

## Identification and prioritization of critical sub-watersheds using swat model

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### ABSTRACT

A distributed parameter model "Soil and Water Assessment Tool" (SWAT) has been tested on monthly basis for estimating the surface runoff and sediment yield and then used for identifying the critical sub-watersheds of a small agricultural watershed 'Nagwan' in eastern India. Hydrological and meteorological data for a period of twelve years (1991-2002) observed at the outlet of the watershed were used in this study. Topographical map, soil map, land resources data and satellite imagery of the study watershed were used to extract most of the input parameters for the SWAT model. Manning's roughness coefficient 'n' for overland flow and channel flow have been calibrated for monsoon season of the year 1996. The model was validated for monsoon season of the year 1997 using the daily rainfall and temperature data. Calibration and validation results revealed that the model was predicting the monthly surface runoff and sediment yield satisfactorily. Manning's 'n' value for overall flow and channel flow were found to be 0.060 and 0.025, respectively for the Nagwan watershed. Performance of the model for simulating the monthly runoff and sediment yield for multiple years has been tested. Simulated monthly runoff and sediment yield for the period of five years (1998 to 2002) compared well with their observed counterparts. Adequately tested model was applied for identifying the critical sub-watersheds of Nagwan watershed. The ranking of different critical sub-watersheds was done according to the annual sediment losses. The sub-watersheds SWS 6, SWS 7, SWS 10, SWS 9 and SWS 5 were found to be critical and therefore, recommended for developing the best management plan to reduce the soil and water losses for sustainable crop production.

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The resource considerations for implementation of watershed management programmes or various other reasons related to administration or even political considerations may limit the implementation of management programmes to a few sub-watersheds only. Even otherwise, it is always better to start management measures from the most critical sub-watershed, which makes it mandatory to prioritise the sub-watershed available. Watershed prioritisation is thus the ranking of different critical sub-watersheds of a watershed according to the order in which they have to be taken up for treatment and soil conservation measures.

The intensive study of individual watersheds is necessary to enable management plans to be developed and also to apply the results of one watershed, to another with similar characteristics. Effective control of runoff and sediment yield requires implementation of best management practices in critical erosion prone areas of the watershed. It can be enhanced by the use of physically based distributed parameter models that can assist management agencies in both identifying most vulnerable erosion prone areas and selecting appropriate management practices.

Numerous studies have indicated that, for many watersheds, a few critical areas are responsible for a

disproportionate amount of the pollution (Dickinson *et al.*, 1990; Maas *et al.*, 1985). Critical areas of non-point source pollution can be defined both from the land resources and the water quality perspectives (Maas *et al.*, 1985). From the land resource perspective, critical areas are those land areas where the soil erosion rate exceeds the soil loss tolerance value. Critical areas from the water quality perspectives are areas where the greatest improvement can be achieved with the least capital investment in best management practices.

The average soil loss value of 16.4 t/ha/yr (Dhruva Narayana, 1993) and permissible soil loss value of 11.2 t/ha/yr (Mannering, 1981) can be taken in to consideration for identifying the critical sub-watershed. Priorities can be fixed on the basis of ranks assigned to each critical sub-watershed according to ranges of soil erosion classes described by Singh *et al.* (1992) for the Indian condition as shown in Table 1.

The Soil Conservation Department of Damodar Valley Corporation (DVC) Hazaribagh, Jharkhand (India) has demarcated 20 prioritized sub-watersheds out of 39 sub-watersheds for treating them with the appropriate soil conservation measures (Misra, 1986). The prioritization of these sub-watersheds was based on an empirical formula developed by DVC using a limited