



**POLITECNICO**  
MILANO 1863

# PROPAGATION OF PRECIPITATION MEASUREMENT BIASES INTO HYDROLOGICAL SIMULATION: A CASE STUDY

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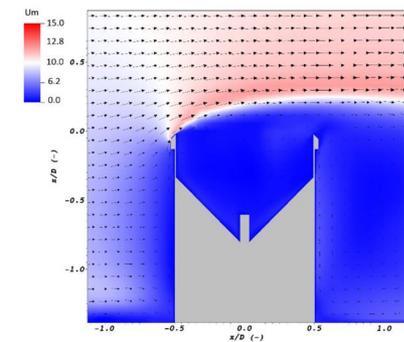


# Objectives

Investigate precipitation bias due to **instrumental issues** and **environmental factors** (wind) and their propagation into hydrological simulation



(a)

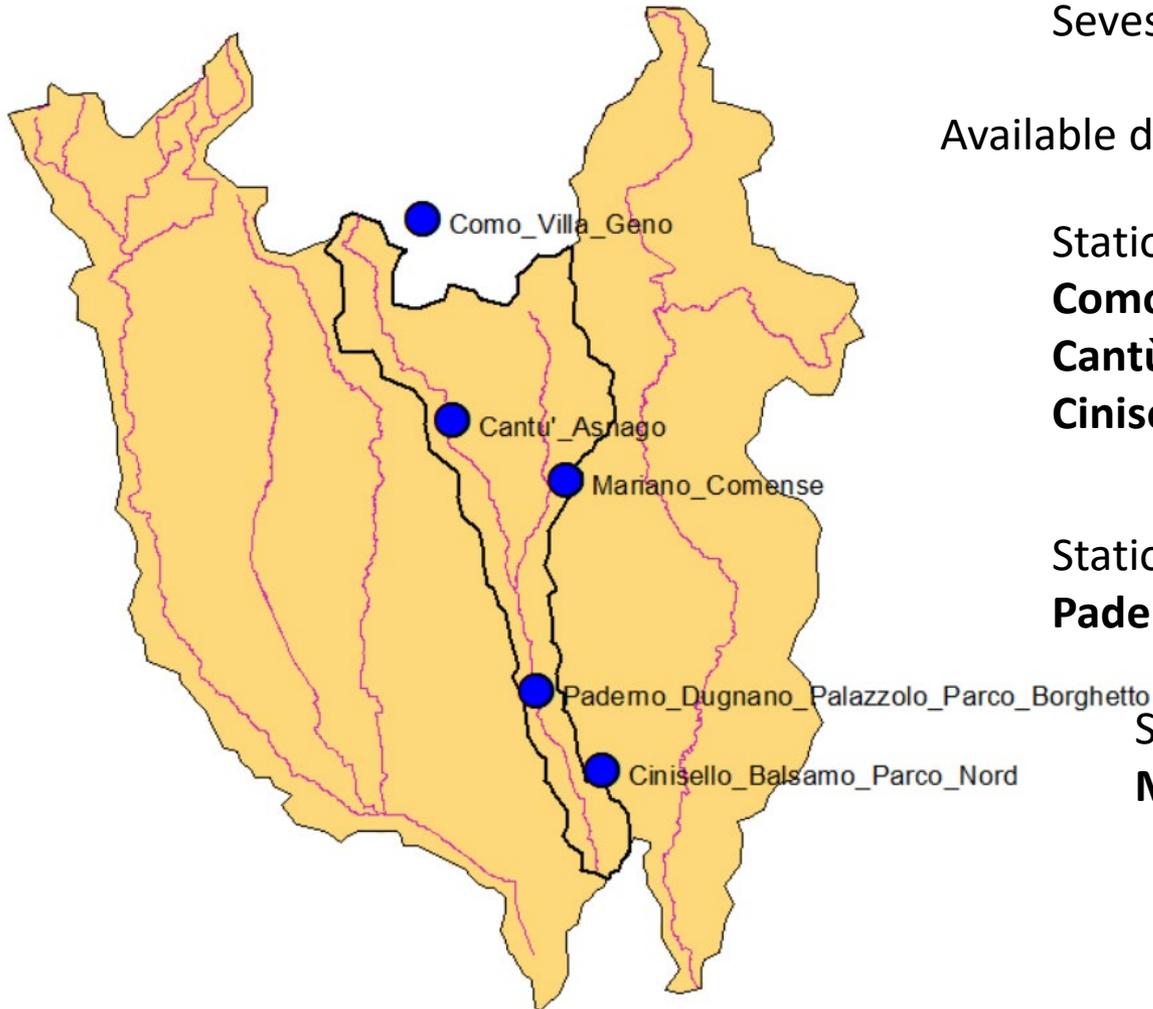


(b)

PRIN-2015 *Reconciling precipitation with runoff: the role of understated measurement biases in the modelling of hydrological processes*

Source: Caeteruccio, A. and Lanza, L. *Water* **2020**, <https://doi.org/10.3390/w12123431>

# Case study: Seveso river



Seveso basin area: 200 km<sup>2</sup>

Available data period: 2015-2018

Stations with 1 minute resolution:

**Como villa Geno**

**Cantù**

**Cinisello Balsamo**

Station with 5 minutes resolution :

**Paderno Dugnano Palazzolo**

Station with 10 minutes resolution :

