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A case study of the propagation of precipitation measurement biases into a distributed hydrological model for the Seveso river basin

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Precipitation measurement biases arise from both instrumental and environmental factors. For Tipping Bucket Rain-gauges (TBRs) the underestimation bias due to the employed mechanical principle was largely described in the literature and considered in recent measurement quality standards (e.g. EN 17277:2019), while wind has been recognized as the main environmental factor affecting the measurement. Precipitation Measurements Biases (PMBs) 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, a highly urbanized catchment of about 200 km^2 located north of the city of Milan (Italy), which experienced a number of severe floods in the last years. To this aim, four TBRs located within the Seveso catchment area were tested using a field portable calibrator in order to quantify their mechanical bias. The calibrator allows generating constant water flows, which serve as the reference, equivalent to three rainfall rates of 50, 100 and 200 mm/h for a gauge with collecting area of 1000 cm^2. 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 fed by the ARPA Lombardia tipping bucket precipitation network and including PMBs correction techniques. 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.

References:

EN 17277:2019 - Hydrometry - Measurement requirements and classification of rainfall intensity measuring instruments, European Committee for Standardization, 2019.