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A comparative analysis between two pluvial flood events in Barcelona (Spain). An example of a success story

Llasat[1,2], M.C., B. Aznar[3], L. Esbrí[1,2], T. Rigo[4] , J.O. Grima, J.O.[3], H. Kreibich[5]

[1] Department of Applied Physics, University of Barcelona, Spain, carmell@meteo.ub.edu
[2] Water Research Institute, University of Barcelona, Spain
[3] Barcelona Cicle de l'Aigua S.A., Barcelona, Spain, baznars@bcn.cat
[4] Servei Meteorològic de Catalunya, Barcelona, Spain
[5] GFZ German Research Centre for Geosciences, Section Hydrology, Potsdam, Germany

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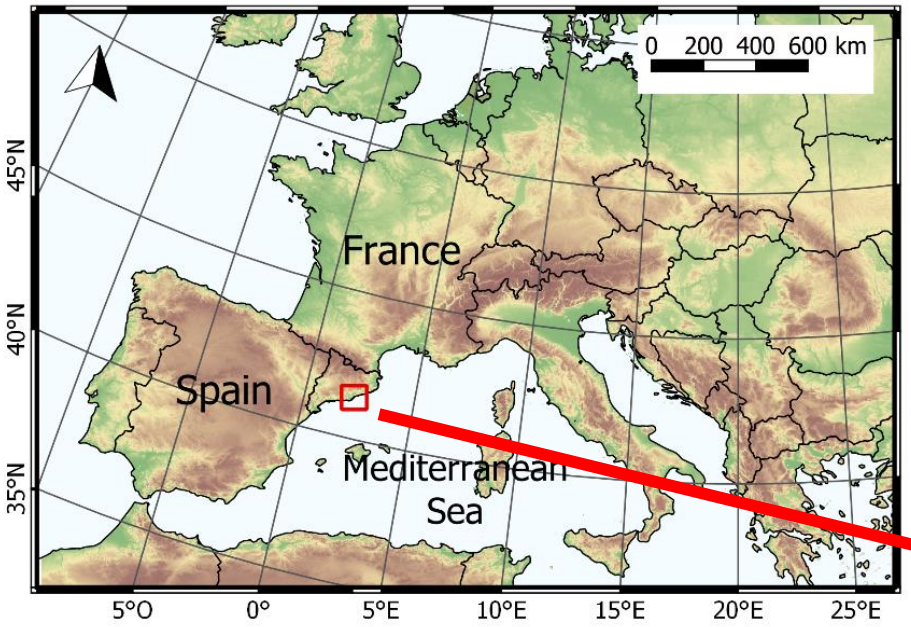
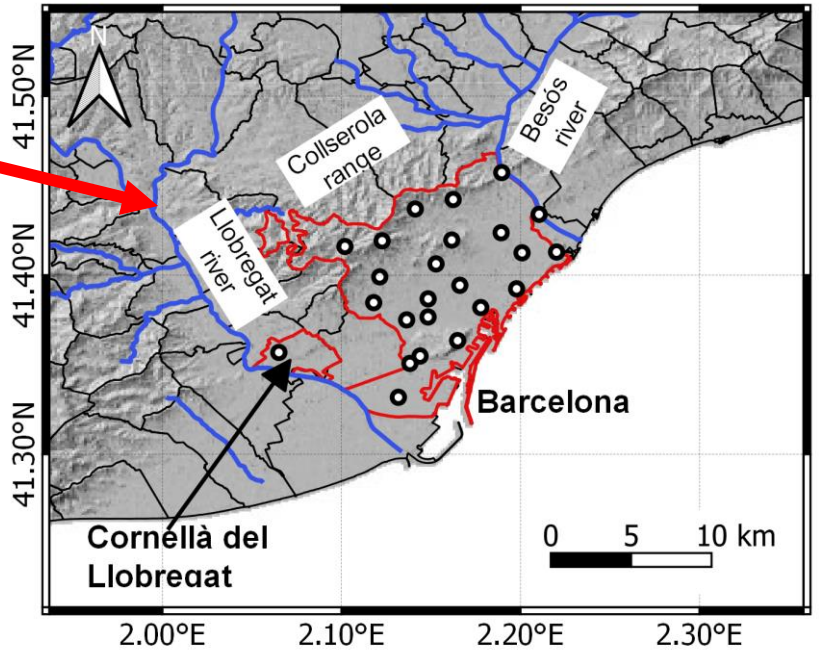
INTRODUCTION. Contextualization