**Mariano Comense**

# Filed campaigns

## Palazzolo

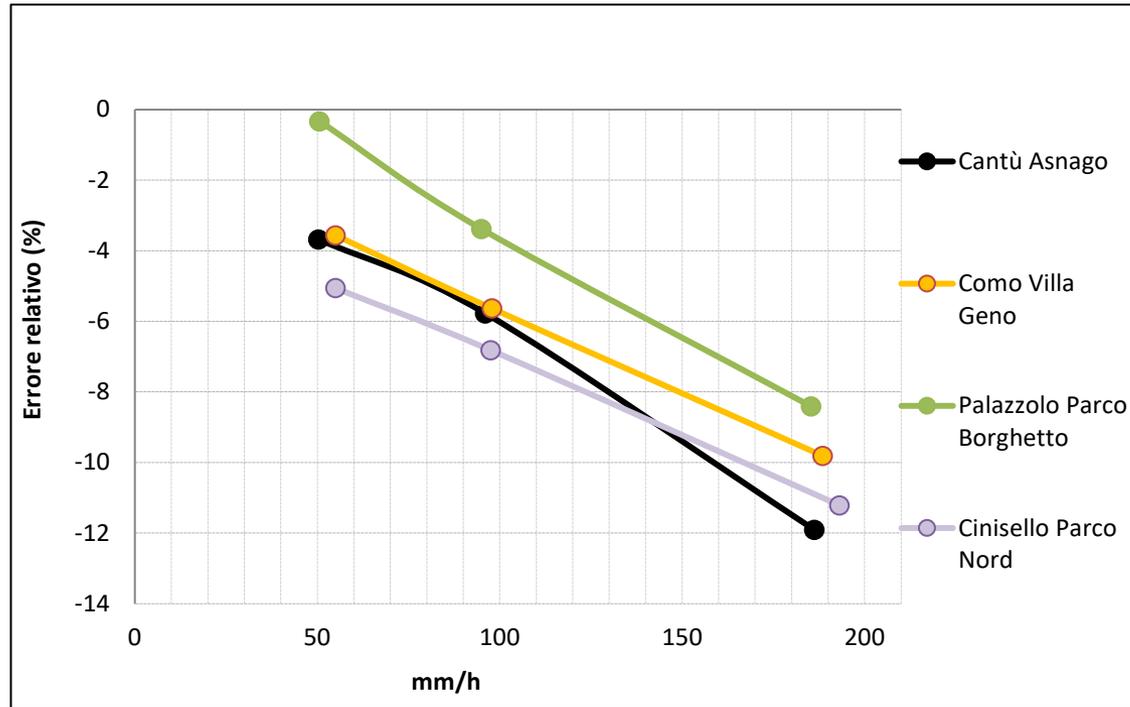


# Filed campaigns

## Palazzolo

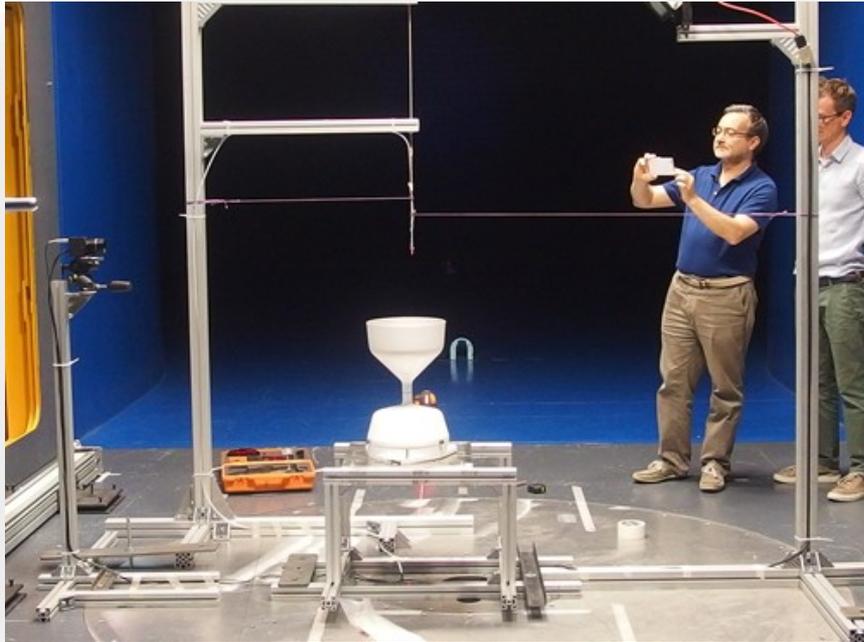


# Experimental Bias



$$e (\%) = \frac{(RI_{mis} - RI_{ref})}{RI_{ref}} 100$$

# Wind tunnel experiments



# Collection Efficiency

La curva dell'efficienza di captazione (CE), per velocità del vento ( $U_{ref}$  [m/s]) e intensità di pioggia (RI [mm/h]) fino a 18 m/s e 25 mm/h, può essere espressa come:

$$CE(U_{ref}) = y_0(RI_c) + \frac{a(RI_c)}{1 + e^{-\frac{(U_{ref} - x_0(RI_c))}{b(RI_c)}}}$$

