EVALUATION OF TRANSFERABILITY OF TANK MODEL PARAMETERS FOR UNGAUGED CATCHMENTS IN NILWALA RIVER BASIN

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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

Supervised by

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

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Professor N.T.S. Wijesekera Date

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Abstract

Water is a fundamental requirement for human persistence and one of the essential resources for achieving sustainable development in the country. The growing population and expansion of economic sectors have created an interconnected competitive demand for finite water resources. Thus, a proper water resources management is required where daily rainfall-runoff modeling will be the most fundamental tool for water resource assessment. Though, most of the catchments are ungauged or with limited data, hydrologic modeling is a challenging task for model calibration and validation. Transferring the hydrological model parameters of a gauged catchment to ungauged catchment is generally practiced in such conditions by the hydrologic modelers with a considerable level of uncertainty. Hence, this study has focused to evaluate the accuracy of such regionalization methods of a Tank model parameters in order to quantify the water resource in ungauged catchments in Nilwala River to assist water resource management.

A Tank model with four tanks was developed with MS Excel software for Pitabeddara and Urawa sub-catchments using data from water years 2008/09 to 2017/18. The model was warmed up for five water years to stabilize the soil moisture in the four tanks. Both models for two sub-catchments were calibrated for the first five water years and validated with the remaining five water years. During the process, the models were optimized by using the multi-start GRG-nonlinear search engine of the Solver add-in of MS Excel where the goodness of fit of the model simulations was evaluated by using the Mean Ratio of Absolute Error (MRAE). The optimized Tank model parameters for each catchment were transposed under spatiotemporal, temporal, and spatial transferability approaches to reconstruct the streamflow of each catchment. Model performances in each simulation was evaluated by comparing annual water balance, total flow hydrograph, and flow duration curves.

The MRAE values during model calibration were 0.32 and 0.31 for Pitabeddara and Urawa sub-catchments respectively. Both models were validated with the MRAE values of 0.48 and 0.54 for Pitabeddara and Urawa catchments respectively. The evaluation indicators also illustrated a better matching between estimated and observed flows where annual water balance error percentages were range from 0.7% to 25.1%.

In light of these results, the spatial parameter transferability approach outperformed than other methods for the concerned catchments during study period. Consequently, the lumped Tank model is capable of simulating daily streamflow of concerned catchments in Nilwala River Basin with an accuracy level within 50% - 68%. Most importantly, the best results are in the high and intermediate flow regimes with an average accuracy more than 61% ranges from 53% - 73%. The seasonal-scaled streamflow showed more than 87% of average accuracy with water quantity error of 70 mm/season – 114 mm/season. The monthly-scaled streamflow had an average accuracy level of more than 76% with water quantity error of less than 20.9 mm/month confirming that the Tank model can be satisfactorily utilized for water resources management tasks in the concerned catchments.

Key Words: Parameter Regionalization, Lumped Tank Model, Ungauged Catchment, Water resources Management, Daily data

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Evaluation of Transferability of Tank Model Parameters for Ungauged Catchments in Nilwala River Basin

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LIST OF ABBREVIATIONS

Avg	-	Average
AWB	-	Annual Water Balance
Cal. SF	-	Calculated Streamflow
Evapo.	-	Evaporation
FDC	-	Flow duration curves
MRAE	-	Mean Ratio of Absolute Error
RF	-	Rainfall
SF	-	Streamflow
WMO	-	World Meteorological Organization