- The city of Barcelona is severely affected by pluvial floods
- Risk management systems reduce the associated damages but they can be further improved

To illustrate how this Risk management system works in Barcelona:

- ✓ Two fluvial flood events are compared: 1995 and 2018
- ✓ Analysis of all convective precipitation events between 2013 and 2018 in Barcelona



OBJECTIVES: Decreasing flood vulnerability in Barcelona

- From the 1996 flood event to the 2018 flood event in Barcelona: structural measures
- From 2018 to future: combination of structural measures+ improvement of early warning systems.

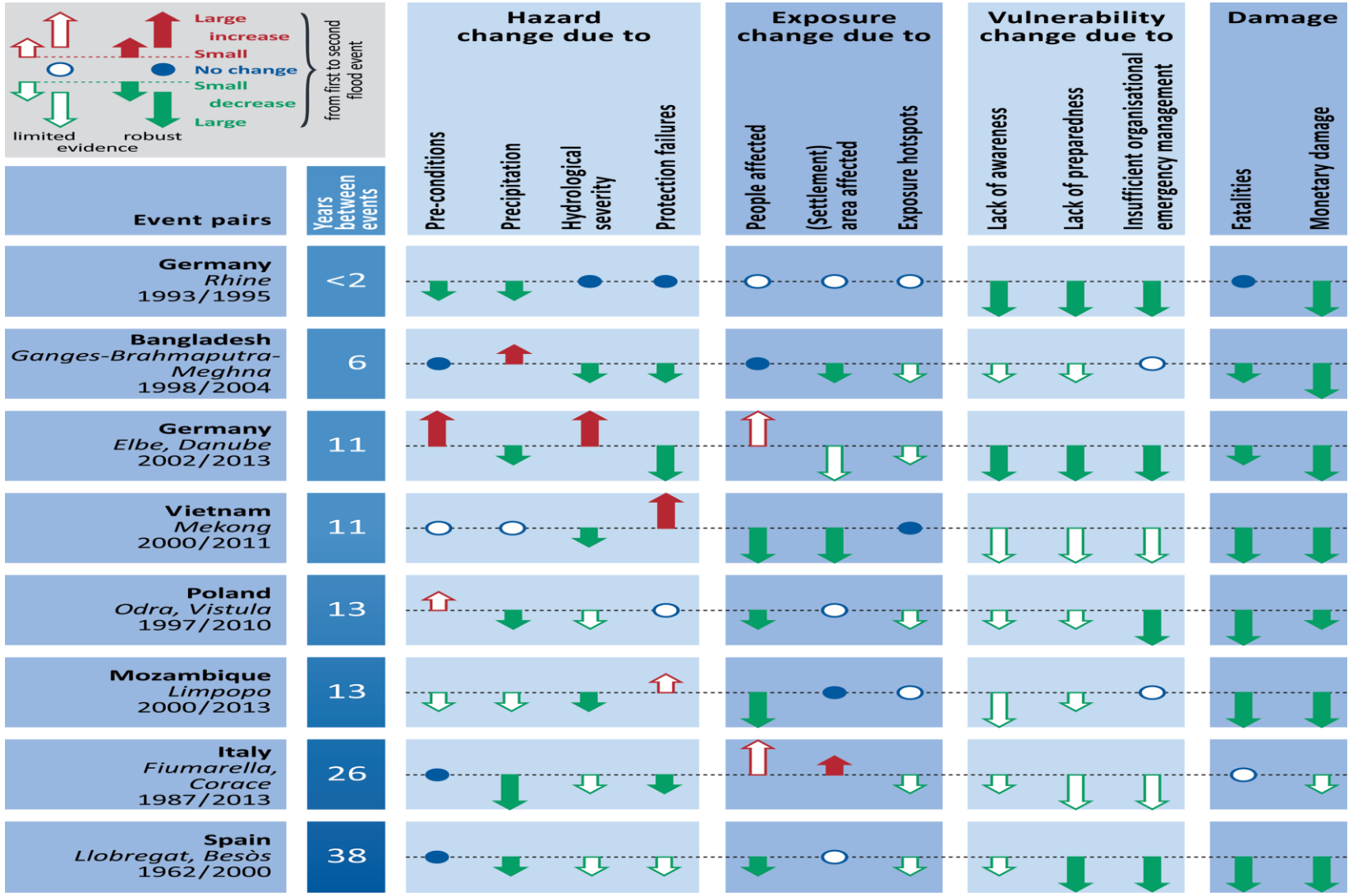
Metropoliabierta.com (blog) 09/10/2018

Metropoli (magazine) 27/07/2019

El País 27/07/2019 (newspaper)

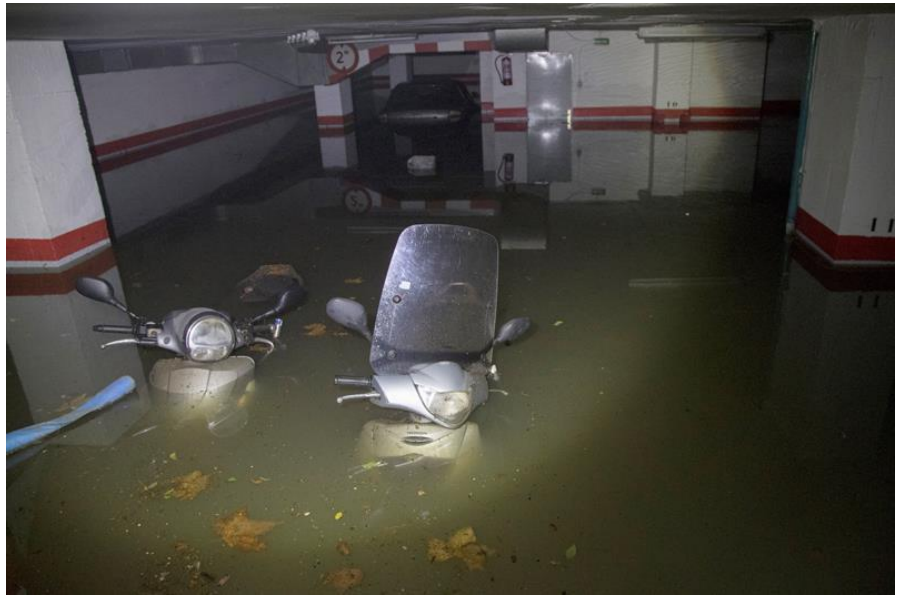
COMPARISON. Paired event approach

- The event comparison followed the paired event approach (Kreibich et al. 2017)



COMPARISON. Meteorological features

La Vanguardia (newpaper) 23/09/1995



El Economista (newpaper) 06/09/2018

	21/09/1995	06/09/2018
5- min intensity	235 mm/h	211 mm/h
I_{max} in 20 min	155,4 mm/h	169,8 mm/h
I_{max} in 60 min	78,6 mm/h	88,1 mm/h
Average water volume	376,5 m^3	457,1 m^3

COMPARISON. Impacts

21/09/1995

- The surface runoff of the streets caused a fatality in the Eixample quartier
- 2,500 calls were registered to the emergency services
- 128,000 subscribers suffered cuts of light,
- Evacuation of the citizens inhabiting two full blocks of houses
- Numerous low floors were flooded
- 33.6 Million $€_{2018}$ were paid by the national insurance company, CCS, to compensate insured losses in Barcelona.

