ABSTRACT

In the present study, physically based distributed hydrological modelling system MIKE SHE was applied for assessing the impact of the watershed structures on surface runoff and groundwater recharge. Two adjacent micro-watersheds, located in the western part of West Midnapore district of West Bengal, India, Guptamani (treated) and Manikpara (control) were selected for the present study. The modelling results of MIKE SHE for both treated and control micro-watersheds showed that the model simulated surface runoff and groundwater levels satisfactorily over the model area. Evaluation of the existing structures showed a significant reduction in surface runoff (9%) compared to the control micro-watershed, leading to moisture conservation and enhanced groundwater recharge (10%). Moisture conservation in subsurface layer due to recharge increased 4% actual evapotranspiration in case of the treated micro-watershed. To evaluate the impact of the watershed structures on surface runoff and groundwater recharge, three management scenarios i.e., simulation with no structures (S1); simulation with existing structures (S2); and simulation with existing structures and additional planned structures (S3) were considered. Simulation with S2 and S3 scenarios showed a notable decrease in surface runoff and increase in groundwater recharge and actual evapotranspiration compared to S1 scenario.

The effect of DEMs on modelling various hydrological cycle processes showed that the mean slope of DEM impacts the generation of surface runoff and groundwater recharge. The decrease in mean slope increased groundwater recharge and reduced surface runoff. Further, relative difference up to 10% in various hydrological cycle processes was observed among DEMs.

Rainfall trend analysis was carried out for the base period (1979 to 2009) and for the future projected rainfall (2010 to 2040). The base period showed an increasing trend, however, the projected annual rainfall under RCP 4.5 and RCP 8.5 scenarios showed decreasing trend. The decreasing trend for the *rabi* season rainfall was seen for the base period, RCP 4.5 and RCP 8.5 scenarios. The long-term simulations were carried out with the combination of climate scenarios and three crops (rice, mustard and chickpea) with the projected rainfall data from 2010 to 2040 for RCP 4.5 and 8.5 scenarios from RegCM4 climate model. The yield evaluation for current crop (rice) and two proposed crops in crop diversification (mustard and chickpea) for the *rabi* season showed maximum returns of INR 2,961/ha, INR 22,940/ha and INR 19,050/ha for rice, mustard and chickpea crops, respectively. The maximum returns showed that rice is less remunerative crop compared to mustard and chickpea crops. Crop diversification in the *rabi* season reduced the risk of the crop failure and augmented the income of marginal and small farmers as compared to current rice crop. The study demonstrated the advantages of applying a physically based comprehensive hydrological modelling tool MIKE SHE to assess the impacts of conservation measures on watershed hydrology.

Key words: Hydrological modelling, MIKE SHE, watershed structures management, effect of DEM, crop diversification