$$X_0 = 0.5222 \ln(RI_c) + 4.4164$$

$$Y_0 = 0.0166 \ln(RI_c) + 0.8645$$

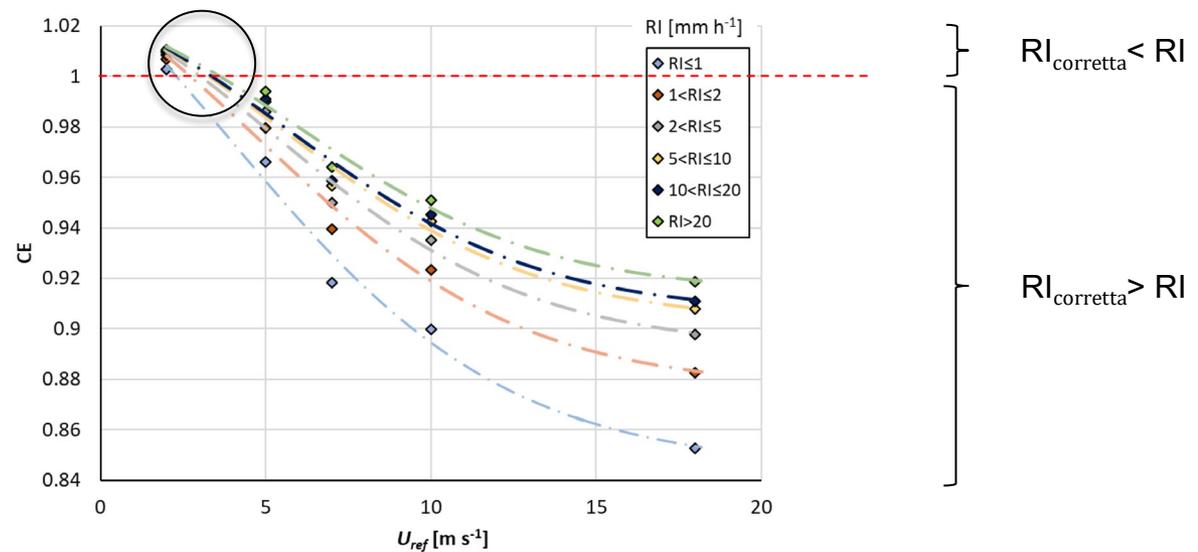
$$a = 0.2213 RI_c^{-0.17}$$

$$b = 0.1191 \ln(RI_c) - 4.1365$$

$$CE = \frac{RI}{RI_{corretta}}$$



$$RI_{corretta} = \frac{RI}{CE}$$



