May 6th 2020 / Session HS - 4.1
Flash floods and rainfall induced hydro-geomorphic hazards: from observation to forecasting and warning

Characterisation of the flood response to the Vaia storm (October 27-30, 2018) in the Eastern Italian Alps.

Mattia Zaramella[1], Lorenzo Marchi[2], Francesco Marra[3], Francesco Comiti[4], Stefano Crema[2], Mattia Marchio[5], and Marco Borga[1]

[1] Department of Land, Environment, Agriculture and Forestry, University of Padova, Legnaro, Italy
[2] CNR-IRPI, Padua, Italy
[3] Institute of Earth Sciences, The Hebrew University of Jerusalem Edmond J. Safra Campus, 91904, Jerusalem – Israel
[4] Facoltà di Scienze e Tecnologie, Università di Bolzano, Bolzano, Italy
[5] Atmospheric Physics Group - DICAM - University of Trento

OBJECTIVES

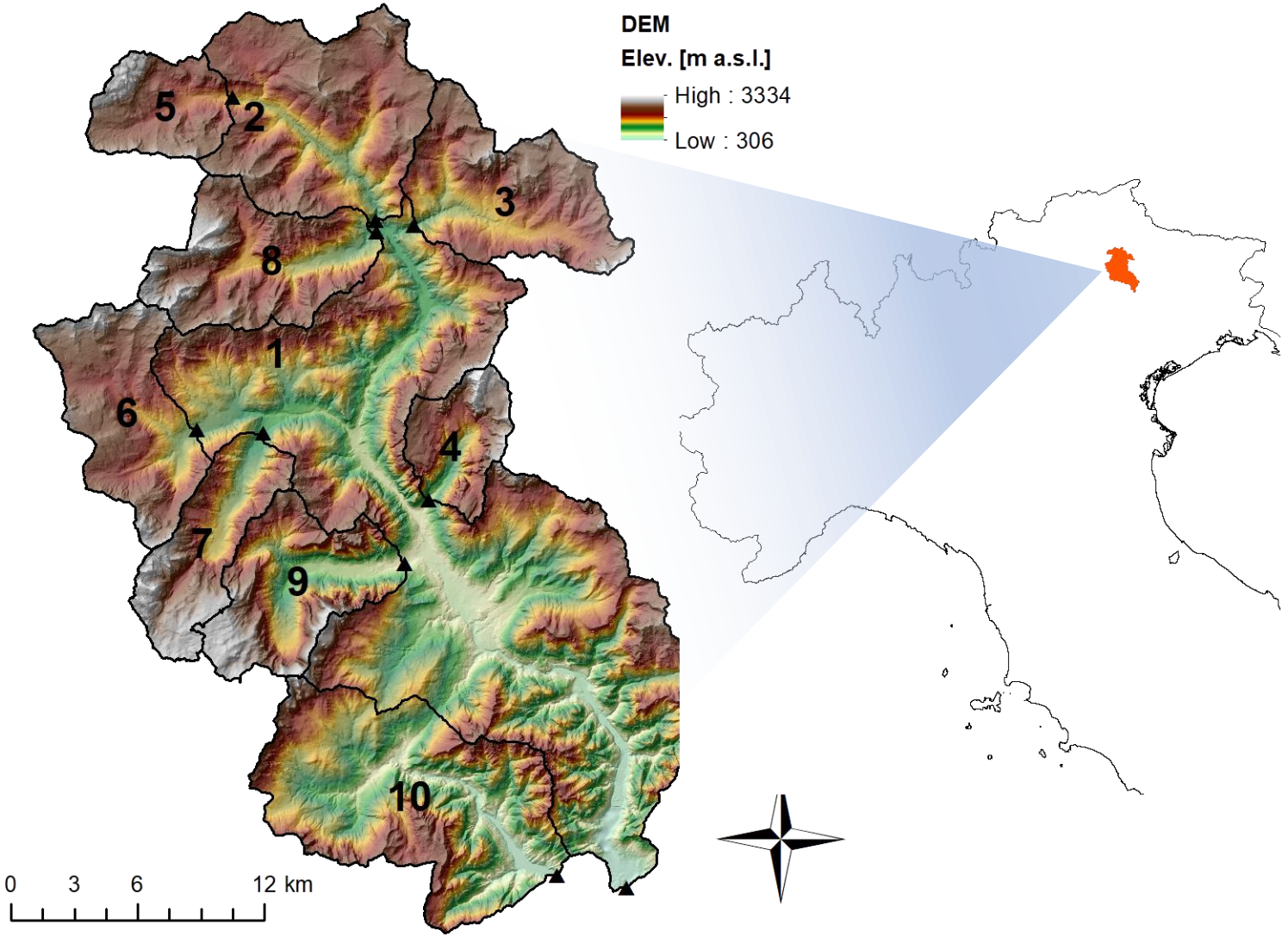
Between the morning of 27 October 2018 and the evening of 29 October 2018, heavy precipitation over the Eastern Italian Alps led to damaging flooding.

- to investigate the impact of the stationary convective bands, and
- to examine the impact of the rainfall hiatus,

  on the flood response to the storm.

