APPLICABILITY OF A TWO PARAMETER WATER BALANCE MODEL TO SIMULATE DAILY RAINFALL RUNOFF – CASE STUDY OF KALU AND GIN RIVER BASINS IN SRI LANKA

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DECLARATION

I hereby declare that, this is my own work and this thesis does not incorporate without acknowledgement of any material previously submitted for a Degree or Diploma in any other University or Institute of higher learning to the best of my knowledge and belief. It does not contain any material previously published or written by another person except where the acknowledgment is made in text.

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

....

Professor N.T.S. Wijesekera Date

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ABSTRACT

Most of hydrological models are complex, data intensive and require optimization of many model parameters. Due to prohibitively high institutional pricing and access constraints associated with data, water research even at daily time scale is a challenge. In this aspect monthly data can be treated as better. Lack of a simple and reliable rainfall runoff model to simulate daily rainfall runoff with an indication for soil moisture is a concern when field applications are carried out. In this backdrop the present work investigated the applicability of a monthly model in the daily time scale. The two-parameter monthly water balance model (Xiong and Guo,1999) performed well in two Sri Lankan watersheds was selected. This model after an initial evaluation was calibrated with monthly data. Daily streamflow estimations were done for Ellagawa (1372 km2) and Thawalama (364 km2) watersheds for the respective durations 2006-2014 and 2000-2015. Estimations were compared using MRAE as the objective function, hydrographs, duration curves and water balance. Nash-Sutclifff was used to observe the goodness of fit in the high flow estimates. Initial evaluations with the previously calibrated dataset showed satisfactory results with the recent data used for the present work but were inferior to the previous outputs probably due to temporal setting or other data quality issues.

The two parameter model calibrated and verified for the recent data showed very good results for the Tawalama watershed and good results for the Ellagawa watershed with different degrees of overestimation. Daily flow estimations agreed reasonably well with the Thiessen averaged rainfall and observed streamflow patterns but demonstrated an overestimation with a noticeable pattern.

After observing monthly and daily outputs in both catchments, the model concept was modified to incorporate a third parameter called AF (Adjustment Factor) to arrest over estimation which may have caused due to the need to incorporate watershed effects arising from variations in slope, land cover, detention and soils.

This Three Parameter Monthly model showed excellent results with the matching of outflow hydrographs, duration curve and water balance for water resources management. In case of Tawalama watershed, the average MRAE values for the two parameter and Three Parameter Models were 0.2061 and 0.1657 respectively. In Ellagawa watershed average MRAE values for the same were 0.7668 and 0.3135 respectively. Respective c and Sc values for the Two Parameter Model were 0.89 and 1,288.63 for Tawalama watershed while the same were 1.29 and 829.84 for Ellagawa. Respective c, Sc and AF values for the Three Parameter Model were 1.02, 1,292 and 0.83 for Tawalama watershed while the same were 0.52, 975.2 and 0.46 for Ellagawa.

Conceptualization extended in the three parameter model demonstrates the potential of successful catchment process conceptualization within the monthly and daily temporal resolutions.

Present work concluded that in case of two case study watersheds, the three parameter monthly model concept is applicable for both monthly and daily time scales.

Therefore this model is recommended for water resources planning and identification of climate change impacts in similar watersheds.

Key Words

Water balance optimization, Water Resources Management, Sri Lanka, Hydrologic Model Objective Function, Flow Duration Curve, Absolute Error

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LIST OF ABBREVIATIONS

Abbreviation	Description
AF	Runoff Adjustment Factor
c	Parameter c
C	Runoff Coefficient
DSD	Divisional Secretary Divisions
E	Nash–Sutcliffe coefficient
E (t)	Actual Evapotranspiration
EP (t)	Pan Evaporation
MAR	Mean Annual Rainfall
MRAE	Mean Ratio of Absolute Error
MSE	Mean Square Error
NEM	North East Monsoon
P (t)	Rainfall
Q (t)	Runoff
RAEM	Ratio of Absolute Error to Mean
RE	Relative Error
RMSE	Root Mean Square Error
S (t)	Soil Moisture Content
SC	Field capacity of the catchment
SWM	South West Monsoon
2PM	Two Parameter Model
3PM	Three Parameter Model