Cauteruccio and Lanza, 2020

# Flood event analysis

Como Villa Geno



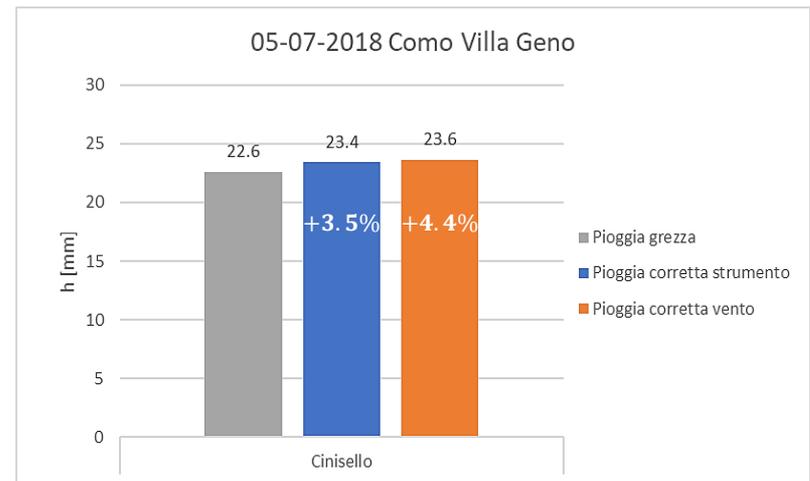
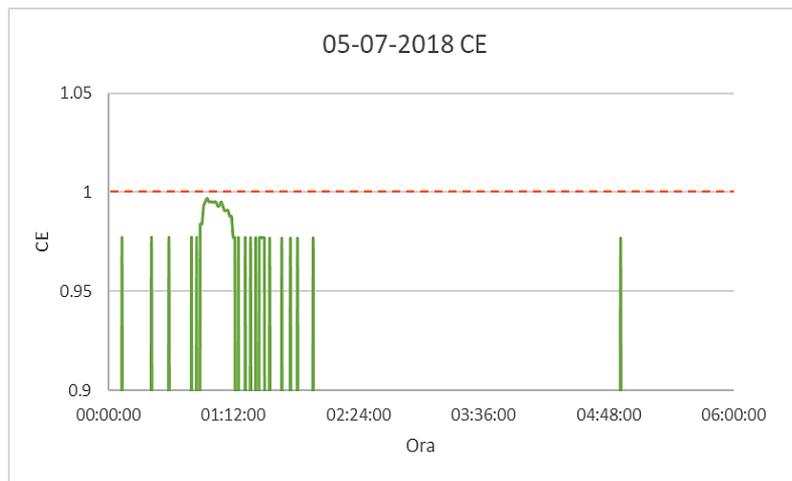
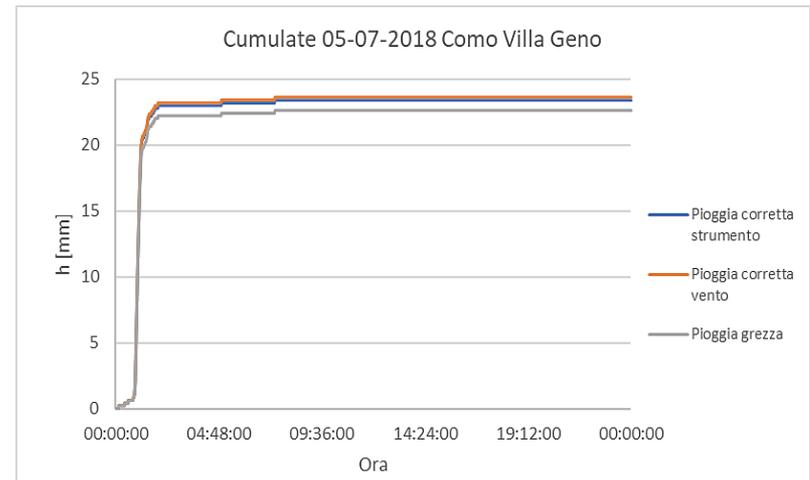
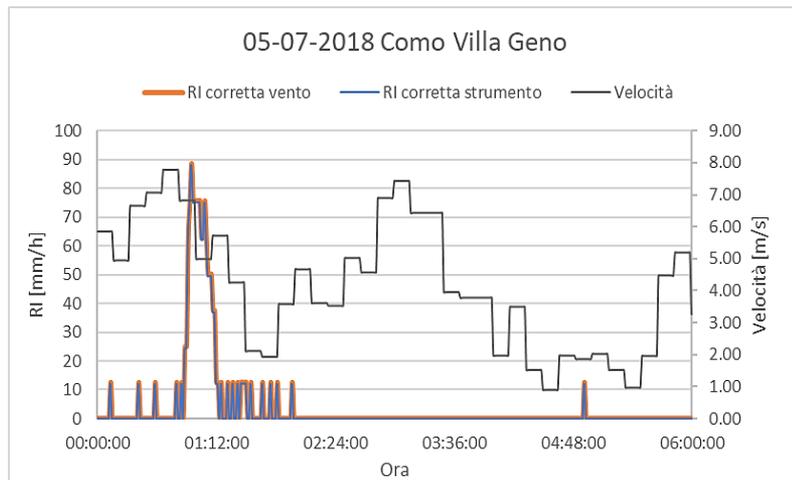
Flood events:

- 11 May 2017
- 28 June 2017
- 5 November 2017
- 5 July 2018
- 27-29 October 2018

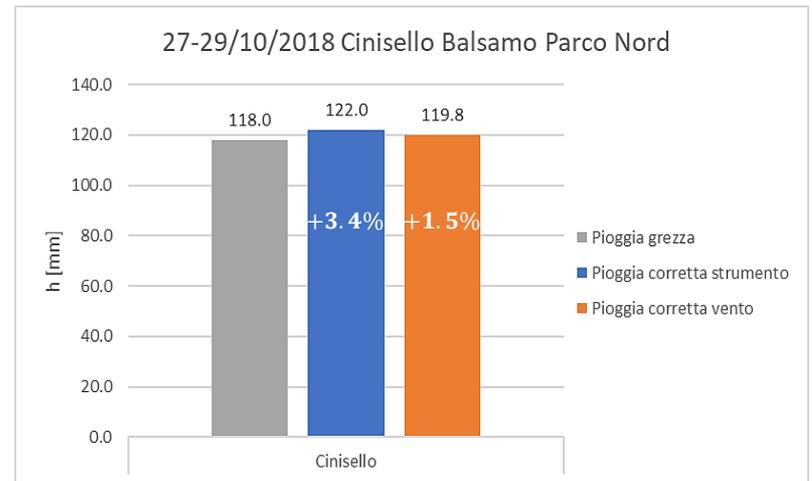