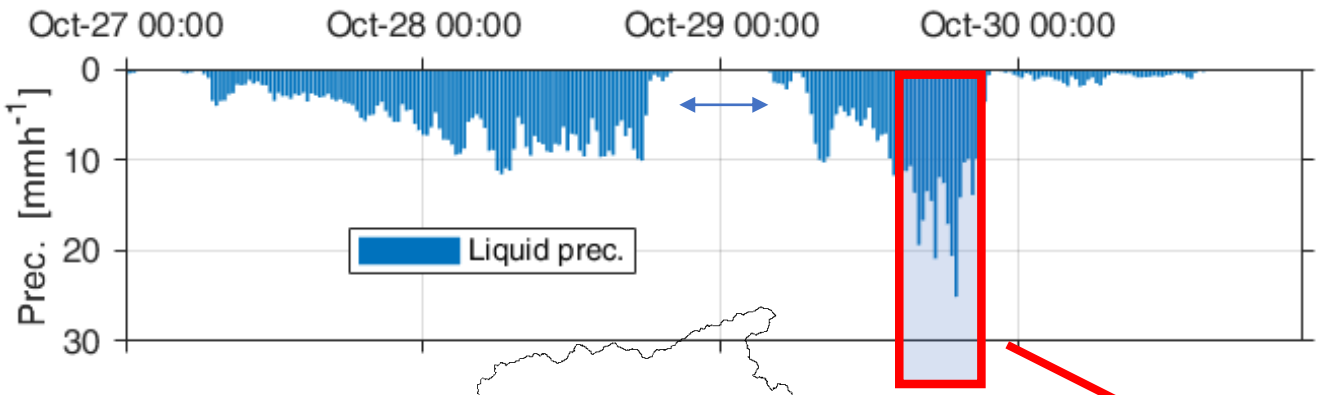
The availability of high-resolution rainfall estimates from weather radar and of dense rain gauge network data, along with flood response observations from stream gauge data and post-event surveys, enables to study the hydrometeorological and hydrological mechanisms associated with this extreme storm and the consequent flood response.

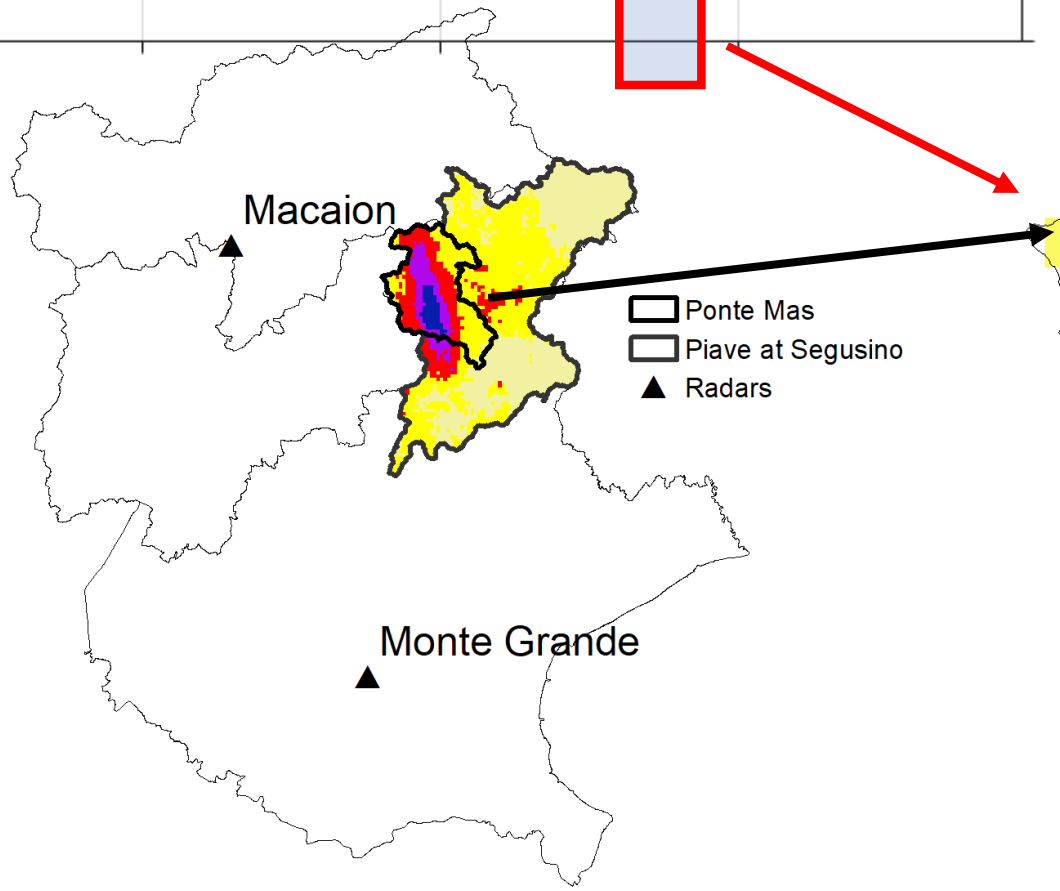
CORDEVOLE RIVER BASIN @ PONTE MAS (704 KM^2)

