

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

Mukhtar Ahmad Masoud  
(189242M)

Degree of Master of Science

Department of Civil Engineering

University of Moratuwa  
Sri Lanka

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Mukhtar Ahmad Masoud

(189242M)

Thesis submitted in partial fulfillment of the requirements for the degree of Master of  
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Supervised by  
Professor N.T.S. Wijesekera

UNESCO Madanjeet Singh Centre for  
South Asia Water Management (UMCSAWM)  
Department of Civil Engineering

University of Moratuwa  
Sri Lanka

September 2019

## **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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Professor N.T.S. Wijesekera

2019. 09. 25  
.....

Date

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

## 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 (324km<sup>2</sup>) 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

DECLARATION .....	i
ACKNOWLEDGEMENTS .....	ii
ABSTRACT .....	iii
LIST OF FIGURES .....	vii
LIST OF TABLES .....	ix
LIST OF ABBREVIATIONS .....	x
1 INTRODUCTION .....	1
1.1 General .....	1
1.2 Problem identification .....	4
1.3 Study Objectives.....	4
1.3.1 Overall Objective .....	4
1.3.2 Specific Objective .....	4
1.4 Study Area Selection .....	4
2 LITERATURE REVIEW .....	7
2.1 General .....	7
2.2 Current state of water balance model .....	7
2.3 Monthly water balance models comparison .....	9
2.4 Two parameter water balance model.....	10
2.5 Model components .....	11
2.5.1 Rainfall.....	11
2.5.2 Actual Monthly evapotranspiration.....	12
2.5.3 Streamflow .....	13
2.5.4 Soil water content.....	13
2.6 Model Calibration and Verification .....	14
2.6.1 Objective Functions .....	14
2.6.2 Parameter Optimization .....	19
2.6.3 Warm up period.....	20
2.7 Rainfall Spatial Variability.....	21
2.7.1 Methods of areal averaging rainfall .....	21

2.7.2	Importance of rainfall spatial variability .....	22
3	Methodology:.....	24
4	Data collection .....	25
4.1	Rainfall and Streamflow .....	26
4.2	Data Checking .....	26
4.3	Filling the missing data .....	26
4.4	Thiessen Rainfall .....	28
4.5	Double Mass Curve .....	43
4.6	Annual Data Comparison .....	45
4.6.1	Annual monthly rainfall comparison .....	45
4.6.2	Annual Water Balance .....	45
4.7	Identification of Missing Data.....	49
5	ANALYSIS AND RESULTS.....	50
5.1	Introduction .....	50
5.2	Model Development .....	51
5.3	Warm up period.....	52
5.4	Model Calibration and Model Verification (Thiessen Rainfall) .....	52
5.5	Selection of Objective function.....	53
5.6	parameter optimization.....	53
5.6.1	Determination of Global Minimum .....	54
5.7	Model Calibration and Model Verification (Optimized Rainfall).....	65
5.8	Model Calibration and Model Verification with two parameters and station weights and optimization.....	74
5.9	Parameters estimation from physical characteristics of the catchment.....	80
6	DISCUSSION .....	93
6.1	Model selection .....	93
6.2	Data collection and checking .....	93
6.3	Rainfall spatial variability .....	94
6.4	Model Development .....	96
6.4.1	Flow duration curve for High Medium and Low flows.....	96
6.4.2	Initial soil water content.....	96

6.4.3	Objective functions selection .....	96
6.4.4	Calibration and verification.....	96
6.5	Overall comparison of models performance .....	97
7	CONCLUSIONS & RECOMMENDATIONS.....	98
7.1	Conclusions .....	98
7.2	Recommendations .....	99
	REFERENCES.....	100
	ANNEX A – DATA checking .....	105



## LIST OF FIGURES

Figure 1-1: Pitabeddara watershed.....	6
Figure 3-1:Methodology flow chart.....	24
Figure 4-1:Thiessen polygon Pitabeddara watershed .....	29
Figure 4-2:Land use Map of Pitabeddara watershed.....	31
Figure 4-3:Soil Map Pitabeddara watershed .....	32
Figure 4-4:Dampahala Streamflow response to rainfall from(1993-2005.....	33
Figure 4-5:Dampahala Streamflow response to rainfall from (2005-2017).....	34
Figure 4-6:Anningkanda Streamflow response to rainfall from (1993-2005) .....	35
Figure 4-7:Anningkanda Streamflow response to rainfall from (2005-2017) .....	36
Figure 4-8:Goluwawtta streamflow response rainfall from (1993-2005).....	37
Figure 4-9:Goluwawatta Streamflow response to rainfall (2005-2017.....	38
Figure 4-10:Deniyaya Streamflow response to rainfall from (1993-2005) .....	39
Figure 4-11:Deniyaya Streamflow response to rainfall from (2005-2017) .....	40
Figure 4-12:Kirama Streamflow response to rainfall from (1993-2005).....	41
Figure 4-13:Kirama Streamflow response to rainfall from (2005-2017).....	42
Figure 4-14:Double Mass Curve for Rainfall Data of Pittabeddara .....	43
Figure 4-15::Monthly Flow Duration Curve.....	44
Figure 4-16:Annual Rainfall Pattern.....	45
Figure 4-17:Annual water balance .....	47
Figure 4-18:Runoff coefficient .....	47
Figure 4-19:Stream flow response vs rainfall .....	48
Figure 4-20:Annual water balance difference.....	48
Figure 5-1:Model Warm-up Period for Initial Soil Water Content.....	52
Figure 5-2:Coarser Resolution Surface for Pitabeddara .....	54
Figure 5-3:Hydrographs from Model calibration -Thiessen rainfall (1993-2005)....	56
Figure 5-4:Hydrographs from model verification -Thiessen rainfall (2005-2017)....	57
Figure 5-5:Hydrographs from model calibration (Thiessen rainfall) on both normal and log scale.....	58
Figure 5-6:Hydrographs from model verification (Thiessen rainfall) on both normal and log scale.....	59
Figure 5-7:Annual Water Balance comparison calibration (Thiessen rainfall) .....	60
Figure 5-8:Annual Water Balance comparison verification (Thiessen rainfall).....	61
Figure 5-9:Water Balance for Calibration period (Thiessen rainfall).....	62
Figure 5-10:Water Balance for Verification period (Thiessen rainfall).....	63
Figure 5-11:Flow duration curve – calibration period (Thiessen rainfall).....	64
Figure 5-12:Flow duration curve – Verification period (Thiessen rainfall) .....	64
Figure 5-13:Optimized station weights .....	65
Figure 5-14:Hydrographs from model calibration using Optimized rainfall on both normal and log scale.....	67
Figure 5-15: Hydrographs from model Verification using Optimized rainfall on both normal and log scale.....	68
Figure 5-16:Annual Water Balance Comparison Calibration (Optimized Rainfall) .	69

