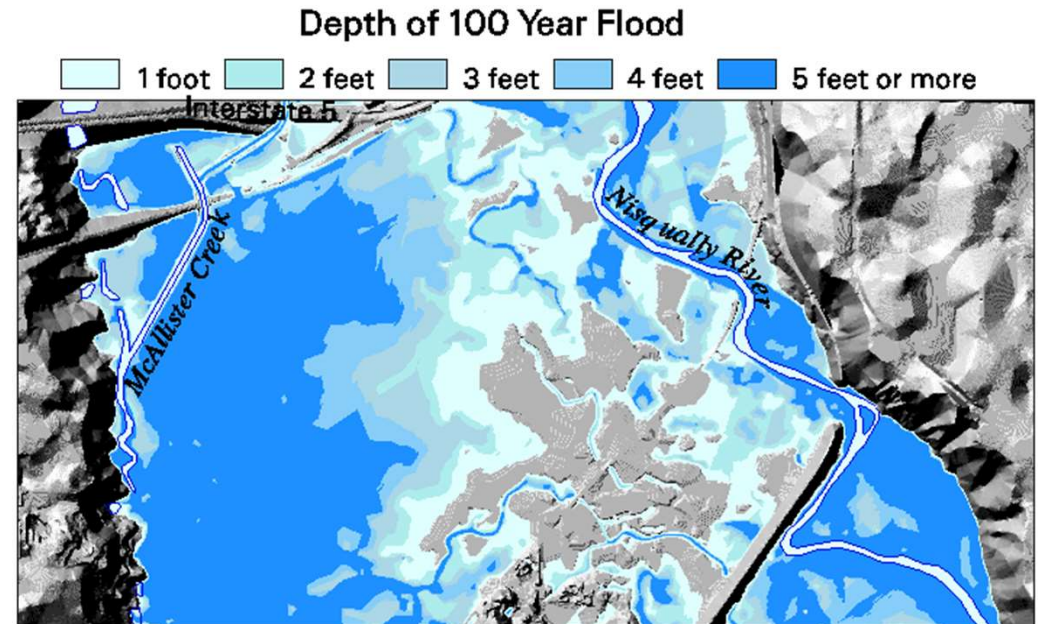
Minimum requirements are 10 m*10 m (possibly 5 m*5 m) horizontal and minimum 0.5 m vertical resolution.

Possible tools/methods to generate DEMs of the required accuracy:

- **LiDAR**
- **SAR and variations (IFSAR, GeoSAR, AIRSAR)**
- **orto-maps, DTM derived from digital satellite images**
- **DEMs derived from the vectorised contour lines of 1:10 000 scaled digital map segments**

Data requirements

Topography, digital elevation models (DEM)



Data requirements

Historical data




Historical data are very important for public awareness rising as well as for the calibration of flood modelling (as long as past and modelling conditions can be compared).

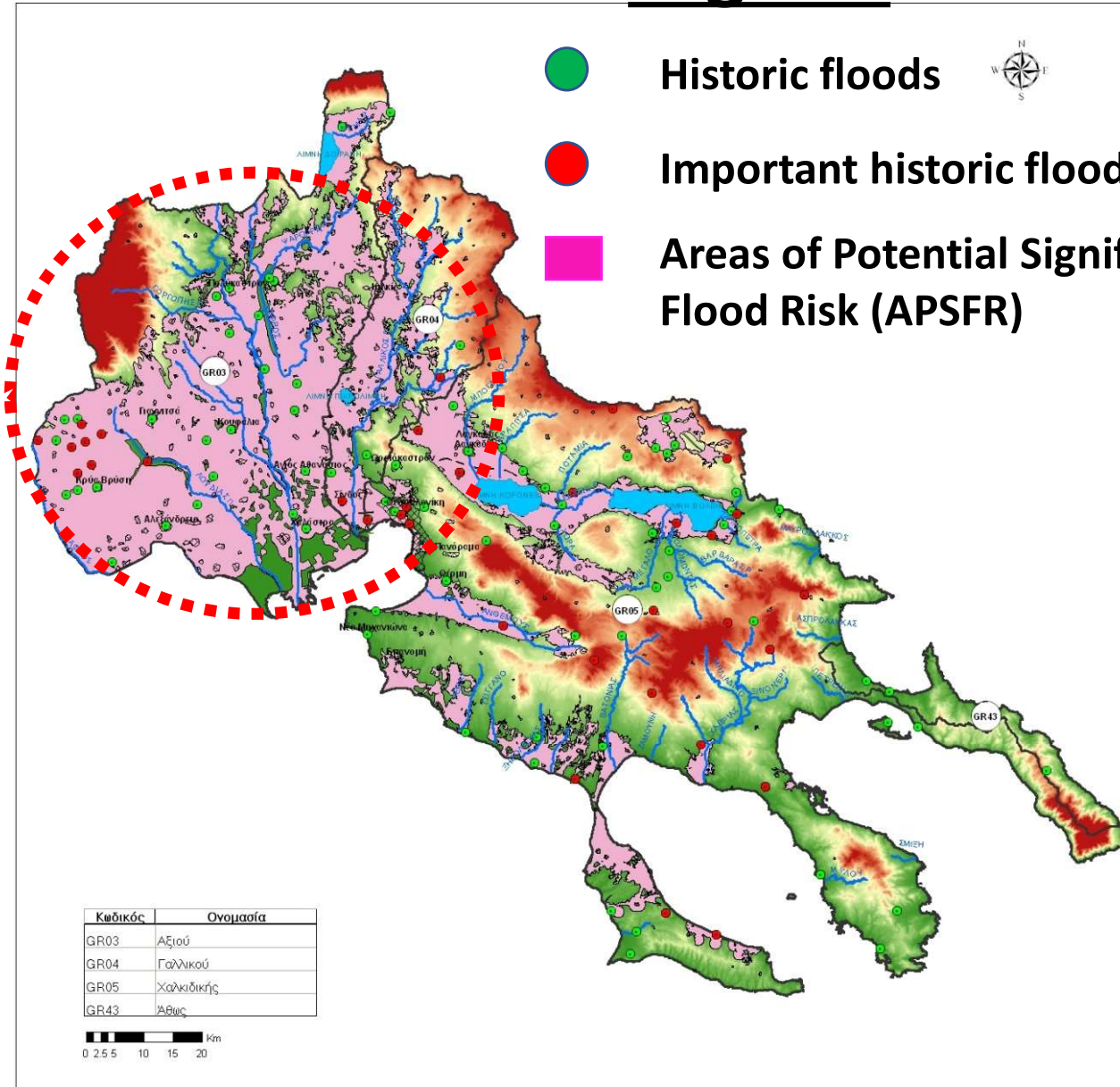
Historical data interesting to be collected are:

- Flood maps
- Water level records in river
- Velocity records (gauge)
- Flood marks
- Pictures, painting or drawing
- Newspapers relating flood events
- Historical reports or books on floods, focusing on damages and on protection upgrade studied or decided after the flood
- Aerial and satellite photos.

