ABSTRACT

Changes in both rainfall pattern and land use/land cover (LULC) have profound impacts on water resources such as streamflow, soil moisture, groundwater recharge, and ultimately on the economy of a country. Therefore, the spatiotemporal analysis of rainfall variability coupled with hydrological modeling is essential for the efficient planning and management of water resources under climate change. The overall goal of this study is to examine the trend in the rainfall over the north-eastern region of India and Tripura state as well as to analyze changes in hydrological fluxes in the Manu-Deo River Basin (MDRB) under present and future climate change scenarios. To achieve this goal, the rainfall data of 119 years (1901–2019) acquired from 16 rain gauge stations across the northeast region of India were used for trend analysis. The results revealed a significant change in the rainfall including the shift of the world's wettest place from Cherrapunji to Mawsynram (located at 15-kilometer from the initial location) from the year 1973 onwards. Thereafter, stations, satellite and reanalysis data of Tripura state were examined for trends and rainfall variability as the river basin falls in this area. The analyses indicated that the monsoon rainfall decreases at a rate of 0.025–0.216 mm/year, with the highest declining rate (-0.216 mm/year) at the Sabroom rainfall station. In addition, the Soil and Water Assessment Tool (SWAT) was calibrated and validated for MDRB using the datasets of 1984–2006 and 2007–2016, respectively. The model performance was found reasonably well during calibration and validation periods at the daily time scale, with the Nash Sutcliffe Efficiency and coefficient of determination of 0.54 and 0.55, and 0.52 and 0.72, respectively. The analysis of the streamflow of 1985–2019 period revealed a decreasing trend in the streamflow. However, an increasing trend in the evapotranspiration (ET) and a decreasing trend in the baseflow (BF) were found. These findings suggest an adverse impact on the agricultural production during lean periods. Furthermore, the analysis of RCP 2.6 and 6.0 scenarios for the monsoon season at future time scales revealed a reduction in different flow components, although the analysis of RCP 8.5 scenario indicated increased water availability. On the other hand, the changes in LULC is another important reason for this shift in rainfall in the past decades, which is confirmed by noticeable reduction in the vegetation area in the northeast region during the period; it shows the extent of anthropogenic influence on the regional weather and climate. In contrast, the combined effect of LULC and climate change indicated an increasing trend in the streamflow as compared to other hydrological fluxes such as ET, BF, Shallow Aquifer Recharge (SAR), and Deep Aquifer Recharge (DAR) for all the RCP scenarios. Based on the findings of this study, suitable plans can be devised for sustainable land and water resources management in the region under changing environmental conditions for present and future generations.

Keywords: Trend analysis, Streamflow simulation, SWAT, Climate change impact, Land use/Land cover, Hydrological fluxes, River basin management.