

Flash floods evolution in Catalonia: from precipitation to societal aspects

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Photo: Calonge, October 2005 (Jordi Oriol)

OUTLINE

- The FLOODHymex database
- Floods and flash floods in Catalonia
- Trends detected in floods and flash floods
- Trends detected in heavy rainfall and convective rainfall
- Two cases of study: the Maresme and Empordà regions



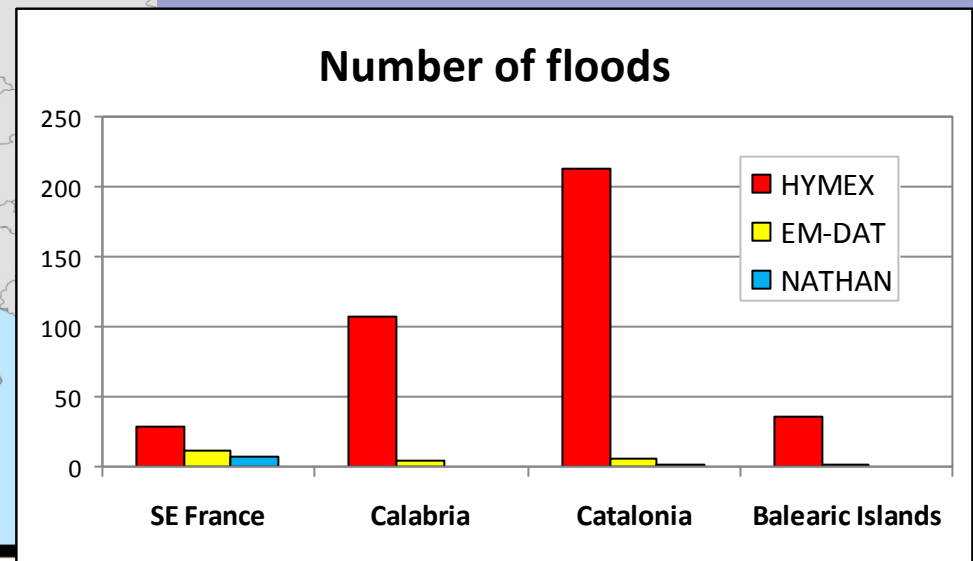
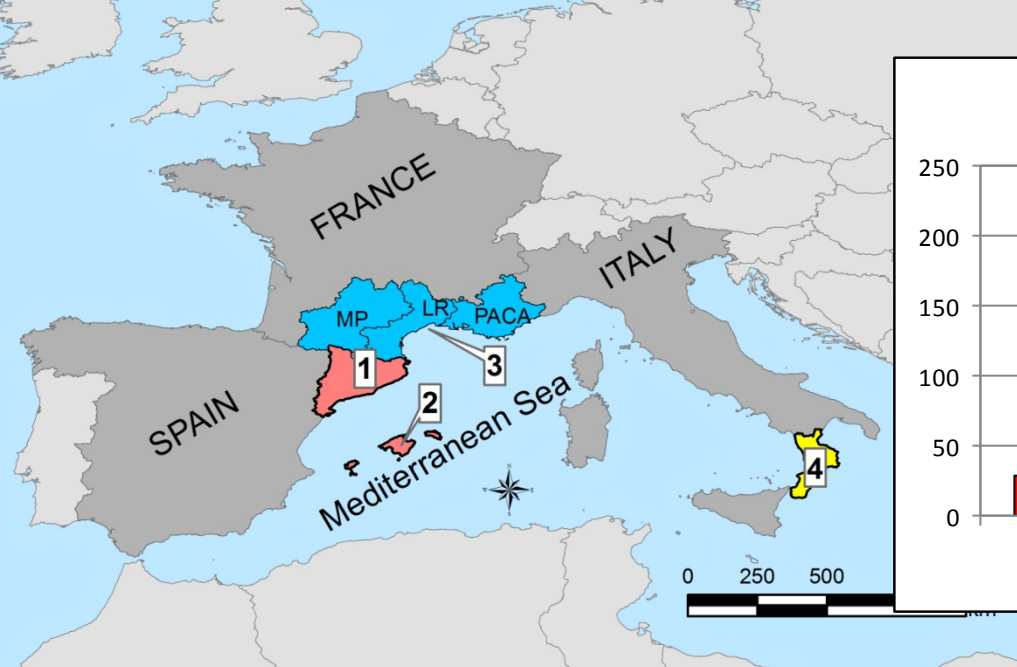


Figure 1. Comparison between the number of floods identified for the four selected regions in the HYMEX, EM-DAT and NATHAN databases for the period 1981-2010

	N_e	N_e Ext	N_e Cat	<i>Number of deaths</i>
<i>SE France</i>	29 (17)	0 (0)	29 (17)	186
<i>Calabria</i>	107 (7)	40 (0)	36 (7)	26
<i>Catalonia</i>	213 (42)	114 (18)	22 (15)	110
<i>Balearic I.</i>	36 (6)	28 (1)	8 (5)	11
TOTAL	385 (72)	182 (19)	95 (44)	333

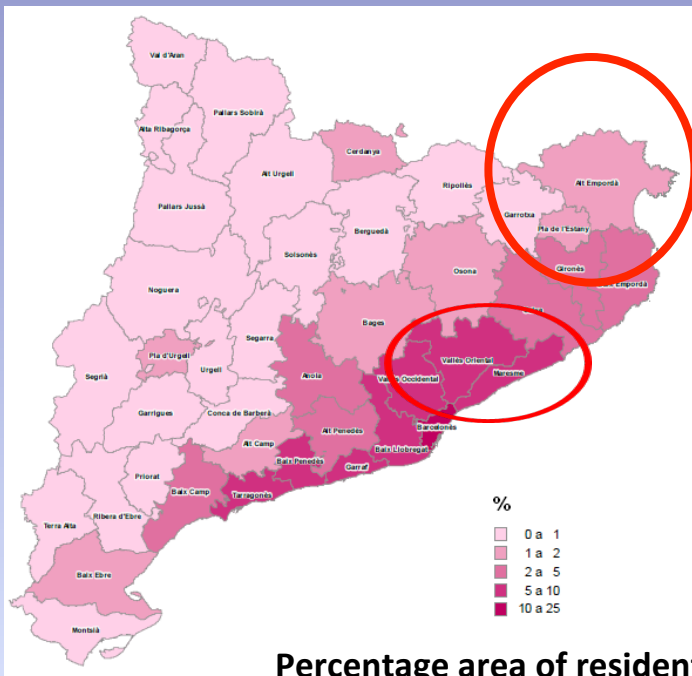
Table 6. Number of events that produced floods (N_e) identified in the FLOODHYMEX database; N_e Ext: number of extraordinary flood events; N_e Cat: number of catastrophic flood events; Total number of deaths. The period analysed is 1981-2010. Between brackets is the number of events which caused casualties.

Only 23 cases from 385 flood events have been recorded in the EMDAT database and this figure decreases to 8 cases when we refer to the NATHAN.

Insured loses by floods paid by the Consorcio de Compensación de Seguros (CCS) 1996-2005

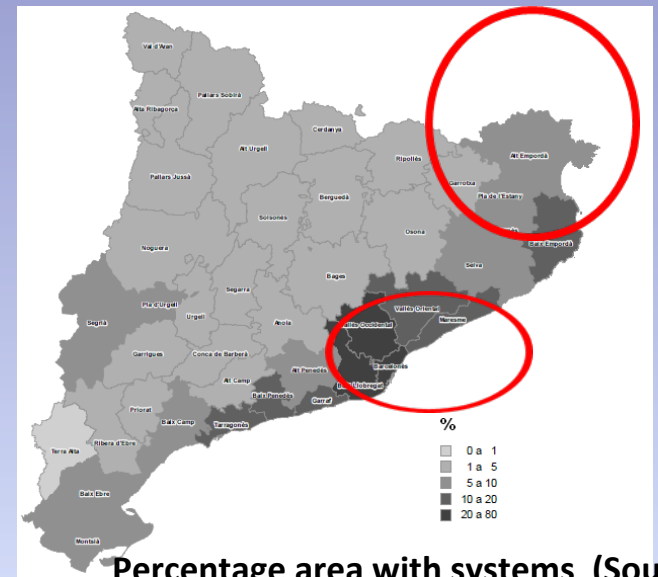
	Total valuation of damages	The less expensive event	Dates of the event	The more expensive event	Dates of the event
Category 0	4 457 668	25 587.61	17/09/1996	1 569 606.29	05/08/2000
Category 1	196 774 166	75 839.34	10/07/2000	83 450 923.1	17/08/2003
Category 2	267 479 907	1 971 053.63	01/11/2005	141 140 543	10/06/2000
TOTAL	468 711 740				



