INCORPORATION OF THE OPTIMUM RAINFALL SPATIAL VARIABILITY IN A MONTHLY RAINFALL RUNOFF MODEL

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Degree of Master of Science

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DECLARATION

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.... Date: 2020 . 04. 20

Ankit Bhatt

The above candidate has carried out research for the Master's thesis under my supervision.

.... Date: 2020 . 04. 27

Professor N.T.S. Wijesekera

Incorporation of the Optimum Rainfall Spatial Variability in a Monthly Rainfall Runoff Model

ABSTRACT

Most common method of accounting spatial variability of rainfall in hydrologic modelling is with the use of Thiessen Weights whereas some authors consider it illogical as it can result in biased distribution of rainfall. Mathematical rainfall-runoff models need a representative rainfall input and adequacy of a geometric method of rainfall accounting requires an investigation. Lack of sufficient information about spatial distribution of rainfall had always been one of the most important sources of errors in runoff estimations. Water resources planning is mostly done at a monthly time scale and hence a simple watershed model with the capability of moisture accounting is a desirable tool for practicing engineers. In 1990, a study of Mahaweli and Kalu Ganga watersheds had demonstrated an application of optimising rainfall station weights. Present study focusing on optimizing rainfall gauging station weights using the two-parameter monthly water balance model Xiong & Guo (1999), used daily rainfall from 2006-2017 of five rainfall gauging stations, evaporation and streamflow of Attanagalu Oya Basin at Dunamale to evaluate the spatial variability to contribute towards efficient water resources applications. Accordingly, the objective of the present study is to estimate streamflow using the 2P monthly water balance model by incorporating optimised rainfall spatial variability for water management, planning and design. First the model was developed, and the two model parameters c and SC were optimized using Thiessen average rainfall. Then in a stepwise manner, the station weights, parameter c and Sc were treated as parameters for optimisation. MRAE was used as the objective function for evaluation while observing the High, Medium and Low flow behaviour during optimisation. Water balance, soil moisture level, evaporation and the NSE model efficiencies were observed for comparison. Initial soil water content was found to be 186.13mm using a warmup period of 5 repetitions. The optimum model parameter (SC and C) values and optimized rainfall weights achieved during first and second optimization stages are 782.47 mm, 1.87 and 0.387, 0.325, 0.145, 135, & 0.008 for Vincit, Pasyala, Nittambuwa, Karasnagala, & Chesterford respectively. The values achieved while simultaneously optimizing both rainfall & model parameters are 846.42 mm, 1.95, and 0.528, 0.199, 0.12, 0.144, 0.009. The mean MRAE value for calibration period is 0.43 and verification period 0.41. The 2P monthly water balance model with Thiessen rainfall station weights when compared with the optimised station weights indicated a difference of 8-9% in MRAE with an average MRAE value of 0.42 and a difference of 67 and 53 mm in average annual water balance error during calibration and verification respectively. On a monthly scale even a small change in rainfall station weight aggregates and gets reflected in the model estimates especially for stations receiving high intensity rainfall. Therefore, using a method of areal averaging that predetermines rainfall station weights and disregards the spatial mobility of a rainfall event will lead to erroneous results.

Keywords: two-parameter model; rainfall weight optimization; monthly water balance

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