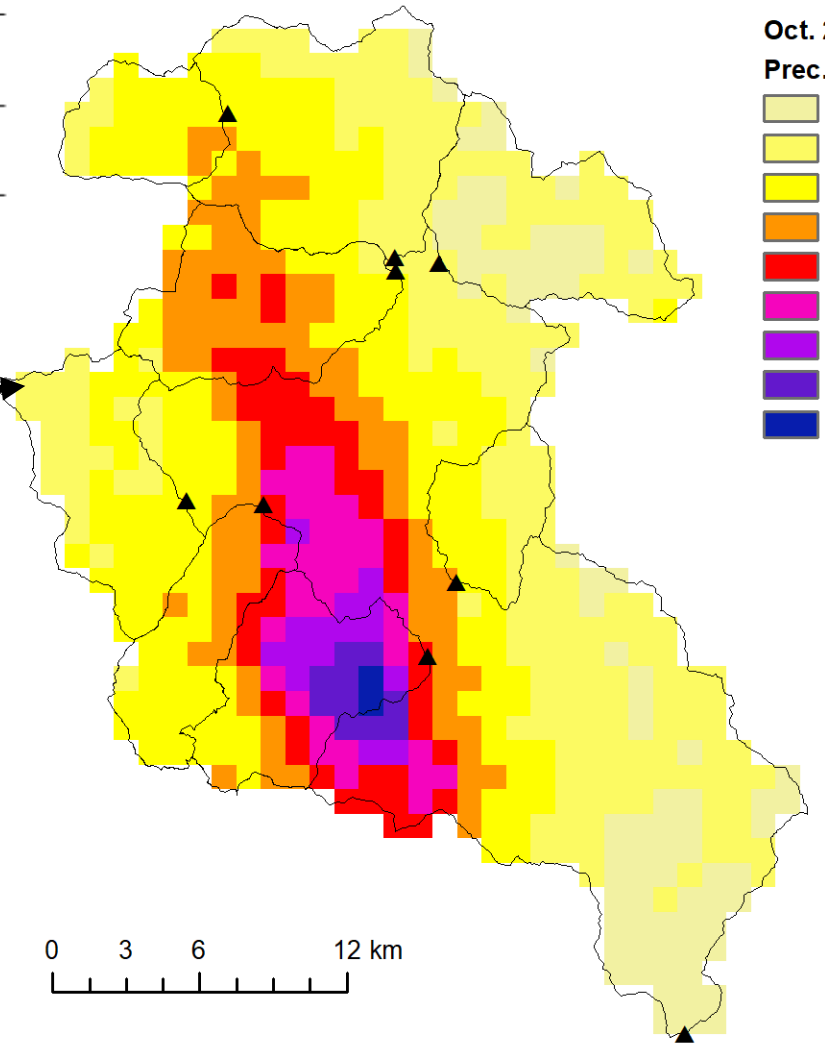


ID	Descr.	AREA [km^2]
1	Cordevole at Ponte Mas	704.49
2	Cordevole at Saviner	109.36
3	Fiorentina at Sottorovei	58.14
4	Corpassa	24.45
5	Cordevole at Renaz	27.63
6	Biois a Falcade	50.47
7	Liera at Canale d'Agordo	37.71
8	Pettorina at Saviner	54.46
9	Tegnas a Taibon	48.92
10	Mis reservoir	107.17

THE VAIA STORM – CONVECTIVE BAND/ RAINFALL HIATUS





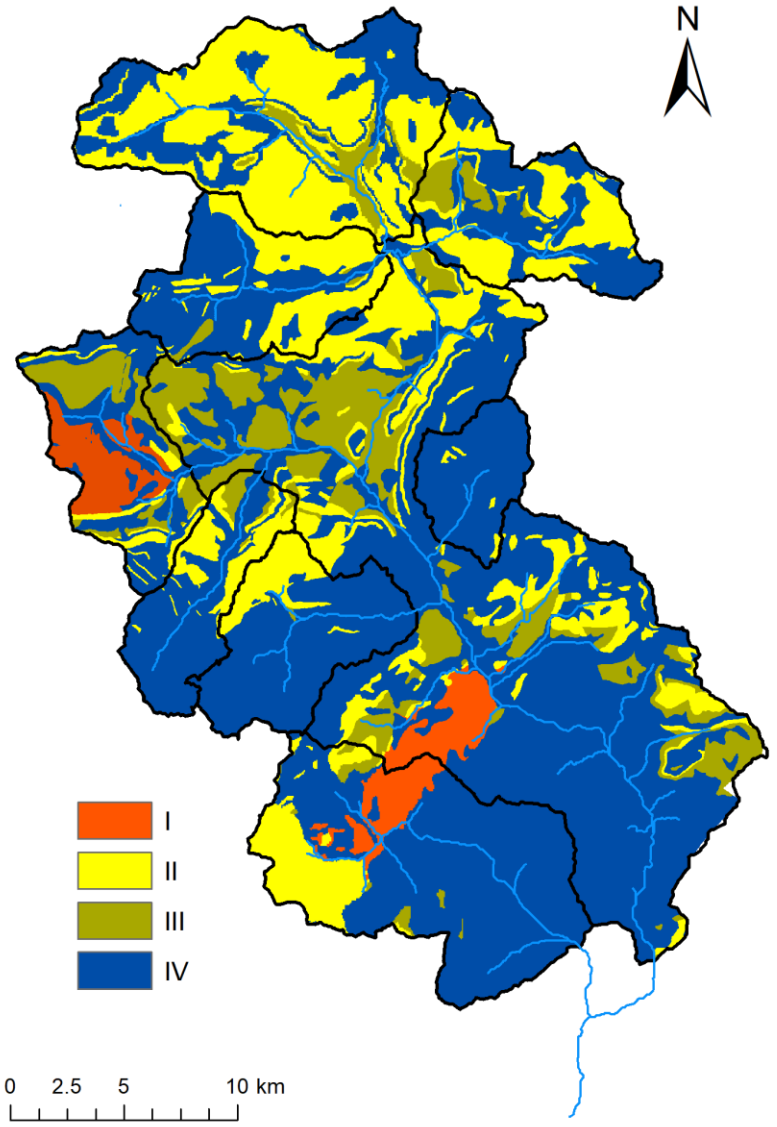


CORDEVOLE BASIN – CHARACTERIZATION OF THE GEOLOGY

Italian Dolomites, characterised by widespread karst features.
Spatial distribution of permeability:

