

Flood Hazard Analyses to Greece

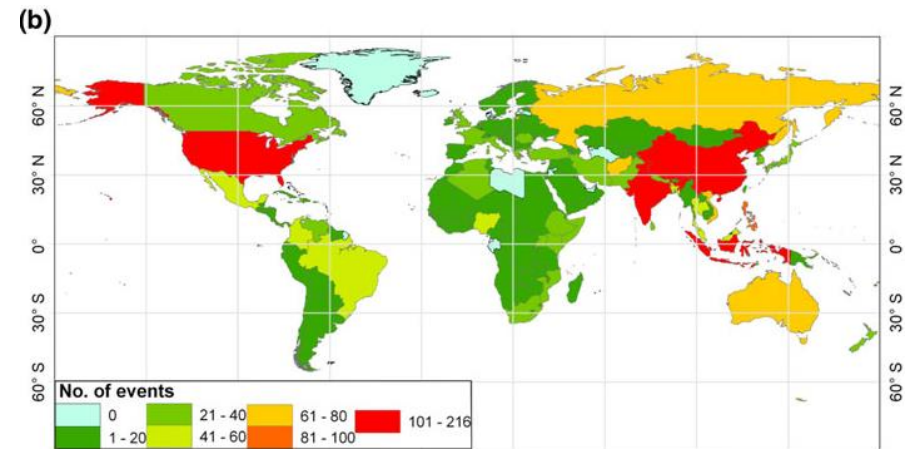
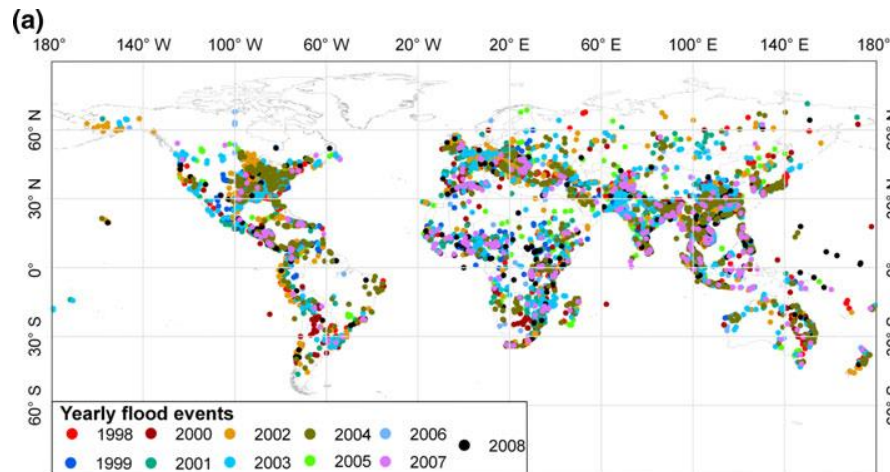
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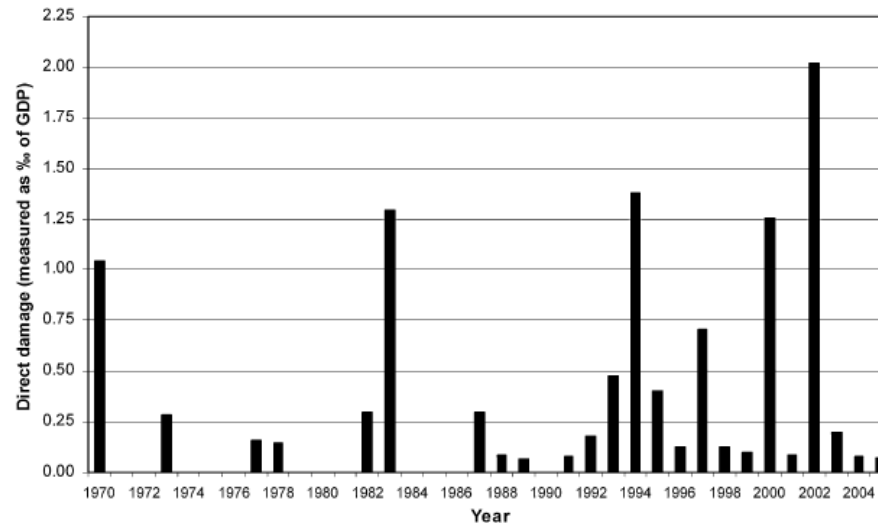
Impact of flood events - worldwide

- The worldwide impact of flood events highlight the increasing importance of studies on flood hazard and risk.
- Not only on a global scale but in particular on a national and sub-national level.



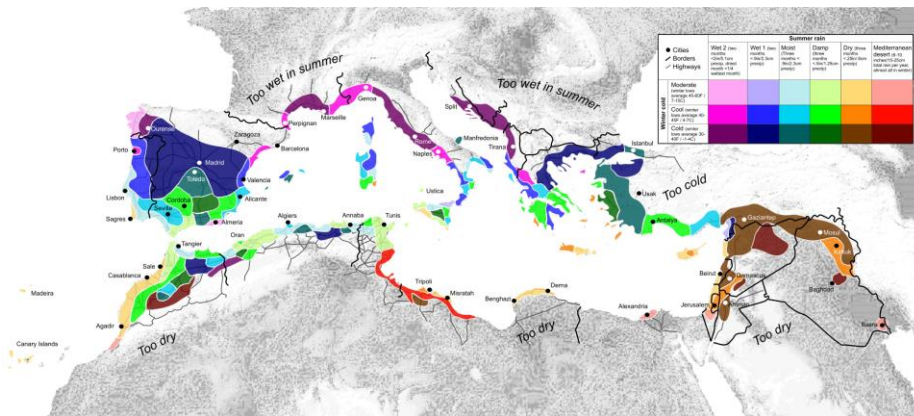
Impact of flood events - Europe

- An increase in mean precipitation and of magnitude and frequency of extreme precipitation events - extreme flood events become more frequent.
- Exposure to floods may increase across Europe as well as flood vulnerability - due to population and wealth moving into flood-prone areas - economic activities.

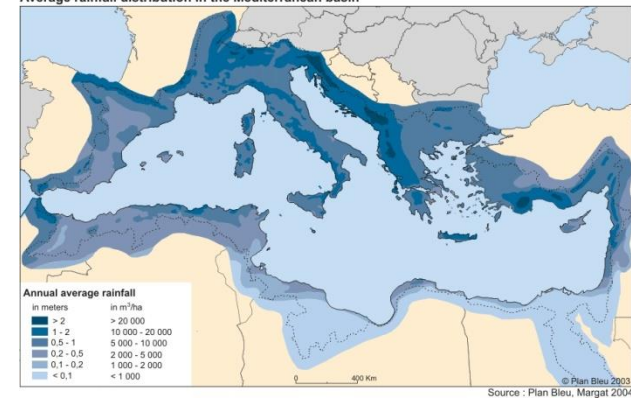


Flood hazard in Mediterranean areas

- Unique flooding conditions,
 - given the influence of a **semi-arid climate**,
 - **geological** characteristics and the **socio-economic** environment.