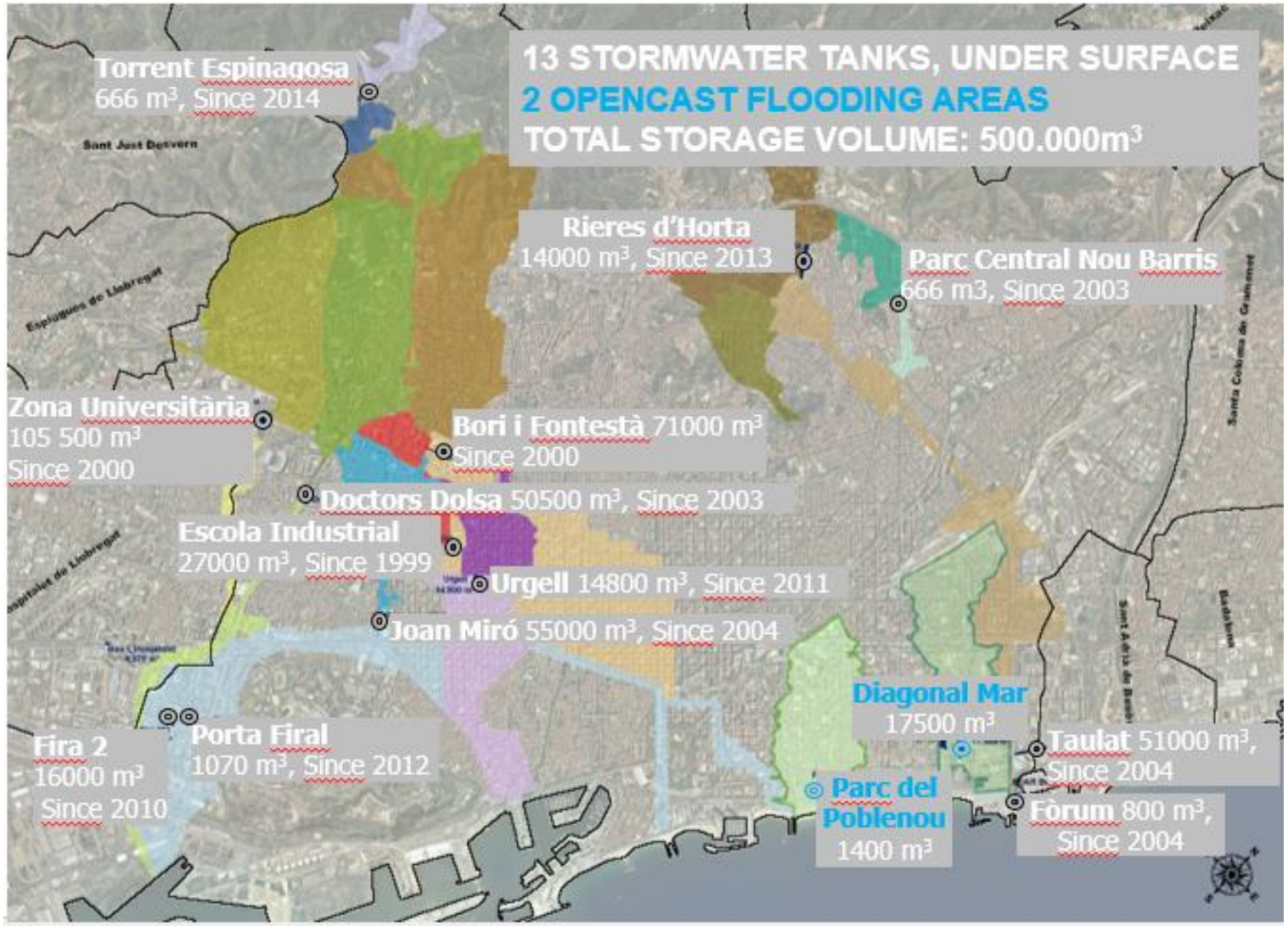
→ The consequences marked a turning point in the **development of the sewerage** in the city.

23/09/2018

- 294 emergency phone calls were received
- Emergency reasons:
  - flooding of low plants and basements
  - water leaks
  - fallen trees
- 3.5 Million $€_{2018}$ were paid by the CCS.