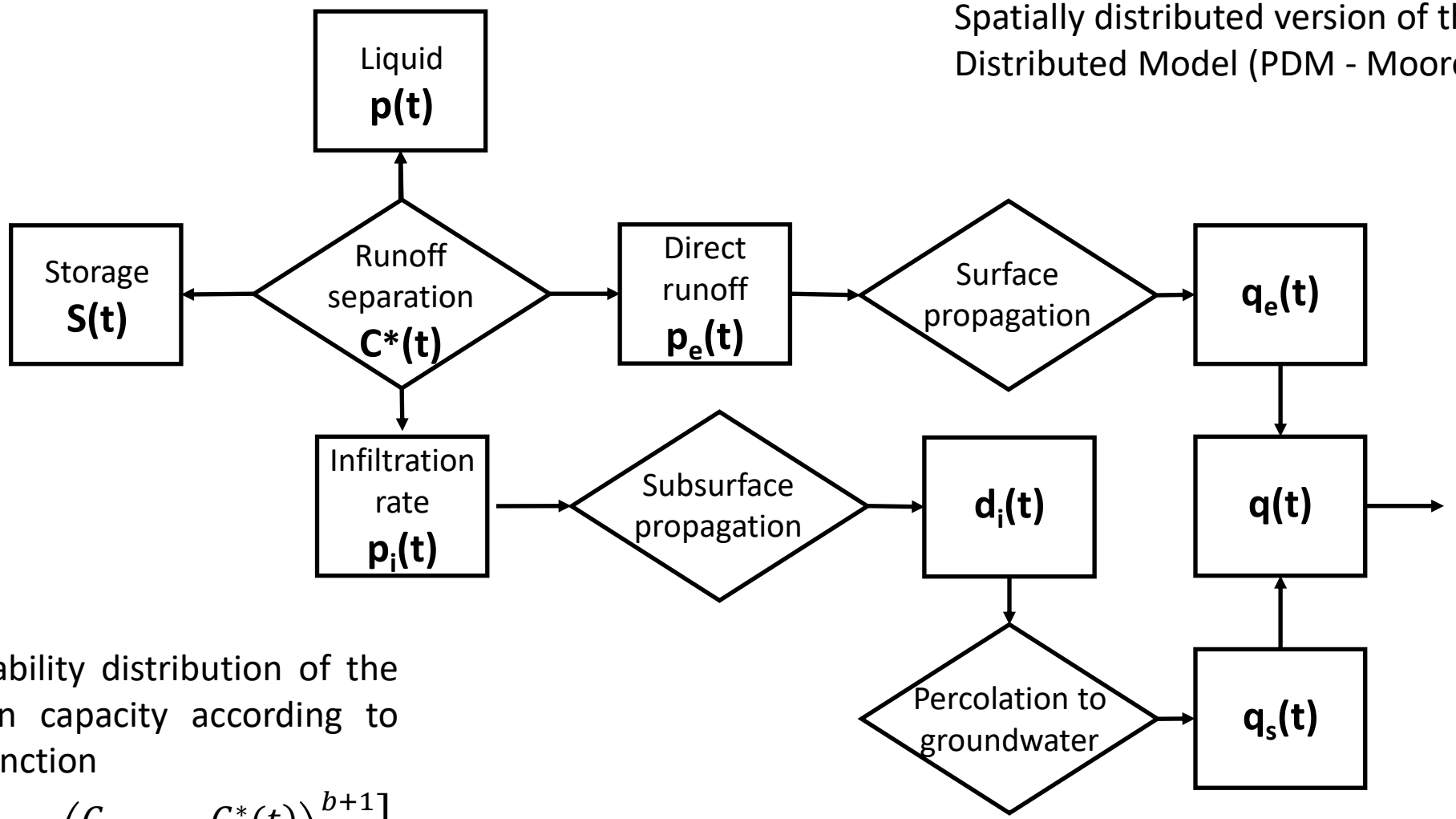
- Class I – low permeability
- Class II – medium-low permeability
- Class III – medium-high permeability
- Class IV – high permeability

Strong North-South gradient in permeability derived by geo-lithologic information



SPATIALLY DISTRIBUTED MODELLING APPROACH - KLEM

Spatially distributed version of the Probability Distributed Model (PDM - Moore, 2007)



Spatial probability distribution of the soil retention capacity according to the Pareto function

$$S(t) = \bar{C} \cdot \left[1 - \left(\frac{C_{max} - C^*(t)}{C_{max}}\right)^{b+1}\right]$$

MODELLING APPROACH

- Spatial distribution of the maximum capacity depending on geo-lithology.

$$\bar{C} = S_{max} = \frac{C_{max}}{b+1}$$

- Surface runoff propagation.

$$q_e(t) = \int_A p_e[t - \tau_{corr}(x), x]dx$$

- Groundwater percolation.

$$d_i = \frac{1}{K_r}(S(t) - S_t)^{b_r},$$

- base flow model

$$q_b = k_{gw}S_{gw}(t)^3$$

- Snowpack routine

$$f(t) = MF \cdot (T(t) - T_b)$$

$$f(t) = \left(\frac{p_l(t)}{cost} + RMF\right) \cdot (T(t) - T_c)$$

MODEL PARAMETER UNCERTAINTY ASSESSMENT - GLUE

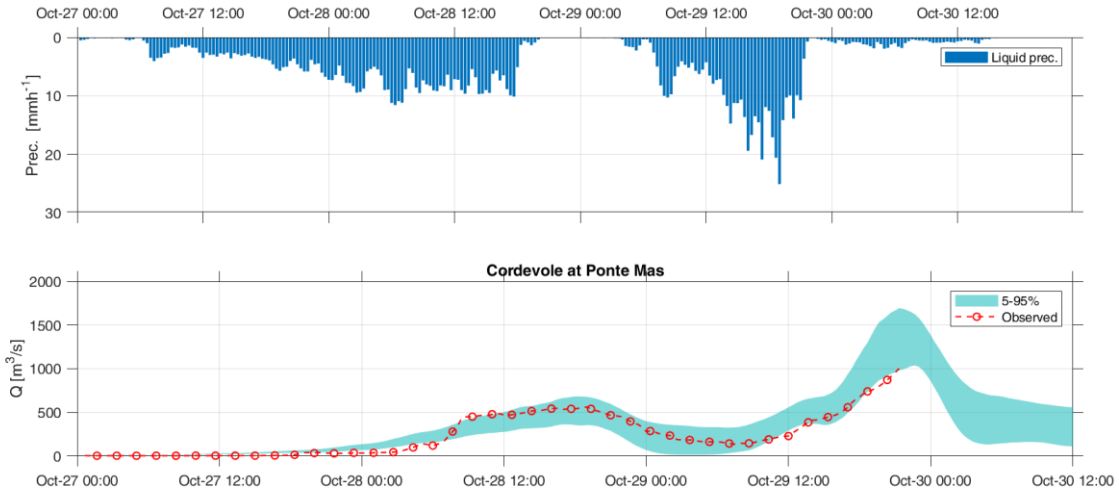
GLUE key parameters:

1. X_0, a multiplier of maximum capacity C_{max};
2. b, the exponent of the Pareto function;
3. S_t, the storage threshold triggering the groundwater recharge;
4. b_r, the groundwater recharge exponent;
5. K_r, the groundwater recharge constant.

