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Evaluation of the SWAT model for predicting the daily surface runoff and sediment yield from a small watershed

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ABSTRACT

A distributed parameter model, Soil and Water Assessment Tool (SWAT) has been tested for estimating the daily surface runoff and sediment yield from Nagwan watershed in eastern India. Hydrological and meteorological data for 12 years (1991-2002) observed at the outlet of the watershed were used in this study.The watershed and sub-watershed boundaries, drainage networks, slope, soil series and texture maps were generated using GIS utility of EASI-PACE. Supervised classification method was used for land use classification from a satellite image. The standard curve number table for the Indian conditions was referred and sub-watershed wise AMC-II curve numbers for the year 1996 were estimated and used for calibration and validation of the SWAT model. Most of the input data for the model were extracted from various maps using GIS technique. Model calibration and validation performance have been evaluated on the basis of various test criterion. Manning's roughness coefficient 'n' for overland flow and channel flow, and initial soil water storage were calibrated for monsoon season of the year 1996. The model was validated for monsoon season of the year 1997. Test results showed that the observed and simulated means of runoff and sediment yield were not significantly different at 95 % level of confidence. The Dv values for runoff and sediment yield were found to be -6.2 and -8.6 %, respectively during calibration and 9.2 and -5.7 %, respectively during validation, indicated that the model was predicting daily surface runoff and sediment yield satisfactorily. Similarly, r^2 values for runoff and sediment yield were found to be 0.94 and 0.98, respectively during calibration and 0.89 and 0.80, respectively during validation indicated a good agreement between observed and simulated values of daily surface runoff and sediment yield. Above results indicated that the SWAT model is capable of predicting daily runoff and sediment yield adequately for the Nagwan watershed. On the basis of these results it can be concluded that the model can be used for estimation of daily surface runoff and sediment yield from the Nagwan watershed for multiple years.

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Surface hydrologic modelling includes processes like generation and transport of runoff and sediment from watersheds. Estimation of runoff and sediment yield is necessary for the design of conservation structures to reduce the ill effects of sedimentation and to select the priority watersheds for implementing and evaluating the watershed management programmes with limited financial resources. This effort can be enhanced by the use of physically based computer simulation models, remote sensing data and GIS technique, which can assist management agencies in both identifying most vulnerable erosion prone areas and selecting appropriate management practices.

Numerous models such as ANSWERS (Beasley and Huggins, 1982), CREAMS (Knisel, 1980), EPIC model (Williams *et al.*, 1984), SHE (Abbott *et al.*, 1986), AGNPS (Young *et al.*, 1987), SWARB (Williams *et al.*, 1985) and SWAT (Arnold *et al.*, 1996) have been developed to predict runoff, erosion, sediment and nutrient transport from agricultural watersheds under various management regimes. The management scenarios can also be developed to minimize surface runoff and sediment yield by identifying the critical erosion prone areas of the watershed.

The Soil and Water Assessment Tool (SWAT) model is the recent one and used successfully for simulating runoff and sediment yield from small and large watersheds. SWAT model has the capability to simulate long-term effect of best management practices and can be operated on more than 100 sub-watersheds in single run. Previously SWAT model was tested and applied for small and large watersheds in India and abroad. There is need to calibrate and validate the model for simulating the runoff and sediment yield form a small agricultural watersheds because planning and development of agricultural activities are generally done on small watershed or sub-watershed basis.

Keeping the above facts in mind the current study