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Simulating hydrological responses in the Hersperange catchment of the Alzette river basin, Luxembourg

G.P. Zhang (1), H.H.G. Savenije (1), F. Fenicia (1,2) and L. Pfister(2)

(1) Water Resources Section, Faculty of Civil Engineering and Applied Geosciences, Delft University of Technology, Stevinweg 1, 2628 CN Delft, The Netherlands, (2) Centre de Recherche Public - Gabriel Lippmann, 162a, Avenue de la Faïencerie, L-1511, Luxembourg, Grand-duchy of Luxembourg

A watershed hydrological modelling tool, called REWASH, has been developed based on the Representative Elementary Watershed (REW) approach. REWASH is a parsimonious tool that can be directly applied to river basins with the scale ranging from small headwater catchments to mega-scale catchments. As a basic mode, the model simulates the most commonly observed hydrological processes in watersheds, using physically based ordinary differential equations. These processes are overland flows, unsaturated flow in the vadose zone, groundwater flow in the saturated zone and river channel flow. In addition, interception and soil evaporation processes are described.

We recently tested the model code to the Hesperange catchment of the Alzette river basin in Luxembourg. This catchment occupies the southern part of the Alzette river basin, one of the subcatchments of the Rhine River Basin. The catchment is geologically characterized by Mesozoic deposits, consisting of marls, schists, limestone, sandstone and clay. Quick subsurface flow is a dominant runoff generation process and overland flow is not widely observed in this catchment. The modelling test results revealed that although the stream hydrographs can be well modelled, the simulated saturation overland flow area fractions for most of the REWs (subcatchments) are unrealistically large compared to the values reported in the other research. This discrepancy is due to the fact that the current model describes the quick watershed response to rainfall solely by the saturation-excess overland flow mechanism, while the subsurface storm flow is ignored. Taking this knowledge into account, we are in the process of adding a quick subsurface flow component to REWASH.

This paper presents the latest development of the REWASH model whereby the quick subsurface flow process is accommodated. A physically based approach is adopted to represent this flow process and the formulation is illustrated. To model this process, which is interact with the other processes in the watershed scale, a REW (subcatchment) is partitioned into six subdomains, namely, 1) the unsaturated flow domain, 2) the quick subsurface flow domain, 3) the saturated flow domain, 4) the saturation-excess overland flow doimain 5) the infiltration-excess flow domain, and 6) the river flow domain. With this modification, the REWASH model has been applied to the Hesperange catchment again and the preliminary results indicate that the water balance regime of the catchment is significantly altered by taking the quick subsurface flow process into account in the modeling. The simulated saturated area is more realistic and the stream flow simulation is noticeably improved.