ABSTRACT

Understanding the hydrological response of tropical watersheds under future climate and land use scenarios is critical for sustainable water and sediment management. This study evaluates the separate impacts of climate change and land use/land cover (LULC) transitions on streamflow, sediment yield, and water balance components in the upper catchment of the Hirakud Reservoir, Mahanadi Basin, India. Using the SWAT model driven by historical LULC maps and bias-corrected high-resolution climate projections from CLIMEA-BCUD for the SSP1-2.6 and SSP5-8.5 scenarios, simulations were conducted for the 2024–2050 period. Compared to the baseline (1985–2021), precipitation is projected to rise by 15% (SSP1-2.6) and 9.79% (SSP5-8.5), while maximum temperatures increase by 0.4–1.0°C and 1.2–1.6°C, and minimum temperatures by 2.4°C and 2.6°C, respectively. Despite the wetter and warmer climate, surface runoff declines sharply by 59.9% and 63.2%, primarily due to enhanced infiltration, higher soil moisture retention, and increased evapotranspiration (ET). Water yield increases by 69.9% (SSP1-2.6) and 57.09% (SSP5-8.5), driven by improved base flow and aquifer recharge. Notably, streamflow during the non-monsoon season rises, shifting the hydrological regime toward groundwater-supported flows. Importantly, sediment yield is projected to decrease, due to reduced surface runoff and altered rainfall characteristics. These findings indicate a climate-induced transition from surface- to subsurface-dominated hydrology, emphasizing the need for integrated management strategies that enhance recharge, reduce erosion, and adapt reservoir operations for future hydro climatic variability.

Key Words: Climate change, SWAT, Stream flow Analysis, Sediment Analysis, LULC Analysis