POTENTIAL OF PARAMETER TRANSFERABILITY WITHIN A RIVER BASIN TO PREDICT DAILY STREAMFLOW IN UNGAUGED CATCHMENTS; CASE STUDY FOR UPPER NILWALA RIVER BASIN

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Thesis submitted in partial fulfilment of the requirements for the degree 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 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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A.K.U.B. Rathnayaka Date

The above candidate has carried out research for the Masters thesis under my supervision.

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Professor N.T.S.Wijesekera Date

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ABSTRACT

Potential of Parameter Transferability within a River Basin to Predict Daily Streamflow in Ungauged Catchments; Case Study for Upper Nilwala River Basin

Water scarcity is being exacerbated by population growth, urbanization, industries and climate change amplifies the prevailing circumstances. Scarcity of water creates the necessity for sustainable water resource planning and management using reliable information and representative models. Since most catchments are ungauged, estimation of streamflow is a challenge faced by hydrologic engineers. Parameter transferability is being investigated by the researchers as a tool to address the issue. In that case, a process-based hydrologic model with daily temporal resolution generates more hydrologically acceptable, accurate catchment response model parameters by which information is provided for hydrological process-based management decisions. Among the many approaches, it is essential to investigate the potential of parameter transferability between sub-watersheds of a river basin to deliver small watersheds wise management decisions. The objective of this study is to evaluate the potential of parameter transferability between main catchment and sub-catchment to estimate daily streamflow by developing a HEC-HMS model for Pitabaddara and Urawa watershed in the Nilwala river basin.

HEC- HMS model was developed for Pitabaddara and Urawa watersheds by using topographical data and daily hydrologic data for water years from 2009/2010 to 2017/2018. Optimal model parameter sets were identified by semi-automatic optimization using Root Mean of Square Error as the objective function. Results were evaluated by selecting model performance criteria as, MRAE, sorted and unsorted FDC, annual water balance, streamflow hydrographs for total and high, intermediate and low flow regimes. Further, identified optimal parameter sets were verified through fully automatic model optimization. Then the sets of optimal parameters were transferred using temporal, spatial and spatiotemporal transfer schemes and model performance was assessed. Further, the potential of predicted streamflow for water resource management at various time resolutions such as annual, seasonal, monthly and daily was investigated.

Both models for Pitabaddara and Urawa calibrated with 3.2 mm/day and 4.36 mm/day RMSE values. However, surprisingly validation result was better in Urawa than calibration with a 3.25 mm/day error value for RMSE. There is an acceptable agreement in simulated and observed flow hydrographs except for extreme hydrological conditions such as drought and flood. Also model was not able to capture low flows at an acceptable level compared to high and intermediate flows due to the fewer number of parameter of selected one-layer precipitation loss model. Transformation of sub-catchment model parameters to the main catchment exhibits high performance than transferring of main catchment model parameters to sub-catchment. The spatial parameter transfer approach is the best way to predict streamflow in both catchments with regards to streamflow magnitude and its sequences and highly performed flow regime is intermediate flow with 95% and 82% of accuracy respectively for Pitabaddara and Urawa catchments. The spatial transfer scheme was capable of capturing streamflow for 84% and 88% of average accuracy level in Maha & Yala season at Pitabaddara. For Urawa catchment, the temporal transfer could provide an average of 91% and 71% when in predicting streamflow volume for Yala and Maha season respectively for seasonal water resource management. Also, the credibility of parameter transfers schemes, spatial, temporal and spatiotemporal is subjective to the objective of the application and temporal resolutions.

Key Words
parameter transferability, ungauged catchment, HEC HMS, Sri Lanka

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TABLE OF CONTENT

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LIST OF FIGURES

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LIST OF TABLES

`

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`

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LIST OF ABBREVIATIONS

Abbreviation	Description
AWB	Annual Water Balance
AWBE	Annual Water Balance Error
CN	Curve Number
FDC	Flow Duration Curve
IDW	Inverse Distance Weighted
MRAE	Mean Ratio of Absolute Error
MSL	Mean Sea Level
RF	Rainfall Only
RMSE	Root Mean of Square Error
SCS	Soil Conservation Service
SF	Streamflow
WB	Water Balance
WMO	World Meteorological Organization