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Impact of climate change on hydrological response in the head waters of Tekeze basin, Northern Ethiopia

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Climate change impacts have been reported on different natural and man-made systems, including the water resource system in different parts of the world. This study deals with the analysis of climate change impact on the hydrological response of the Agula catchment (area = ca. 700 km^2) of the Tekeze basin in Northern Ethiopia. Baseline and future climate variables were generated using HADCM3 a General Circulation Model (GCM) which is considered as the most advanced tool for estimating future climatic conditions. Two GCM-derived scenarios (HadCM3 A2a and B2a emission scenarios) were used for the climate projection, and Statistical Downscaling Model (SDSM) to downscale to the study area. Moreover, a spatially-distributed Soil Water Analysis Tool (SWAT) model was used to predict future annual potential evapotranspiration (PET) and surface runoff. The projected average annual maximum air temperature (max T°) and minimum air temperature (min T°) for the future shows increasing trends. For the A2a scenario an increase in min T° between 1.26 to 2.56 °C while an increase in max T° from 1.22 to 2.20 °C is predicted, with lower and higher values found in 2020s and 2080s respectively. Similarly, for B2a scenario, the increase in min T° ranges between 1.18 °C in 2020 and 2.55 °C in 2080, and the increase in max T° ranges between 0.99 °C in 2020 to 1.81 °C in 2080. The scenarios developed for the years 2020-2080 generally showed an increasing trend for both min T° and max T° while the result of downscaled precipitation did not show any systematic increase or decrease in all future time horizons for both A2a and B2a scenarios though there is an overall increase compared to the 1980-2011 annual precipitation (baseline). In addition, SWAT model results show an increasing trend in PET considering 1980-2011 annual PET (1522.31mm) as a baseline. Accordingly, PET increases by 4.5%, 10.1% and 14% for A2a, and by 5.7%, 10.3%, and 14.2% for B2a in 2020s, 2050s and 2080s respectively. The global warming simulated by all GCMs under A2a and B2a scenario will increase PET and hence reduce surface runoff volume by 2.8- 5.7 % for the next 90 years in both scenarios.