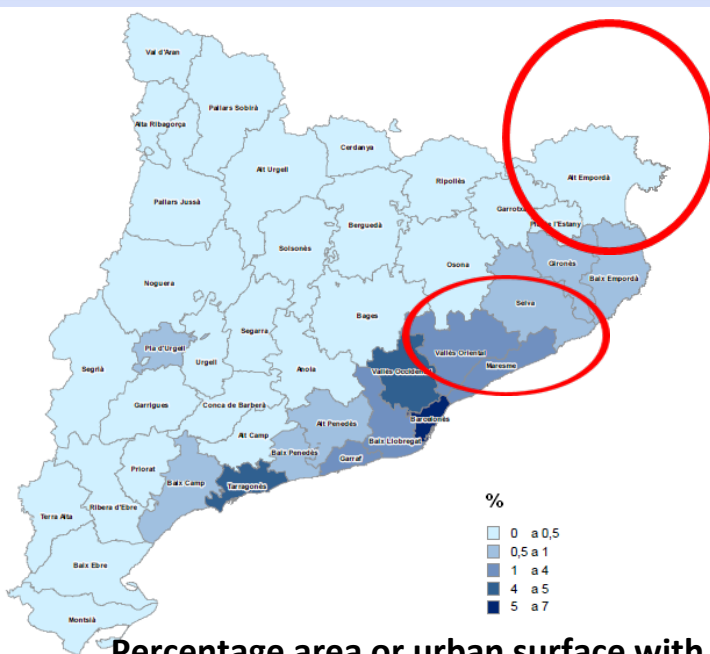


Percentage area of residential land (2011) (IET)

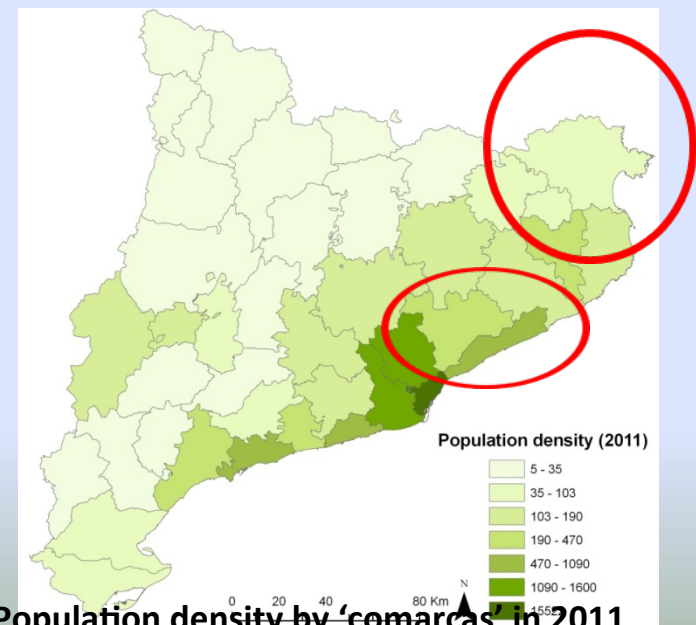
Relevant
role of
vulnerability
and
exposure
factors



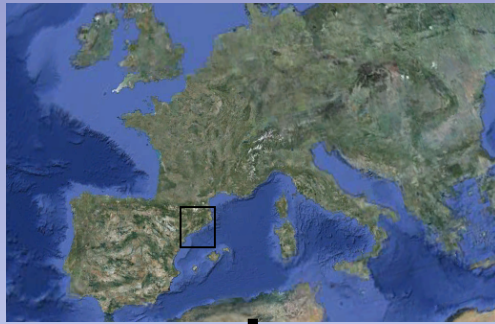
Percentage area with systems (Source: Institut d'Estudis Territorials)



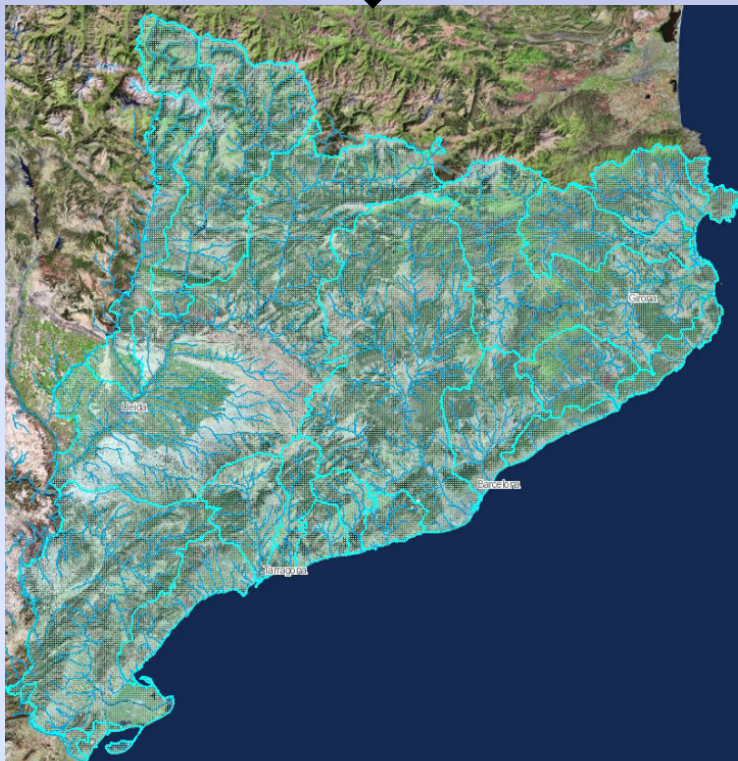
Percentage area of urban surface with economic activity (Source: Institut d'Estudis Territorials)



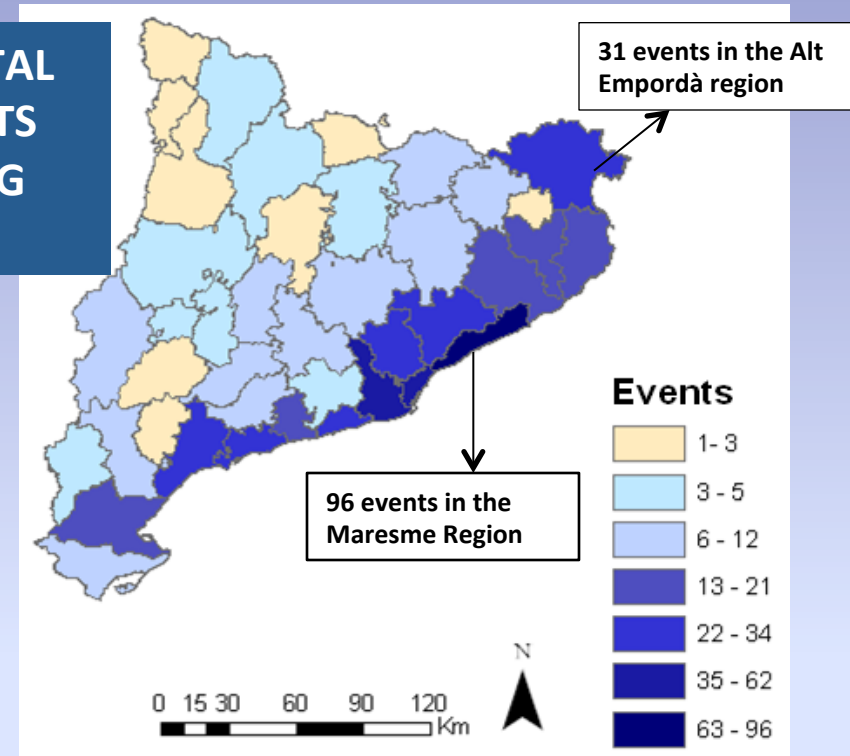
Population density by 'comarcas' in 2011 (GAMA from information of idescat)



**LITTLE COASTAL
CATCHMENTS
WITH STRONG
SLOPE**



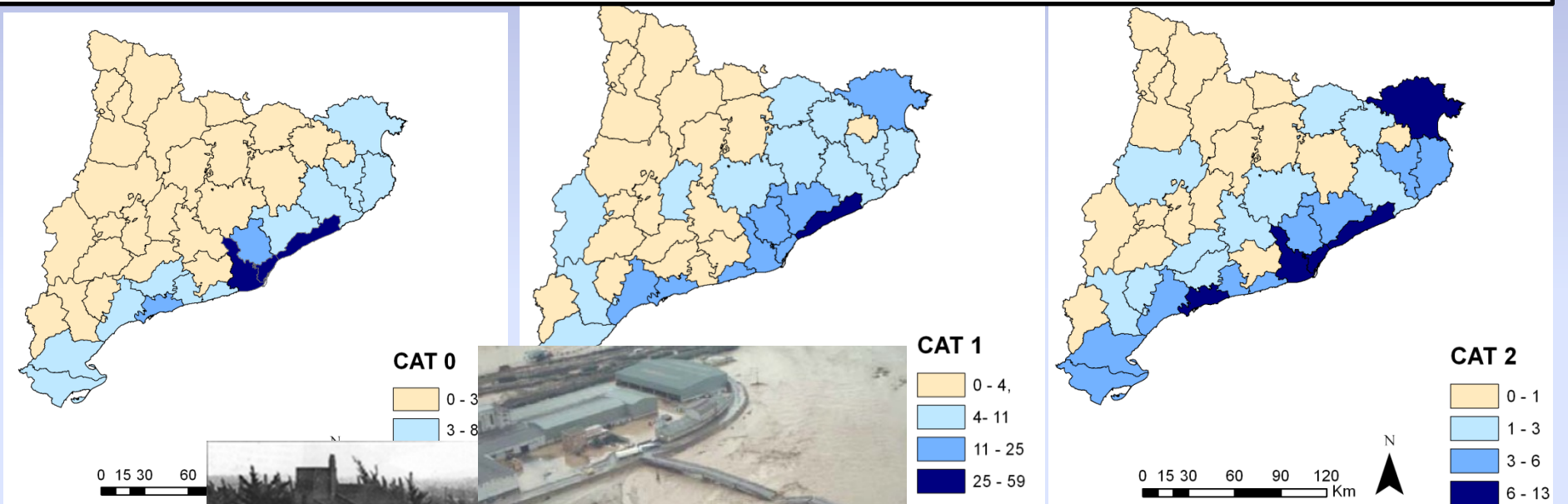
Satellite image of Catalonia with drainage basins and rivers. Source: Institut Cartogràfic de Catalunya (ICC)



