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Case study for the identification and evaluation of rainfall-runoff models

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We investigate the modeling assumptions used in two rainfall-runoff models, namely the model ENNS (Nachtnebel et al., 1993) and the model MIKE SHE (http://www.dhigroup.com/), and study how those assumptions affect the effectiveness and quality of model fitting and runoff simulation. To avoid artificial effects caused by simplifications in the equations used in ENNS for the calculation of the outflow from two-outlet linear reservoirs, a new version of the ENNS code is developed that is fully compatible with the corresponding equations used in MIKE SHE.

The two models are applied in a real-word case study, using 19-year long historical time-series of daily precipitation, temperature and runoff from Glafkos river basin. The latter is located near the city of Patras, in Peloponnese, Greece. Both models are manually calibrated using five years of the available data, whereas the remaining part of the data is used for model validation. The effectiveness of the models to simulate the runoff process is evaluated using (a) the relative model bias, (b) the criterion of Nash and Sutcliffe (N-S) and (c) the modified N-S-criterion calculated using the logarithmically or square root transformed observed and simulated flows.

While both models describe the base- and inter-flow hydrological processes using the same conceptual model of linear reservoirs, they use different modeling assumptions to describe surface runoff and infiltration through the unsaturated zone. To that extent, the presented comparison sheds light to (a) the effectiveness of each modeling assumption to describe surface runoff and infiltration through the unsaturated zone, (b) the quality of model calibration, and (c) the optimality and robustness of the estimated parameters, common to the two models (thickness of the unsaturated zone, water content, field capacity, wilting point etc.).

Differences in the simulated surface runoff, the infiltration and other runoff components, are not caused solely by the different conceptualizations used in the two rainfall-runoff models. Even for the same model, different parameter sets, which are behavioral, (i.e. they provide comparable but not identical time series of the total runoff), lead to different runoff components. The variability of the runoff components produced using behavioral parameter sets is investigated with the model ENNS. For this purpose, we developed: (a) a code to automatically run the ENNS model for a large number of randomly generated parameter sets, and (b) a multi-criteria procedure for the identification of behavioral parameter sets.

Reference

Nachtnebel H.P., W. Lettl and St. Baumung (1993): Abflussprognosemodell fuer das Einzugsgebiet der Enns und der Steyr (Handbuch), Institut fuer Wasserwirtschaft, Hydrologie und konstruktiven Wasserbau, Wien, Austria.

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