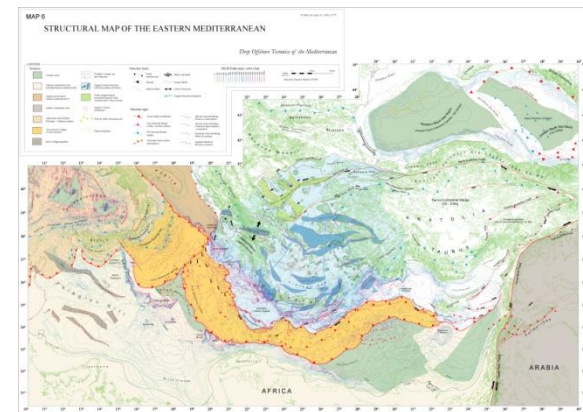
Average rainfall distribution in the Mediterranean basin



EU coastal regions by MS	2005	2006	2007	2008	2009	% Women 2008
CY	0.4	0.4	0.4	0.4	0.4	44.8
ES*	8.6	8.9	9.3	9.6	9.6	42.7
FR*	2.7	2.7	2.8	2.8	2.9	:
EL	4.5	4.6	4.6	4.6	4.7	40.8
IT	13.9	14.0	14.0	14.2	14.0	39.0
MT	0.2	0.2	0.2	0.2	0.2	33.5
SI	0.1	0.1	0.1	0.1	0.1	44.1
Mediterranean coastal regions	30.5	30.9	31.4	31.9	31.9	40.6**
BG	0.5	0.5	0.5	0.5	:	44.8
RO	0.4	0.4	0.4	0.4	0.4	38.4
Black Sea coastal regions	0.9	0.9	0.9	0.9	:	41.9
EU-27	232.0	230.3	236.5	239.0	239.8	45.0

*Mediterranean coastal regions only

**Excluding France

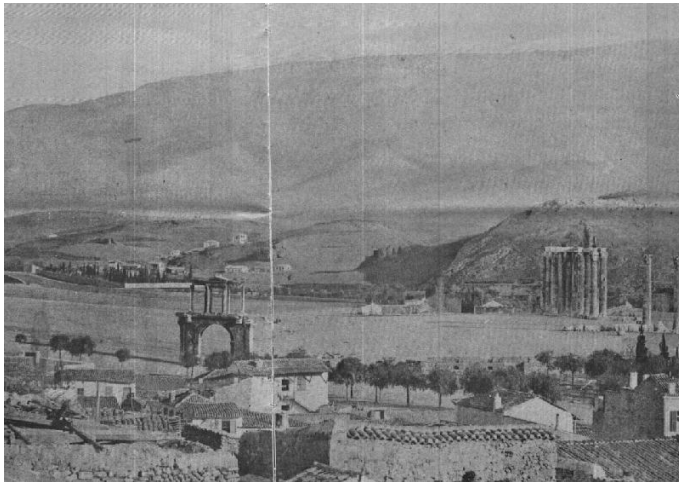


Flood hazard in Mediterranean

- The main diagnostic characteristics of floods in the Mediterranean basin may be delineated as follows
 - The presence of **heavy rainfall** in autumn and winter may originate flash floods in catchments and streams,
 - During flash flooding, **soil erosion** and **sediment transport** are important issues,
 - In **Karst** areas, which make up more than one half of the Mediterranean drainage basins, flash floods are challenging due to their **hazard** potential,
 - Heavy **concentration of population** in urban and residential areas around the centers of historic cities have, in many cases, resulted in the occupation of the beds and floodways of ephemeral streams.

Flood loss data – risk management

- There is a strong need on flood loss data in order to establish risk management strategies based on flood risk analyses and assessment.
- This becomes increasingly important in Mediterranean regions.
- as population continuously expands to river deltas and coastal areas that are subject to inundation mostly from small rivers and mountain torrents.



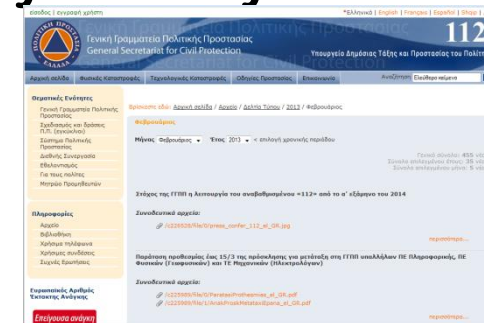
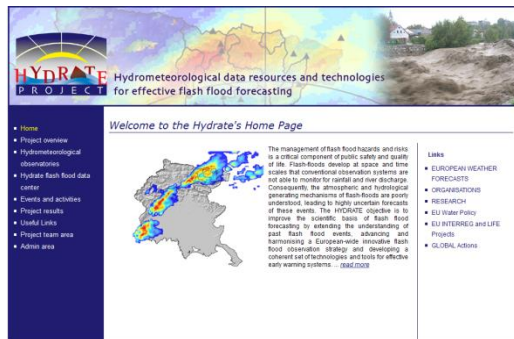
Data on flood hazard and losses

- There are several databases accessible that report flood events and losses for the territory of Greece.

Source	Time	Events	Fatalities
Newspapers	1887-2010	221	527
EM-DAT	1900-2010	20	84
Hydrate	1960-2010	17	2
ESWD	1995-2010	62	57
National Observatory of Athens	2001-2010	78	16
Hellenic Earthquake Rehabilitation Service	1978-2010	75	-
Prefecture of East Attica	1990-2010	55	-
General Secretary of Civil Protection	2003-2010	29	-

Data on flood hazard and losses

- Some of this information is limited due to the variability of collection criteria and missing geospatial characteristics of flood impacts.
- A standardised and continuous recording of flood events by civil protection agencies started only recently.



