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Evaluation of Surface Runoff Estimation in Ungauged Watersheds using SWAT and GIUH

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Abstract

Soil and Water Assessment Tool (SWAT) is a physically based distributed model that can estimate runoff, sediment and soil erosion from agricultural watersheds under different management conditions. The new SWAT has provision to simulate watershed process using sub daily rainfall. Though the model is generally meant for continuous modelling, the provision to make use of sub daily rainfall enables the model to be used for event modelling. GIUH is a methodology which can also be used for predicting the surface runoff from ungauged basins. On assessing the performance of these models in modeling of different events in Manali watershed, it is concluded that the GIUH method are marginally better than that from the SWAT model.

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1. Introduction

Geomorphological Instantaneous Unit Hydrographs (GIUH) has been considered as an effective tool to simulate runoff from rainfall for ungauged catchments. The GIUH can be interpreted as the probability density function of the travel time of a drop of water landing anywhere in the basin to the outlet. Horton's geomorphic laws of stream order are used for deriving the same. Among complex hydrological models, the Soil and Water Assessment Tool (SWAT) with ArcGIS interface can also be used for estimating the surface runoff in ungauged basins.

Jeong et al. [1] studied the development and testing of a sub-hourly rainfall–runoff model in SWAT by using one minute sub-hourly time step. The SWAT model is modified to find infiltration, surface runoff, flow routing, impoundments, and lagging of surface runoff. Maharjan et al. [2] modified the SWAT model for sub-daily rainfall and predicted the flow from a watershed within the range of acceptable accuracy. Rodriguez-Iturbe and Valdes [3] developed the theory of the Geomorphologic Instantaneous Unit Hydrograph (GIUH) which couples the hydrologic characteristics of a catchment with its geomorphologic parameters. Gupta et al. [4] linked the hydrologic response of watersheds totheir geomorphologic parameters. Anju [5] developed a tool for the automatic generation of GIUH parameters from delineated watershed in ArcGIS.

As indicated in the literature, the GIUH is a potential tool for simulation of flood events in case of ungauged catchment. The SWAT model is generally used for continuous modelling. However, there is an option for running the model using hourly rainfall which could be utilised for event modelling. Accuracy of the SWAT model in simulating daily flow is less compared with that in simulating monthly flow and hence the accuracy at hourly time scale is to be assessed. In this study, it is attempted to compare the performance GIUH and the SWAT modelin predicting the surface runoff in case of event modelling using sub daily rainfall and runoff.

2. Materials and methods

2.1. Study Area

For the comparison of GIUH and SWAT models, a watershed from Kerala, viz. Manali watershed is selected. The Manali watershed is located in the central region of Kerala state, lying between $10^{o}10'$ and $10^{o}46'$north latitude and $75^{o}57'$ and $76^{o}54'$ east longitude. Annual rainfall of the state is about 3000 mm. The Manali tributary of Karuvanoor puzha originates from Vaniampara hills. This watershed covers an area of 148 km^2, with outlet located at latitude of $10^{o}26'30.76''$ and longitude of $76^{o}16'2.30''$. Fig.1 shows the Manali watershed. It also shows digitized stream network and location of gauging station for the selected watersheds. The catchment area upstream of the Peechi dam is removed from the analysis as the spill way discharge is zero during the period of events.

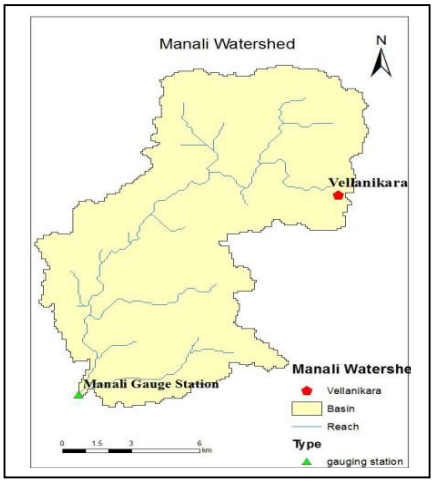

Fig.1.Manali watershed.