ABSTRACT

The Subarnarekha river basin in Eastern India, draining an area of 19,296 km^2, is facing considerable land and water resources constraints due to rapid deforestation, urbanisation and population growth. The present study focuses on the integrated management of land and water resources to achieve the sustainable development goals (SDGs), i.e., clean water and sanitisation (SDG-6) and life of land (SDG-15), in the basin. The study deals with two aspects: the first one highlights the ongoing sustainability issues, i.e., climate change, land use land cover (LULC) change, rainfall pattern change, and the combined climate and LULC changes, while the second deals with the spatial pattern-oriented evaluation of a distributed hydrological model in the basin. Two distributed hydrological models, MIKE SHE/MIKE HDRO RIVER and SWAT, are used to achieve the objectives. Regional climate models (RCMs) are utilised to obtain future climate projections, while several hybrid models, i.e., a combination of machine learning and statistical techniques, are used for LULC predictions. For simulating the combined impact of climate and LULC changes, a spatially explicit integrated modelling system, i.e., a combination of LULC change model, hydrological model, and set of climate models, is developed. The segregation of uncertainty associated with the future streamflow is performed through ANOVA. Moreover, three spatial performance metrics are used to carry out the spatial pattern-based evaluation. Overall, results suggest that the Multilayer perceptron Markov model (MLP-MC) outperforms other techniques for LULC prediction. The MLP-MC model projections show that in comparison to 2011, by 2030, agricultural land and dense forest may decrease by 8.3 and 28.2%, respectively, while scrubland and the built-up area may increase by 22.5 and 87.3%, respectively. A hybrid scenario, i.e., the combination of sustainable and economic growth, is the most plausible for the basin. Rainfall magnitudes with smoothened means show the possibility of early monsoon occurrences (8 to 23 days ahead) during future periods. Results under combined climate and LULC changes suggest that low, high, and medium flows will probably increase by 20%-85% in future, indicating a higher risk of floods, especially in the 2050s and 2080s. Segregation of uncertainty suggests that the RCMs are the main contributor (>45%) to the uncertainty in streamflow projections. Spatial pattern-oriented evaluation of the hydrological model results in an acceptable performance of the model in mimicking the observed spatial patterns temporally. The uncertainty analysis shows reasonable predictive ranges, with a 95 per cent prediction uncertainty (PPU) band enclosing 83%-97% of actual evapotranspiration and 85%-98% of the soil moisture observations. These findings will help achieve the SDG-6 and SDG-15 over the Subarnarekha and nearby basins of Eastern India.

Keywords: *ANOVA, climate change, LULC, machine learning, MIKE SHE/MIKE HYDRO RIVER, SDG, SWAT, uncertainty*