Frameworks for Evaluating and Improving Simplified Hydrologic Models for Baseflow and Rainfall-Runoff Estimation Using Distributed Physical Models

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Abstract

Hydrologic models are becoming increasingly important in the planning, design, operation and management of natural and engineered systems. However, development of such models is complicated by the fact that the underlying physical processes are extremely complex and that the observation and measurement of these processes are expensive and difficult. Consequently, simplified models are generally used in practice for purposes such as baseflow estimation and rainfall-runoff prediction. However, it is difficult to provide a rigorous assessment of how well such simplified models perform under a range of catchment characteristics (e.g. catchment area, soil type, slope) and hydrological inputs (e.g. rainfall, evaporation) and how well they are able to capture the underlying physical processes. In addition, without such assessments, it is difficult to change model structure and parameterization in order to improve the models' predictive capability and the ability to better represent physical processes.

In order to address these shortcomings, in this research, generic frameworks for (i) evaluating and improving recursive digital filters (RDFs) for baseflow estimation and (ii) evaluating the internal dynamic performance of conceptual rainfall runoff (CRR) models are developed and applied. The underlying premise of the frameworks is that fully integrated surface water/groundwater (SW/GW) models are able to provide the best possible approximation to the physical processes of water flow within catchments and can therefore be used as a benchmark against which the performance of these simplified models can be assessed for a variety of physical catchment characteristics and hydrological inputs.

The major research contributions are presented in three journal publications. These publications describe: 1) the development of frameworks to evaluate

and improve RDF performance for baseflow estimation based on catchment characteristics and hydrological inputs and their application to a single RDF under a limited number of catchment characteristics; 2) the application of the frameworks developed in the first paper to three RDFs under a larger range of catchment characteristics and hydrological inputs, as well as the development of regression equations for predicting RDF performance and optimal RDF parameters for improving RDF performance; and 3) the development and application of framework to evaluate the internal dynamic performance of one commonly used CRR model-Australian Water Balance Model (AWBM) under different calibration regimes under a larger range of catchment characteristics and hydrological inputs. Consequently, this research has developed a new way of evaluating and improving commonly used simplified hydrologic models for baseflow estimation and rainfall-runoff prediction.

Statement of Originality

I, *Li Li*, hereby declare that this work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution to Li Li and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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