Extending a rainfall-runoff model for lowland catchments from lumped to semi-distributed

Claudia Brauer, Paul Torfs, Ryan Teuling, and Remko Uijlenhoet

Wageningen University, Wageningen, Netherlands (claudia.brauer@wur.nl)

The Wageningen Lowland Runoff Simulator (WALRUS) is a parametric rainfall-runoff model for catchments with shallow groundwater (Brauer et al., 2014ab). WALRUS was developed using data and experience from two Dutch experimental catchments: the Hupsel Brook catchment (6.5 km^2) and the Cabauw polder (0.5 km^2). We identified key processes for runoff generation in lowland catchments, notably (1) groundwater-unsaturated zone coupling, (2) wetness-dependent flow routes, (3) groundwater-surface water feedbacks and (4) seepage and surface water supply, and accounted for these in the model structure.

Up to now, WALRUS has been used in a lumped manner. However, water managers and researchers have expressed an interest in a semi-distributed version for application to larger catchments with varying forcing and catchment characteristics and to investigate the effect of groundwater flow within the catchment on modelled variables (e.g. groundwater depth).

We combined WALRUS and a model for 2-dimensional groundwater flow into a simple modelling framework. WALRUS was already designed to cope with groundwater flow into or out of the model domain, because seepage and lateral groundwater flow are common in lowlands. In the semi-distributed version, we used this feature to couple different WALRUS elements (grid cells or subcatchments) to each other. Groundwater flow was computed using a digital elevation model, groundwater depths computed by WALRUS, soil transmissivity data and Darcy's law. Finally, we implemented a surface routing model including backwater effects, which are relevant in areas with little relief. With respect to the lumped version, the semi-distributed requires more data. Therefore, we investigated the added value of different data sources (forcing, elevation, soil, surface water) separately.

We will present the rationale behind the semi-distributed model and show how the model structure compares to observations and and simulations without lateral transport.

C.C. Brauer, A.J. Teuling, P.J.J.F. Torfs, R. Uijlenhoet (2014a): The Wageningen Lowland Runoff Simulator (WALRUS): a lumped rainfall-runoff model for catchments with shallow groundwater, Geosci. Model Dev., 7, 2313-2332.

C.C. Brauer, P.J.J.F. Torfs, A.J. Teuling, R. Uijlenhoet (2014b): The Wageningen Lowland Runoff Simulator (WALRUS): application to the Hupsel Brook catchment and Cabauw polder, Hydrol. Earth Syst. Sci., 18, 4007-4028.