→ The lack of major damages proves the effectiveness of the **mitigation measures** taken in the city after the 1995 flood event, they **have diminished the vulnerability.**

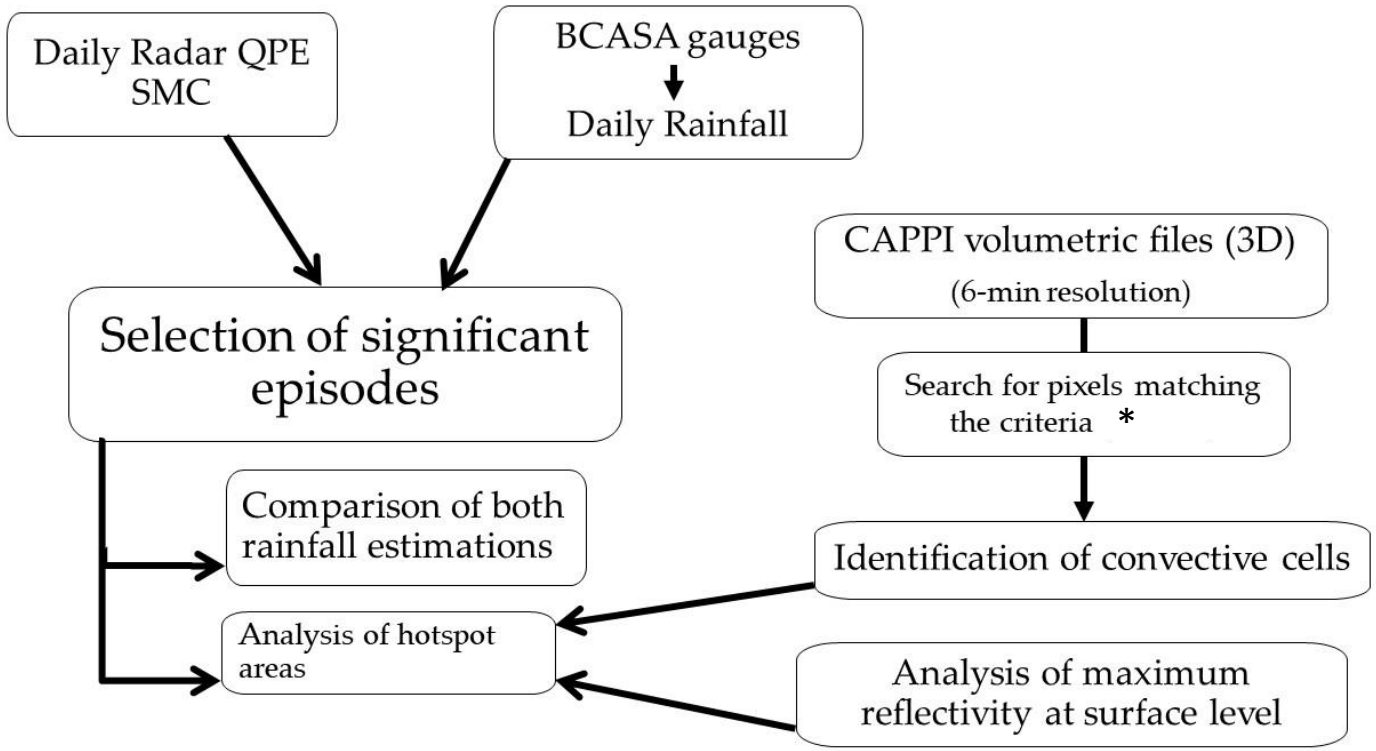
COMPARISON. Actions



One of the undergrown water retention tanks in Barcelona (Joan Miró)

https://www.bcasa.cat/

IMPROVEMENT. Analysis of convective precipitation events (2013 – 2018) in Barcelona



* Criteria:

1. Maximum reflectivity value surpassing the threshold of 35 dBZ
2. Reflectivity >= 30 dBZ above 3 km of altitude
3. At least five contiguous pixels matching the previous conditions

Objectives of the analysis:

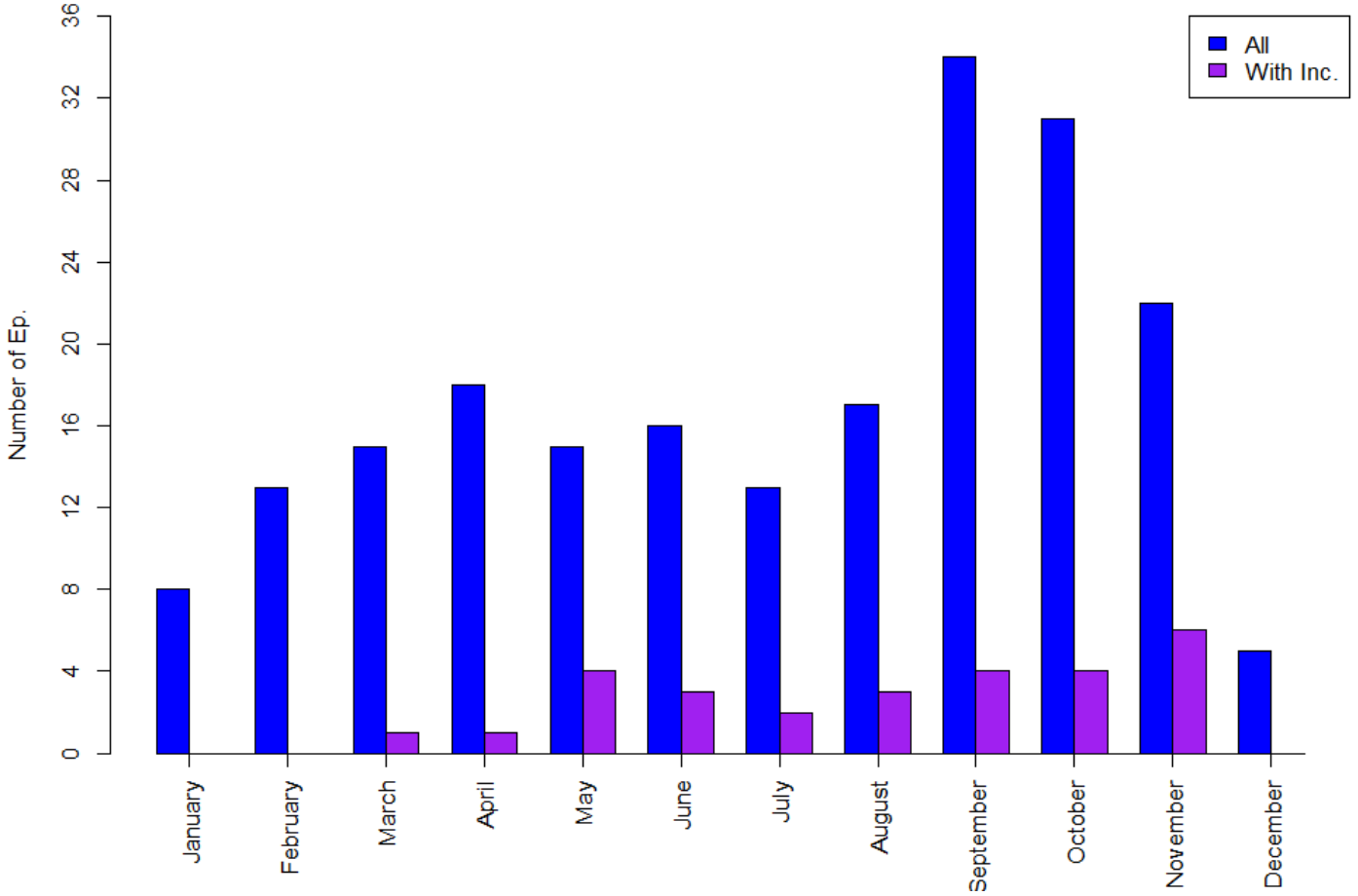
1) Build a database for significant rainfall episodes in Barcelona from 2013 to 2018

2) Analyze weather radar accuracy on computing 24h QPE locally at such variation small scale

3) Development of efficient methodology to identify and track storm cells

4) To know the urban distribution of rainfall in Barcelona. Specially if there are any host spot areas in the city.

