EVALUATION OF A MONTHLY WATER BALANCE MODEL CONSIDERING RAINFALL STATION WEIGHTS AND PHYSICAL PARAMETERS IN NILWALA BASIN SRI LANKA

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Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Water Resources Engineering and Management

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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and 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.

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2019. 09. 25

Professor N.T.S.Wijesekera Date

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ABSTRACT

Water Resources Management is key for economic growth and sustainable development. Monthly Water Balance Models are widely applied for its easy and simple structure characteristics. Many research efforts have been carried out using Two Parameter Monthly Water Balance Model for water resources management in Sri Lanka in which model estimation are influenced by rainfall and the approach for the selection of parameters which can be performed using rainfall station weights optimization ;on the contrary, the non-availability of gauged streamflow data in hydrological modelling for optimization remains one of the major challenges where many modelers suggests parameter estimation using physical characteristic of a watershed as solution.

The objective of the study is to evaluate monthly water balance model incorporating optimization of rainfall station weights and physical parameters of the catchment for water resources planning and development. Two parameter model was used for monthly water resource estimation of Nilwala Ganga basin in Sri Lanka. The model was calibrated and verified for Pitabeddara (324km2) watershed using 24 years' monthly rainfall, pan evaporation and streamflow data successfully. Initially, the model parameters values C and Sc estimated with Thiessen method later rainfall stations weights were optimized while keeping the model parameters C and Sc unchanged for calibration and verification. Secondly C and Sc parameters of two parameters monthly water balance model with station weights were optimized simultaneously where parameters were estimated using physical characteristics of the catchment taking into account rainfall, pan evaporation and landuse variables. Rainfall and pan evaporation relationship was utilized for estimation of C and Sc parameter was estimated using correlation of curve number (CN). After Two Parameter Monthly Water Balance Model Applied using Thiessen method on Pitabeddara watershed.

The value for C and Sc were 1.5 and 1700 respectively with average MRAE of 0.22 and 0.31 during calibration and verification periods. Rainfall station weights optimization only resulted in values of 1.3 and 1600 for C and Sc parameters respectively with average MRAE of 0.22 during calibration and 0.27 during verification, stations weights of (0.47, 0.31, 0.07, 0.12, 0.03) for Deniyaya, Dampahala, Anningkanda, Goluwawatta, Kirama stations respectively. Obtained C and Sc values of 1.41 and 1550 while station weights are parameters are optimized simultaneously with average MRAE of 0.19 and 0.25 for calibration and verification respectively, stations weights of (0.12, 0.22, 0.32, 0.22,0.12) for mentioned stations respectively. Also, value of C and Sc parameters were 1.40 and 1500 were retrieved by accounting physical characteristics of catchment and MRAE of 0.23 and 0.28 for calibration and verification. The station weights optimization improved the MRAE results of model by (10%) which is significant with indication of better MRAE than conventional rainfall averaging method. Estimation using physical characteristics of model resulted in (5%) superior results than empirical approach.

This research effort concludes that rainfall station weights optimization method results are superior then Thiessen Method and parameters estimation using physical characteristics of the catchment can be useful for ungauged catchments and it can provide acceptable results.

Keywords: Ungauged streamflow estimation, Physical catchment characteristics, Spatial Variability of Rainfall, Water balance modelling,

Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

Abbreviation	Description
c	Parameter c
C	Runoff Coefficient
DSD	Divisional Secretary Divisions
E	Nash–Sutcliffe coefficient
E (t)	Actual Evapotranspiration
EP (t)	Pan Evaporation
IPCC	Intergovernmental Panel on Climate Change
K	Pan Coefficient
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
TPMWBM	Two Parameter Monthly Water Balance Model
WMO	World Meteorological Organization