Jun 25th, 10:40 AM - 12:00 PM

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iEMSs International Congress on Environmental Modelling and Software

9th International Congress on Environmental Modelling and Software
Fort Collins, Colorado, USA, Mazdak Arabi, Olaf David, Jack Carlson, Daniel P. Ames (Eds.)
https://scholarsarchive.byu.edu/iemssconference/2018/

Distributed Hydrologic Modelling: Lessons Learned from a Probabilistic Appraisal of Various Rainfall-Runoff Modelling Methods in a Mixed Land Use Watershed

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Abstract: A Bayesian total uncertainty assessment framework, which explicitly accounts for various sources of modeling uncertainty, was employed to compare the performance of different rainfall-runoff methods within the distributed hydrologic model SWAT in a mixed-land use watershed. While the models were trained for streamflow estimation only at the watershed outlet, the performances of the models were compared at different stream locations within the watershed. At the watershed outlet, the empirical Curve Number (CN) method had a slightly better, but not significant, performance in terms of streamflow error statistics. Similar results were obtained for the predominantly forested and agricultural tributaries. However, in tributaries with higher percentage of developed land, the physically-based Green and Ampt (G&A) outperformed the CN method in simulating streamflow based on various performance metrics. In general, the 95% prediction intervals from the models with G&A method covered a higher percentage of observed streamflow especially during the high flow events. Using 95% prediction interval for estimated flow duration curves, results indicated that the models with CN methods underestimated high flow events especially in tributaries with highly developed land use, while generating overall higher water yields. The results of this study have important implications for selection of appropriate rainfall-runoff methods within complex distributed hydrologic models particularly in mixed-land use watersheds. In the present study, while CN and G&A methods in the SWAT model performed similarly at the outlet of a mixed-land use watershed, G&A captured the internal processes more realistically.

***Keywords**:* Rainfall-runoff model; Green and Ampt; Curve number; Distributed hydrologic modelling; Bayesian uncertainty analysis; SWAT