INVESTIGATION OF HEC-HMS MODEL PARAMETER TRANSFERABILITY FOR DAILY RAINFALL RUNOFF SIMULATION IN MAHA OYA BASIN

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Thesis submitted in partial fulfillment of the requirements for the degree 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 acknowledgment 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 the text.

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Medaweriye Herath Bandaralage Chulani Wathsala Herath Date

The above candidate has researched for the Masters thesis under my supervision.

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Professor N.T.S.Wijesekera Date

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Investigation of HEC-HMS Model Parameter Transferability for Daily Rainfall Runoff Simulation in Maha Oya basin

Abstract

Water is an essential finite natural resource for the developing world, however water is under growing stress due to, increased water consumption resulting from rapid population growth, development activities and industrialization for economic prosperity. Therefore, considerable attention for water resource management and development activities are required. The main challenge in this context is the unavailability of observed flow data. To address the prevailing condition, it is necessary to understand the catchment behavior from the hydrological point of view. Therefore, water quantification with the aid of hydrological modeling is an essential requirement, to facilitate the water resource development in ungauged watersheds.

The objective of this work is to investigate the level of applicability of hydrological parameter transferability by using the HEC-HMS model for Badalgama and Giriulla catchments in the Maha Oya basin, for sustainable development and management of water Resources.

The HEC-HMS model has been developed for Giriulla and Badalgama watersheds in the Maha Oya basin with the use of hydro-meteorological data, climatic data, and topographical data. Then model development, parameter estimation and simulation of the model have been performed systematically. Thereafter model calibration and validation were carried out based on identified objective function as RMSE and model performance evaluation criteria as MRAE. Optimized parameters were transferred by deploying different approaches, including temporal, spatial, and spatiotemporal methods. Model performance evaluation was carried out by observing total flow hydrograph, annual and seasonal water balance, behavior of low, medium and high flow regimes in the flow duration curve.

Developed HEC-HMS models of Giriulla and Badalgama catchments were calibrated with 0.24 and 0.25 of MRAE values, while validated with 0.18 and 0.19 of MRAE value respectively. In addition to that, flow hydrographs and flow duration curves matched well with the observed data. According to the transferability results, it was revealed that best approach for reproducing streamflow in both catchments are temporal transferability, which showed approximately 80% accuracy level. The spatial and spatiotemporal transferability approaches were not capable enough to capture the streamflow in satisfactory accuracy level, as it was approximately less than 50% for both catchments. Further, based on model results, it shows good performance for high and medium flows when compared with low flows in both catchments. Accordingly, at Giriulla watershed high and medium flow prediction accuracy for temporal transferability are 76% and 85%, while same for Badalgama watershed are 89% and 84%. However low flow prediction accuracy maintained approximately less than 60%. Further, annual average water balance error at Giriulla is overestimated 20%, while indicating seasonal water balance errors are overestimated 23% (Maha) and 17% (Yala). Similarly, at Badalgama average water balance error is underestimated 11%, and seasonal water balance errors are underestimated 8% and 20% for Maha and Yala seasons respectively.

In the light of these findings, calibrated and validated HEC-HMS model can be utilized for water resources development activities in daily timescale with approximately 75% accuracy for both catchments. Further, low flow estimation with this model must be carried out with caution due to selection of one layer precipitation loss model. The temporal transferability could be done for the selected catchments with good level of confidence (80% for both catchments), while spatial transferability and spatiotemporal transferability cannot be done with acceptable accuracy, though both catchments are in the same river basin.

Key Words:

HEC-HMS, Hydrological Model, parameter transferability, Calibration, and Validation, Maha Oya Basin

INVESTIGATION OF HEC HMS MODEL PARAMETER TRANSFERABILITY FOR DAILY RAINFALL RUNOFF SIMULATION IN MAHA OYA BASIN

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

2-P	- Two Parameter
4-P	- Four Parameter
AMC	- Antecedent Moisture Condition
AMSL	- At Mean Sea Level
ANN	- Artificial Neural Network
CN	- Curve Number
ET	- Evapotranspiration
FDC	- Flow Duration Curve
GIS	- Geographic Information System
GW	- Ground Water
HEC-HMS	- Hydrological Engineering Center-Hydrological Modeling System
IDW	- Inverse Distance Weighted
ID	- Irrigation Deparment
L	- Stream Length
MRAE	- Mean Ratio of Absolute Error
MSL	- Mean Sea Level
MSE	- Mean Square Error
NASH	- Nash Sutcliffe
PoR	- Period of Record
RF	- Rainfall
RMSE	- Root Mean Square Error
RR	- Rainfall-Runoff
SCS	- Soil Conservation Service
SD	- Survey Department
SF	- Stream Flow
SMA	- Soil Moisture Accounting
SWAT	- Soil Water Allocation Model
WMO	- World Meteorological Organization