Data requirements








Legend:

-  Historic floods
-  Important historic flood
-  Areas of Potential Significant Flood Risk (APsFR)



Κωδικός	Όνομασία
GR03	Αξιού
GR04	Γαλλικού
GR05	Χαλκιδικής
GR43	Άθως

ΥΠΟΜΝΗΜΑ

-  Σημαντική Ιστορική Πλημμύρα
-  Ιστορική Πλημμύρα
-  Οικισμός
-  Ποτάμιο Υδάτινο Σώμα
-  Λιμναίο Υδάτινο Σώμα
-  Ζώνες Δυνητικά Υψηλού Κινδύνου Πλημμύρας
-  Λεκάνη Απορροής Ποταμού της ΥΑ 706/2012 (ΦΕΚ 1383B-2.9.2010)


ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ

 **ΕΙΔΙΚΗ ΓΡΑΜΜΑΤΕΙΑ ΥΔΑΤΩΝ**  **ΥΠΟΥΡΓΕΙΟ ΠΕΡΙΒΑΛΛΟΝΤΟΣ ΕΝΕΡΓΕΙΑΣ & ΚΛΙΜΑΤΟΣ**

**ΕΦΑΡΜΟΓΗ ΟΔΗΓΙΑΣ 2007/60/ΕΚ
ΠΡΟΚΑΤΑΡΚΤΙΚΗ ΑΞΙΟΛΟΓΗΣΗ ΚΙΝΔΥΝΩΝ ΠΛΗΜΜΥΡΑΣ**

ΖΩΝΕΣ ΔΥΝΗΤΙΚΑ ΥΨΗΛΟΥ ΚΙΝΔΥΝΟΥ ΠΛΗΜΜΥΡΑΣ	ΑΡ. ΣΧΕΔΙΟΥ 10
ΥΔΑΤΙΚΟ ΔΙΑΜΕΡΙΣΜΑ 10 "ΚΕΝΤΡΙΚΗ ΜΑΚΕΔΟΝΙΑ"	ΗΜΕΡΟΜΗΝΙΑ ΔΕΚΕΜΒΡΙΟΣ 2012

ΣΥΝΤΑΞΗ: **ΕΙΔΙΚΗ ΓΡΑΜΜΑΤΕΙΑ ΥΔΑΤΩΝ**
με την υποστήριξη της
Κ/Σ ΣΥΜΒΟΥΛΟΥ ΔΙΑΧΕΙΡΙΣΗΣ ΚΙΝΔΥΝΩΝ ΠΛΗΜΜΥΡΑΣ
ΕCOS ΜΕΛΕΤΗΤΙΚΗ Α.Ε. ΕΦΗ ΚΑΡΑΘΑΝΑΣΗ & ΣΥΝΕΡΓΑΤΕΣ & ΣΙΑ

στο πλαίσιο του έργου:
"ΤΕΧΝΙΚΟΣ ΣΥΜΒΟΥΛΟΣ ΥΠΟΣΤΗΡΙΞΗΣ ΚΑΙ ΥΠΟΒΟΗΘΗΣΗΣ
της Ειδικής Γραμματείας Υδάτων
στην Εφαρμογή της Οδηγίας 2007/60/ΕΚ
για την Αξιολόγηση και τη Διαχείριση των Κινδύνων Πλημμύρας"

  
Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης

Data requirements

Land use and related data

The types of land use and related data used by European countries and the place where to get them are as described below:

- **Population data** – data acquisition: statistics (ZIP-code based registers)
- **Corine Land Cover:** The pan-European project CORINE Land Cover (CLC) provides a unique and comparable data set of land cover for Europe. It is part of the European Union programme CORINE
- **Economical data** – data acquisition: land use maps, statistics, (ZIP-code based registers)
- **Basic services:** transportation, energy supply, communication, water supply, sewerage, healthcare, social and education facilities– partly from statistics, or ZIP code based registers, land registry, databases and maps of linear infrastructures.
- **Environment – pollution sources and protected areas:** facilities and pipelines of chemical industry, filling stations, agricultural pollution sources (herbicides, pesticides, fertilizers, manure, poisonous substances and nutrients), wastewater treatment plants, waste storage, septic tanks;
- **Protected areas** – Natura 2000, nature conservation– thematic databases and maps.
- **Cultural heritage** – thematic databases and maps

Flood modelling

Hydrological models:

Various rainfall-runoff models or statistical models are used to determine hydrological parameters of the flood waves (which are input data of hydrodynamic models). The rainfall-runoff models are typically used to simulate the flash floods of mountain torrents and watercourses of mountain toe regions, but are also used for flood forecasting purposes even in large catchments where the time required for accumulation and runoff enables early warning of operational and/or emergency organisations.

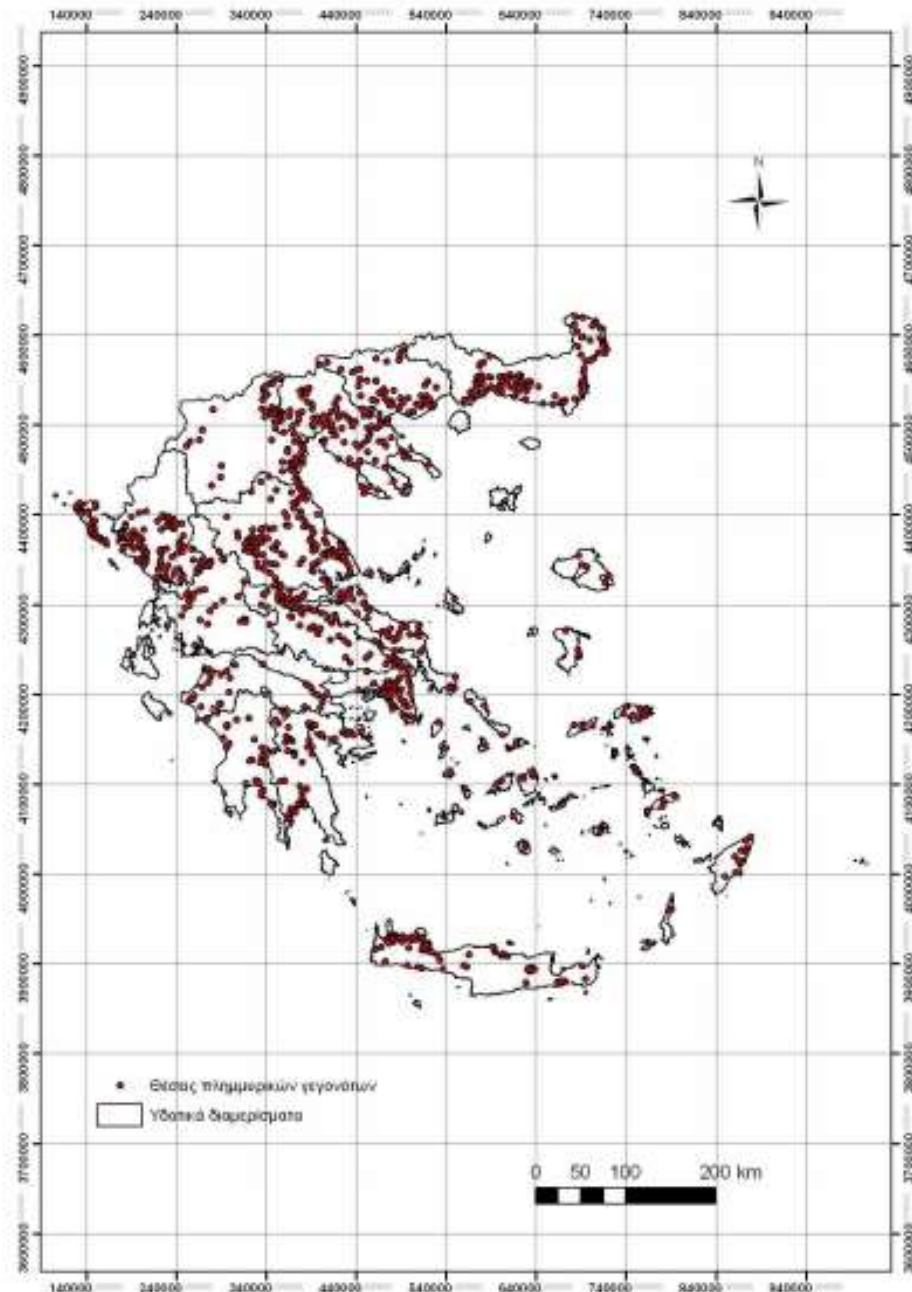
Hydraulic models:

River flood routing (flood propagation in rivers) can be described by one dimensional (1D) mathematical model. This solution is suitable for the modelling of inundation of open floodplains.