Number of floods (1981-2010) by *comarca*

213 flash floods and flood events have been identified for the period of 30 years (365 starting in 1900), that have produced 42 casualties. The major part of them are produced between the months of August and November.

- **Ordinary flood:** It takes place when the river flow increases in such a way that it can affect the day-to-day of local population, temporary infrastructures around the river (e.g. walkways) or flood river crossings. However there's no major damage.
- **Extraordinary flood:** It takes place when the river overflows and even though it does affect the day-to-day of local population and it does cause some damage it does not completely destroy infrastructure. These floods can be local or extensive
- **Catastrophic flood:** It takes place when serious material losses happen such as total or partial destruction of bridges, mills or any other infrastructure, as well as cattle and crop loss.

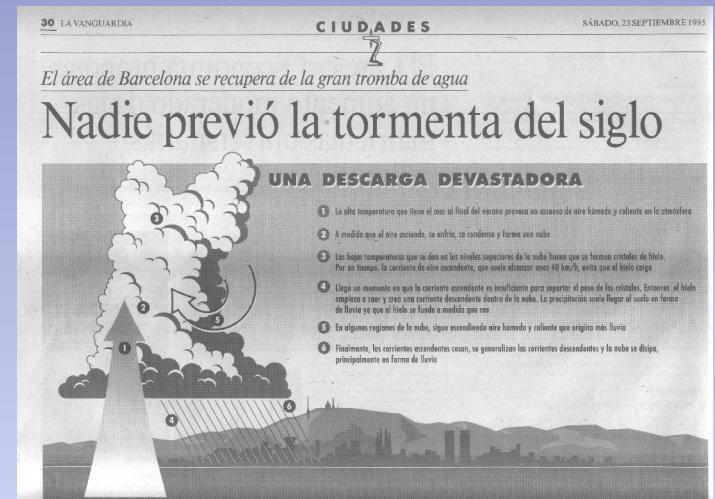
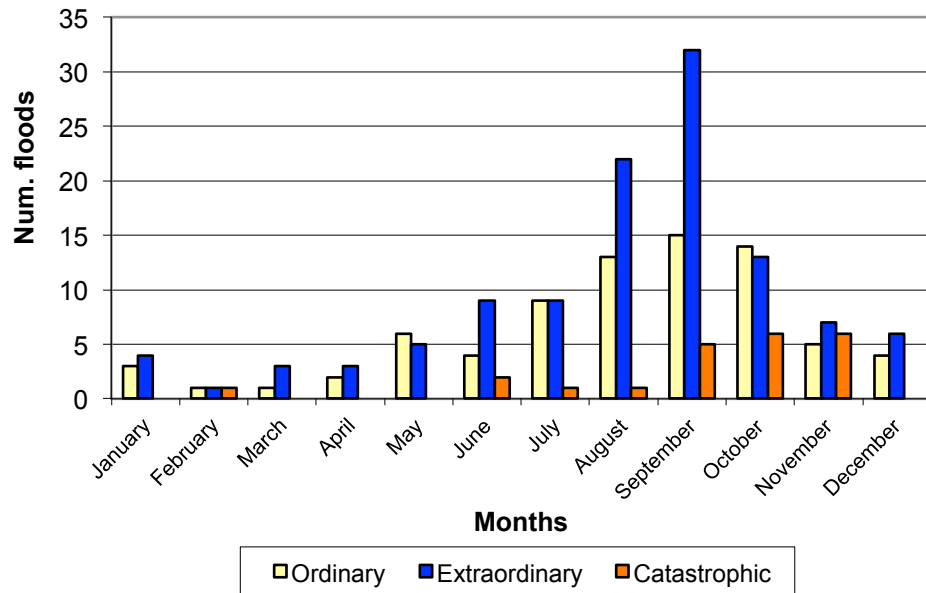


categories.

36,2% ordinary CAT 0

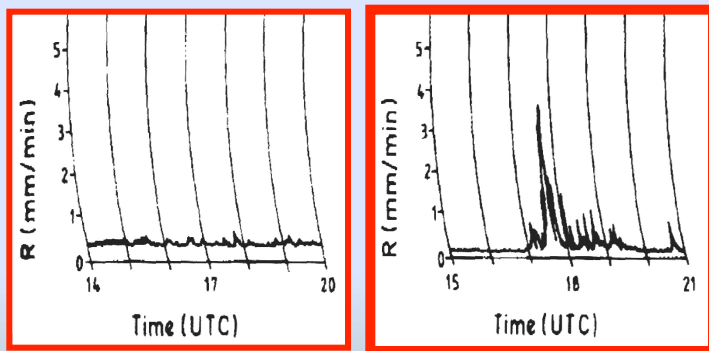
53,5% extraordinary CAT 1

10,3% catastrophic CAT 2



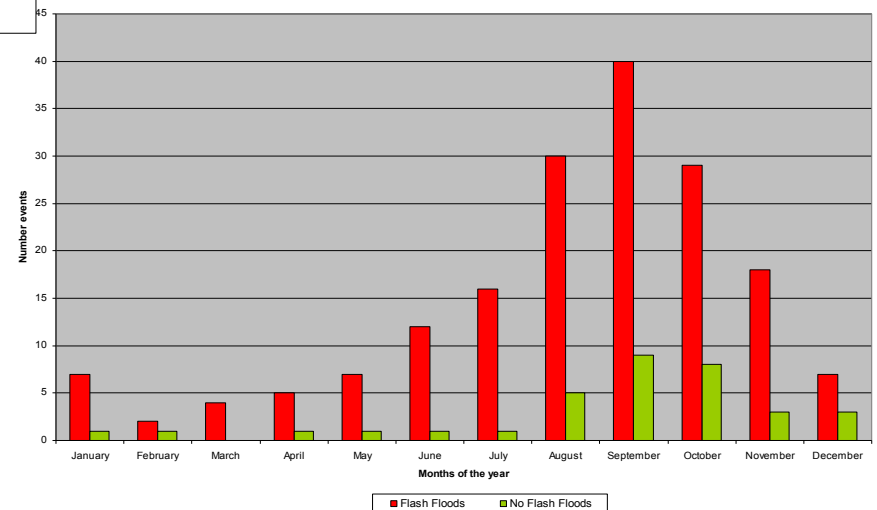
25 September 1995: 80 mm 21:30 -22:30 1 †

Monthly distribution of floods in Catalonia taking into account their impact



Convective precipitation versus stratiform precipitation by using raingauge data

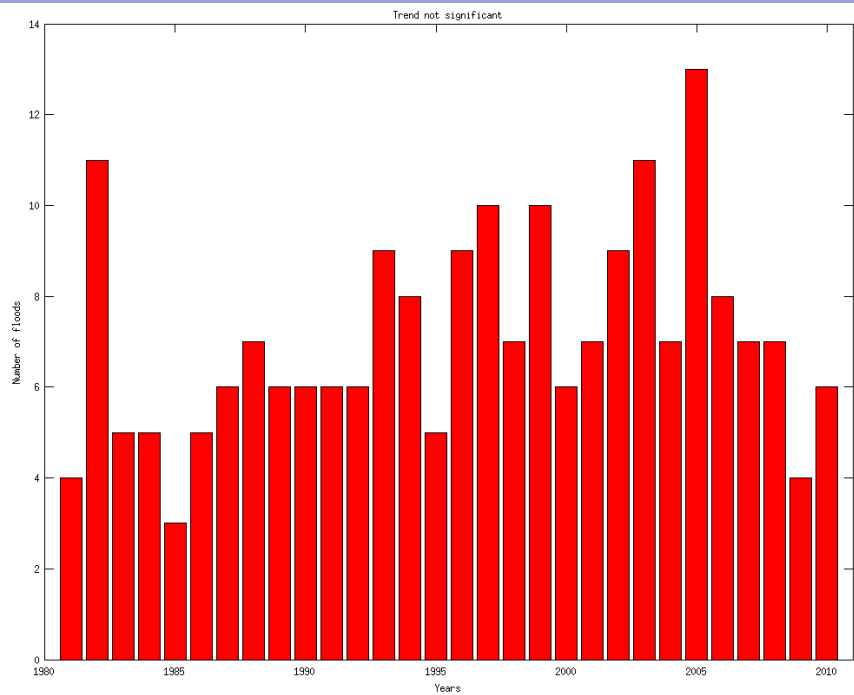
MONTHLY DISTRIBUTION OF FLASH FLOODS AND NO FLASH FLOODS EVENTS (1982-2007)



