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The Wageningen Lowland Runoff Simulator (WALRUS): implementation and application to the freely draining Hupsel Brook catchment and controlled Cabauw polder

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Recently, we developed the Wageningen Lowland Runoff Simulator (WALRUS) to fill the gap between complex, spatially distributed models which are often used in lowland catchments and simple, parametric models which have mostly been developed for mountainous catchments. This parametric rainfall-runoff model can be used all over the world in both freely draining lowland catchments and polders with controlled water levels. Here, we present the model implementation, opportunities for practical application and experience from validation studies with data from two field sites.

The open source model code is implemented in R and is set-up such that it can be used by both practitioners and researchers. For direct use by practitioners, defaults are implemented for relations between model variables and to compute initial conditions, leaving only four parameters which require calibration. For research purposes, the defaults can easily be changed.

WALRUS is computationally efficient, which allows operational forecasting and uncertainty estimation by creating ensembles. An approach for flexible time steps increases numerical stability and makes model parameter values independent of time step size, which facilitates use of the model with the same parameter set for multi-year water balance studies as well as detailed analyses of individual flood peaks.

We applied WALRUS to two contrasting Dutch catchments: the slightly sloping, freely draining Hupsel Brook catchment and the flat Cabauw polder with controlled water levels. In both catchments, WALRUS performs well during the years used for calibration and validation. The model also performs well during extremely wet periods (flash flood in the Hupsel Brook catchment in August 2010) and extremely dry periods (summer 1976) and can forecast the effect of control operations (changing weir elevations and surface water supply).