In case of sophisticated morphological conditions application of quasi 2D or 2D models might be necessary.

Flood distribution and inundation maps need to be examined through the use of 2D models

Preliminary Flood Risk Assessment – PFRA summary results



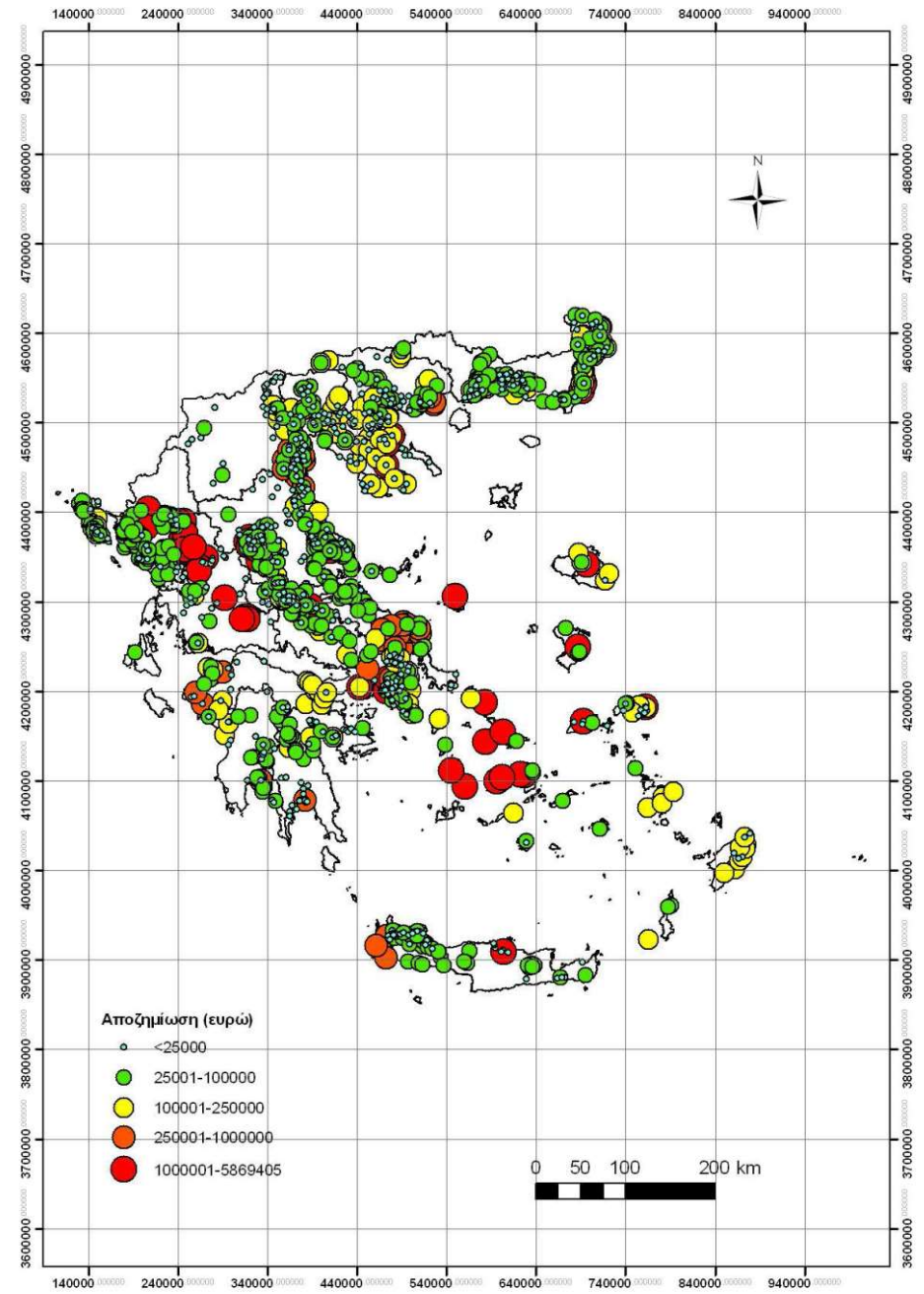
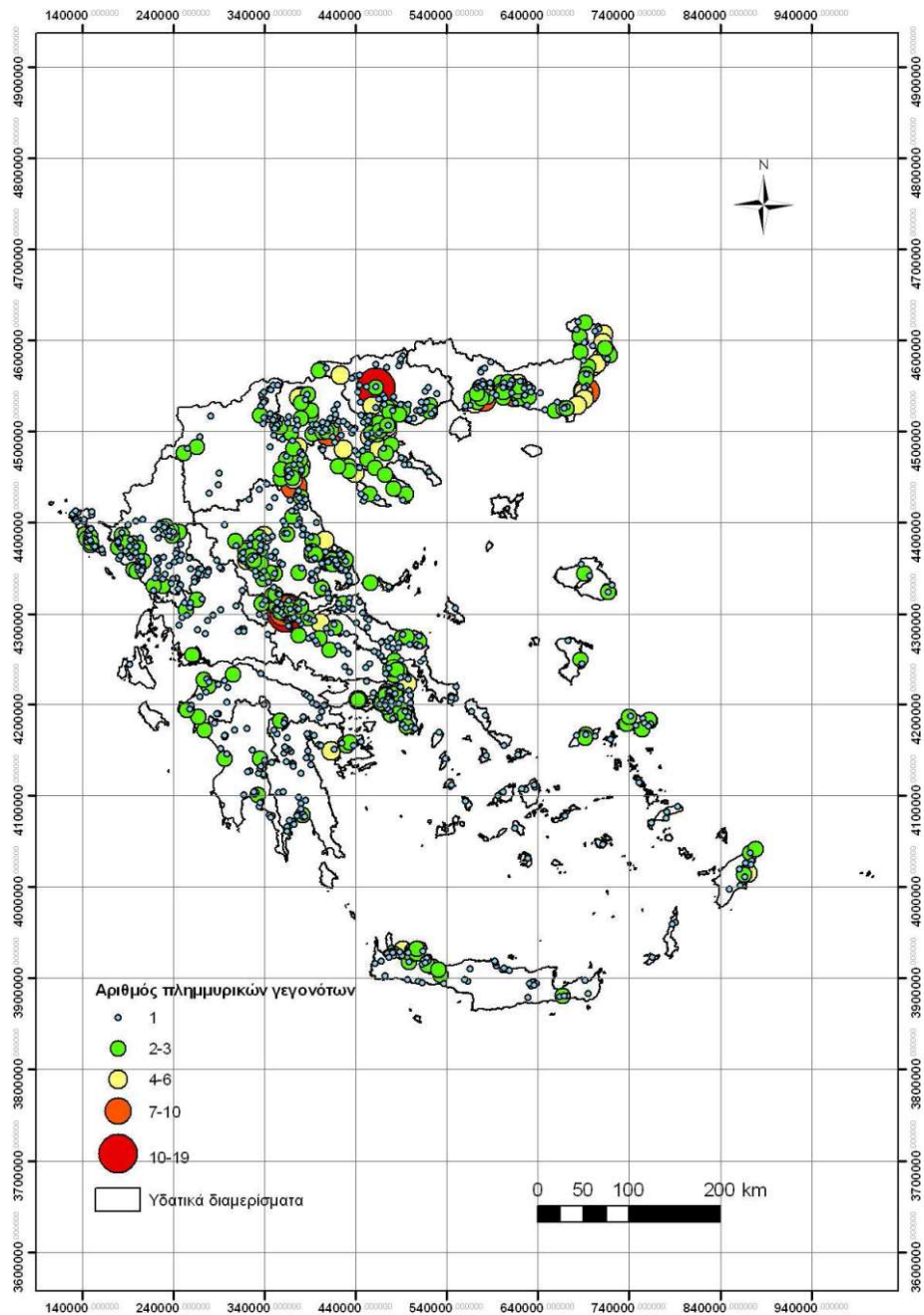
Greece: 1077 historic floods at different locations, which correspond to 1627 flood events, i.e. there are locations where more than one flood has occurred.

