Abstract

Severe soil erosion due to traditional system of cultivation in high rainfall and steep slope conditions of eastern Himalayan region of India calls for appropriate management practices. The reported study was aimed at developing vegetative and structural management strategies using field-measured data and the physically based distributed parameter Water Erosion Prediction Project (WEPP) model. The WEPP model was rigorously tested for a small untreated watershed of 239.44 ha, two micro watersheds of 12.99 and 10.68 ha treated with graded bunds and water harvesting tank and eight research plots of 20 m^2 each with different land uses located at a distance of 60 km from Mawsynram, the world's highest rainfall place in eastern Himalaya range. Daily runoff, sediment yield and nutrients load were monitored during the years 2003 and 2004. The model was calibrated by using the data set of 2003 and validated with the data set of 2004 for runoff and sediment yield at the outlet of the catchments. The WEPP model simulated surface runoff and sediment yield for the research plots and the untreated watershed with considerable accuracy as indicated by the low percent deviations D_V (within ±15%) and high simulation coefficients E_{NS} (>0.82) for the rainfall events during calibration and validation. Performance of the model in simulating runoff and sediment yield from a treated watershed using the calibrated parameters of the untreated watershed was not up to the mark possibly due to the minor differences in soil physical properties, average land slope and land use/land cover conditions of the untreated and treated watersheds. However, when the model parameters were recalibrated for the treated watershed, the performance of the model improved considerably. The model simulated the runoff and sediment yield from the treated watersheds quite satisfactorily during calibration and validation periods as indicated by the low values of D_V (within ± 10%) and high value of E_{NS} (>0.80). The model tended to under-predict the runoff and sediment yield during rainstorms of high magnitudes. The model was found to be most sensitive to rill erodibility, followed by hydraulic conductivity, interrill erodibility and critical shear stress of the soil in that order for sediment yield simulation and was quite sensitive to hydraulic conductivity only for runoff simulation. Simulation results indicated that soybean and peanut crops in upland situations could reduce sediment yield by 27% as compared to the traditional upland paddy cultivation whereas use of drill-no-tillage system and field cultivator in lowland caused reduction of sediment yield by 9% as compared to traditional tillage using spade and country plough. Vegetative measures could not restrict the soil loss from the untreated watershed within the tolerable limit of 11 Mg ha^{-1}. However, simulation of adequate numbers of check dams (26 numbers) in drainage line could control the sediment yield within the tolerable limit as indicated by simulation results. The results of the study indicates that the WEPP model performance is not quite sensitive to change in size of the catchment in the range of 20 m^2 to 240 ha and could be applied for developing vegetative and structural measures under high rainfall and steep slope conditions for catchments of different sizes. Runoff–sediment yield–nutrients loss relationships developed for the study watershed could be used for hilly watershed under similar hydrologic and climate conditions.

Keywords: Hilly watershed; WEPP; sediment yield; runoff; vegetative measures; structural measures; soil nutrient