ABSTRACT

When sources of water pollution are enumerated, agriculture is listed as a major contributor, which is also the victim of pollution. Intensive study on watershed basis is necessary for developing management strategies for abating the agricultural NPS pollution. The present study was undertaken to hydrologically evaluate two agricultural watersheds and their sub watersheds in eastern region of India with the objectives to develop synthetic UHs of different durations, compare the composite and distributed CN techniques and to identify critical areas contributing to NPS pollution of water resources and develop effective management strategies using a continuous simulation, distributed parameter model, AnnAGNPS. The watersheds considered for the study are Kapgari (973.5 ha) and Simana (8256 ha) located in West Midnapore district of West Bengal state in India. Hydrologic and water quality monitoring of the watersheds were done during the rainy seasons of 2002-05. All geomorphologic parameters of the watersheds were extracted using ARC/INFO GIS. The watersheds were converted into grids of 200 m × 200 m and grid wise slope, aspect, slope shape factor, soil characteristics etc. were found out by GIS analysis. The IRS satellite images for the year 2002 were classified using supervised classification with maximum likelihood classification algorithm in ERDAS/IMAGINE software to generate the LU/LC of the watersheds. Unit hydrographs for 1h, 2h and 3h duration were developed at the outlet of Kapgari and Simana watersheds. Time to rise (t_p), time base (t_b) and peak discharge (q_p) were found out for individual events and then average values were modeled with different geomorphologic parameters. Least square equations of all forms (linear, logarithmic, power, exponential, and polynomial) were developed taking UH parameters as dependant variables and individual geomorphologic parameters as independent variables. Best-fit regression equations (in power form) were developed between UH parameters and individual geomorphologic parameters. Nonlinear models were developed after optimizing the coefficients of the equations by using Gauss-Newton method of parameter optimization technique. The goodness-of-fit statistics revealed that all the UH models developed for Kapgari watershed were acceptable for simulation. Furthermore, these UH models were validated for nearby Simana watershed. From this study it was inferred that unit hydrograph parameters can be modeled with geomorphologic parameters, and be used to generate unit hydrograph for ungauged basin of similar hydrologic condition. The distributed as well as composite CN techniques were used to estimate runoff for Kapgari and Simana watersheds using initial abstractions of 0.2S and 0.3S. From this study it was revealed that distributed curve number approach with initial abstraction, 0.3 times of potential maximum retention of soil should be used for runoff estimation in small and medium sized agricultural watersheds of India having similar hydro meteorological conditions. AnnAGNPS model was calibrated for simulation of surface runoff, sediment yield and nutrient loss from Kapgari watershed using observed hydrologic and water quality data of the watersheds monitored during the rainy seasons of 2002-03. The calibrated AnnAGNPS model was validated for Simana watersheds for simulation of runoff, sediment yield and nutrient loss for the rainy seasons of 2003-05 and also validated for Kapgari watershed for 2004-05. Different statistical tests revealed that AnnAGNPS model simulates daily runoff, sediment yield and nutrient loss within the acceptable accuracy for both the watersheds. The calibrated model was then successfully used for identifying the critical sub-watersheds and for development of best management practices. Considering the LU/LC based management alternatives the most economical BMP for Kapgari watershed was noted to be conversion of fallow land to agriculture followed by contour bunding in agricultural lands, where as for Simana watershed

it is contour bunding in agricultural lands followed by converting fallow lands to agriculture. Considering agronomy based BMPs, it was inferred that the existing conventional tillage practice of the watersheds needs to be replaced by improved tillage practice like conservation tillage in order to minimize the sediment yield and nutrient losses. Moreover, fertilizer application rate of 80:40 kg ha^{-1} of N: P is also recommended to minimize the surface water pollution in the watersheds. The management strategies evolved in the present study can be used for abating non-point source pollution of surface water resources under similar hydro-geomorphologic conditions.

Keywords: NPS pollution, hydrology, water quality, remote sensing, GIS, AnnAGNPS