Flooding typology:

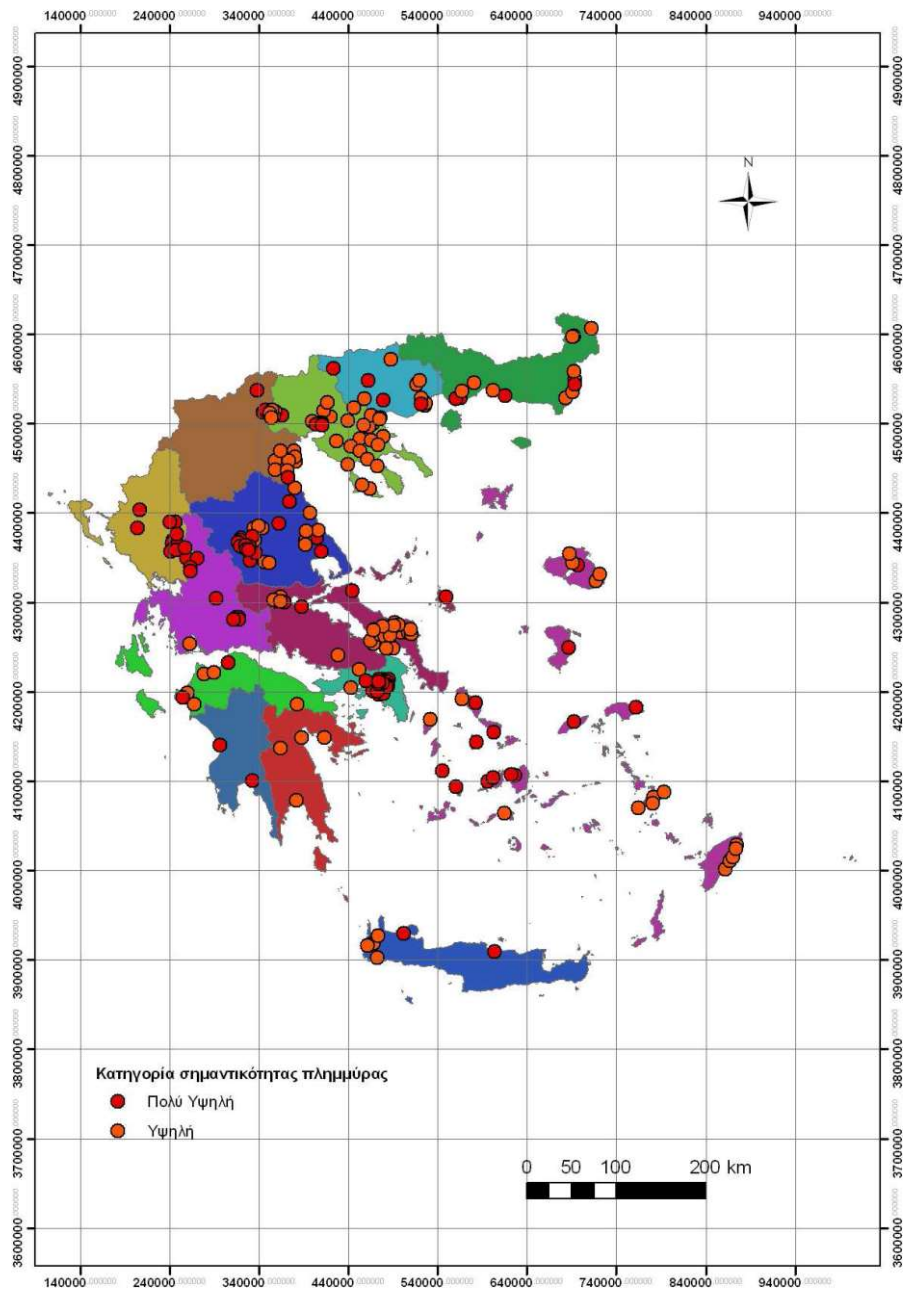
- 211 floods have designated as "Flash floods",
- 18 have designated as "Other rapid onset",
- 6 as "High Velocity Flow",
- 1342 flood events there are "No data available on the characteristics of flooding".

Axios : 36 historic floods at different locations.

