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Propagation of precipitation measurement biases into the hydraulic modelling of urban drainage systems – A case study of the Parco D'Orleans sub-urban catchment

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Aim of this study is to evaluate the impact of Precipitation Measurement Biases (PMBs) of tipping-bucket rain gauges onto the hydraulic modelling of urban drainage networks. As a case study, the monitored experimental suburban catchment of Parco d'Orleans located in the University Campus of Palermo, Italy and managed since 1987 by the Department of Engineering of the University of Palermo is considered. . Two tipping-bucket rain gauges provide a good spatial coverage of the catchment area and an acoustic level gauge is installed at the outlet of the drainage network for flow mesaurements. Contemporary high temporal resolution rainfall and runoff data series are available between 1993 to 1998, and are used for the calibration of the hydraulic model in terms of roughness of the urban surfaces. The total drainage area is 12.8 ha with 68% of impervious areas; the drainage network is composed of circular and egg-shaped concrete conduits. In the present work, the sensitivity of this rapid response system to the accuracy of the rainfall input is studied, with reference to drainage failures and urban flooding issues. In order to quantify the instrumental mechanical error of the two available Tipping Bucket Rain-gauges, these were calibrated at the rain gauge laboratory of the WMO Lead Centre on Precipitation Intensity "B. Castelli" following the procedure described in the recent EN 17277:2019 standard on precipitation measurements. For each gauge a calibration curve was provided in order to quantify the measurement bias and the associated calibration uncertainty.

For rainfall-runoff transformation in the urban drainage system, a conceptual model for urban catchment, which incorporates semi-distributed modelling concepts has been used. The urban basin is divided in external sub-catchments connected to the drainage network. Each external sub-catchment is modelled as two separate conceptual linear elements, a reservoir and a channel, one for the pervious part, the other for the impervious part of the investigated area. The drainage network is schematized as a cascade of non-linear cells and the flood routing is simplified in the form of kinematic wave and represented as a flux transfer between adjacent cells. The sensitivity of this rapid response system to the accuracy of the rainfall input has been studied with reference to drainage failures and urban flooding issues.

To examine the effects due to PMBs on the catchment response, a number of simulations were carried out using raw rainfall data and corrected data obtained after the application of the calibration curve for each rain gauge. Results, expressed in terms of comparisons between the hydrographs at catchment outlet, show a significant influence of the PMB on the peak flow and the total hydrograph volume.