Distribution of flash flood events and non flash-flood events. Flash floods are associated to heavy convective precipitation

TRENDS IN FLASH FLOODS and FLOODS

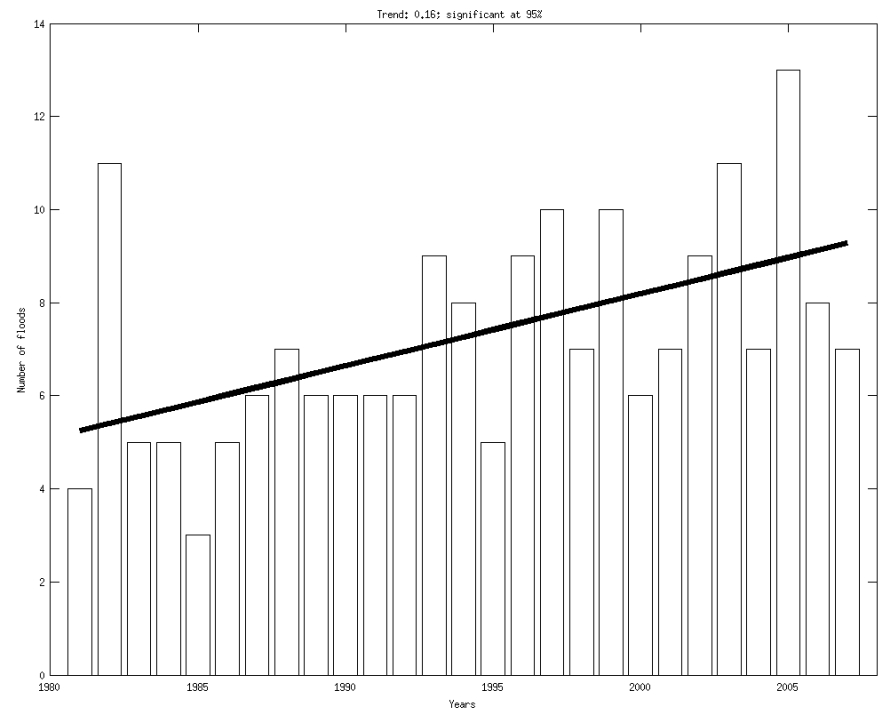




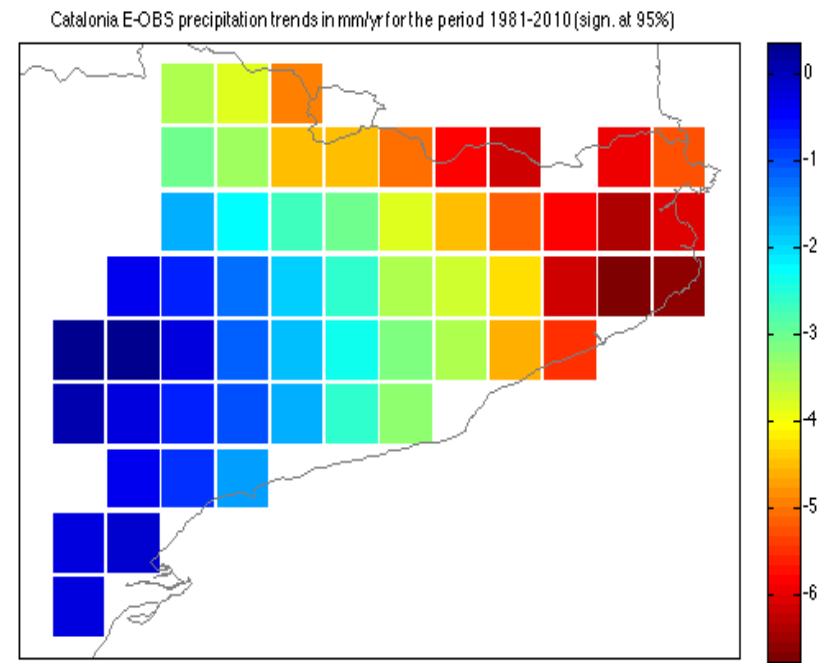
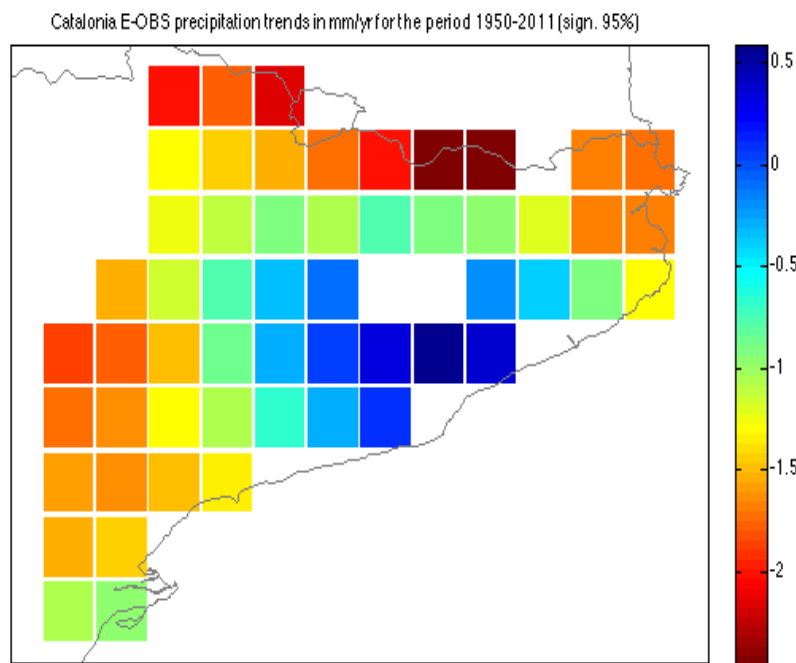
Number of floods between 1981-2010

- The extraordinary floods show a tendency to an increase of 0.15 flood/year with a 95% flood until 2007.
- In the ordinary and catastrophic floods there are no significative trend.

- Between 1981-2010 there is no significant trend in the total number. The period 1981-2007 the trend of increase 0.16 floods/year is significant at 95% (according to Turco and Llasat method, NHESS, 2011).