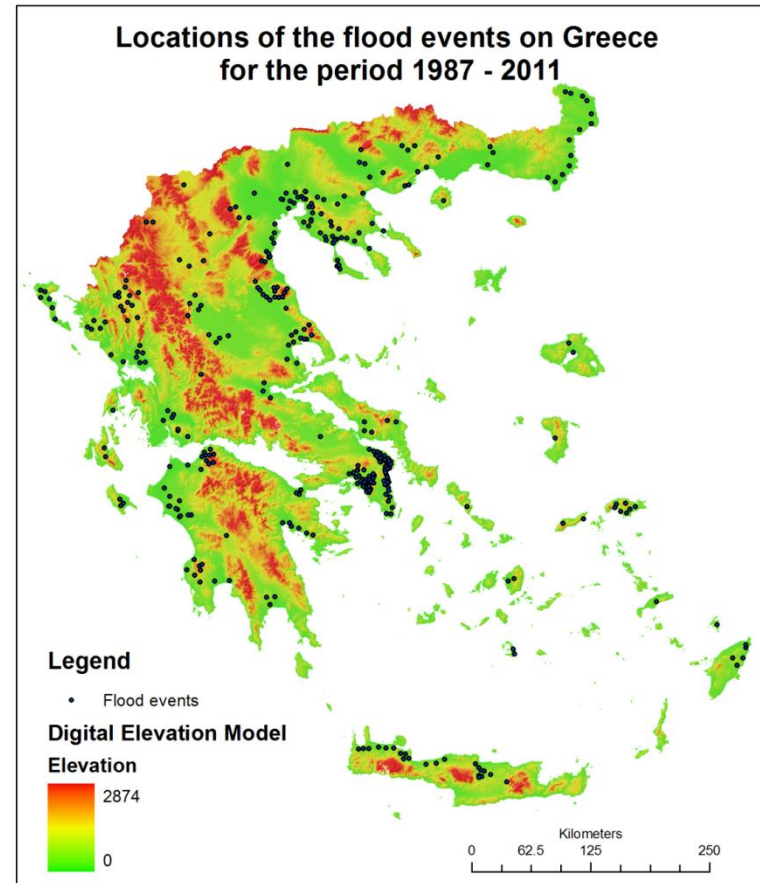
Data on flood hazard and losses

- We developed a relational database for the establishment of a nation-wide flood inventory.
- major information that had to be gathered was related to the date of occurrence and the geographical location of the event (**watershed, community, prefecture, district and geographical coordinates**), followed by a verbal description of the event in order to assess the flood magnitude.

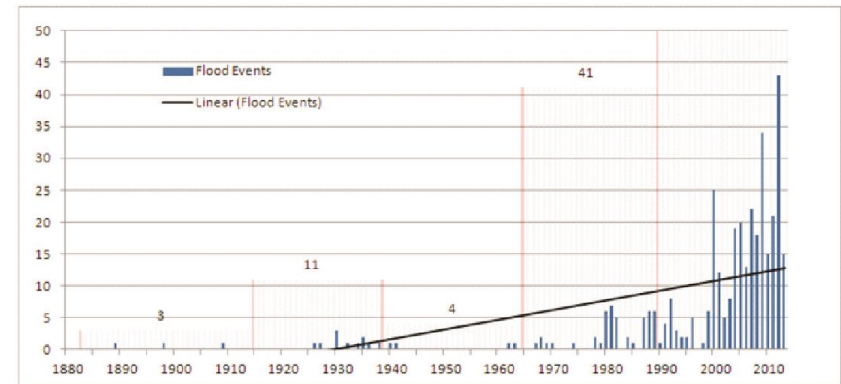
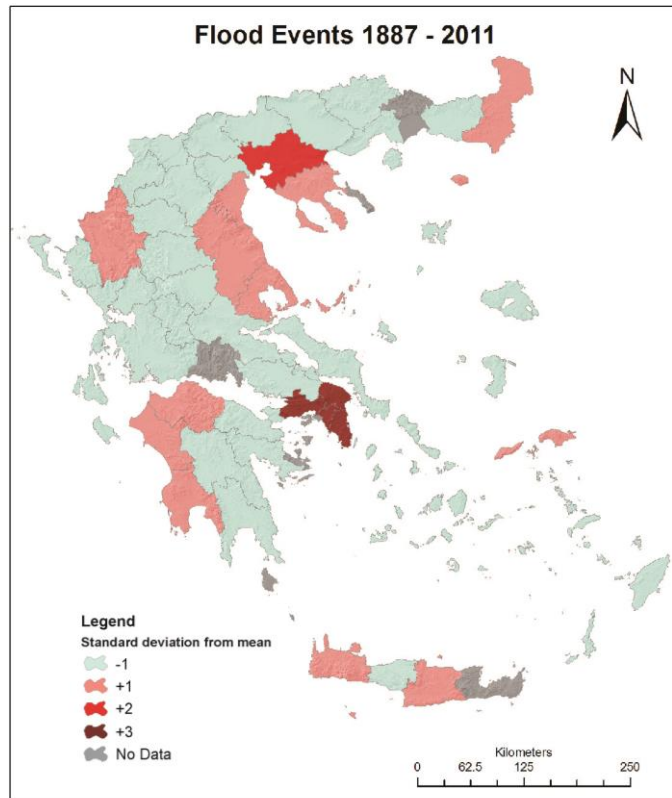
Date	Position	Event description	Damages	Loss of lives	Affected people	Estimated damages	Source
22/10/1887	Attica	Rainstorm in Athens with 2 two days duration and catastrophic effects	Settlement of one building and one family house	1			Estia
14/11/1896	Attica	Damages in Ilisos, Vathi, St. Panteleimona districts and around them. Ilisos and Kifisos rivers became dangerous for the citizens	Many roads destroyed. Flooded buildings, bridges and trees unrooted. The transport placed out of order.	21			Anagenisis Akropolis
14/11/1896	Attica	Flooded the districts of Kaminia, Neou Xoriou, Pervolion, Agiou Ioanni, Elaiona and Neou Falhrou. The water level was a lot of meters.	Destroyed 450 buildings. For 2 days the town lighted for the ships. Broaked the transport between Athens and Piraeus.	40			
4/6/1907	Trikala	The Night of 4th of Juny a terrible flood in the town of Trikala.	Many rivers overflowed as a result many people died	300			Newspaper
4/11/1924	Kalamata	Important rain in Kalamata. Overflowed Nedonas river	Roads and squares sinked in 2 meters depth and many houses flooded. The damages cost 200 million drachmas.	15			Eleythero Vima
23/11/1925	Attica	The rainstorm kept four hours and the effects were scarily.	Flooded refugee districts. Total destroyed 127 buildings.	8			Eleythero Vima

