DEVELOPMENT OF A RAINFALL RUNOFF MODEL FOR KALU GANGA BASIN OF SRI LANKA USING HEC- HMS MODEL

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Degree of Master of Engineering in Water Resources Engineering and Management

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Degree of Master of Engineering in Water Resources Engineering and Management

Supervised by

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May 2016

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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Professor N.T.S.Wijesekera Date

ABSTRACT

Water resources management and flood management in a watershed needs identification of the runoff hydrographs and their relationship with the watershed parameters. Sri Lankan Engineering guidelines or literature in Sri Lankan studies do not provide recommendations for a Hydrologic Model or a modeling methodology guideline for a water manager to use for application purposes. In order to fill the gap in knowledge, this research developed a model using Hydrologic Engineering Centre - Hydrologic Modeling System (HEC-HMS) through a case study application on Ellagawa watershed in Kalu Ganga basin of Sri Lanka.

Eight year daily rainfall data from 2006 to 2014 for five rain gauging stations scattered in the Ellagawa watershed with daily streamflow data in Ratnapura and Ellagawa river gauging stations together with eight year monthly evaporation data of Ratnapura station for the same period were used for this study. After a critical evaluation of HEC HMS options, one layer Deficit and Constant loss method in HEC HMS, was used as precipitation loss model which accounts for the soil moisture content in the continuous model. Soil Conservation Service (SCS) unit hydrograph method and recession method were selected for simulation of direct runoff and baseflow respectively. The evaluation identified Muskingam model as the suitable routing model.

Model calibration was done using data from 2006 to 2010 and the calibrated model was verified using the dataset from 2010 to 2014. Both automated parameter optimization in HEC HMS and manual calibration were used in model calibration. The study demonstrates a systematic methodology for the selection of a search algorithm and the appropriate objective function was incorporated. The univariate gradient search method was selected to optimize the parameters by minimizing the Sum of Absolute Residual objective function. Manual calibration was carried out using Mean Ratio of Absolute Error (MRAE) as the objective function. In addition, another two statistical goodness of fit measures such as percent error in volume, and Nash-Sutcliff model efficiency were also checked as an observation.

Evaluation shows that the value of MRAE for Ellagawa and Ratnapura catchments were 0.5406 and 0.5226 respectively during calibration. The MRAE values for Ellagawa and Ratnapura catchments during model verification were 0.6070 and 0.7732 respectively. Model estimated intermediate flows between 17 m^3/s and 31 m^3/s, with a very high accuracy of MRAE 0.326 and flows between 31 m^3/s and 143 m^3/s, estimations was acceptable at a MRAE of 0.5279. Model estimated high flows greater than 143m^3/s with a very high accuracy of MRAE 0.3244, while the low flows which was less than 17 m^3/s, could not be estimated very well. But the magnitude of lowflow errors for both catchments were only 1% of average annual streamflow of Ellagawa and Ratnapura and therefore this model can be used satisfactorily for water resources management. The model matching of time of peakflow occurrence was at an accuracy of 60% while the peak flow magnitude accuracy was 75%. Therefore, this model is acceptable to use in flood management.

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