SPATIALLY DISTRIBUTED WATERSHED MODELLING FOR RIVER BASIN PLANNING A COMPARATIVE ANALYSIS OF ATTANAGALU OYA

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Degree of Master of Science

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Thesis Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Science

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April 2011

DECLARATION

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Professor N.T.S.Wijesekera Date

Abstract

Information on streamflow is a central component for water resource and water quality engineering and management. A majority of stream reaches which require discharge information are ungauged. Therefore a comparative study using the catchment characteristics and observed streamflows of Attanagalu Oya watershed at Karasnagala gauging station was carried out.

In the described work two Spatially Distributed Models using two sub catchments and four sub catchments were developed. Results from the spatially distributed approaches were compared with the results from a Lumped Watershed approach. In the lumped catchment approach the main watershed of Attanagalu Oya at Karasnagala was considered as single lumped unit. In the Spatially Distributed Approaches Karasnagala Watershed was divided into two and four sub catchments respectively. In each of the models a Unit Hydrograph was developed using the watershed characteristics. A Direct Runoff Hydrograph was then developed incorporating the rainfall for the selected event. In this model it was assumed that effective rainfall fraction contributes to the Direct Runoff while the rest infiltrates to the ground and contributes to storage in the catchment sub surface. Baseflow component was incorporated to the model and checks for mass balance were conducted. Baseflow was assumed as proportional to the storage in the catchment. In the model a coefficient was taken to represent the fraction of water released as baseflow. Mean Ratio of Absolute Error (MRAE) and the Relative Error in Peak Discharge were used as the objective function of comparing the streamflows. For each of the approaches the model was calibrated using 28 events and verification was done using 30 events. The model consists of five parameters. The Baseflow coefficient, α was one calibration coefficient. Two separate runoff coefficients C_L and C_H were used for the rainfall values less than and greater than a particular threshold value, R_0 respectively. In addition, an initial moisture level, m_I of the catchment sub surface was assumed. Average values of the parameters for the 28 calibration events were obtained. Calibration and Verification were carried out for High and Low Rainfall Events separately and also as a single set of events.

The variation of Baseflow coefficient and the two runoff coefficients were kept in a minimum levels during calibration, since their variation within a one particular catchment was identified as very low from event to event. When the average calibration parameters were used for the model verification, the model indicated a reasonable accuracy when the MRAE and Relative Error in Peak Discharge values were very low.

The Spatially Distributed Approach with four sub catchments can be used for Karasnagala when high accuracy of peak flows is required while the lumped catchment approach can be used for quick estimations where less accuracy is required. The average error in peak discharge for lumped catchment approach is 2.4% and the same for Spatially Distributed Approach is 2.2%.The average MRAE for the lumped catchment approach and the spatially distributed approach are 0.3140 and 0.3132 respectively. Results showed a good match of the calculated flows with the observed, when the average baseflow coefficient, α is 0.033 for Four Watershed Approach. Average R_0 value was 68 mm. Average C_L and C_H values were 0.375 and 0.384 while average m_I is 68.03mm.

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