A virtual hydrological calibration procedure for stochastic rainfall model

# Abstract

# Introduction

* focus of the paper: stochastic rainfall model and streamflow-based application
* literature review: (1) stochastic rainfall model development (with observed rainfall statistics), (2) influence of rainfall input on simulated streamflow, (3) evaluation of stochastic rainfall model
* gap and motivations: (1) the qualities and defects of simulated streamflow are rarely a consideration in develment of rainfall model. (2) representation of “good” rainfall to “bad” streamflow
* objective: (1) to present the the virtual hydrological calibration procedure for SRMs, (2) demonstrate the calibration procedure with a single site rainfall model and a conceptual rainfall runoff model

# Virtual hydrological calibration

## Overview

A typical calibration procedure for a stochastic rainfall model involves matching some rainfall statistics with the observed data by adjusting rainfall model’s parameters. Figure 4.2 illustrates the calibration procedure of stochastic rainfall models with observed rainfall data.



Calibrating with observed rainfall data allows stochastic rainfall models to preserve identified rainfall statistics. The simulated rainfall time series can be used as input for hydrological models to produce streamflow time series for hydrological assessment. However, it is not necessarily given that simulated rainfall time series will translate to streamflow time series that preserve the properties of observed streamflow data. Therefore, the first objective of this project is to assess the feasibility of calibrating stochastic rainfall models that are able to preserve streamflow statistics. Figure 4.3 illustrates a schematic of the hydrological calibration procedure for stochastic rainfall models.



## Step 1 – rainfall simulation

**Estimating stochastic rainfall model and rainfall model parameters**: To initiate the experiment, the stochastic rainfall model will be calibrated with at-site observed rainfall data; while the rainfall-runoff model will be calibrated with at-site observed runoff data. This procedure will allow the stochastic rainfall model to simulate rainfall data that are similar to the condition at the site which could avoid potential divergence to the hydrological calibration procedure at later stages. While the set of parameters for the rainfall-runoff model will be fixed throughout the process after they are calibrated and evaluated with the observed runoff.

## Step 2 – streamflow simulation

**Simulating streamflow with simulated rainfall input:** the sequences of simulated rainfall will be used as input to the (already calibrated) rainfall-runoff model to generate sequences of simulated streamflow. Note that a separate aim will investigate the influence of the hydrological model on the overall method.

**Simulating virtual-observed streamflow with observed rainfall input**: A sequence of observed rainfall data will be used as input to the same rainfall-runoff model to generate a sequence of virtual-observed streamflow. This approach removes the possibility of errors from observed streamflow influencing the comparison

# Step 3 – objective function

* Sum of square errors
* Relative errors

# Step 4 – optimization

**Comparing simulated streamflow and virtual-observed streamflow**: The flow duration curve (FDC) will be the subject of the comparison. The FDC is computed from the streamflow sequences produced in the previous stage. The simulated FDC and the virtual observed FDC will be compared against each other forming an objective function using the sum of squares error (SSE) metric. The value of the objective function will be used to inform the calibration of the stochastic rainfall model parameters (i.e. minimizing the SSE by changing stochastic rainfall model parameters).

**Evaluating stochastic rainfall model performance**: To ensure the performance of the stochastic rainfall model in simulating rainfall input that preserves streamflow characteristics, the model will be verified with a virtual-observed FDC at a different time period (split-sample validation)

# Case study

# Results

# Discussion

* Rainfall attributes

# Limitations and opportunities

* Rainfall runoff models
* Objective function
* Feasibility – runtime

# Conclusions

* Limitation and future opportunities

*Data availability.* All the data used in this study can be requested by contacting the corresponding author Thien Nguyen at truonghuythien.nguyen@adelaide.edu.au.

*Author contributions.*

*Competing interest.* The authors declare that they have no conflict of interest.

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# Reference