Delineating Hydrological Response Units in Hydrological Modelling

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Over the last two decays a consensus has begun to form that the physics of catchment behavior can be captured in a meaningful way at an appropriate scale to model the exact physically based hydrological processes occurring in complex watershed terrains. Identifying an appropriate scale in the flied of hydrological modeling would facilitate operational engineers to forecast floods and water related disaster to enhance the fields of water related disaster mitigation and hazard mapping.

Point to hill-slope scale hydrological processes which occur at three dimensional spatial and continuous time scale domains depend on watersheds physical properties and meteorological variables. Hydrological modelers lump the point/hill-slope scale processes to grid scale assuming the heterogeneity of process governing parameters within the grid. Most of those processes are influenced by the nature of neighboring locations. Closed boundaries such as bus basins, blocks and watersheds are defined assembling several grids to differentiate the influence on each other. Theoretically this should patrician the land surface by ridges and it includes all the basic components of a watershed.

It is important to understand the relationships between watershed physical properties and hydrological response unit to transfer the methodology of delineating sub-units in to other watershed models. In this paper a new approach is proposed to delineate sub-basin in a watershed model.

Modified BTOPMC (Block wise TOPMODEL with Muskingum-Cunge flow routing method) uses the block average saturation deficit instead of basin average value that is proposed in the TOPMODEL to calculate local saturation deficit. The model was applied to the Mekong River basin upstream of Pakse with catchment area of 277,000 square kilometers to simulate hydrological processes. Four parameters namely; lateral transmissivity under saturated conditions T_0, decay factor m, maximum root zone storage S_{rmax}, and Manning's coefficient n, were assigned as functions of land use type. The Manning’s roughness coefficient of river segments were assigned as a function of slope and the best fitted value at know locations. Daily observed discharge at Luang Prabang gauging station was used as an upstream boundary condition to the model.

The watershed is divided into several imaginary blocks in order to understand the effect of dividing into blocks on hydrological simulations. Number of blocks that gives the minimum standard deviation of block average elevation or slope is suggested as the optimum number of blocks for BTOPMC simulations. Once the optimum values for parameters T_0 and m are established, it is necessary to verify that the number of blocks selected provides the highest standard deviation of block average soil topographic index. For the study region (part of the Mekong river basin) four blocks provided the best hydrological simulation result. That concludes diving watershed into large number of sub-basins does not always provide the optimum solution in watershed hydrological modeling.

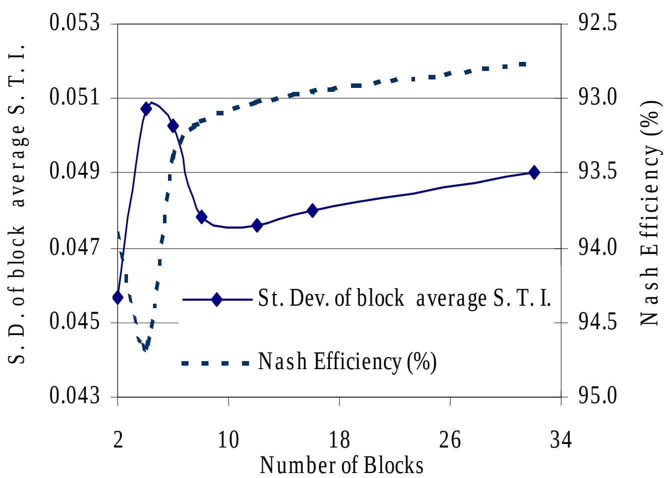

Figure 1. The variation of standard deviation of block average soil topographic index and Nash efficiency coefficient of the hydrological simulations with number of blocks