EFFECT OF WATERSHED SUBDIVISION AND ANTECEDENT MOISTURE CONDITION ON HEC-HMS MODEL PERFORMANCE IN THE MAHA OYA BASIN, SRI LANKA

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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

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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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Muhammad Kamran Date

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

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Dr. R. L. H. L. Rajapakse Date

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ABSTRACT

Effect of Watershed Subdivision and Antecedent Moisture Condition on HEC-HMS Model Performance in the Maha Oya Basin, Sri Lanka

Rainfall-Runoff models such as Hydrologic Modeling System (HEC-HMS) are used for predicting the hydrologic response of watersheds. Due to the effect of discretization, the model accuracy increases with number and watershed sub-divisions and the inferred level of soil saturation in the model. Therefore, an important issue that must be addressed by all users of these models is the determining of an appropriate level of watershed subdivision and Antecedent Moisture Condition (AMC) for runoff simulation.

The present research study was conducted in an attempt to find appropriate answers for the above two modelling issues. As a case study, the Badalgama watershed is selected as study area in the Maha Oya Basin in Sri Lanka. Spatial extent of Badalgama watershed is 1272 km^2 with an upstream river length of 96 km. Four rainfall stations and one river gauge station are selected in Badalgama watershed. Daily rainfall and streamflow data were used for calibration period from 2005 ~ 2008 and for validation period from 2010 ~ 2013.

River basin was divided into 3, 6, 9, and 16 number of subdivisions based on critical threshold area method using ArcGIS 10.5. Nash–Sutcliffe (NASH) and Mean Ratio of Absolute Error (MRAE) objective functions were selected as the evaluation criteria of the model. HEC-HMS modeling was carried out for different subdivisions and varying AMC conditions.

The result shows that with MRAE objective function, the accuracy of the model increased by 4.5% up to six subdivisions and with NASH, the accuracy increased by 4.2% with respect to the same lumped model. The accuracy of the model found to decrease for the model with six subdivisions to sixteen sub-divisions. The accuracy of the model with Antecedent Moisture Condition with AMC-III was found to increase by 12.04% as compared to AMC-II.

With the above findings, it is concluded that subdivision of watershed for modeling results in no more than modest improvements in prediction of low flow and medium flow simulation. As the result shows in the AMC analysis AMC-III produced improved accuracy of 12.04% in calibration period and 6.60% for validation period as compared to AMC-II. The event-wise estimation of AMC led to further increase in model accuracy.

In this research, the recession method was considered for the base flow simulation which led to a mass balance error exceeding 20%. Therefore, it is recommended apply linear reservoir method as base flow simulation method to further improve the modelling accuracy by conserving the water balance.

Keywords: Antecedent Moisture Condition, Hydrological modeling, Sensitivity analysis, Watershed subdivision

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