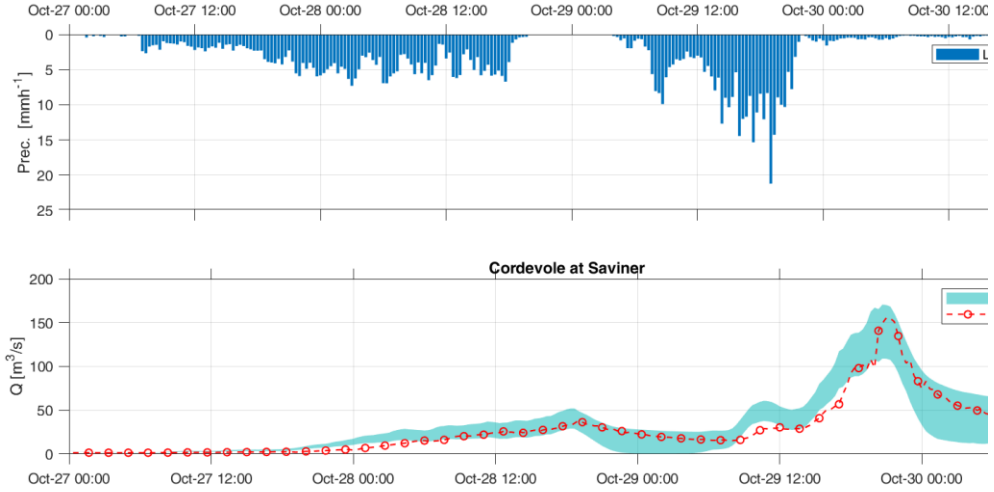
- Ensembles of 2000 simulations for 9 basins.
- Model parameters were conditioned the Cordevole at Saviner and Ponte Mas basins according to the condition of average NSE>0.70, yielding 3280 behavioural parameterizations.
- Model uncertainty is represented by the 5th and the 95th percentiles of the behavioural simulated runoff.

MODEL APPLICATION

Post – flood peak assessment:
Uncertainities of post-flood estimates according to Amponsah et al. (2016)

