International Journal of Agricultural Engineering, Vol. 2 No. 2 (October 2009 to March 2010) : 278-284

Research Paper :

Estimation of monthly surface runoff and sediment yield from a small watershed by using simulation technique

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Accepted : *August, 2009*

ABSTRACT

The hydrological and meteorological data from 1991 to 2002 (12 years) observed at the outlet of Nagwan watershed in eastern India were collected for study. For the estimation of the monthly surface runoff and sediment yield from watershed, Soil and Water Assessment Tool (SWAT) model has been tested. The data like 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 CN table for the Indian conditions was referred. Sub-watershed wise AMC-II CNs, Manning's roughness coefficient for overland flow and channel flow and the initial soil water storage were calibrated for monsoon season of the year 1996 and the model was validated for monsoon season of the year 1997. Various test criterions are used for calibration and validation of the SWAT model. The test results showed that the mean values of monthly observed and simulated runoff and sediment yield were not significantly different at 95 per cent of confidence level. The per cent deviation values for monthly surface runoff and sediment yield were found to be -6.2 and -13.65%, respectively during calibration, and 9.2 and -6.56 during validation, respectively, indicated the satisfactory prediction of monthly surface runoff and sediment yield by SWAT. Similarly, r^2 values for runoff and sediment yield were found to be 0.991 and 0.981, respectively during calibration and 0.965 and 0.904, during validation, respectively, indicated a good agreement between observed and simulated values of monthly surface runoff and sediment yield from the Nagwan watershed. The attempt was made to test the model performance for prediction of monthly surface runoff and sediment yield for the duration of five years (1998 to 2002). The means of observed and simulated monthly runoff and sediment yield were found to be similar at 95 per cent confidence level. The per cent deviation values obtained in simulation of monthly surface runoff and sediment yield during monsoon season were found to be -8.4 and 7.1 per cent, respectively. In general a close agreement was obtained between simulated and observed monthly values.

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Key words : Runoff, Sediment yield, Sub-watershed, SWAT model, Calibration, Validation

The deterioration of natural resources in an area can be controlled effectively by adopting the watershed approach. Watershed, a geographically dynamic unit area that contributes runoff to a common point, has been accepted as a basic unit for planning and implementation of the protective, curative and ameliorative programmes. An accurate understanding of the hydrological behavior of a watershed is important for effective management. The processes like generation and transport of runoff and sediment from watersheds are included in Surface hydrologic modelling. The design of conservation structures require estimation of runoff and sediment yield to reduce the ill effect of sedimentation. 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 (Williams *et al.*, 1984), 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.

Soil and Water Assessment Tool (SWAT) is the continuation of a long-term effort of non-point source pollution modelling by the USDA-Agricultural Research Service (ARS) at Temple Texas, USA. SWAT was obtained by adding a new routing structure of ROTO (Arnold *et al.*, 1995) to the SWRRB (Williams *et al.*,