Propagation of precipitation measurement biases into a distributed hydrological model for the Seveso river basin

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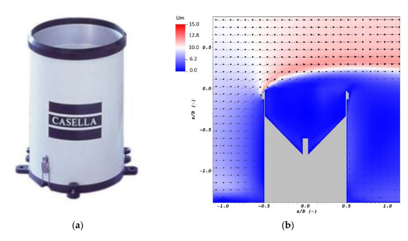
Abstract

Precipitation Measurement Biases (PMBs), arising from both instrumental and environmental factors, are largely understated and propagate through the modelling of hydrological processes at the catchment scale, affecting the results of hydrological simulation. The present work addresses the propagation of PMBs within a distributed hydrological model applied to the case study of the Seveso river basin (Italy), which experienced a number of severe floods in the last years. To this aim, four tipping bucket rain gauges were tested using a field portable calibrator in order to quantify their mechanical bias. Furthermore, the wind-induced error was considered using a numerical Collection Efficiency curve obtained from the computational fluid-dynamic simulation of cylindrical gauges. Flow discharge was simulated using a spatially distributed hydrological model. The results are compared to the discharge observations in specific section along the Seveso river and the influence of the PMBs is evaluated. Results show that, for high intensity rainfall events, when TBR measurements are subject to larger underestimation, the bias of peak discharge can be up to about 5 %. Of the same magnitude is the impact of the wind that mostly affects events with low precipitation intensity and often compensates mechanical error effect.

1 OBJECTIVES

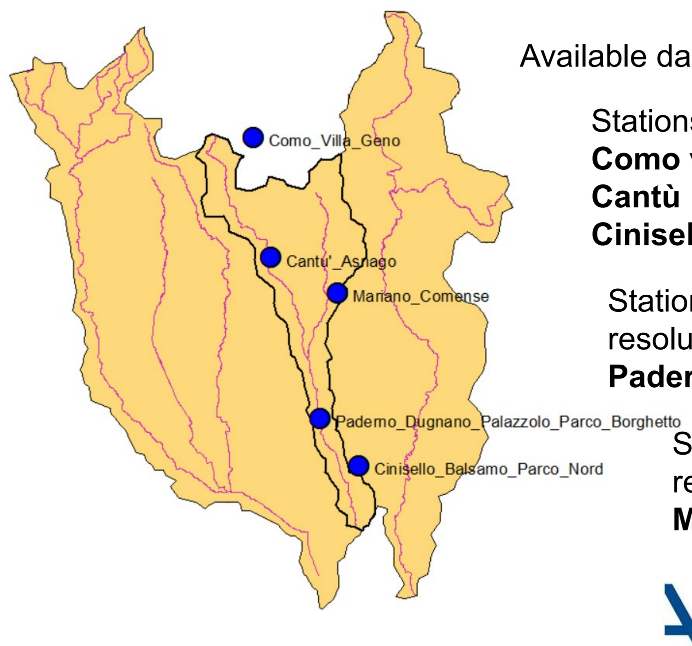
Investigate precipitation bias due to **instrumental issues** and **environmental factors** (wind) and their propagation into hydrological simulation

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



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

2 CASE STUDY



Seveso basin area: 200 km^2

Available data period: 2015-2018

Stations with 1 minute resolution:
Como villa Geno
Cantù
Cinisello Balsamo

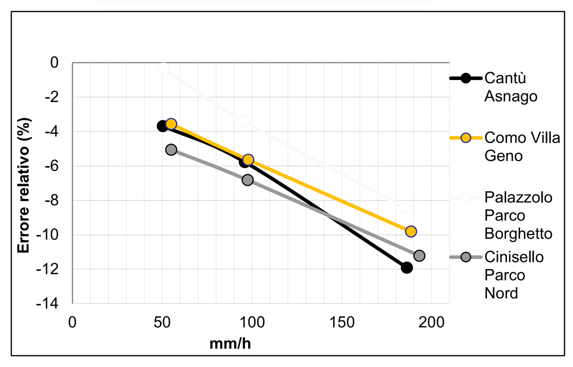
Station with 5 minutes resolution :
Paderno Dugnano Palazzolo