Development of losses - Greece

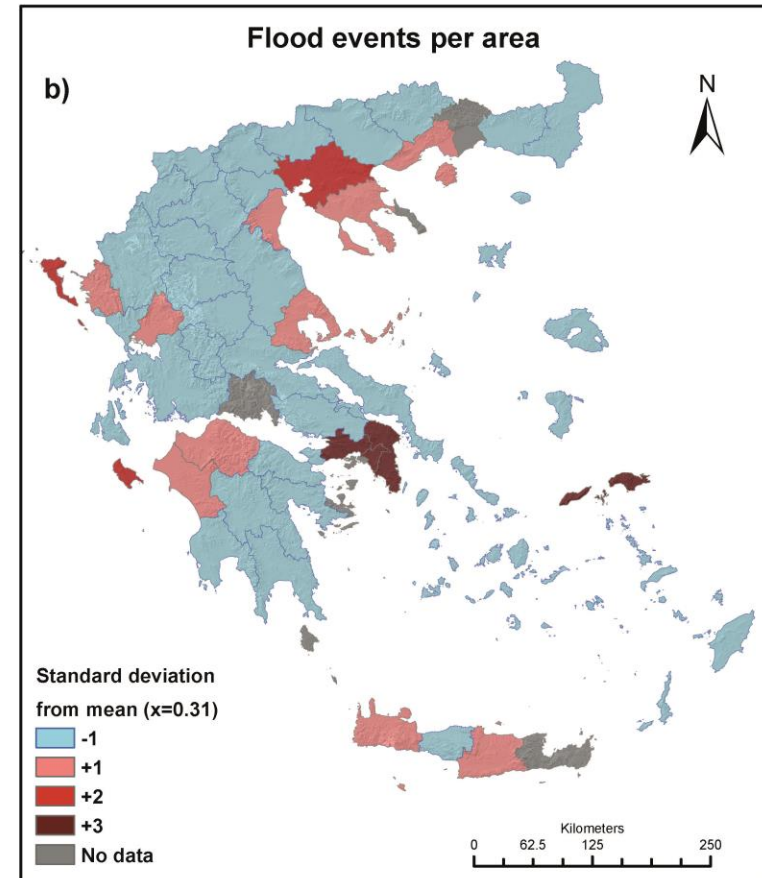
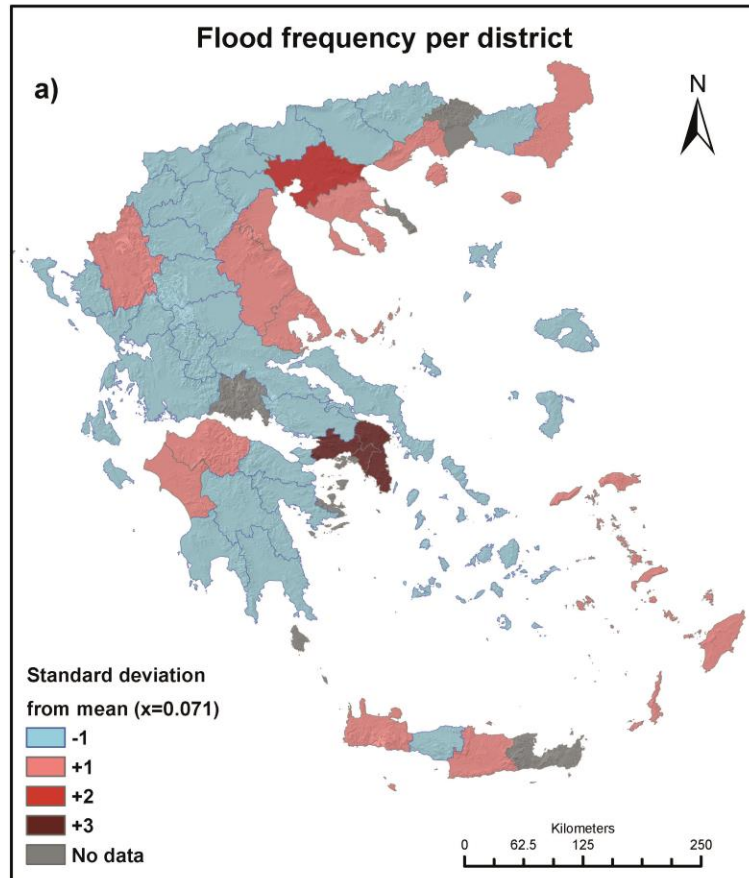
- The collected data was processed in the database and further analysed with respect to the spatial and temporal occurrence of flood events, fatalities, and losses.
- In the following section, results for the Republic of Greece are shown on a national scale, as well as selected results from the heavily-affected region of Attica.



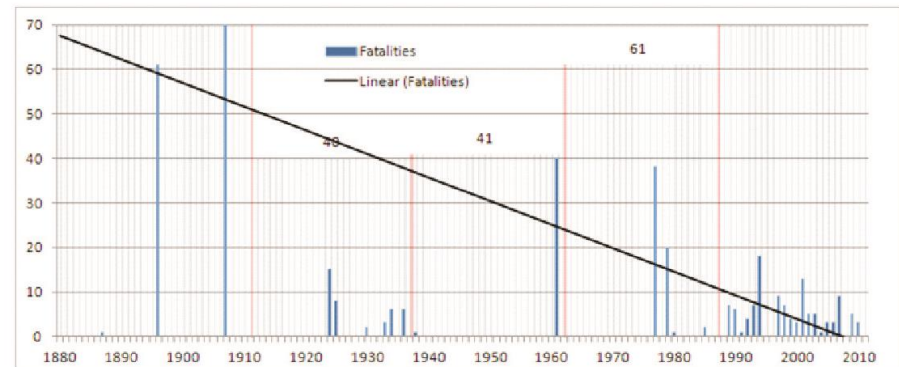
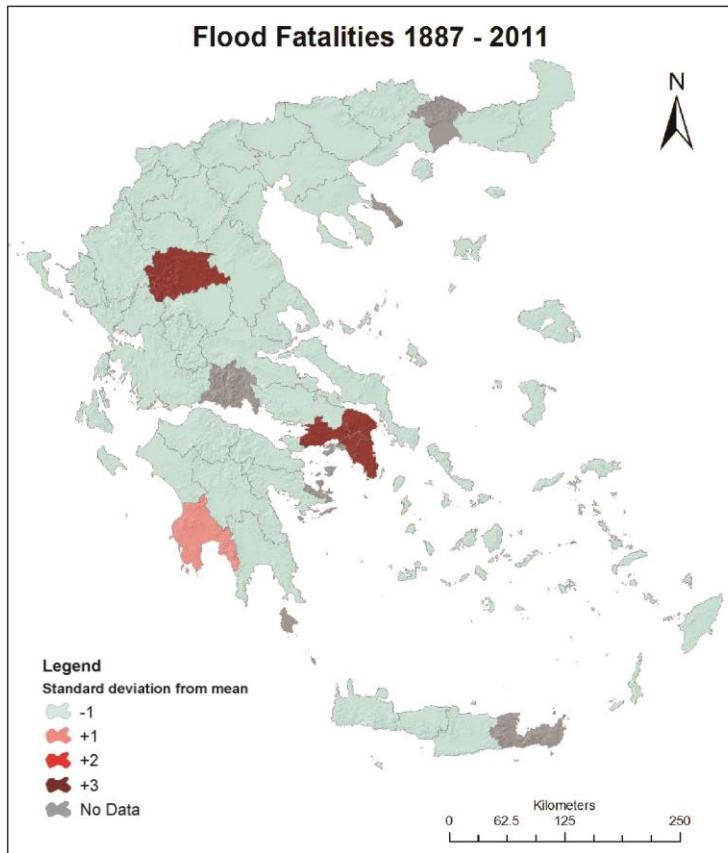
Development of losses