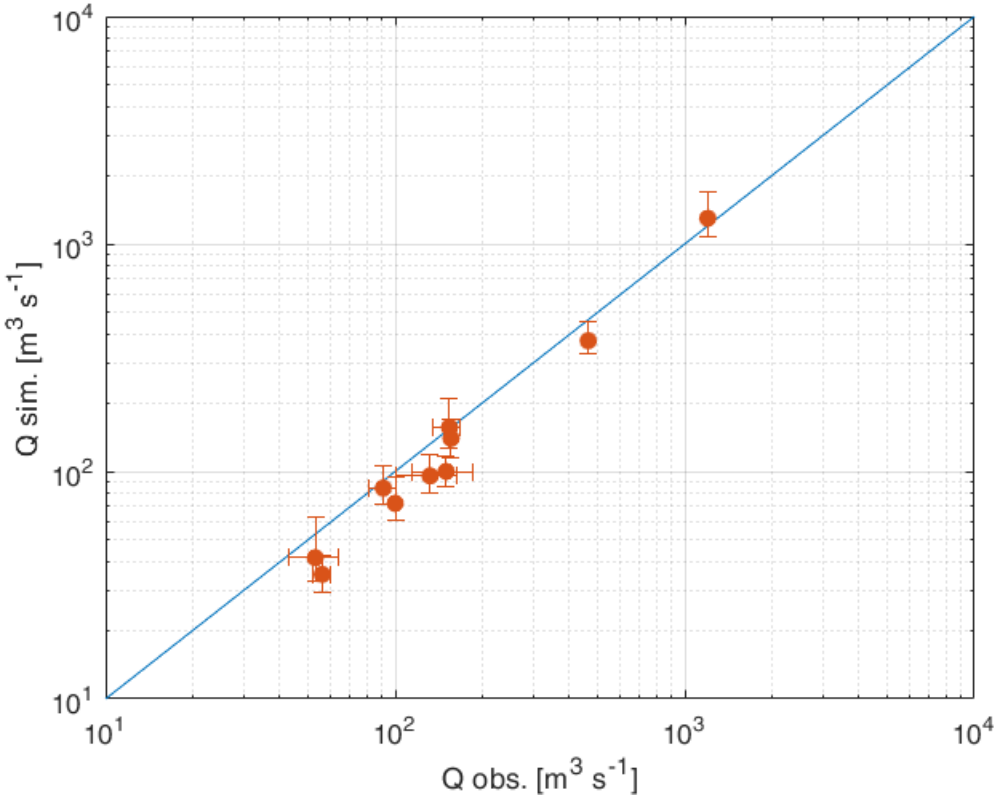


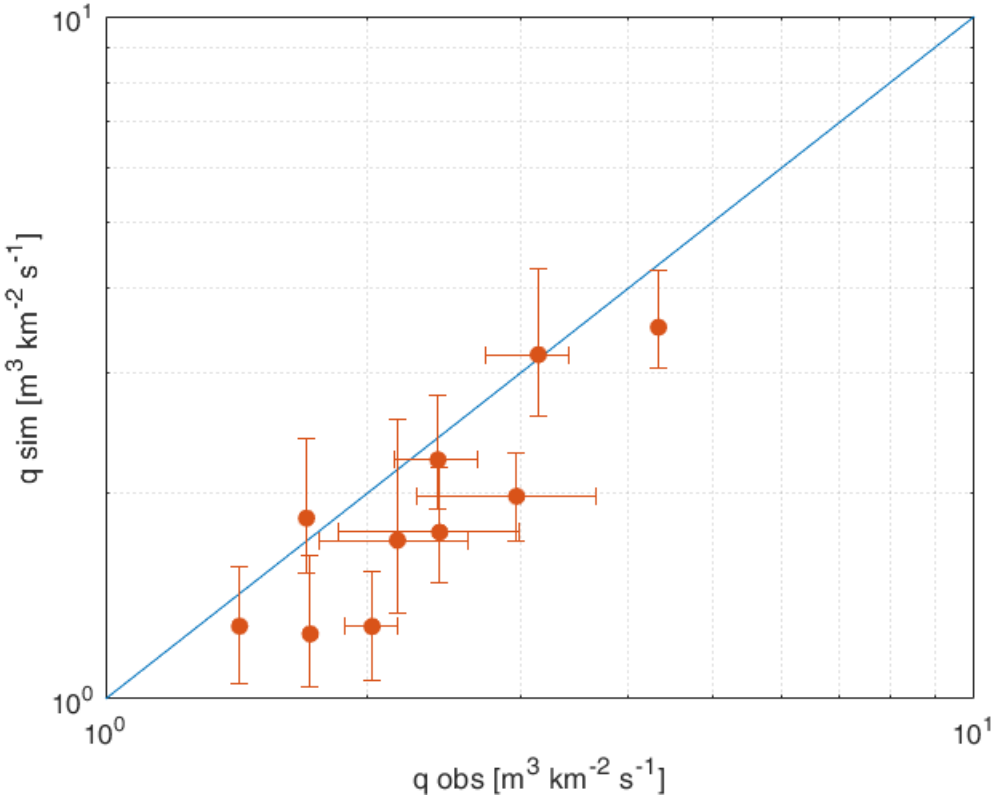
Basin	Q_{obs} [m^3/s]	A [km^2]	q_{obs} [$m^3s^{-1}km^2$]
Ponte Mas	1200	704	1.7
Pettorina	132 (101-163)	54	2.4
Fiorentina	100	58	1.8
Cordevole a Renaz	56 (52-60)	28	2.0
Cordevole a Saviner	156	110	1.4
Biois a Falcade	150 (115-185)	52	2.9
Tegnas	154 (134-167)	49	3.1
Liera	91 (81-101)	38	2.4
Corpassa	53	25	2.1



MODEL APPLICATION – SIMULATED VS OBSERVED

- Observed uncertainty: from measuring error or post-event estimate
- Simulated uncertainty: 5th-95th percentile of the simulated discharge





