INVESTIGATION OF THE TRANSFERABILITY OF BASIN HYDROLOGICAL PARAMETERS IN SRI LANKA'S WET ZONE RIVER BASINS

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Sustainable water resource management is essential as urbanization and population growth intensify competition for limited freshwater resources. Accurate streamflow estimation in river basins is a key tool for effective management. Hydrologic modelling provides a flexible approach for estimating streamflow, but its application can be challenging in ungauged basins due to data scarcity and other constraints. This research improves streamflow estimation in data-scarce regions, aiding more effective water resource management amid rising demands.

This research explores the applicability of the spatial and temporal transferability approaches for parameter transfer in the semi-lumped HEC-HMS hydrological model. Three sub-basins, namely, Ellagawa, Ratnapura, and Baddegama, were selected for the analysis. All sub-basins are located within Sri Lanka's wet zone and have varying area extents (Ellagawa: 1,393 km², Ratnapura: 603 km², Baddegama: 681 km²). The HEC-HMS model was applied to each sub-basin, with a calibration period from 2006 to 2012. Verification utilized different periods due to limited observed data availability. Model performance was evaluated using the Nash-Sutcliffe Efficiency Coefficient (NSE) and Mean Ratio Absolute Error (MRAE). The spatial transferability approach involved transferring calibrated parameters within basins (Ellagawa and Ratnapura) and across basins (Ratnapura in Kalu Ganga vs Baddegama in Gin Ganga). The temporal approach involved transferring parameters from calibrated models to the same basins for a different time period. Streamflow hydrographs and flow duration curves for low, high, and intermediate flows were used to assess the transferability of calibrated HEC-HMS parameters. The calibrated models for Ellagawa, Ratnapura, and Baddegama achieved satisfactory performance with NSE values ranging from 0.62 to 0.78 and MRAE values between 0.35 and 0.74. Within-basin transferability showed moderate success, with NSE ranging from 0.60 to 0.63 and MRAE varying between 0.51 and 0.84. Initial attempts at across-basin transferability resulted in low accuracy. However, adjusting sensitive parameters (Groundwater 1 Storage, Groundwater 1 Percolation, Groundwater 1 Coefficient, etc.) improved overall model accuracy to 87% in Ratnapura and 85% in Baddegama.

Based on these results, an Excel-based interactive hydrological modelling system (E-HMS) was developed to assess parameter transferability within and across river basins. Calibration becomes achievable with minimal effort and in less time using E-HMS. The temporal transferability approach exhibited greater success, particularly when transferring parameters from the main basin to sub-basins. These findings demonstrate the potential of the HEC-HMS model with transferable parameters for sustainable water resource management in Sri Lanka's wet zone basins. The research highlights the viability of the spatial transferability approach within similar basins and the temporal approach for transferring parameters from main to sub-basins. Further research could explore the applicability of these approaches in different geographical contexts and investigate methods for identifying the most transferable parameters.

Keywords: HEC-HMS model performance, Parameter sensitivity analysis, Sustainable water management strategies, Ungauged watersheds

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Investigation of the Transferability of Basin Hydrological Parameters in Sri Lanka's Wet Zone River Basins

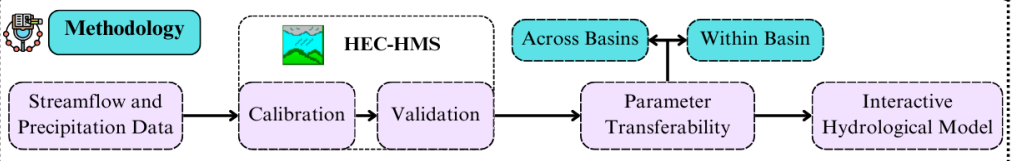
Aim and Objectives

Aim: Investigation of the transferability of hydrological parameters within and across wet zone river basins in Sri Lanka to assess hydrological processes.

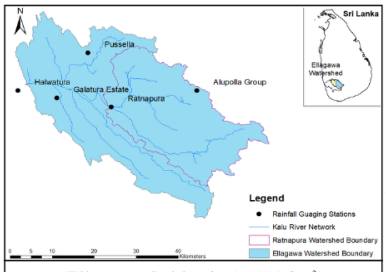
Objectives

- To review recent studies carried out to access the parameter transferability and identification of model parameters
- To develop hydrological models for the identification of an optimized set of model parameters by calibration and validation of data
- To evaluate the possibility of model parameter transferability, implement and analyze the outcomes, and summarise the results
- To develop a web-based interactive hydrological modeling system customized with datasets for Sri Lankan river basins

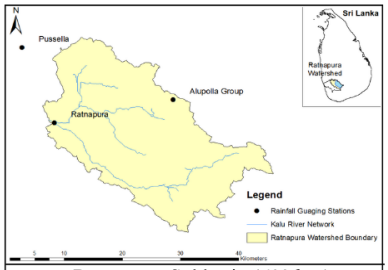
Methodology



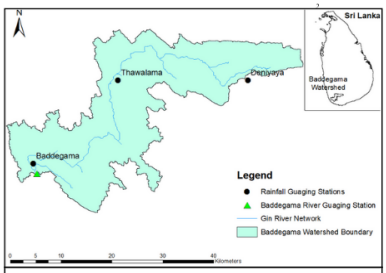
Study Area



Ellagawa Subbasin (*1,393 km²*)



Ratnapura Subbasin (*603 km²*)



Baddegama Subbasin (*681 km²*)

Calibration and Validation

Subbasin	Calibration		Validation	
	NSE	MRAE	NSE	MRAE
Ellagawa	0.78	0.36	0.68	0.35
Ratnapura	0.62	0.74	0.73	0.95
Baddegama	0.78	0.35	0.75	0.37

Parameter Transferability

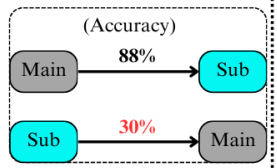
Within Basin ⟶ Direct Transferability

Objective Functions

NSE - Nash-Sutcliffe Efficiency Coefficient

MRAE - Mean Ratio Absolute Error

Subbasin	NSE	MRAE
Ellagawa (Main)	0.68	0.84
Ratnapura (sub)	0.60	0.51



Across Basins ⟶ Direct Transferability ⟶ Unsatisfactory Results

Modified Parameter Transferability

Subbasin	NSE	MRAE
Ratnapura (R)	0.61	0.53
Baddegama (B)	0.74	0.33