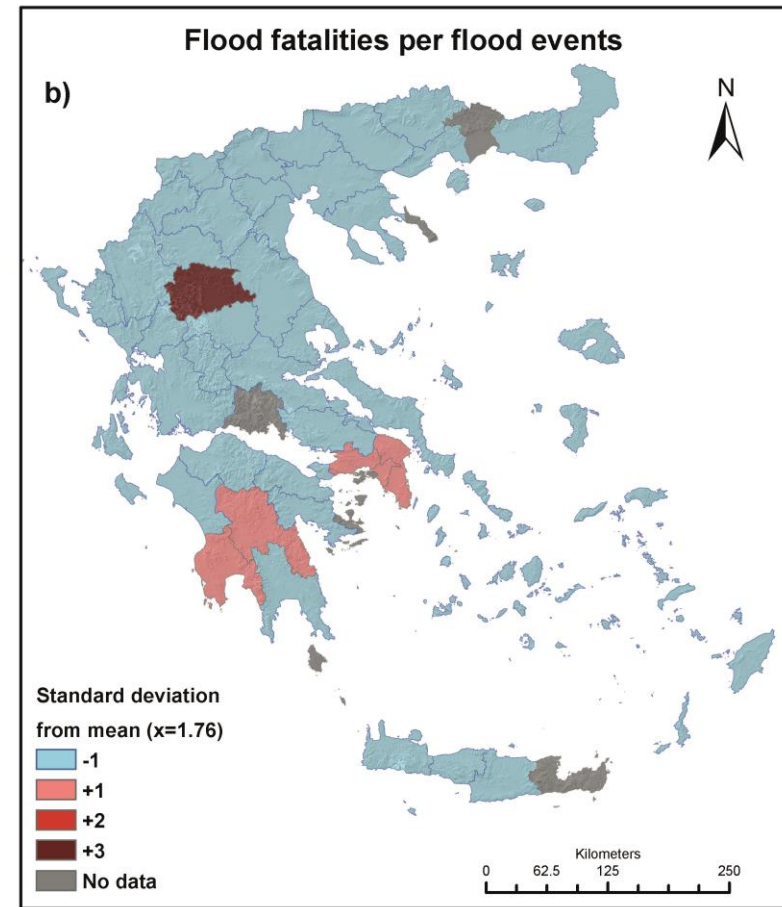
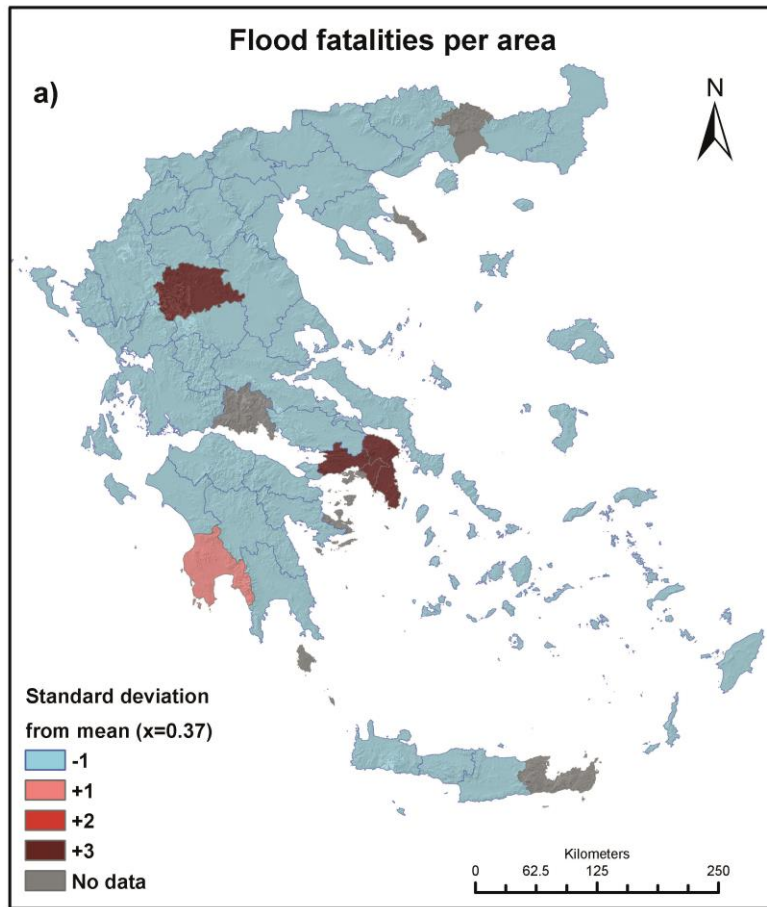
Development of losses - Greece