IMPROVEMENT. Rainfall episodes data base

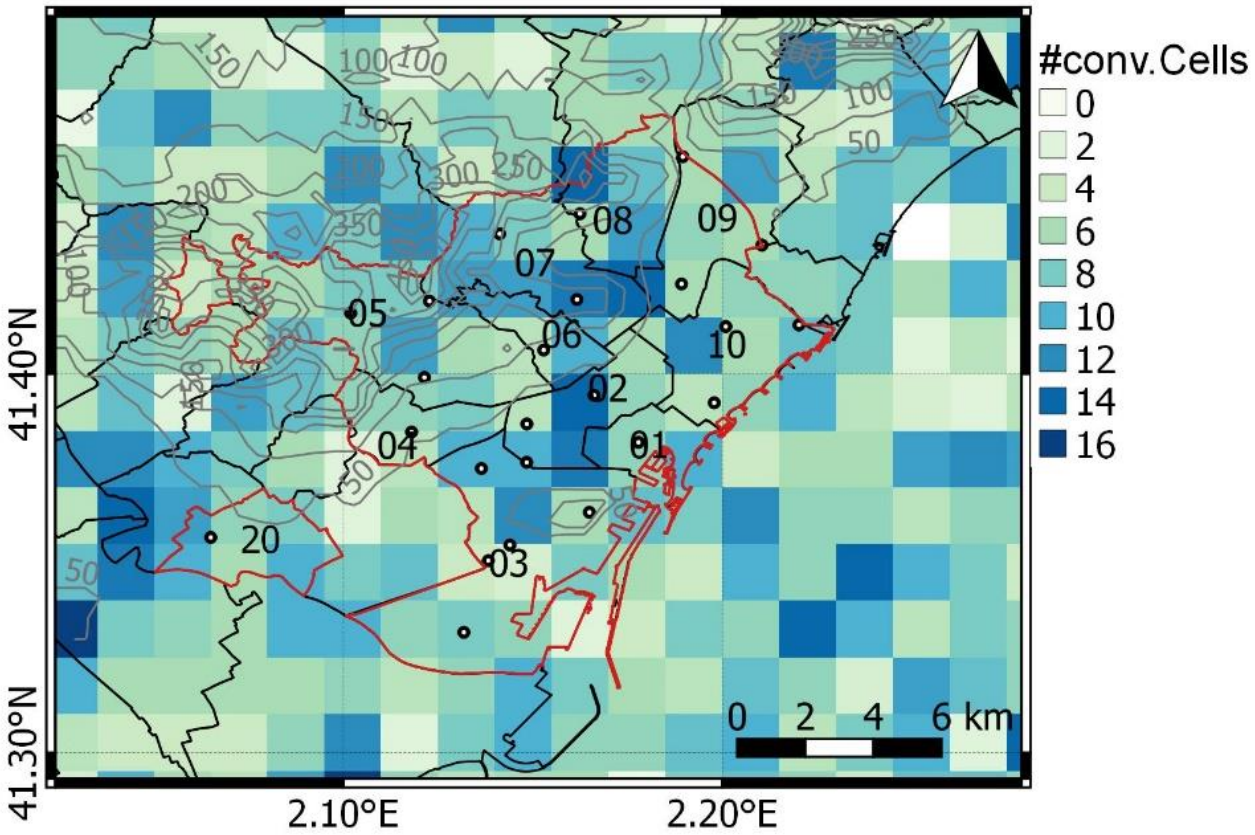


Climatology for the number of significant episodes from 2013 to of 2018

Significant rainfall episode: single day (from 00:00 UTC to 23:59 UTC) in which at least 10 mm of accumulated rain are exceeded at a given point in Barcelona