Preliminary Flood Risk Assessment – PFRA summary results

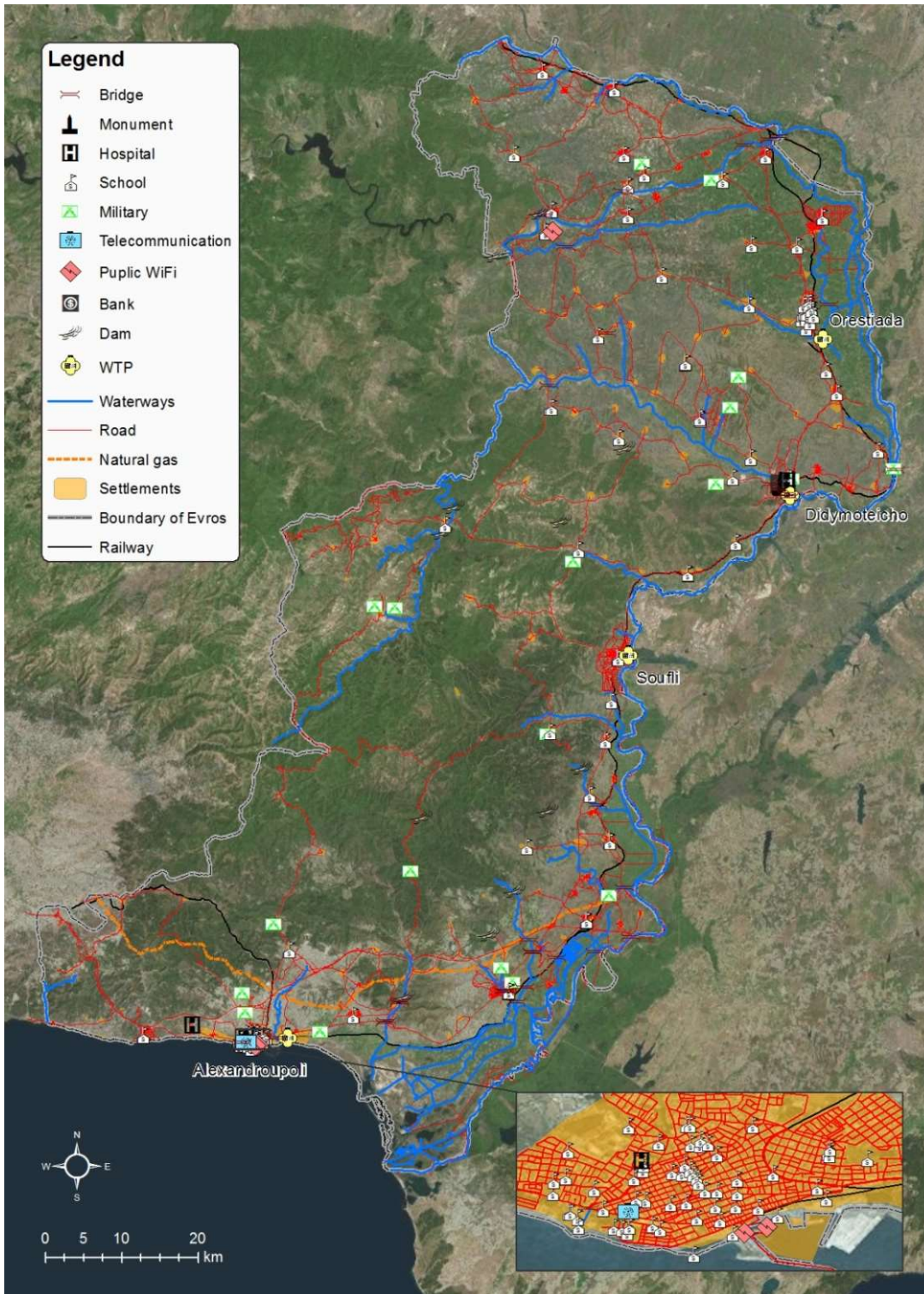


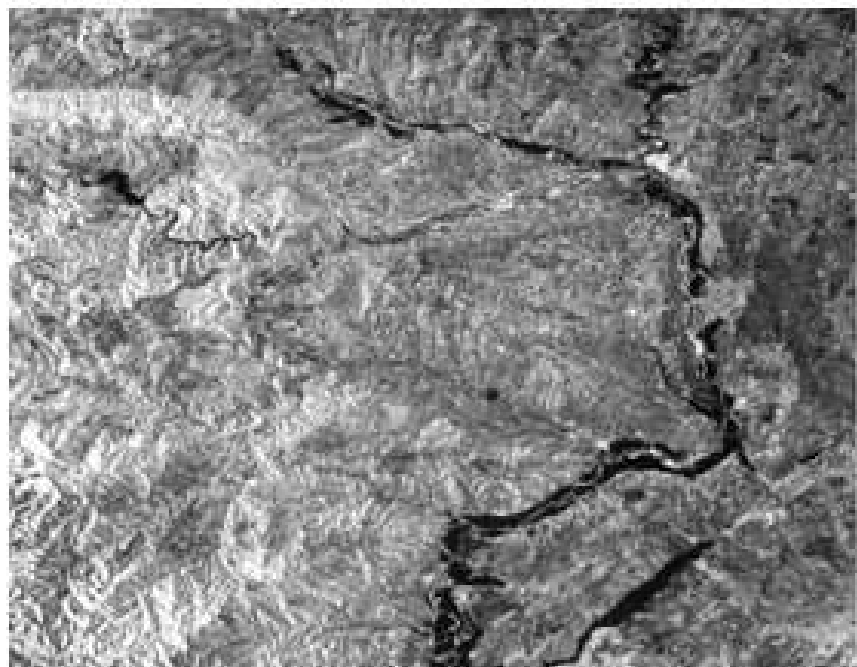
Preliminary Flood Risk Assessment – PFRA summary results



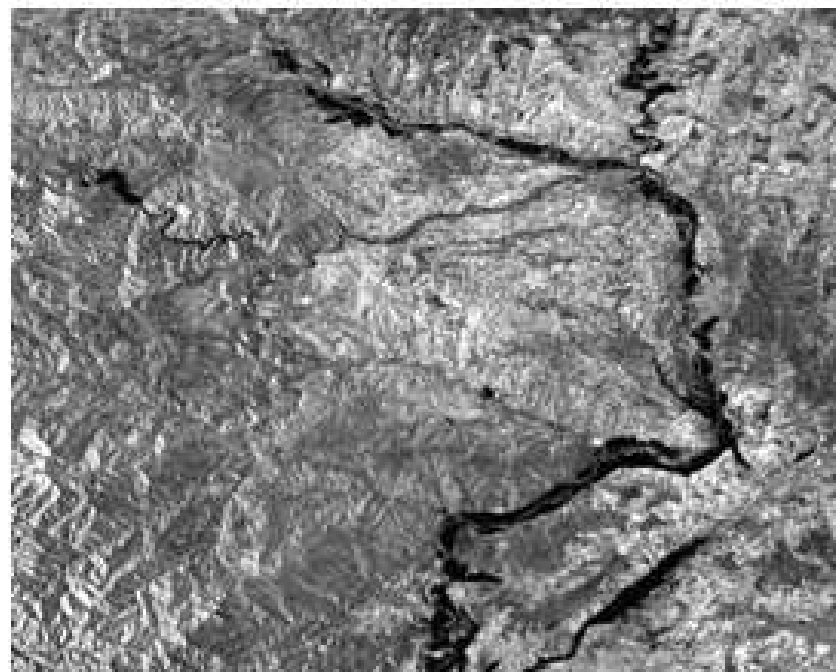
Significant historic floods

- 249 locations are denoted as significant historic flooding locations at national level.
- These locations correspond to 297 significant flooding events, i.e. there are locations where more than one significant flood has occurred.
- 61 floods are categorized as floods of type A31, i.e. flash floods. Unfortunately, these flash floods were almost all correlated to B11 category, i.e they have adverse consequences to human health (53 fatalities).





a)