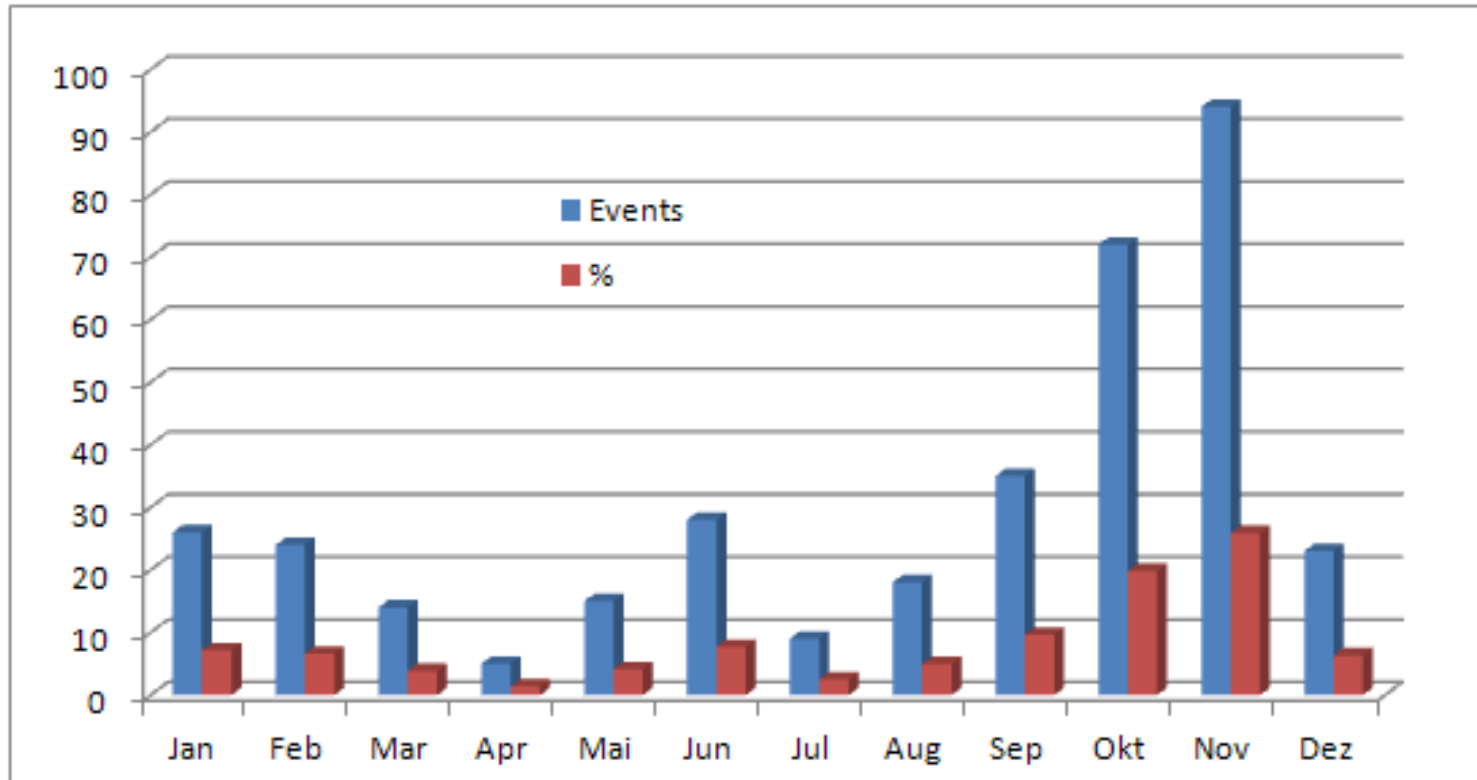
Development of losses - Greece



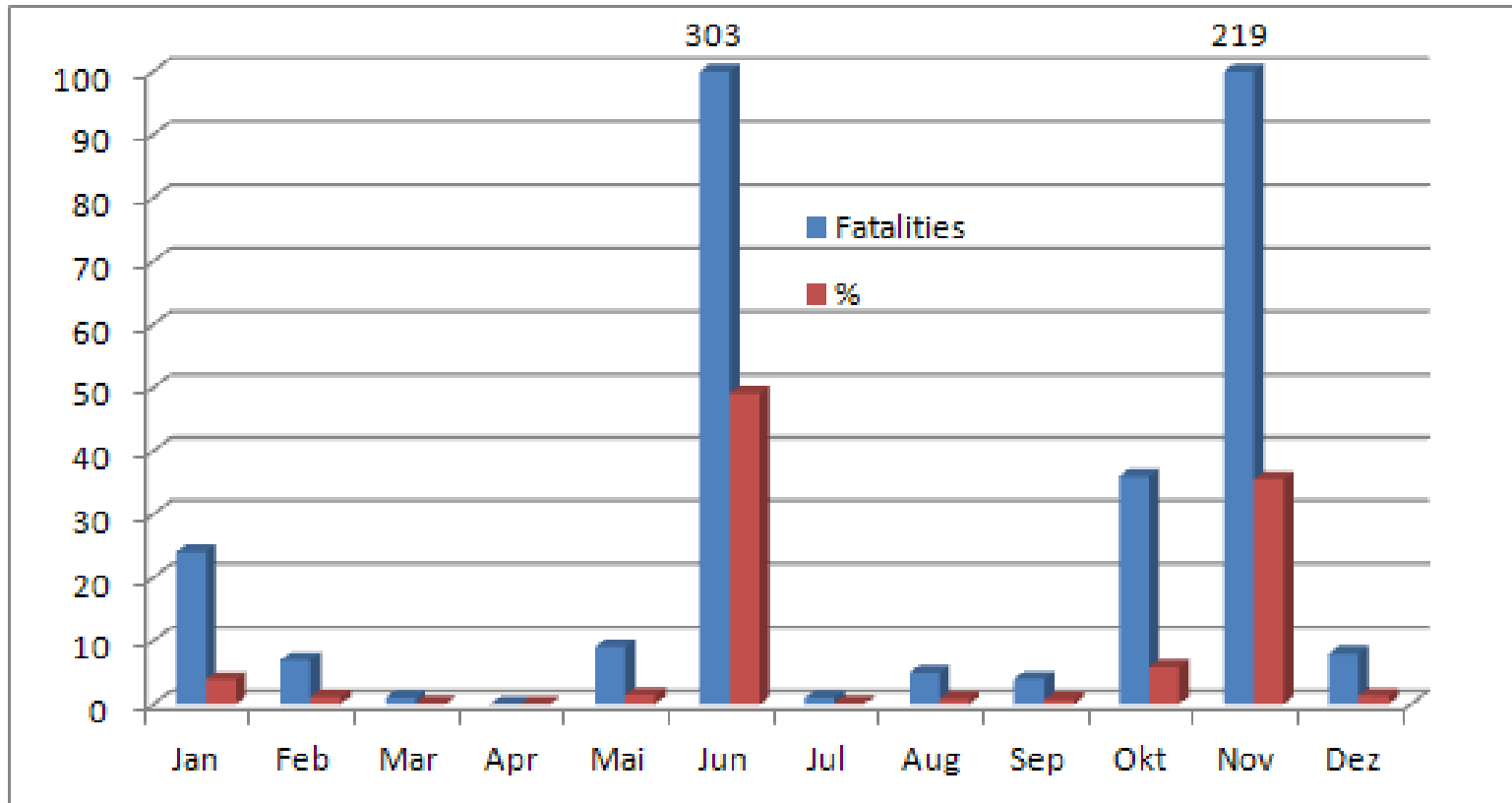
Development of losses - Greece



Development of losses - Greece



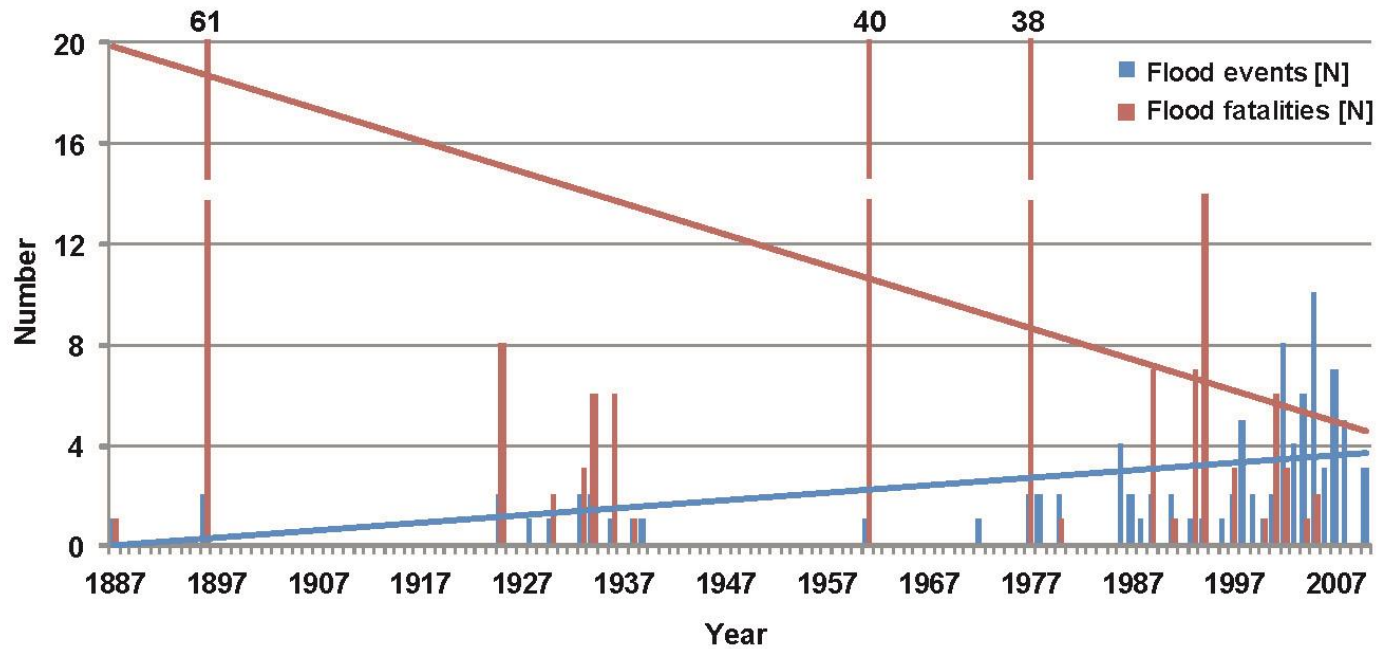
Development of losses - Greece



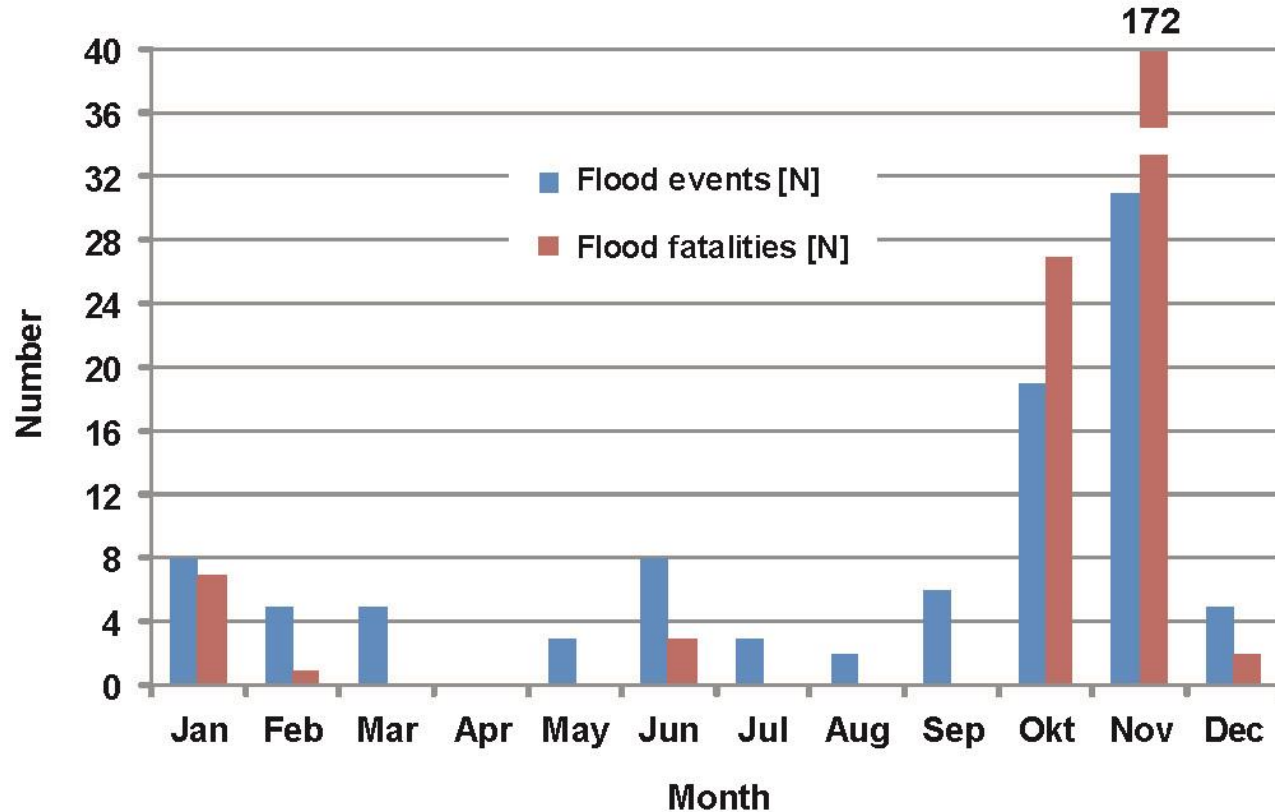
Development of losses - Attica

- In the district of Attica 25,6% of the flood events and 34,4% of the flood fatalities for the period 1887 – 2010.