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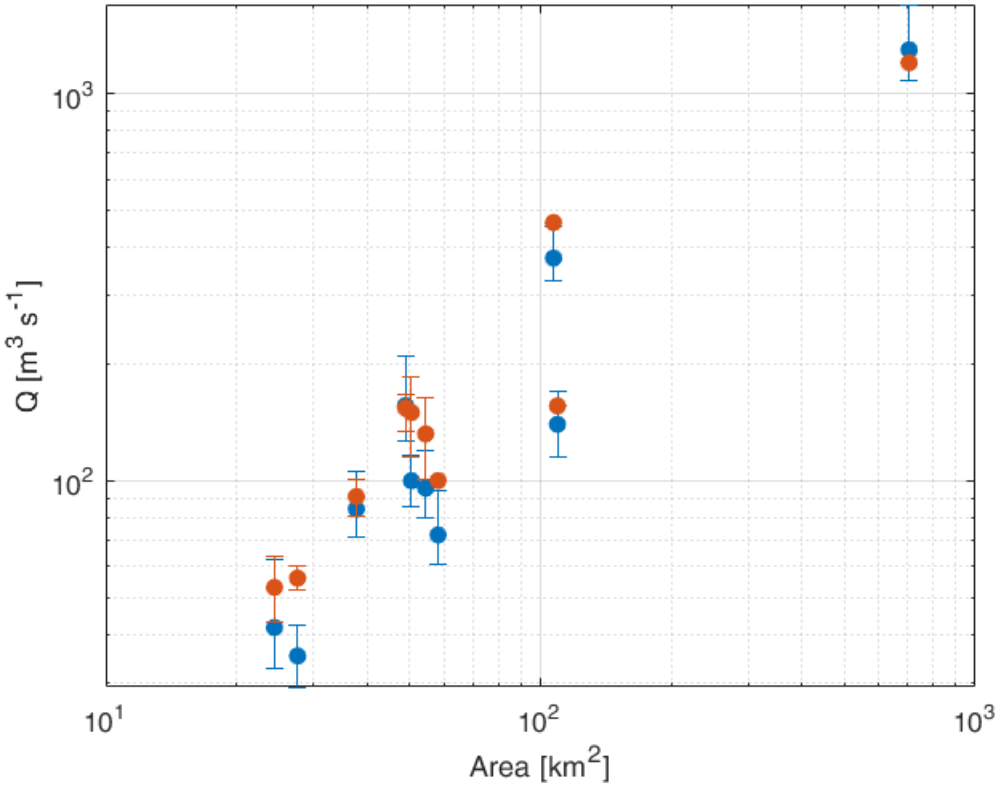
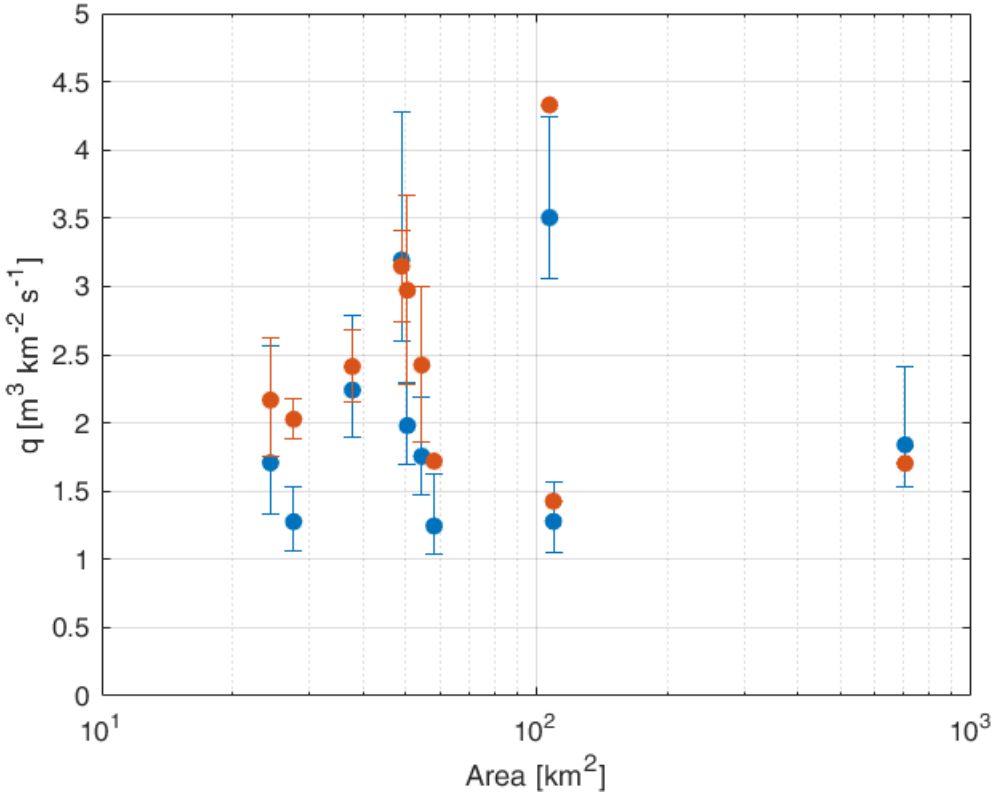
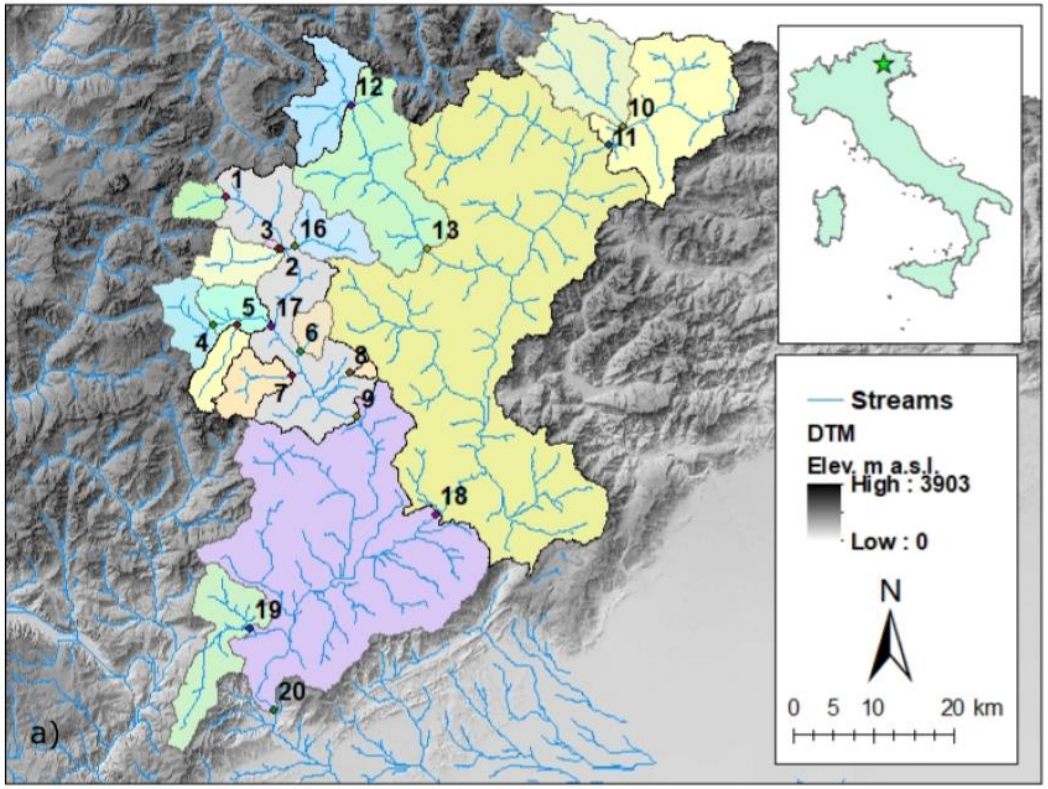
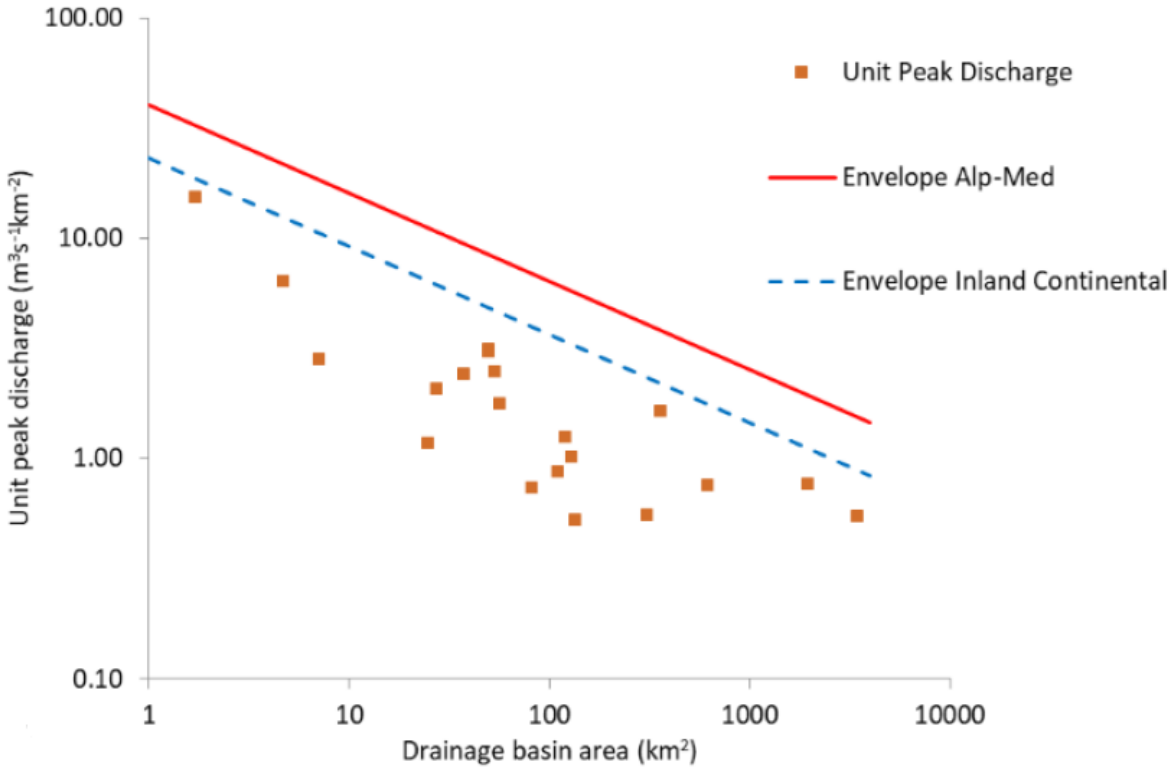


