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GIS based critical watershed analysis for soil conservation management using SWAT model

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ABSTRACT

A few areas of the watershed are critical and responsible for high amount of soil erosion. Implementation of best management practices is required in those critical erosion prone areas of the watershed for controlling the soil erosion. Identification of these critical areas is essential for the effective and efficient implementation of watershed management programmes. In this study, GIS interfaced Soil and Water Assessment Tool (SWAT) model for a small watershed (Dudhi) is used for identification and prioritization of critical sub-watersheds to develop an effective management plan. A GIS based distributed approach using MUSLE formulations is used for soil erosion assessment. Daily rainfall, Maximum and minimum temperature data of six years (1997-2002) are used in the study. Besides these data, the soil, landuse, DEM, and drainage map of study area are used in the study. GIS is used for generating the watershed and sub-watershed boundaries, drainage networks, and soil series. Supervised classification method is used for landuse/cover classification from satellite imageries. The weighted average value of parameters such as runoff curve number, surface slope, channel length, average slope length, channel width, soil erodibility factor and other soil layer data are taken for each sub-watershed (HRU) to verify the model. Critical Sub-watersheds are identified on the basis of average annual sediment yield. The erosion rates and their classes are used as a criterion for identifying the critical sub watersheds. Out of the 33 HRU, six fell under high soil loss group, six HRU fell under very high soil loss group, five fell under severe soil loss group and five HRU fell under very severe soil loss group. Remaining HRU fell under slight soil loss group. The study revealed that the SWAT model could successfully be used for identifying and prioritizing critical sub watersheds for management purposes. The region prone to high rate of soil erosion associated with scarce irrigation facilities or scarcity of water are identified and considered for the study purpose. Dudhi watershed experiencing heavy rainfall accompanied with high intensity rains having excessive runoff and soil erosion are considered for study purpose.

The study adopts a GIS based distributed runoff model for the watershed to estimate the runoff using SCS procedure. To know the impact of landuse/cover change various scenarios are made. The study shows that in the land-cover change scenarios, for different land-cover change different results are obtained. When we change land-cover from culturable wasteland to single crop, maximum surface runoff and soil erosion increased and that is 30.25% and 97.88%. Most of the critical HRU mentioned above fells under Wasteland landuse class, so one scenario is generated in which land-cover is changed from wasteland to dense forest. This results in decreased surface runoff and sediment yield that is 15.6% & 53.09% respectively.