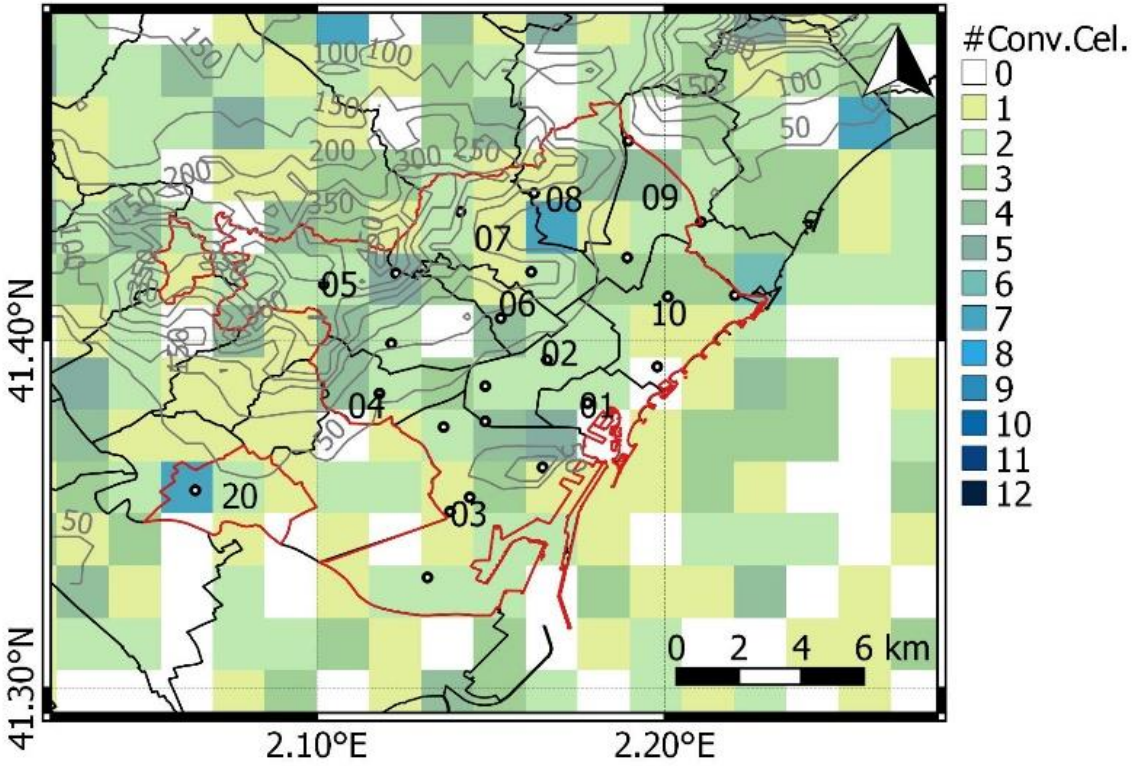
- Purple columns refer to those episode for whom there is a register of reported incidences

IMPROVEMENT. Storm nest analysis



Distribution of centroids from convective cells for significant episodes.

Distribution of centroids from storm cells on most intense episodes with reported incidents



Barcelona districts: 01 – Ciutat Vella; 02 – Eixample; 03 – Sants-Munjuïc; 04 – Les Corts; 05 – Sarrià; 06-Sant Gervasi; 07 – Horta-Guinardó; 08 - Nou Barris; 09 – Sant Andreu; 10 – Sant Martí; 20 – Cornellà del Llobregat.

CONCLUSIONS. What we have learned?

- The severe consequences from the 1995 pluvial flood event promoted an infrastructural improvement of the drainage system in Barcelona

- Although the precipitation in the 2018 pluvial flood event was heavier the impacts were fewer → The vulnerability has decreased

- In a big city as Barcelona with an increasing exposure there is still the need to improve the early warning systems to face pluvial floods

→ Greater knowledge of the most conflictive spots of the city will provide essential information for this improvement.

CONCLUSIONS. What we have learned?

- Episodes with the highest intensities mostly concentrate between summer and autumn. This directly affects the economic activity

- There are some intense rainfall episodes with few or no incidents reported. Citizen science could help to increase the information about impacts

- Some episodes with a significant impact on the city, but without large rainfall accumulations were also found. High intensity rainfall can cause damage despite its short duration

- A higher concentration of convective cells in the middle of the city is observed. This affects all the activity in the heart of the city.

- Greater concentrations of the most intense convective cells were identified on the lower side of the complex orography of Barcelona. Some of these places are considered among the most vulnerable due to the low income of their inhabitants.

THANKS FOR YOUR ATTENTION

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