AN IMPROVED OPERATIONAL RAINFALL-RUNOFF MODEL USING A COUPLED DETERMINISTIC-BASED MODEL AND DATA-DRIVEN TECHNIQUE

SOON-THIAM KHU[1], DAWEI HAN[2],
EDWARD KEEDWELL[3], and OLIVER POLLARD[4]

[1] School of Engineering, Computer Science and Mathematics,
University of Exeter, UK EX4 4QF.
(e-mail: s.t.khu@ex.ac.uk)
[2] Department of Civil Engineering, University of Bristol, UK.
(e-mail: D.han@bristol.ac.uk)
[3] Centre for Water Systems, School of Engineering, Computer Science and Mathematics,
University of Exeter, UK. EX4 4QF.
(e-mail: e.d.keedwell@ex.ac.uk)
[4] Environment Agency, Southwest Regional Office, UK.
(e-mail: Oliver.pollard@environmentagency.gov.uk)

In the Environment Agency (especially for the Southwest region), a key element of the flood forecasting strategy is to use rainfall-runoff modelling as part of the catchment flood forecasting system in order to increase the lead-time for key flood forecasting sites. This will allow flood duty officers to assess the severity during a flood event and prepare for emergency actions if necessary. A catchment flood forecasting system is a system that takes information on the past and current states of meteorological conditions and those of the catchment, as inputs to it, and forecasts the catchment's response into the future. Recently, Khu et al. (2001) presented an novel rainfall-runoff model using a coupled deterministic-based model and data-driven technique demonstrated on a catchment in France.

Data driven methods are highly flexible methods to extract information (mainly causal relationship) between available data and has been shown to be one of the effective methods in real-time rainfall-runoff forecasting. Moreover, these methods tend to be easy to implement, requiring "loose" coupling with existing rainfall-runoff models. Methods such as autoregressive (AR) or autoregressive integrated moving average (ARIMA) have been widely used but the main disadvantage of such approaches is the prior assumption of the form of error correlation. Genetic programming (GP), a relatively new evolutionary-based technique, can be used to generate a suitable expression linking the observations, simulation model results and the error in the simulation for the purpose of error correction.

In a recent study, Khu et al (2004) compared the performance of using genetic programming as an error-updating scheme against that using an ANN. They found that even though ANN performed better than GP in for the short prediction horizon (lead-times) of 1-2 hours on the two calibration events, their performance on two validation events were comparable in the short lead times. For long lead times (3-6 hours), the proposed GP scheme was far better than ANN. However, they did not investigate the effect of direct versus iterative prediction.

In this study, GP functions as an error correction scheme to complement a runoff

forecasting model (PRTF) used by the UK Environment Agency (Southwest region) WRIP system. WRIP (Weather Radar Information Processor) (Cluckie and Han, 2000) is a real time flood forecasting system with spatial radar rainfall data as its primary input. PRTF (Physically Realizable Transfer Function) is basically a linear transfer function model with three controllable parameters.

The main objective of this study was to investigate the use of direct versus iterative updating. The proposed evolutionary-based updating method is applied to simulate flow in 3 flashy catchment in Devon, UK.namely: Bishops Hull on River Tone; Great Somerford on Bristol Avon river; and Woolstone Mill on River Neet. Hourly runoff forecasts of different updating intervals are performed for forecast horizons of up to six hours.

The results show that the proposed updating scheme is able to forecast the runoff quite accurately for all updating intervals considered and particularly for those updating intervals not exceeding the time of concentration of the catchment. It can also be seen that direct prediction of simulation errors seemed to provide consistent results for both catchments and on both calibration and validation events for all lead times (Fig. 1). One of the major advantage of using the proposed scheme is that both deterministic and dynamic component of the rainfall-runoff process can be captured. Any over or under prediction by the WRIP software will be captured via the simulated flow terms. Any error in the correction terms from the previous time-step will be automatically adjusted by the error terms.

These results form part of an ongoing study by the UK Environment Agency and the proposed method will be extended to longer forecasting horizon in the future.

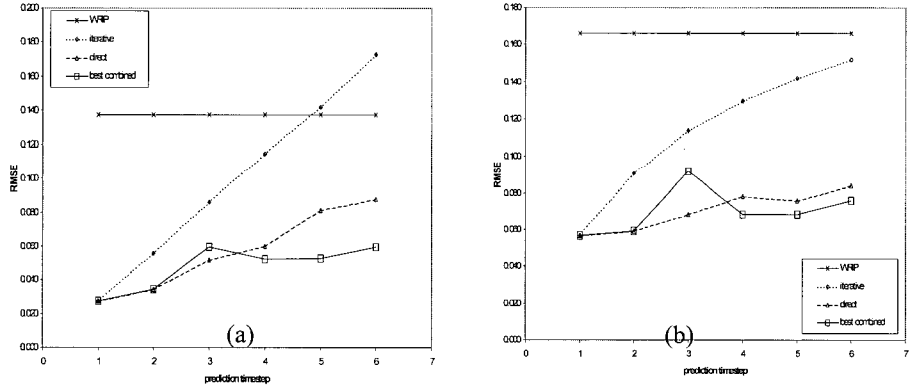

Fig. 1 Comparison of performance using difference error correction schemes for Great Somerford catchment. (a) calibration event 35; (b) validation event 54

Keywords: Genetic programming; Real-time flood forecasting; Updating; Rainfall-runoff; Direct; Iterative

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