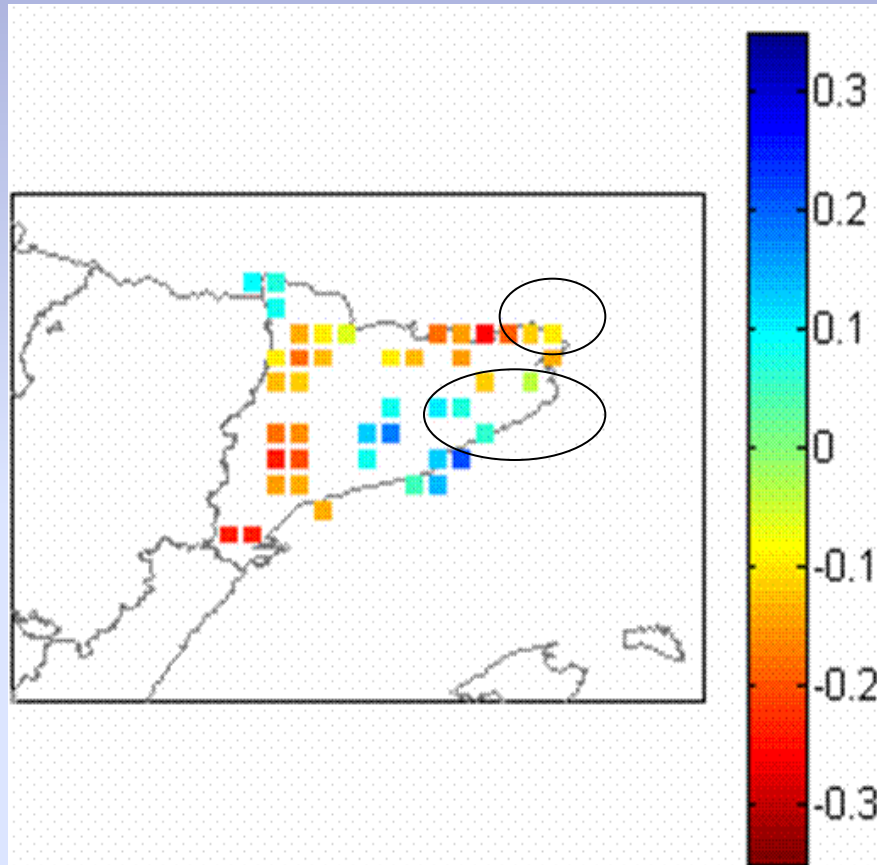


Number of extraordinary floods between 1981-2007

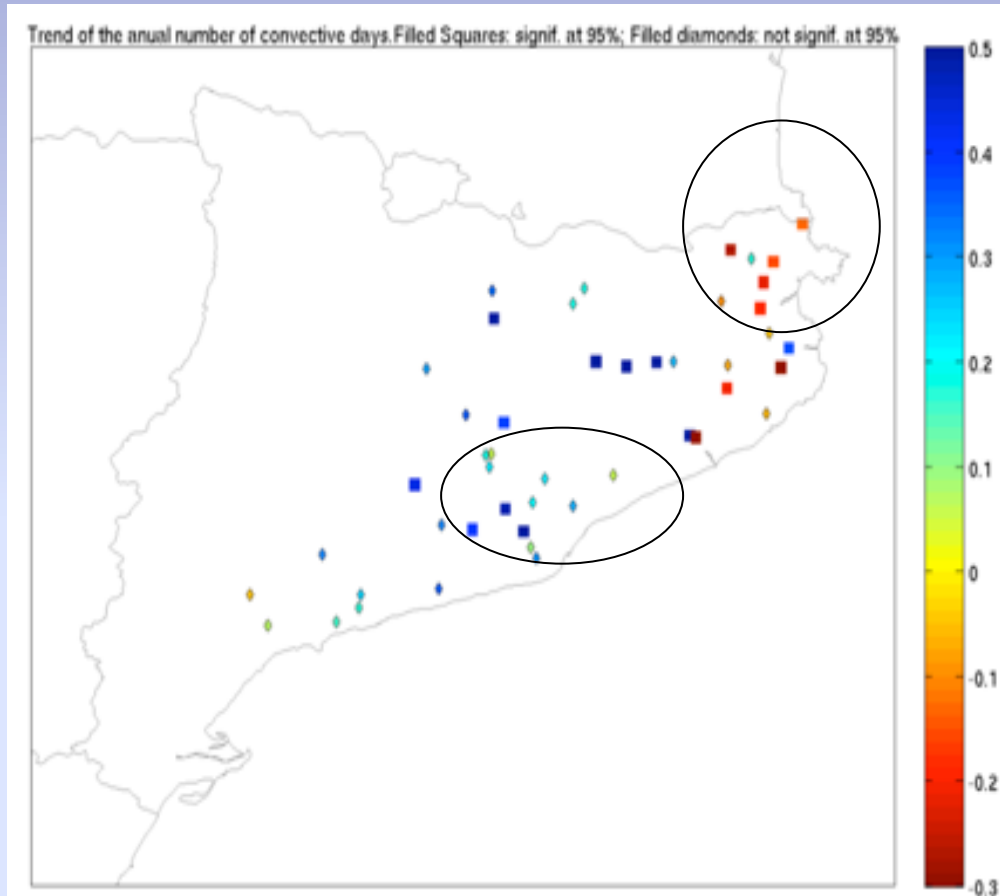


Trend of annual precipitation a) 1950-2011; b) 1981-2010. Significance at 95%, E-OBS data at 25 km resolution. The great dependence with the considered period to calculate the trend is signaled. For the last period a general negative trend is observed in all Catalonia.

No general trends at a regional scale have been observed in ECCTI related with heavy rainfalls, considering the annual and the seasonal regional values of all the indices and considering all the different time windows.

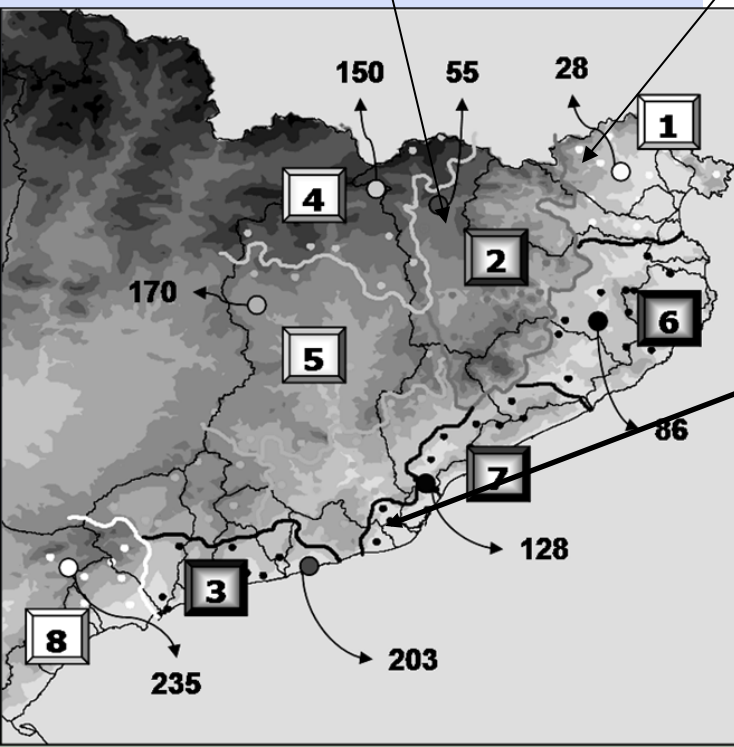
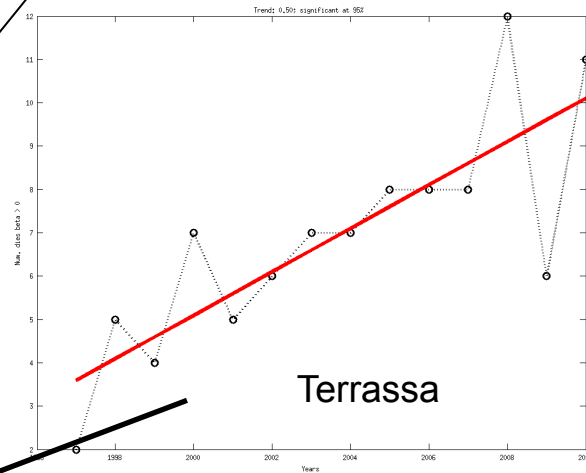
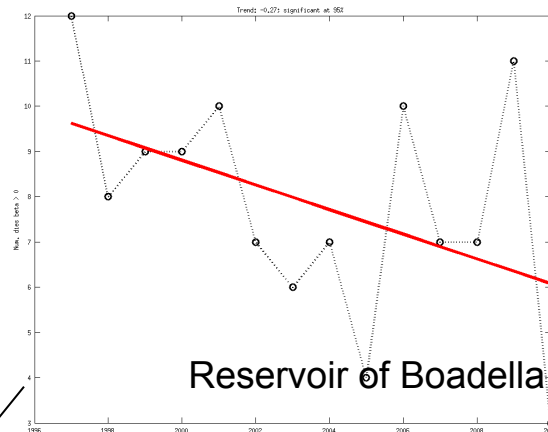
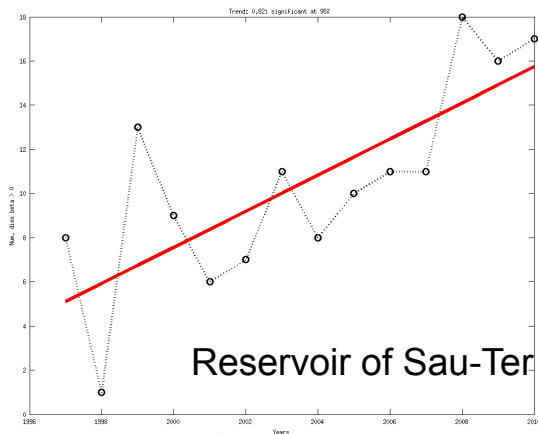


Trend evolution of SDII 1973-2003 (this trend is not sustained for different time windows of 30 years, 1950-2003, SPAIN-02, 20 km resolution) shows a negative value at the NE and SE parts (Turco and Llasat, NHESS, 2011)



