Identifying fit-for-purpose lumped surrogate models for large urban drainage systems using GLUE - DTU Orbit (19/10/2019)

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Distributed physically based models (DPMs) have become the standard tool for urban drainage modelling. However, high computational demands limit these in applications where fast or multiple simulations are needed. This paper presents simple fit-for-purpose cheaper-to-run surrogate models (SMs) for pipe network simulations which are validated against a DPM. The SMs are set up by lumping the DPM network into compartments in which the volume of water is governed by mass balances. Outgoing discharges to downstream compartment(s) and surcharging are computed from unambiguous volume-discharge curves. The SMs are applied on a 45 km² catchment, Elster Creek in Melbourne, Australia. The number of simulated states and simulation times are reduced by approximately 3 and 6 orders of magnitude, respectively. Different SM complexities are examined. The simplest SM using steady state training data performed well with NSE of 0.98 for volume in the most upstream compartment. When emulating the aggregated surcharge from that compartment, the SM captured all surcharge events correctly. NSE improved from 0.35 to 0.84 when subdividing the compartment into 17 subcompartments. Uncertainty of SM parameters was examined using the Generalized Likelihood Uncertainty Estimation (GLUE) methodology. Two different sampling methods were applied. Limits of acceptability for real-time control, warning and planning, resulted in many accepted models upstream and few to none in downstream backwater-prone areas. All applications showed SM uncertainty bands within expected uncertainty bands for DPM, supporting the use of a simpler conceptual model in fit-for-purpose modelling in urban water systems when computational demands of DPMs are prohibitive.

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