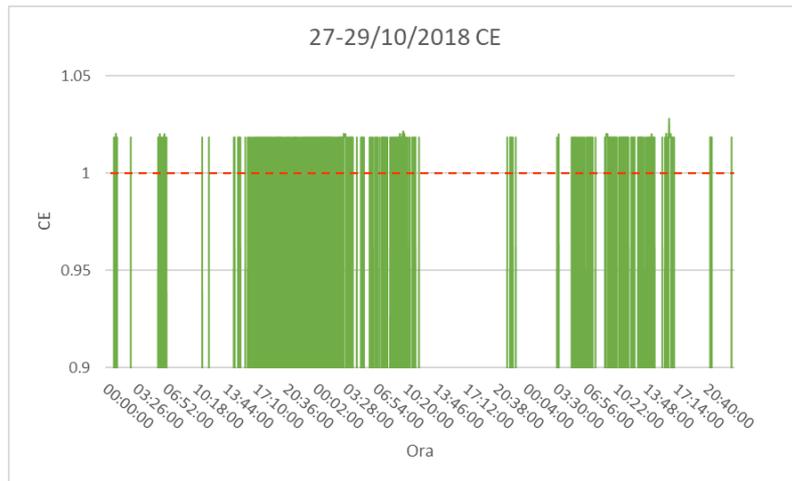
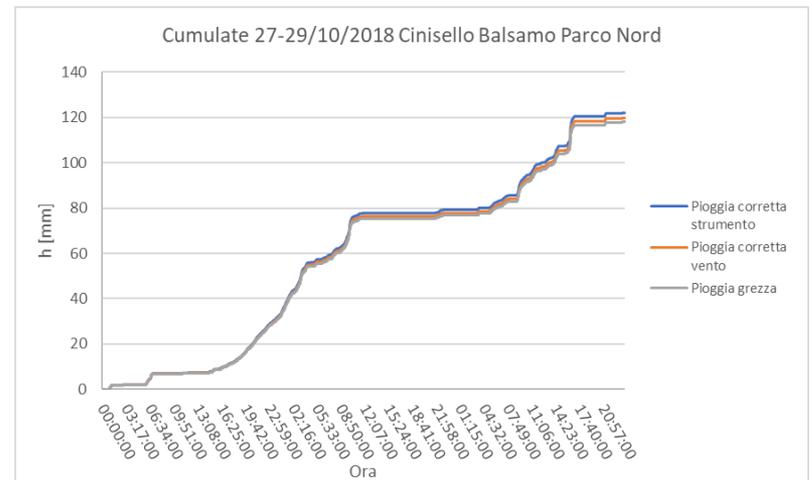
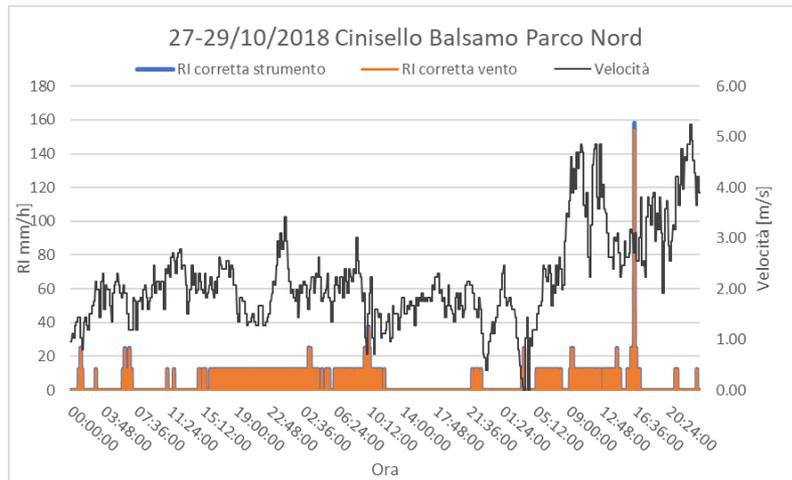