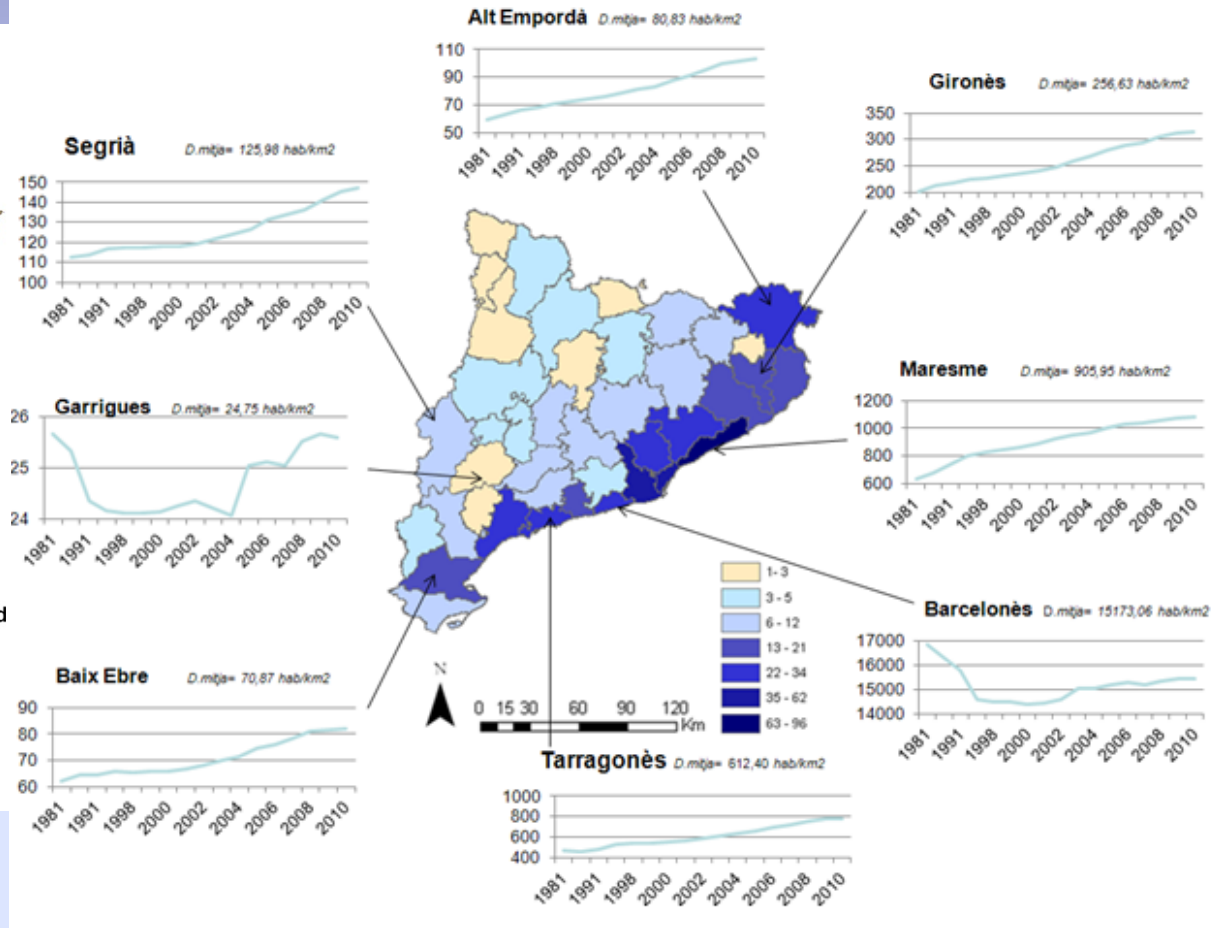
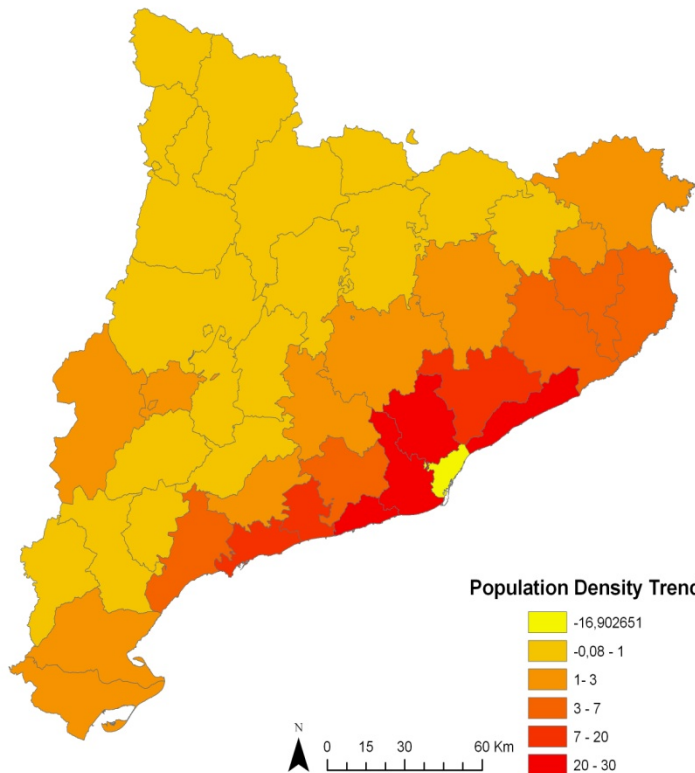
Trend evolution of annual days with convective precipitation (5-min intensity > 35 mm/h), 1996-2011 (15 years). SAIH network of Catalan Water Agency had initially 126 raingauge stations; after a quality control only 43 stations have been

Trend of annual convective days



Pluviometric regionalization of Catalonia taking into account the convective precipitation. The Northern part has de major convective contribution (Llasat et al, Atmospheric Research, 2007).

No significative trend in the ratio of convective precipitation, at annual scale, 1996-2011. However, trends point to an increase. Increase of days with moderate convective events ($0,3 < \beta < 0,8$). A generalised increase (although not significative) is found in the number of days with very high convective events ($0,8 < \beta$). This

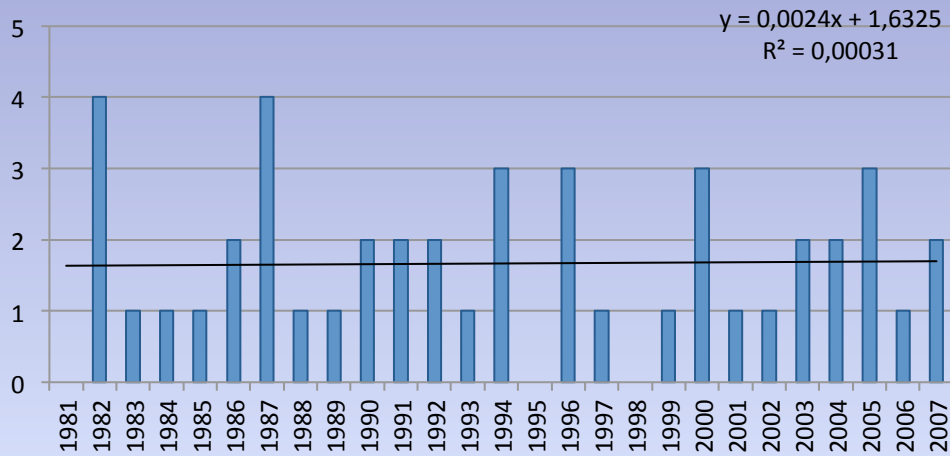


Population density trend by regions (1981-2010). Barcelona has a negative trend and also is the region with more population density by far.

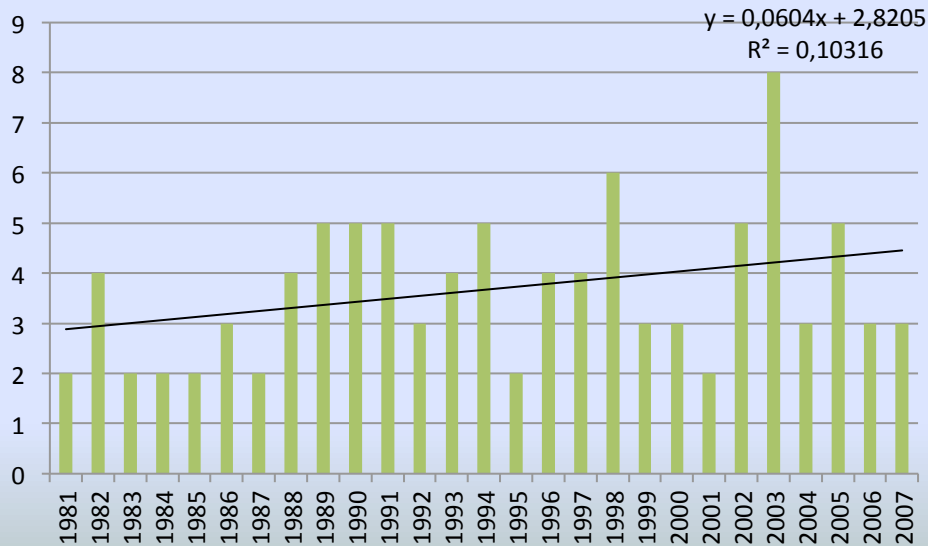
Changes in population density (1981-2010) in some regions of Catalonia and number of floods in the period of 1981-2010 by regions.

Where there is more density population is where there are more floods. Density population is an important factor of exposure and vulnerability.

A decrease of convective precipitation contribution has been found in Alt Empordà and an increase has been found near Maresme Region.



