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Recession analysis of the Hupselse Beek catchment, The Netherlands

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Many parametric hydrological models use one or more linear reservoirs as model components. However, linear reservoirs may not be ideal to represent the real, nonlinear hydrologic behavior of a catchment. The reservoir coefficients of catchments can be obtained from discharge data with a method suggested by Brutsaert and Nieber (1977). From dry weather recession curves in hydrographs, the negative of the discharge changes over time were extracted and plotted against the discharge in a double logarithmic graph. The slope of the lower envelope around the separate points corresponds with the exponent of the reservoir (one for linear reservoirs). Kirchner (in press) adapted this method and fitted a regression line through the means of the points to determine reservoir coefficients for the Plynlimon catchment. The obtained reservoir coefficients were implemented in a simple model based on an integration of the nonlinear storage – discharge relation to reconstruct the streamflow hydrograph
In this research project Kirchner's method is used to determine the reservoir coefficients and run the model for the Hupselse Beek catchment in the Netherlands. Hourly discharge, precipitation and evapotranspiration data for the period May 1979 – March 1987 have been used for this purpose. Compared to the Plynlimon catchment, our study catchment is much less humid and soil physical processes such as capillary rise play a more important role.
The results show that the reservoir exponent is larger than one, which implies that the behavior of the catchment is nonlinear. The reservoir coefficients obtained for summer periods differ from those obtained for winter periods. Another result is that streamflow in the Hupselse Beek catchment cannot be reconstructed completely with the simple model described above. Winter discharges can often be modeled quite well, but the model fails in simulating summer periods or dry spells. When evapotranspiration rates exceed modeled storage volume plus precipitation, negative discharges are produced and the model collapses.
A quick fix could be to introduce a fixed lower limit to avoid negative discharges. However, it does not yield satisfactory results either. This suggests that additional hydrological processes (eg. a soil moisture reservoir and capillary rise) should be included in the parameterization in order to obtain plausible model results for the study catchment.

Brutsaert, W. and J. L. Nieber, Regionalized drought flow hydrographs from a mature glaciated plateau, Water Resources Research, 13, 637-643, 1977

Kirchner, J.W., Catchments as simple dynamical systems: catchment characterization, rainfall-runoff modeling, and doing hydrology backwards, Water Resources Research, in press