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Effect of the spatiotemporal variability of rainfall inputs in water quality integrated catchment modelling for dissolved oxygen concentrations

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Maintaining water quality standards in highly urbanised hydrological catchments is a worldwide challenge. Water management authorities struggle to cope with changing climate and an increase in pollution pressures. Water quality modelling has been used as a decision support tool for investment and regulatory developments. This approach led to the development of integrated catchment models (ICM), which account for the link between the urban/rural hydrology and the in-river pollutant dynamics. In the modelled system, rainfall triggers the drainage systems of urban areas scattered along a river. When flow exceeds the sewer infrastructure capacity, untreated wastewater enters the natural system by combined sewer overflows. This results in a degradation of the river water quality, depending on the magnitude of the emission and river conditions. Thus, being capable of representing these dynamics in the modelling process is key for a correct assessment of the water quality. In many urbanised hydrological systems the distances between draining sewer infrastructures go beyond the de-correlation length of rainfall processes, especially, for convective summer storms. Hence, spatial and temporal scales of selected rainfall inputs are expected to affect water quality dynamics. The objective of this work is to evaluate how the use of rainfall data from different sources and with different space-time characteristics affects modelled output concentrations of dissolved oxygen in a simplified ICM. The study area is located at the Dommel, a relatively small and sensitive river flowing through the city of Eindhoven (The Netherlands). This river stretch receives the discharge of the 750,000 p.e. WWTP of Eindhoven and from over 200 combined sewer overflows scattered along its length. A pseudo-distributed water quality model has been developed in WEST (mikedhi.com); this is a lumped-physically based model that accounts for urban drainage processes, WWTP and river dynamics for several pollutant typologies. Different rainfall products are tested: 1) Block kriging of a single reliable rain gauge, 2) Block kriging product from a network of 13 rain gauges and, 3) Universal block kriging with 13 rain gauges and KNMI weather radar estimates as a covariate. Different temporal accumulation levels are compared ranging from 10min to 1h. A geostatistical approach is used to allocate the prediction of the rainfall input in each of the urban hydrological units composing the model. The change in model performance is then assessed by contrasting it with dissolved oxygen monitoring data in a series of events.