Station with 10 minutes resolution :
Mariano Comense

3 EXPERIMENTAL BIAS

Palazzolo

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



4 COLLECTION EFFICIENCY

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

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

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

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

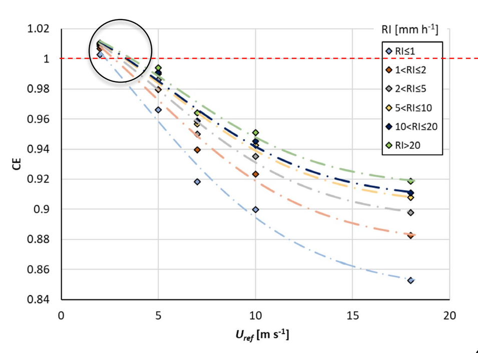
$a = 0.2213\, RI_c^{-0.17}$

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

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

↓

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



$RI_{corretta} < RI$

$RI_{corretta} > RI$

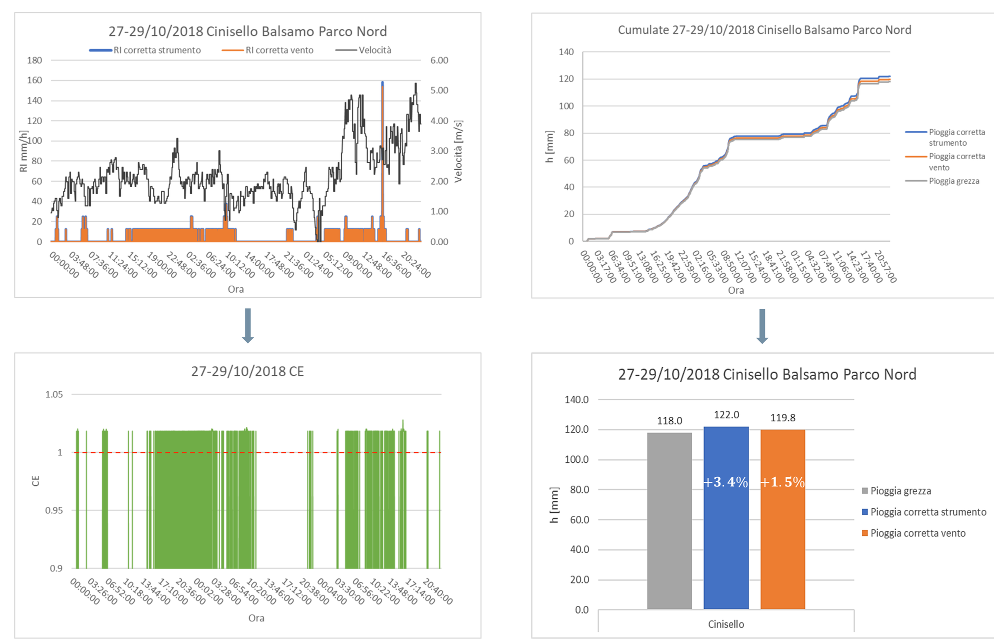
Cauteruccio and Lanza, 2020

5a PRECIPITATION ANALYSIS

Precipitation at Como Villa Geno – Event 4

5b PRECIPITATION ANALYSIS

Precipitation Cinisello Balsamo – Event 5



6a FLOOD SIMULATION

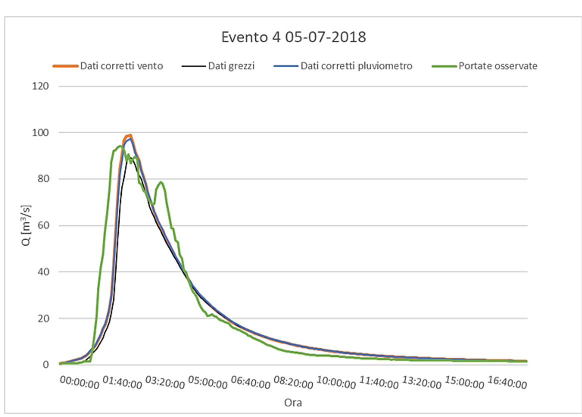
Event 4

Q max [m³/s]	Grezza	Corretta Pluviometro	Corretta vento	
	89.63	97.44 (+**8.71** %)	98.82 (+**10.25** %)	95.95

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

$CE < 1$

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



6b FLOOD SIMULATION

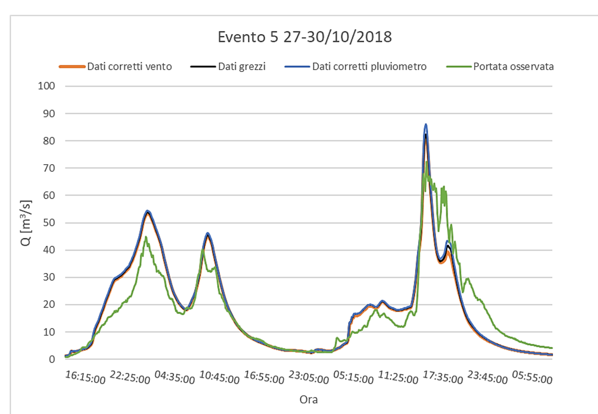
Event 5

Q max [m³/s]	Grezza	Corretta Pluviometro	Corretta vento	
	82.38	86.09 (+**4.50** %)	81.19 (-**1.45** %)	72.34

$U_{ref} < 4$ m/s

$CE > 1$

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



7 SIMULATION RESULTS

Q max [m³/s]	Grezza	Corretta Pluviometro		Corretta Vento		
Evento 1	**71.36**	73.98	+**3.67** %	71.95	+**0.83** %	49.53
Evento 2	**65.07**	67.91	+**4.37** %	63.56	−**2.32** %	81.29
Evento 3	**61.76**	62.50	+**1.20** %	61.23	−**0.86** %	57.95
Evento 4	**89.63**	97.44	+**8.71** %	98.82	+**10.25** %	94.13
Evento 5	**82.38**	86.09	+**4.50** %	81.19	−**1.44** %	72.34

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