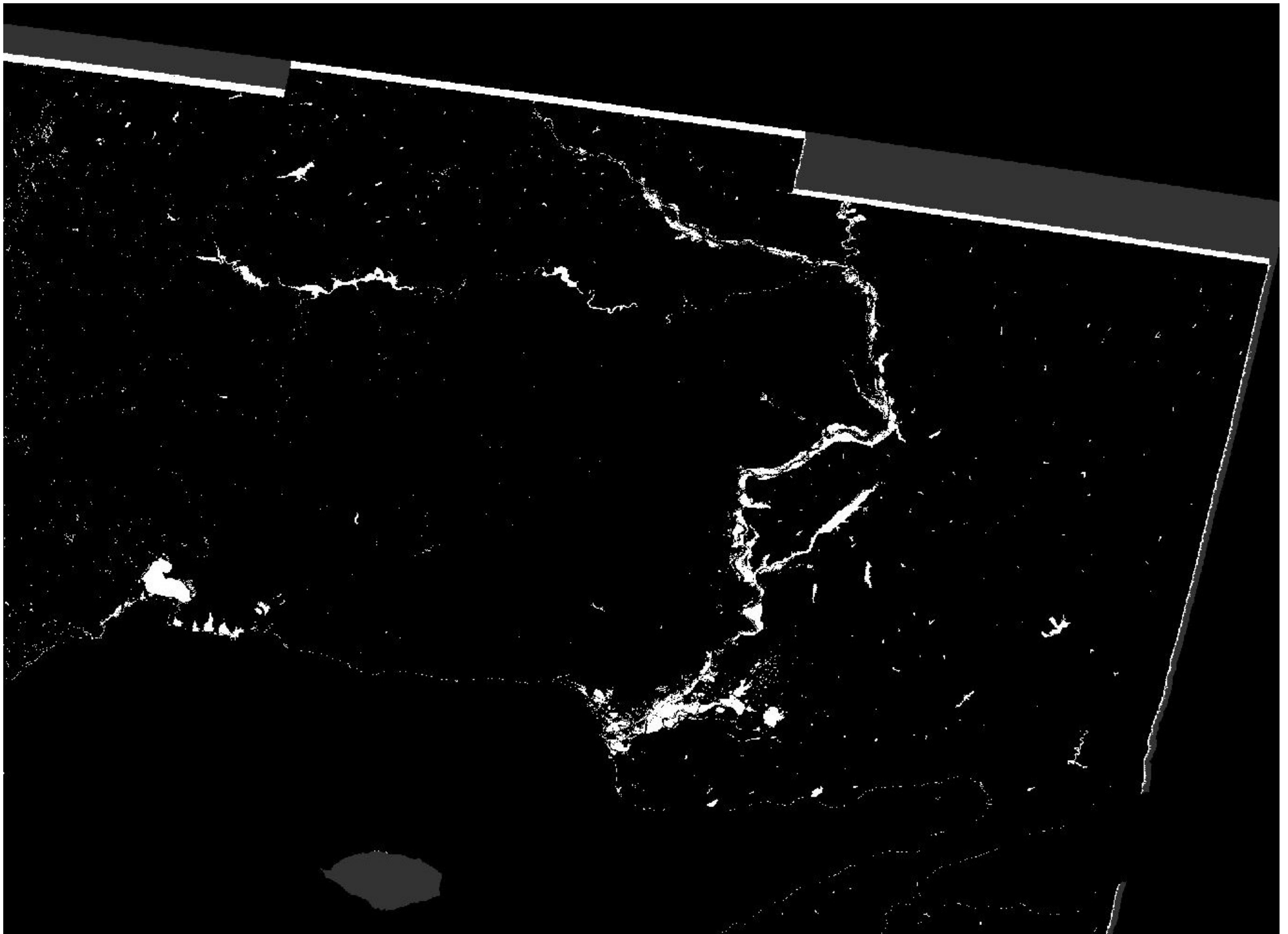


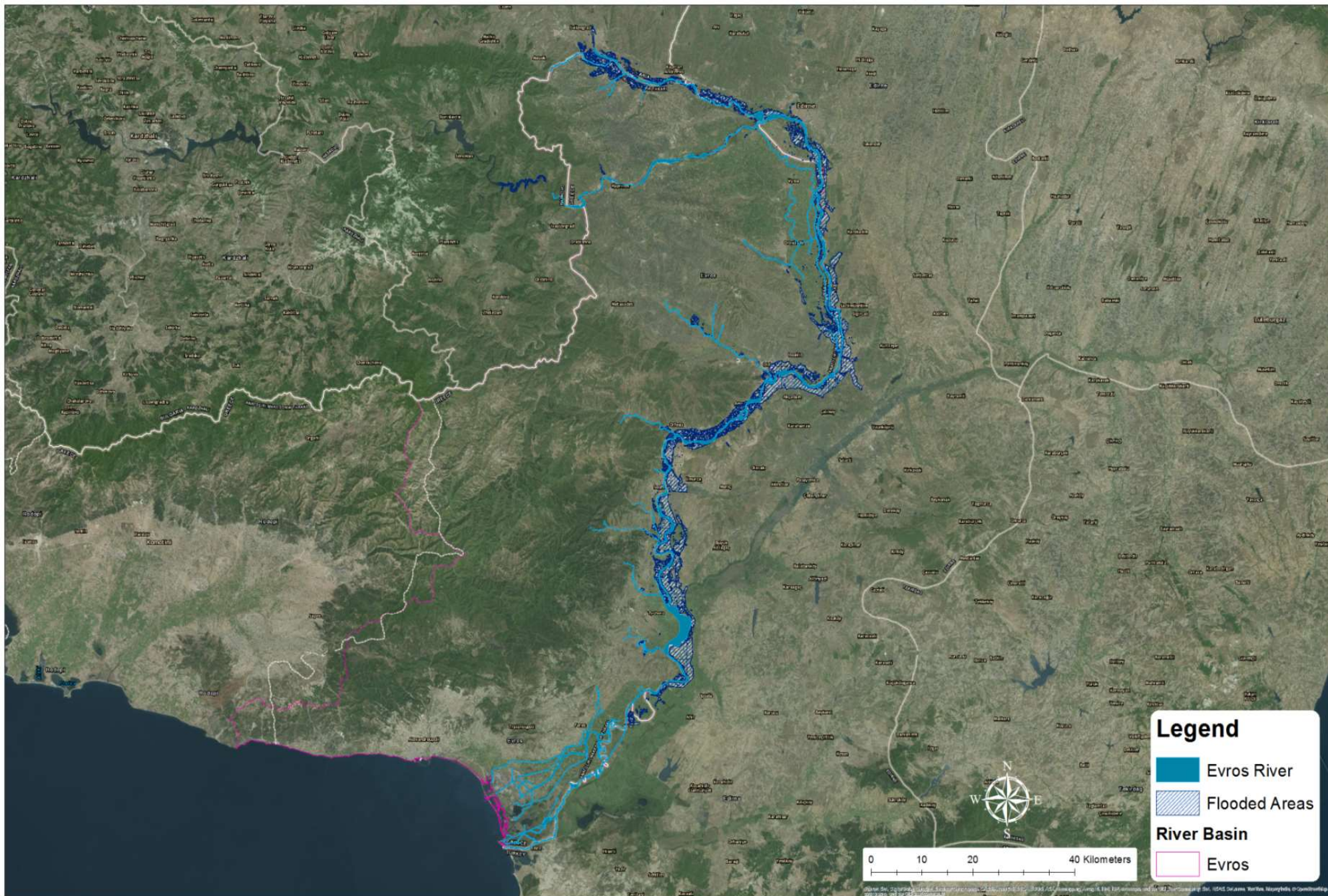
b)



c)

Figure. Time-series SAR images over a section of Evros River for a) 12/12/2014 and b) 13/12/2014.