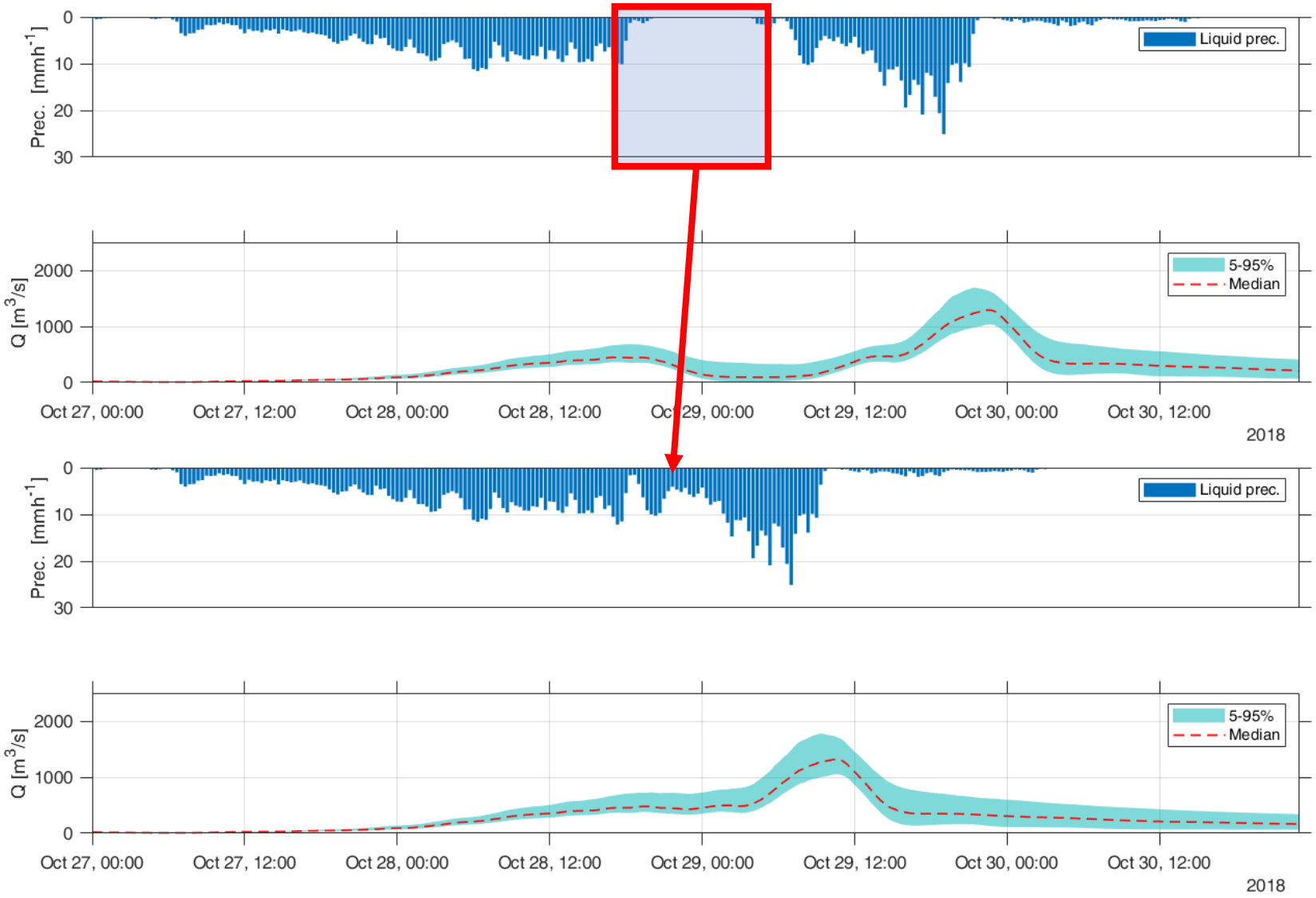


THE VAIA STORM - FLOOD RESPONSE





Role of rainfall hiatus on flood response



Cordevole at Ponte Mas:

- 12 hours anticipation of the second event
- Negligible impact on peak flow

CONCLUSIONS

- Convective band characterization (and radar observations) is crucial for the simulation of the peak flow.
- Geology-based classification provides a simple and effective representation of soil permeability and capacity.
- Flood response modelling confirms post flood peak assessment (at least for the upper Cordevole basin).
- Rainfall hiatus has a negligible impact on runoff peak.