

Abstract

The Teesta River basin is one of the least studied river basins in India due to its inaccessible Himalayan terrain, extreme climate, and scarcity of ground-based observational data. In this study, daily rainfall estimates from various sources were compared with ground-observed rainfall with the objective to identify best rainfall estimate which is used in gap filling in data-scarce part of Teesta basin before going for hydrological modeling using Soil and Water Assessment Tool (SWAT). Rainfall estimate from the Climate Forecast System Reanalysis (CFSR) showed better evaluation statistics than others in the data-scarce part of the Teesta basin. Trend analysis of streamflow and sediment yield was carried out in the upper and middle reaches of the Teesta River and changes were linked to the climatic and anthropogenic factors. A significant contribution of snowmelt water has been detected in streamflow in stations located in upstream areas. Declining trend in streamflow in the Teesta results in a decline in the inflow to downstream. Energy related to deposition and transportation of sediments at various reaches of the Teesta River was assessed and linked with different floodplain formations. In addition, spatiotemporal lateral movement of the channels of the river in the plains was assessed. Land use and land cover (LULC) change modeling for the future period was carried out using the Cellular Automata (CA)-Markov model, based on the historical LULC changes of the study area. The results suggest that rocky land, agricultural land, and the built-up area would increase to 18.1%, 17.0% and 82.0%, respectively, whereas snow covered area would reduce to 51.0% by the year 2040 in the Rangit sub-basin of Teesta basin. Hydrological modeling carried out with the SWAT model showed that significant contribution of lateral flow (50%) and shallow groundwater flow (33%) on catchment water yield. Future precipitation data of regional climate model (RCM) showed that there will be 13.3 and 14.0% increase in precipitation under Representative Concentration Pathways (RCP) 4.5 and 8.5 scenarios during 2040-50 compared to baseline period (1998-2005). The model suggested a significant increase in streamflow particularly during the monsoon months under changed precipitation rather than changed land-use scenarios. This study provides insights of different hydrological components which will help in better managing of water resources of the Teesta basin under changed land use and precipitation conditions.

Keywords: Hydroclimatological variable, Trend analysis, Stream power, land use change, CA-Markov model, Hydrological modeling