The Impact of future Climate Change on Runoff and Sediment Yield towards the Geba reservoir, northern Ethiopia

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Abstract

The objective of this study was to assess the impact of future climate change on runoff and sediment yield for the planned lake (reservoir) on Geba river, using Statistical Downscaling Model (SDSM) and the Soil and Water Assessment Tool (SWAT) model. Three climatic variables (precipitation, maximum air temperature and minimum temperature) were downscaled at Hawzen station, assuming other climatic variables to be constant for the near, mid and long-term future using General Circulation Model (GCM) (HadCM3 A2a and B2a emission scenarios). SDSM was used to downscale to the study area, and the downscaled data was used as an input to the spatially-distributed Soil Water Analysis Tool (SWAT) model to predict future monthly surface runoff. On an annual basis, precipitation showed a decreasing trend while maximum and minimum air temperature showed an increasing trend. Precipitation decreases by 7.84% in the 2020s and by 29.93% in 2080s for A2a scenario and by 6.78% in 2020s and 21% in 2080s for B2a scenario. Similarly maximum air temperature showed an increase by 0.002^{o}C in 2020s and by 0.02^{o}C in 2080s for A2a scenario and by 0^{o}C and 0.04^{o}C for B2a scenario. Minimum air temperature also showed an increase by 0.1 ^{o}C in 2020s and by 0.48^{o}C in 2080s for A2a scenario and similarly by 0.16^{o}C and 0.36^{o}C for B2a scenario. The hydrological model was calibrated and validated at the outlet of the catchment and the performance was checked using statistical parameters and the performance was found to range from good to satisfactory. The results of the downscaling for the three climatic variables were used as an input for the hydrological model to assess the impact of the changes in these climatic variables on stream flow discharge and on sediment yield. Furthermore, runoff discharge and sediment yield for the catchment showed a decreasing trend for all time horizons for both A2a and B2a scenario. The decrease in precipitation expected for the future is higher in the rainy season, which implies a reduction in stream flow towards the Geba reservoir in the rainy months of July, August and September by respectively 8.6%, 6.9%, 2.5% in 2020s, by 12.5%, 11.8%, 3.2 % in 2050s and by 13.8%, 12.4%, 3.8% in 2080s.

Keywords: Climate change, GCM, SDSM, SWAT, Stream flow, Sediment yield