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Case study: The Strymon River basin

Sub-Danubian Transboundary River & Lake in the Balkans



Basin area: 17,276 km²

- ❖ 8,734 km² (51%) in Bulgaria,
- ❖ 6,439 km² (38%) in Greece,
- ❖ 7% in FYROM, 4% in Serbia

WebGIS for real time monitoring

RIVER ALERT
WebGIS Platform

Identify Results

- ▼ RIVERALERT Monitoring Stations (Thematic Maps)
 - Πενονία
- ▼ Water bodies (Thematic Maps)
 - Strymonas Katanti
- ▼ Strymonas basin (Thematic Maps)
 - Strymonas

FID:	2
ID:	3
Τοποθεσία:	Πενονία
Location:	Peponia
Type:	Quantity gauge
Τύπος:	Ποσοτικός
Descriptio:	Water velocity, water levels
Περιγραφή:	Ταχύτητα νερού, Στάθμη νερού
X:	458706,98
Y:	4535938
Data:	http://155.207.3.219/StrymonTelemetry/default.aspx?stationid=59

Map Content

- Thematic Maps
- RiverAlert Flood DSS
 - Trimeristis
 - Peponia
 - Aggitis
- Monitoring Data
- Administrative Data
- Hydrographic Data
- Environmental Data
- Land Use
- Topographic Basemaps
- Flood Propagation Scenarios
 - Flood Propagation Scenario
 - Flood impact CaseA Q: 300
 - Flood impact CaseA Q: 1200
 - Vulnerability to Flooding
 - Sediment Transport Capacity Ind
- Soil Erosion Risk
 - Seasonal Soil Erosion Risk
 - Soil Erosion Risk: Autumn

Strymonas basin
Strymonas

Soil Erosion Risk Legend:

- low
- moderate
- average
- high

Inset Map: GePlan - Case study A- Scenario 2 (N-rc) - Case study A- Scenario 2 (E-rc) - unsteady run Q=1200m³/s - Case study A- Scenario 2 - DT1M0.7 [Target] (01.01.2000 09:00:00)

WebGIS for real time monitoring

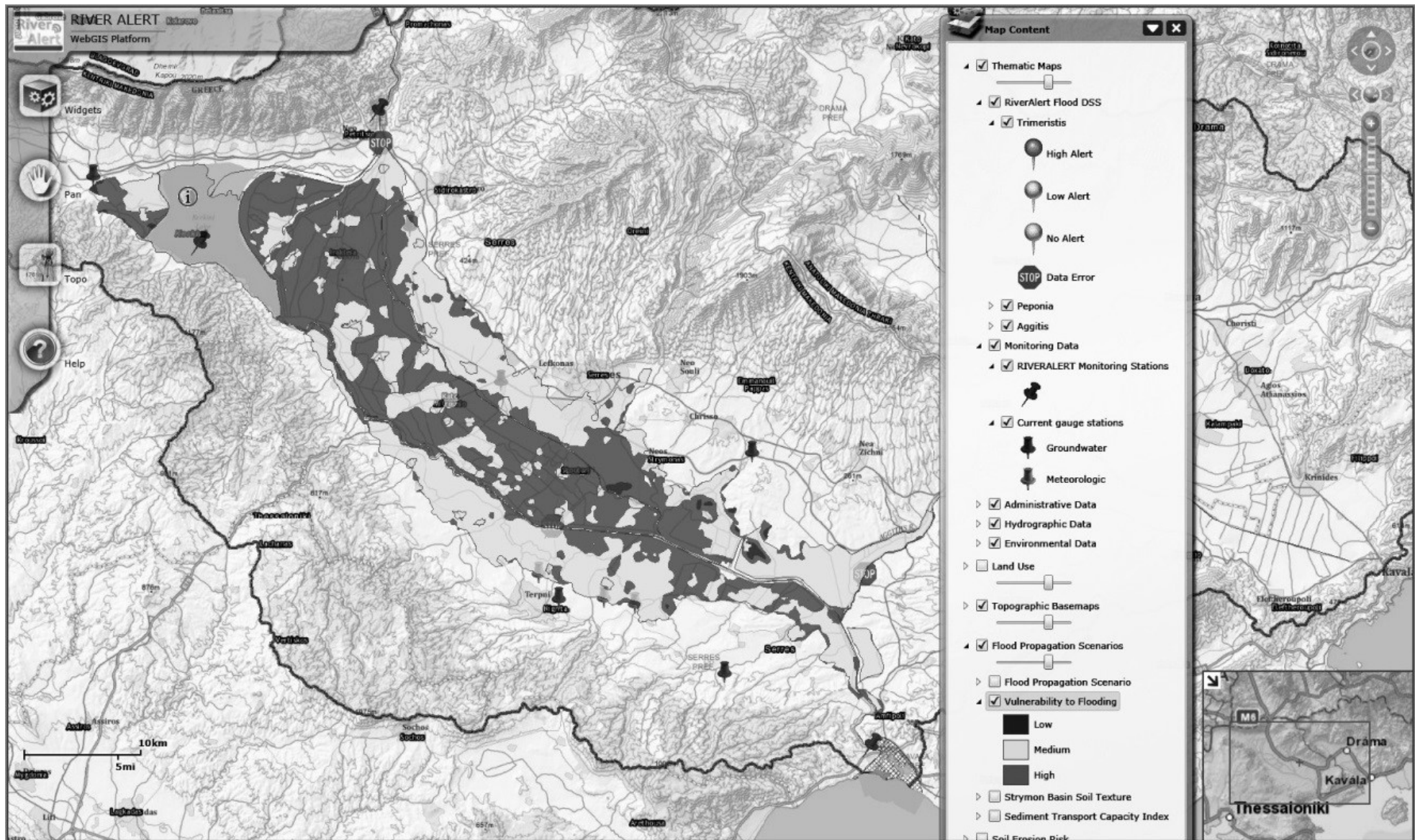


Illustration of monitoring stations and their operational status, and the area's vulnerability to floods for the Greek part of the Strymon transboundary river basin (Skoulikaris et al., 2014-IAHS Publications 363)



```

1 /MODSURNG_91915_V6H2/DOSPAT/FLOW/01JAN1991 - 01JAN1995/1DAY/MODSURNG/
2 M3/SEC
3 INST-VAL
4 05Aug01 04-00
5 0 28 C in the following OPEN.
6 0 29 C
7 0 30 OPEN ( UNIT=10, FILE='gpcp_v2_psg.1987', ACCESS='DIRECT',
8 0 31 + FORM='UNFORMATTED', STATUS='OLD', RECL=144*4,
9 0 32 + IOSTAT=iret )
10 0 33 IF ( iret .NE. 0 ) THEN
11 0 34 WRITE (*, *) 'Error: open error', iret,
12 0 35 + ' on file gpcp_v2_psg.1987'
13 0 36 STOP
14 0 37 END IF
15 0 38 C
16 0 39 C Compute the number of records to skip, namely 1 for the header
17 0 40 C and 72 for each intervening month.
18 0 41 C
19 0 42 nskip = 1 + ( month - 1 ) * 72
20 0 43 C
21 0 44 C Read the 72 rows of data and close the file.
22 0 45 C
23 0 46 DO 10 j = 1, 72
24 0 47 READ ( UNIT=10, REC=j+nskip, IOSTAT=iret )
25 0 48 READ ( UNIT=10, REC=j+nskip)
26 0 49 + ( data (i, j), i = 1, 144 )
27 0 50 IF ( iret .NE. 0 ) THEN
28 0 51 WRITE (*, *) 'Error: read error', iret,
29 0 52 + ' on file gpcp_v2_psg.1987'
30 0 53 STOP

```

Modèle

Modèle
que

```

*****
*****
*****
*****
0.2306 0.2338
0.3997 0.4175
0.6100 0.6496
0.8544 0.9214
1.1265 1.2254
1.4193 1.5538
1.7273 1.9003
2.0464 2.2601
2.3734 2.6296
2.7058 3.0058

```

```

1 size=(char
2 1.87368774
3 2.13807844
4 -3.30738694
5 -4.80367407
6 -1.35634818

```

```

11 -----
12 Negative latitudes indicate South and negative longitude indicate West.
13
14 INDEX LATITUDE INDEX LONGITUDE
15 1) 88.750 1) 1.250
16 2) 86.250 2) 3.750
17 3) 83.750 3) 6.250

```

Dor
changement
climatique

nées

Homogenization of data

- **Spatial homogenization**
- **Temporal homogenization**
- **Values with common units**

The necessity is greater for the management of international water resources

The world's transboundary river basins



Spatial homogenization of data

The INSPIRE Directive

The INSPIRE (Infrastructure for Spatial Information in the European Community) directive (2007) aims to create a European Union (EU) spatial data infrastructure.

