EVALUATION OF MODELS FOR YIELD COMPUTATION IN UNGAUGED WATERSHEDS FOR IRRIGATION INFRASTRUCTURE DESIGN

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Degree of Master of Science

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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 acknowledgement is made in the text.

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ABSTRACT

In any country water management and water infrastructure development activities are mostly associated with ungauged watersheds. Yield computation method recommended by Irrigation Guideline of Sri Lanka does not provide sufficient evidence to ascertain the accuracy of the estimations. Unavailability of a reliable yield calculation method for a practicing engineer to plan, design, construct and manage water infrastructure in ungauged catchments, affects planning, and design of infrastructure and carrying out efficient water management. Therefore a comparison of available yield models and a verification of model outputs with observed values is required to fill a much needed gap in reliable yield estimations for water resources engineering and management. Moreover, the seasonal yield limitations in the Irrigation Department guideline (1984) should be verified to assess the need of changes to the thresholds. IGM is empirical. HEC-HMS, UH are two other catchment yield models commonly used for water engineering applications. These three models were selected and evaluated with observed daily streamflow data of two watersheds from Attanagalu Oya and Kalu River basins.

The present work at first attempted to evaluate the capability of an ungauged catchment modeler to accurately estimate the yield for water infrastructure planning and design. Subsequently these results were evaluated with the actual observations in order to make suitable recommendations. The period of comparisons in the Attanagalu Oya and Kalu river basins were from 2005-2015 and 2006-2014 respectively.

Three spreadsheet models were developed by using the parameters reported in the literature. Lack of recommended methods were overcome by evaluating literature recommendations and incorporating the best engineering judgement. Model parameters were identified by making best estimations from available literature. Seasonal yield thresholds of IGM were checked with observed yield values. Comparison of model estimations with the observations was done using annual water balance and flow duration curves while using Mean Ratio of Absolute Error as the indicator.

According to the state of art review, Irrigation department yield estimation model (IGM) is the best available watershed yield estimation model. Comparison of three models revealed that IGM is the closest monthly yield estimation model with 12.5% and 22.5% annual difference in estimation for Dunamale and Ellagawa watersheds respectively. HEC model over estimates streamflows by 53.2% and 25.7% in Dunamale and Ellagawa watersheds respectively while the UH model overestimates the streamflow of Ellagawa by 101% and underestimates the streamflow by 16.7% in Dunamale watershed. IGM underestimates the streamflow in rainy months and overestimates during relatively dry months and the threshold time of exceedance is 60% for both Dunamale and Ellagawa watersheds. The use of HEC and UH model results create significant ambiguities when compared with the IGM because of the unreliability associated with the process and parameters in the guidance material. Yield model estimates when compared with the observations show that in all three models the antecedent rainfall acts as a key factor influencing model overestimation and underestimations. IGM, HEC-HMS and UH model development and parameter estimations need better reference material to arrive at accurate watershed yield values. It is therefore important to systematically determine design safety factors to account modelling uncertainties.

Key words: Yield computation, ungauged watersheds, Infrastructure design, hydrological models

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