Floods evolution in Alt Empordà



Floods evolution in Maresme



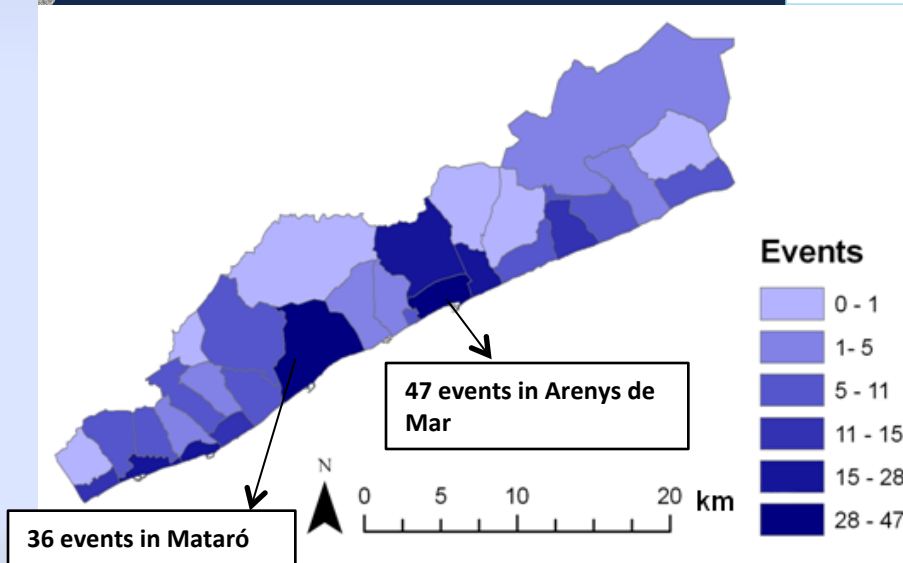
April 2002, Alt Empordà more than 350 mm/24 h



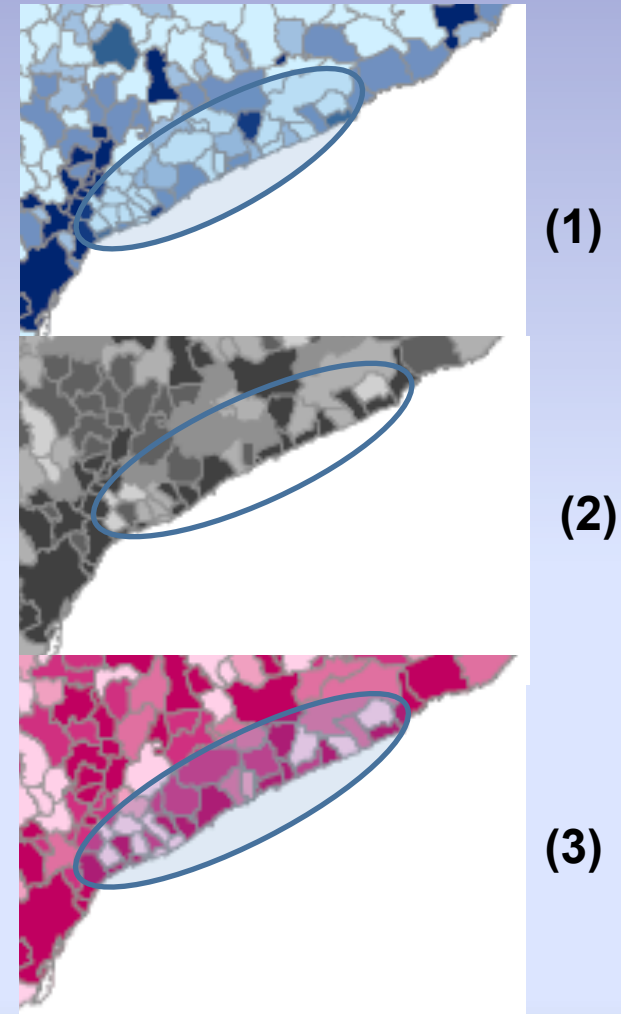
September 2006, Catalan coast, near 250 mm/24 h

MARESME

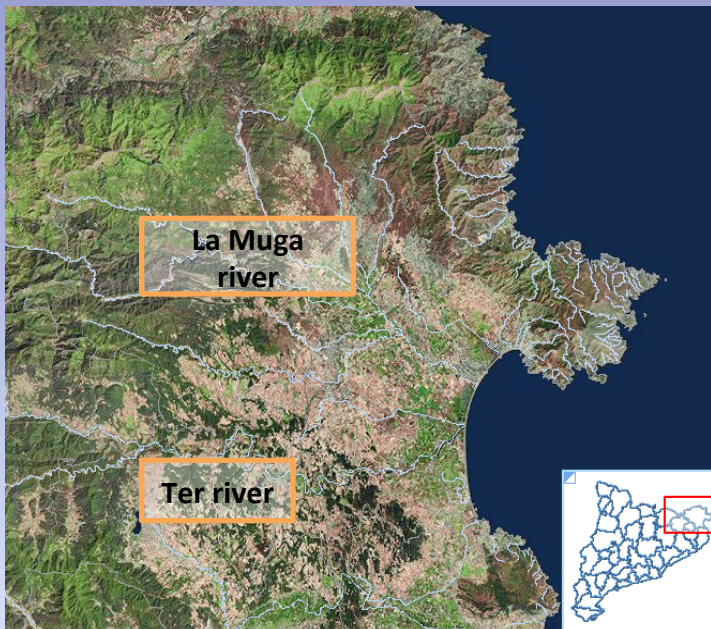
Other factors different to precipitation have to be considered



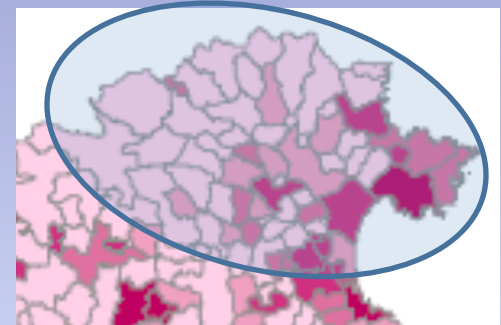
Number of floods in the period of 1981-2010 in Maresme by municipalities.



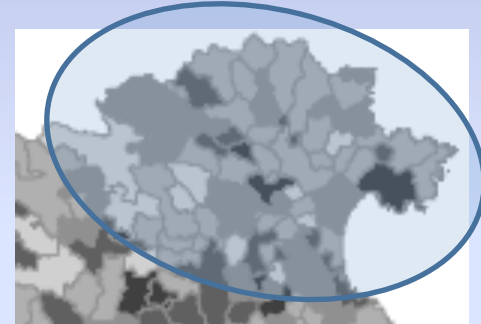
Percentage area of economical sector (1), systems (2) and residential land (3) for Maresme municipalities.



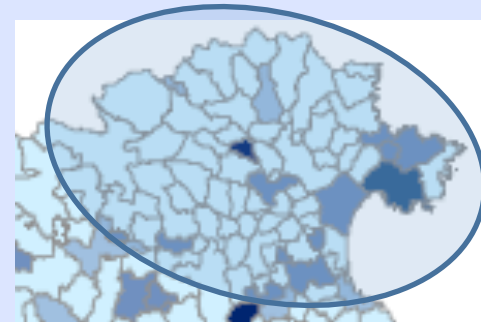
ALT EMPORDA



(1)

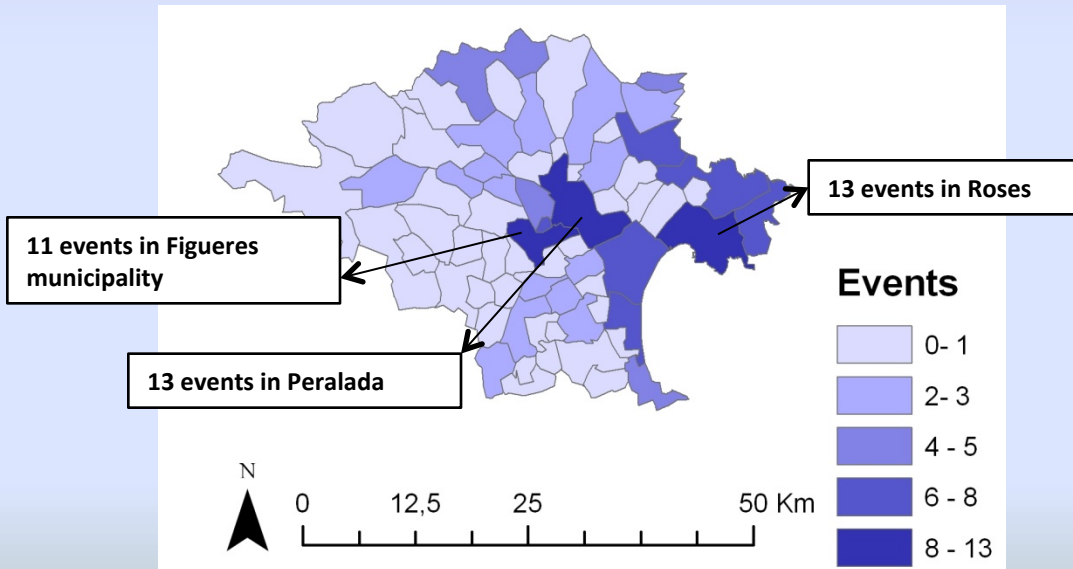


(2)



(3)

Percentage area of economical sector (1), systems (2) and residential land (3) for Maresme municipalities.