Figure 5-17:Annual Water Balance Comparison Verification (Optimized Rainfall)	70
Figure 5-18:Annual Water Balance Comparison Calibration (Optimized Rainfall)	. 71
Figure 5-19:Annual Water Balance Comparison Verification (Optimized Rainfall)	72
Figure 5-20:Flow duration curve – Calibration period (Optimized rainfall)	73
Figure 5-21:Flow duration curve – Verification period (Optimized rainfall)	73
Figure 5-22:Annual Water Balance Comparison calibration two parameter- station weights	77
Figure 5-23:Annual Water Balance Comparison two parameter verification two parameter - station weights	78
Figure 5-24:Flow duration curve – Calibration period two parameters and station weights	79
Figure 5-25:Flow duration curve – Verification period two parameters and station weights	79
Figure 5-26:Annual Water Balance Comparison Calibration (Physical Parameters)	84
Figure 5-27:Annual Water Balance Comparison Verification (Physical Parameters)	85
Figure 5-28:Flow duration curve – Calibration period (Physical Parameters)	85
Figure 5-29:Flow duration curve – Verification period (Physical Parameters)	86
Figure 5-30:Hydrographs from model calibration using physical parameter on both normal and log scale	87
Figure 5-31:Annual Water Balance Comparison Calibration (Physical Parameters)	88
Figure 5-32:Hydrographs from Model Verification using Physical Parameter on both normal and log scale	89
Figure 5-33:Annual Water Balance Comparison Verification (Physical Parameters)	90
Figure 6-1:Thiessen and Optimized Rainfall Comparison	95
Figure 9-4:Variation of Maximum, Mean and average monthly rainfall, streamflow & evaporation	109

## LIST OF TABLES

Table 4-1:Data source and Data Resolution of Nilwala ganga at Pitabeddara .....	25
Table 4-2:Rain Gauging Station Details of Nilwala ganga at Pitabeddara .....	26
Table 4-3:Distribution of Gauging Stations in Pittabeddara at Nilwala gaga.....	26
Table 4-4:Missing value for each month .....	28
Table 4-5:Each station Thiessen polygon area and Thiessen weight.....	28
Table 4-6:Annul water balance for Pittabeddara watershed .....	46
Table 5-1:Comparison of Model Performance Calibration (Thiessen Rainfall).....	55
Table 5-2:Comparison of Model Performance Calibration (Thiessen Rainfall).....	55
Table 5-3:Water Balance Estimation Calibration Period (Thiessen rainfall) .....	62
Table 5-4:Water Balance Estimation Verification Period (Thiessen rainfall) .....	63
Table 5-5:Comparison of Model Performance Calibration (Optimized Rainfall) .....	66
Table 5-6:Comparison of Model Performance Verification (Optimized Rainfall).....	66
Table 5-7:Water Balance Estimation Calibration Period (Optimized Rainfall) .....	71
Table 5-8:Water Balance Estimation Verification Period (Optimized Rainfall) .....	72
Table 5-9:Two parameters and station weights optimization .....	74
Table 5-10:Comparison of Model Performance Calibration with two parameter and station weights .....	75
Table 5-11:Comparison of Model Performance Verification with two parameter and station weights .....	75
Table 5-12:Hydrographs from Model calibration –two parameter & station weights optimization (1993-2005) .....	76
Table 5-13:Water Balance Estimation Calibration Period two parameters- station weights .	77
Table 5-14:Water Balance Estimation Verification Period two parameters- station weights	78
Table 5-15:Comparison of Model Performance Calibration (Physical based parameters)....	82
Table 5-16:Comparison of Model Performance Verification (Physical based parameters) ..	83
Table 5-17:Water Balance Estimation Calibration Period (Physical Parameters) .....	83
Table 5-18:Water Balance Estimation Verification Period (Physical Parameters) .....	84
Table 5-19:Mean Rainfall computation for parameter C.....	91
Table 5-20:Mean Evaporation computation for parameter .....	92
Table 6-1: Rainfall Average by Thiessen and Optimized station weights .....	95
Table 6-2:Overall Summary sheet of all models results .....	97
Table A-1:Thiessen Average Rainfall Data .....	106
Table A-2:Evaporation Data .....	107
Table A-3:Streamflow Data .....	108

## 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