- For the above period, most of the flood events of the district of Attica occurred in East Attica.
- Population increased (36.34%) in the decade 1991-2001 (National Statistical Service, 2001) – will be doubled by 2030.
- In the period 1998-2010, the annual rate of increase of building development had been expected to range between 5% and 30%.

Development of losses - Attica

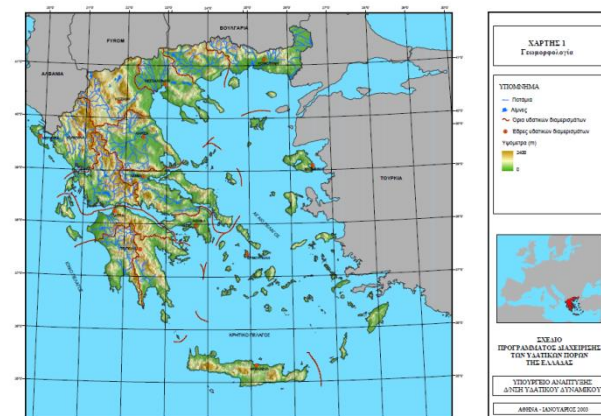
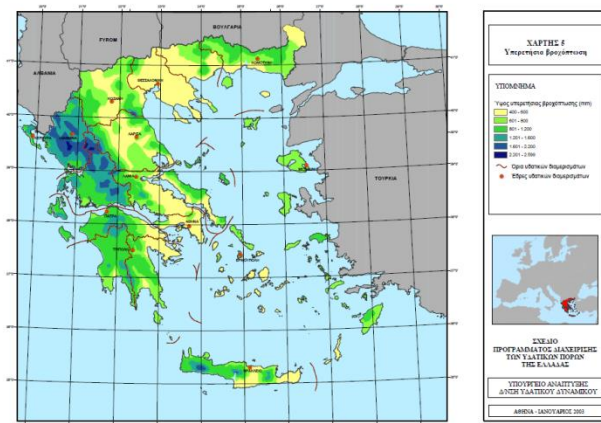