Cinisello Balsamo  
Parco Nord

# Precipitation at Como Villa Geno – Event 4

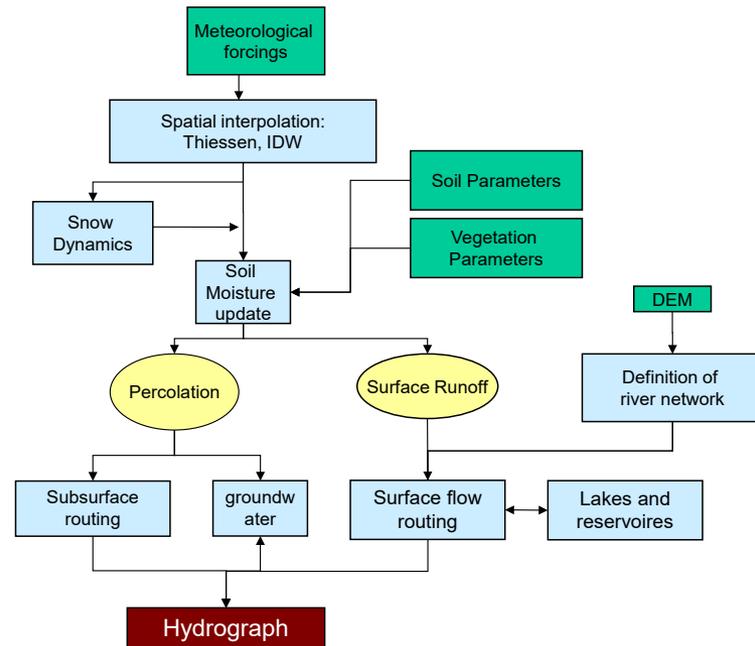


# Precipitation Cinisello Balsamo – Event 5



# Hydrological modelling

FEST-WB: Flash – flood Event – based Spatially – distributed rainfall – runoff Transformation – including Water Balance

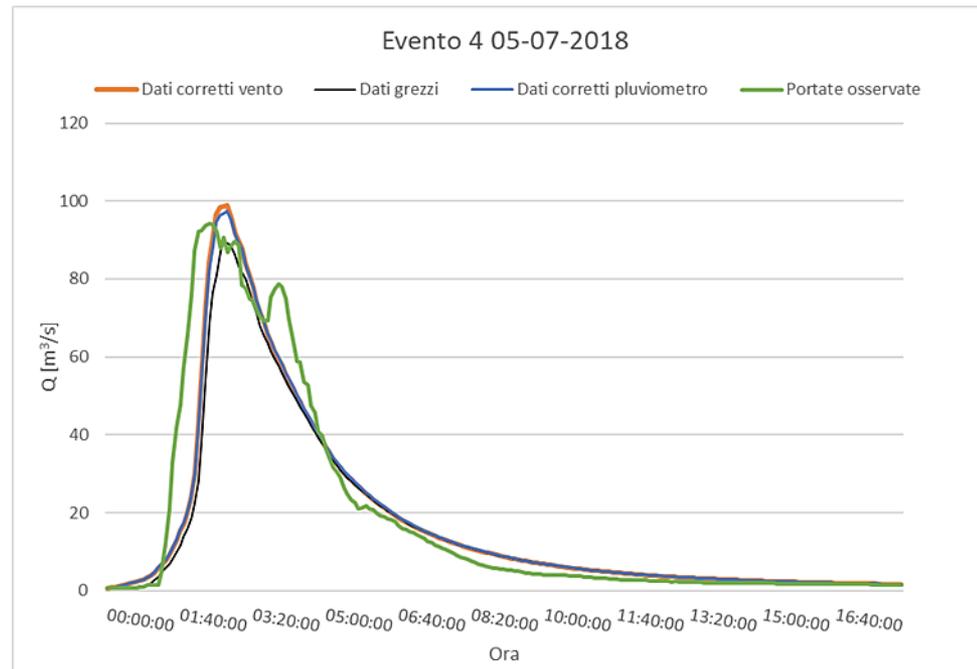


Precipitation input (mm):

- Precipitation corrected for instrumental bias
- As before plus correction for wind induced bias
- Original data as provided by ARPA Lombardia

# Flood simulation – event 4

Q max [m <sup>3</sup> /s]	Grezza	Corretta Pluviometro	Corretta vento	Osservata
	89.63	97.44 (+8.71 %)	98.82 (+10.25 %)	57.95