This will aim at making available relevant, harmonised and quality geographic information to support the formulation, implementation, monitoring and evaluation of policies and activities which directly or indirectly impact the environment.

A European Spatial Data Infrastructure will assist in policy-making across boundaries

Principles of the INSPIRE Directive

- **Data should be collected only once**
- **It should be possible to combine seamless spatial information from different sources across Europe and share it with many users and applications.**
- **Easy to find what geographic information is available, how it can be used to meet a particular need, and under which conditions it can be acquired and used.**

Spatial data themes of INSPIRE

INSPIRE requires EU Members States to share 34 different spatial data themes through a network of 'services'.

Annex I

- 1 Coordinate reference systems
- 2 Geographical grid systems
- 3 Geographical names
- 4 Administrative units
- 5 Addresses
- 6 Cadastral parcels
- 7 Transport networks
- 8 Hydrography
- 9 Protected sites

Annex II

- 1 Elevation
- 2 Land cover
- 3 Orthoimagery
- 4 Geology

Annex III

- 1 Statistical units
- 2 Buildings
- 3 Soil
- 4 Land use
- 5 Human health and safety
- 6 Utility and governmental services
- 7 Environmental monitoring Facilities
- 8 Production and industrial facilities
- 9 Agricultural and aquaculture facilities
- 10 Population distribution and demography
- 11 Area management / restriction / regulation zones & reporting units
- 12 Natural risk zones
- 13 Atmospheric conditions
- 14 Meteorological geographical features
- 15 Oceanographic geographical features
- 16 Sea regions
- 17 Bio-geographical regions
- 18 Habitats and biotopes
- 19 Species distribution
- 20 Energy Resources
- 21 Mineral Resources

Implementing Rules of INSPIRE

The directive also requires the adoption of the following rules:

- ❑ Metadata: Descriptions of available information (spatial data sets, series and services).**
- ❑ Data specifications: Agreements on how data should be defined and presented, or modelled into 'virtual reality' - for example, defining the width of a highway lane for standardized mapping.**
- ❑ Network and sharing services: Discovery, view, download, transformation and invoke services.**

Example of metadata

```
<gmd:MD_Metadata xmlns:gmd="http://www.isotc211.org/2005/gmd"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-
  instance" xmlns:xlink="http://.....
```

```
<gmd:organisationName>
```

```
<gco:CharacterString>
```

```
MEDDE/DGPR/SRNH - Bureau des risques météorologiques
```

```
</gco:CharacterString>....
```

```
<NameofAPSFR>CENTRE_GUADELOUPE</NameofAPSFR>
```

```
<LAT>16.294</LAT>
```

```
<LON>-61.414</LON>
```

```
<TypeofFloods>
```

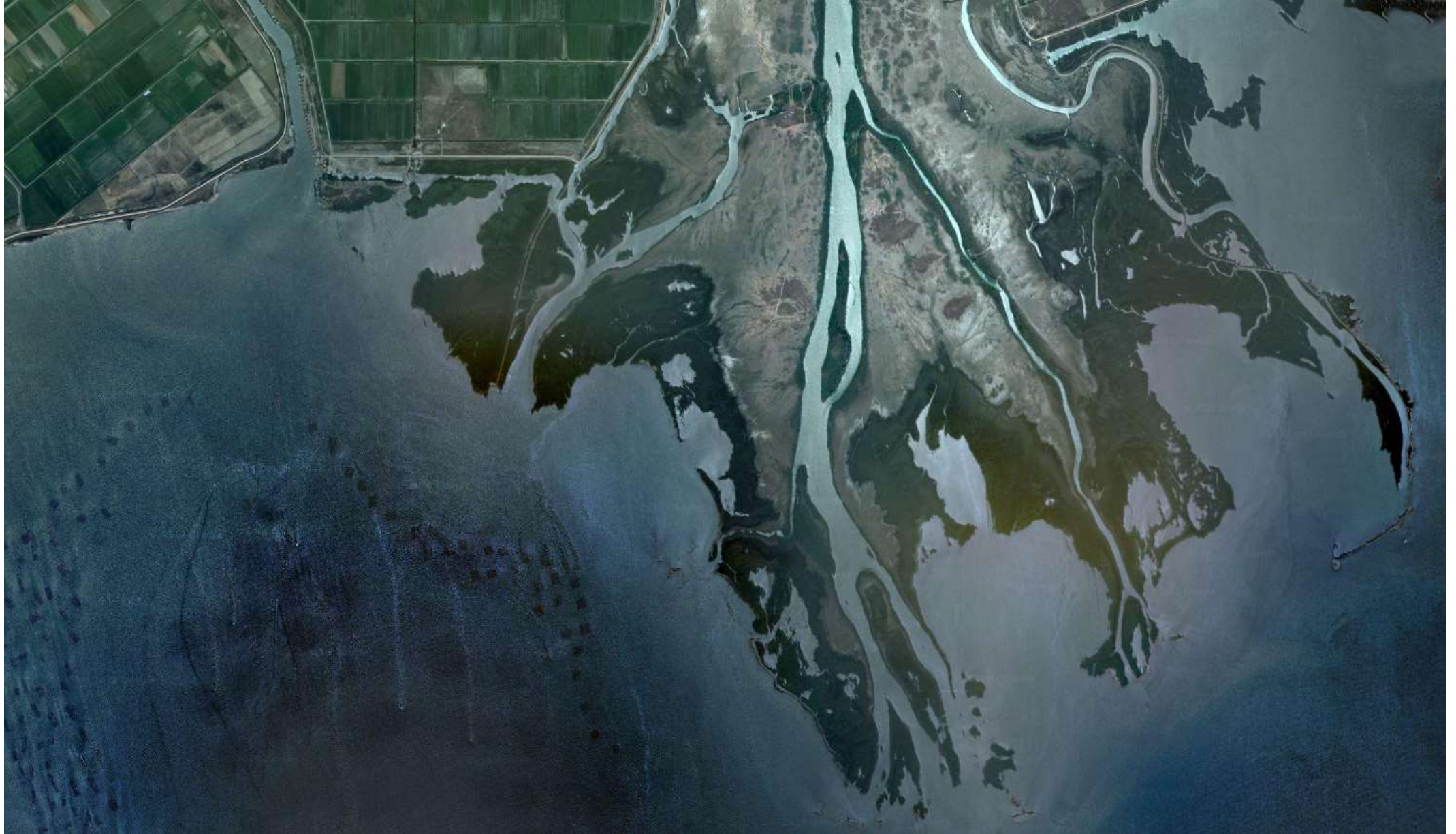
```
<SourceofFlooding>A12</SourceofFlooding>
```

```
<SourceofFlooding>A11</SourceofFlooding>
```

```
<SourceofFlooding>A14</SourceofFlooding>
```

```
<SummaryofMethodology>
```

Un TRI est une portion du territoire guadeloupéen présentant les caractéristiques suivantes :



Thank you for your attention!
hskoulik@civil.auth.gr