Development of losses - Attica



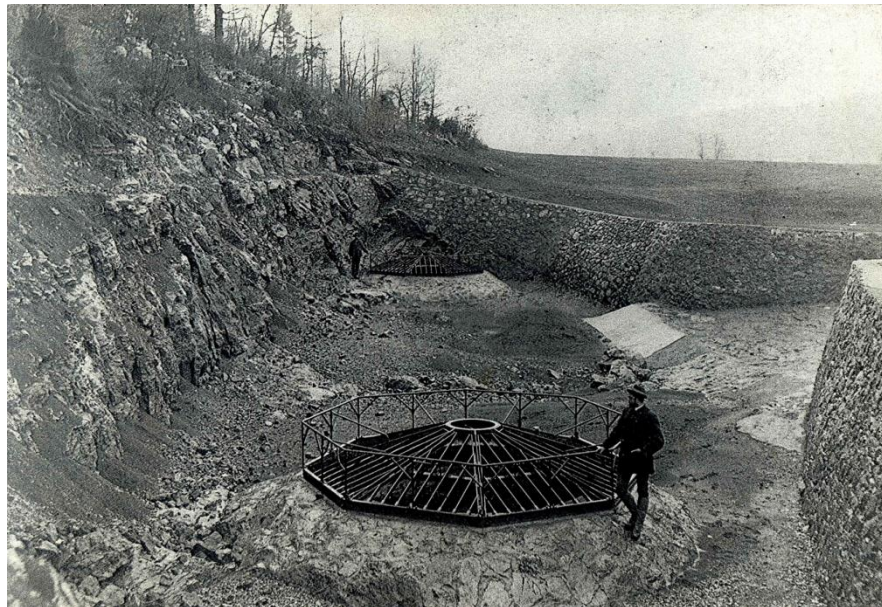
Flood phenomena - Greece

- Flood phenomena in Greece caused by intense rainfall - snowmelt is not a dominant factor.
- Intense rainstorms are produced by the passage of depressions possibly accompanied by cold fronts approaching from west, southwest and northwest.
- Pindos mountain range plays an important role in rainfall and runoff generation.
- 1,800mm in the mountain areas of western Greece - in the eastern regions approximates 300mm.



Flood phenomena - Greece

- The areas that suffer particularly from flood events can be classified into three categories.
- The first category includes hydrological basins close to karst areas which normally are drained by natural sinkholes (ponors) with limited drainage capacity.



Flood phenomena - Greece

- The second category includes the plains located in the downstream section and traversed by large rivers where the discharge capacity of the channel regularly exceeds the available cross section of the channel bed.



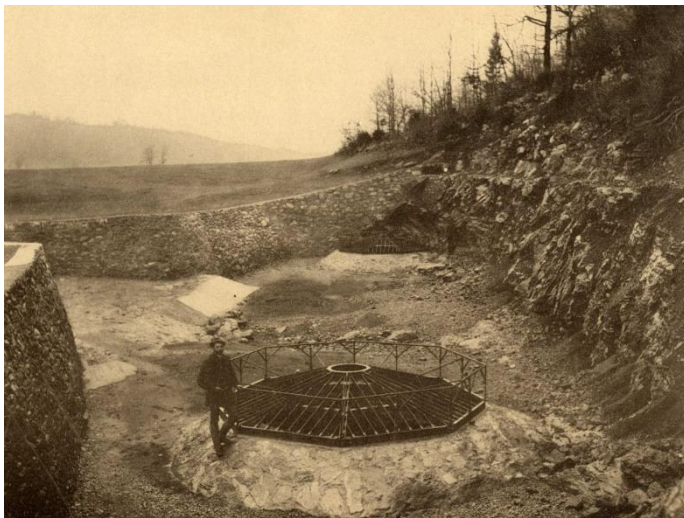
Flood phenomena - Greece

- The third category is within the urbanised areas of Greece such as Athens, Thessaloniki and Patras where compression and surface sealing are dominant.



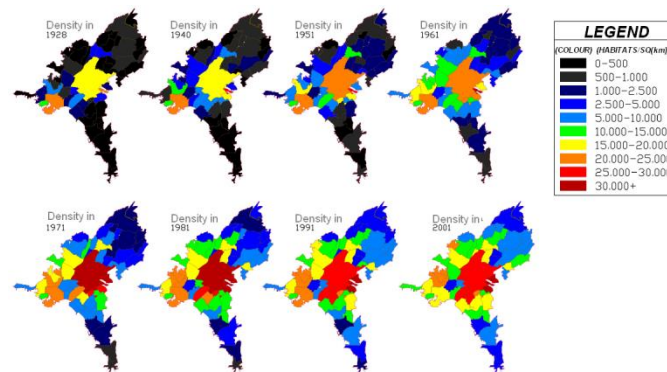
Flood phenomena - Greece

- During the last century the areas affected by flood hazards have continuously decreased in the first two categories due to the implementation of technical mitigation along the rivers and in the catchments, such as drainage tunnels for closed karst basins and dams and levees for the rivers traversing plains.
- In contrast, the flood events in the third category increased, mainly because of the high population density in urban areas, and the associated reduction of natural retention areas.



Flood phenomena - Attica

- According to census data, in 1951 only 18% (1,394,922) of the Greek population inhabited this district, while in 2001 this ratio increased to 36% (3,761,810; Greece National Statistics, 2001)
- In parallel, remarkable land use changes took place.
- The annual rate of building development increased from 17.7% in 1945 to 39.6% in 1973, and to 68.5% in 1995. Simultaneously, the cumulative cultivated and forested areas as well as the areas dominated by shrubs decreased from 81.3% in 1945 to 42.5% in 1973 and 31% in 1995.



Conclusions

- **Considerable spatial and temporal dynamics in the events recorded, as well as in the number of fatalities.**
- **The flood database established provides valuable information on major events that occurred in the Greek history.**
- **Besides many national and European efforts to reduce natural hazard impact on society, considerable damage has still occurred in recent years throughout Europe.**
- **Thereby, greater availability of information of natural hazard resulted in an increase of hazard awareness on a societal level**