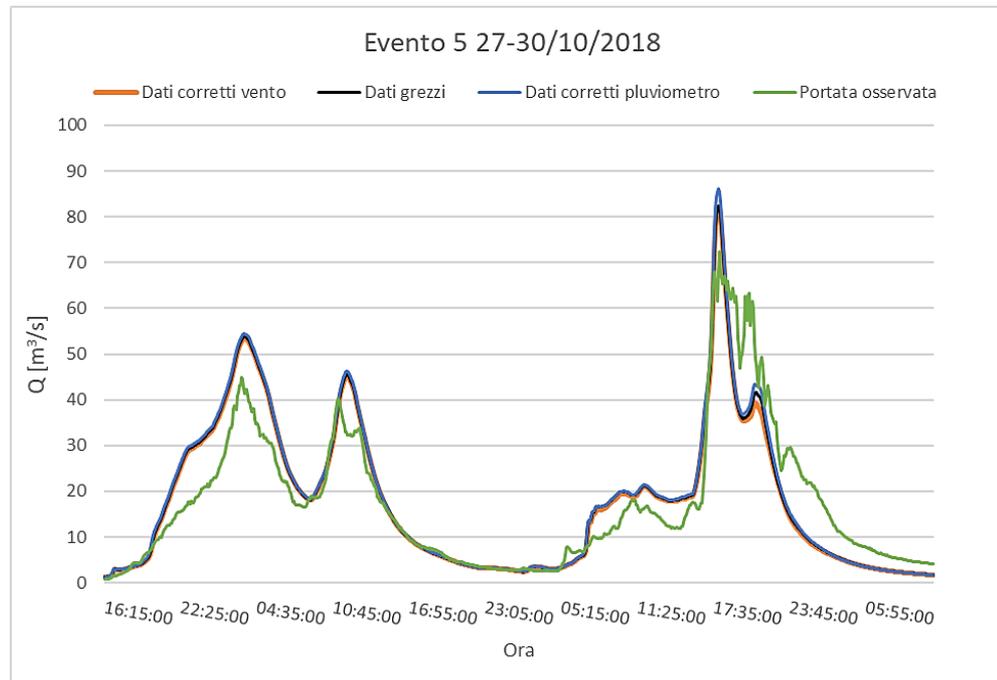
$$U_{\text{ref}} = 4 \div 8 \text{ m/s}$$

$$CE < 1$$

$$h_{\text{corretta vento}} > h_{\text{corretta pluviometro}}$$

# Flood simulation – event 5

Q max [m <sup>3</sup> /s]	Grezza	Corretta Pluviometro	Corretta vento	Osservata
	82.38	86.09 (+4.50 %)	81.19 (-1.45 %)	72.34



$U_{\text{ref}} < 4 \text{ m/s}$

$CE > 1$

$h_{\text{corretta vento}} < h_{\text{corretta pluviometro}}$

# Flood simulation results

Q max [m <sup>3</sup> /s]	Grezza	Corretta Pluviometro		Corretta Vento		Osservata
Evento 1	<b>71.36</b>	73.98	+ <b>3.67</b> %	71.95	+ <b>0.83</b> %	49.53
Evento 2	<b>65.07</b>	67.91	+ <b>4.37</b> %	63.56	- <b>2.32</b> %	81.29
Evento 3	<b>61.76</b>	62.50	+ <b>1.20</b> %	61.23	- <b>0.86</b> %	57.95
Evento 4	<b>89.63</b>	97.44	+ <b>8.71</b> %	98.82	+ <b>10.25</b> %	94.13
Evento 5	<b>82.38</b>	86.09	+ <b>4.50</b> %	81.19	- <b>1.44</b> %	72.34

# Conclusions

1. Instrumental bias in investigated stations is  $> 10\%$  for high precipitation intensity
2. Wind induced error becomes relevant and can be greater than instrumental bias for high values of wind speed
3. When wind speed is low, wind induced error compensates the instrumental bias
4. The maximum total precipitation bias, out of the five flood events considered, was  $4.4\%$  with a discharge bias of  $10.25\%$

# Thank you for your attention

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