Number of floods in the period of 1981-2010 in Costa Brava by municipalities.

Conclusions

Mediterranean coast experiences every year important flash floods with damages that frequently are not included in the «official» databases.

Catalunya has experienced 213 f/ff in 30 years, being concentrated in areas with great exposure and vulnerability. The major part of them are extraordinary ones, concentrated between July and November. Major exposure in summer.

A positive trend has been found in extraordinary floods (1981-2010).

A negative trend of annual rainfall has been found.

A positive trend in the number of days with convective precipitation has been found and a significative negative trend in the North Eastern part. Both trends are mainly due to the increase /decrease of days with moderate convective events.

Changes in use of soil and a positive trend in population density have been observed.

Both factors have contributed positively to the increase of floods in central area. On the contrary, the disminution of convective contribution in the NE part can justify the lack of trend in floods

The NE part has an anomalous behaviour in comparison with the rest of the region

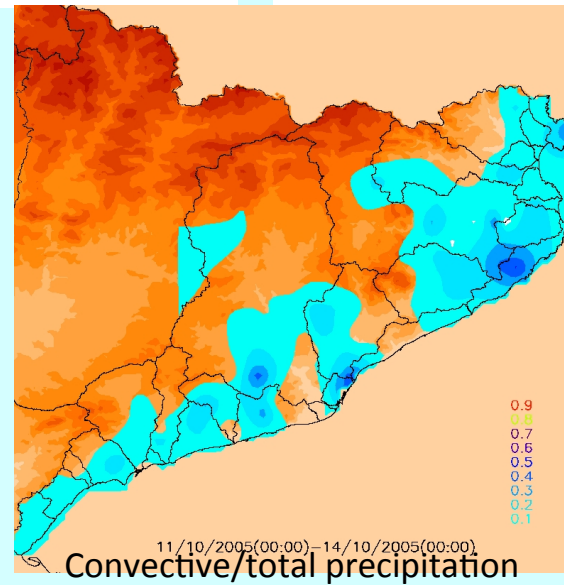
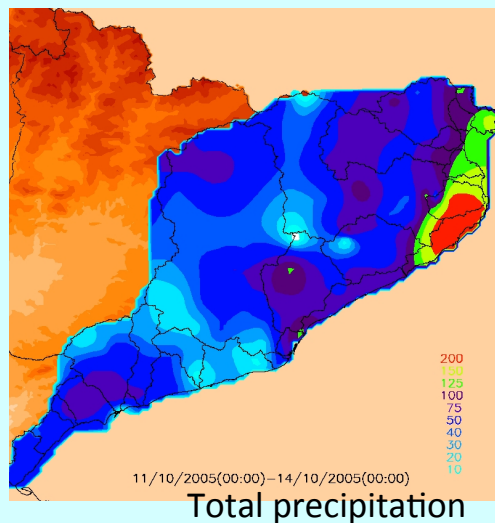
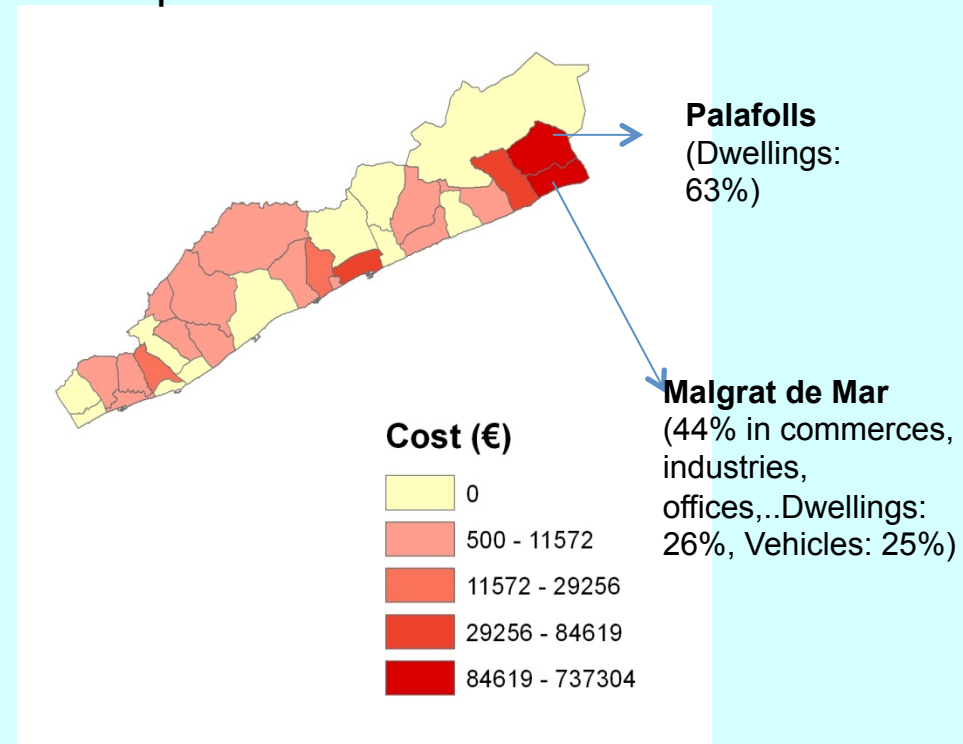
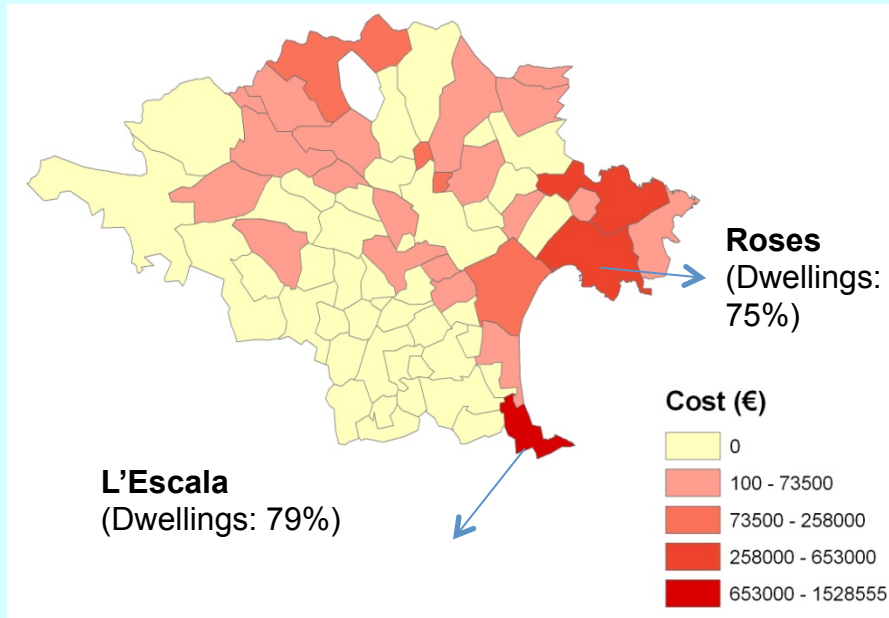


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FOR YOUR
ATTENTION!**

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Impacts of the case of 11/10/2005 in Alt Empordà i Maresme



And hydrological and hydraulic conditions have also changed...



M.C. Llasat

Example of an ephemeral stream flow channeled in Maresme

Database	Coverage	Kind of events	Criteria	Start date	Owner	Public access?
EM-DAT-Emergency Events Database -	Global	Natural and technological disasters	At least one of the following criteria: a) 10 or more people killed; b) 100 or more people affected/injured/homeless; c) declaration of state of emergency; d) appeal for international assistance.	1900	Univ. Catholique de Louvain, Belgium	Yes
NATHAN-Natural Hazards Assessment Network	Global	Natural hazard-based disasters	Great natural catastrophes: supra-regional or international assistance is required: thousands of fatalities; hundreds of thousands of people homeless; or when the overall losses and/or insured losses reach exceptional orders of magnitude.	1974	Munich Re Germany	Partially
ESWD-European Severe Weather Database	European	Severe convective storms	No common criteria. Information is reported by the sources	2006	European Severe Storms Laboratory Germany	Yes
Global Active Archive of Large Flood Events	Global	Floods	At least one of the following criteria: a) significant damage to structures or agriculture, b) long intervals since the last similar event or fatalities	1985	Dartmouth Colorado: Darmouth Flood Observatory Colorado	Yes
Swiss Re (Sigma)	Global	Natural and man-made disasters	Losses of US \$86.6 M and/or insured losses of US \$43.3 M (both in 2010 values) and/or 20 fatalities/ people missing	2003	Swiss Re	Partially

Table 2: Largest public world databases on disaster events that include flood events. (More information is available at <http://www.emdat.be/>, <http://www.munichre.com>, www.eswd.eu, <http://www.dartmouth.edu/~floods/Currentt.htm>), <http://www.swissre.com/sigma/>.