IAHS2017-9-7
IAHS Scientific Assembly 2017

Potential Impact of Climate Change to the Future Streamflow of Yellow River Basin Based on CMIP5 Data

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The Yellow River basin (YRB) is the largest river basin in northern China, which has long been suffering water scarcity and drought problems. Therefore, prediction of potential impact of climate change to the future streamflow in this basin scale could also serve as a scientific reference for local water security and early warning issues. In this study, we have investigated the potential impacts of climate change on the Yellow River basin that could significantly alter the hydrology of the river basin. The future precipitation and temperature over YRB were developed based on 8 climate models and three emissions scenarios (RCP4.5 and RCP8.5) from phase five of the Coupled Model Intercomparison Project (CMIP5) by means of equidistant CDF matching (EDCDFm) statistical downscaling approach. The downscaled temperature and precipitation data generally compares well with the observational data from 101 meteorological stations during the historical period (1961 to 2005). Then the semi-distributed variable infiltration capacity distributed hydrologic model (VIC) was developed based on downscaled temperature and precipitation for simulating streamflow in the future period over YRB. We used the 8 CMIP5 model downscaled outputs at 0.25 degree by 0.25 degree (resolution) as the initial and boundary conditions to VIC model for simulating the climate of YRB for the base (1961 to 2005) as well as the future periods based on the RCP4.5 and RCP8.5 climate change scenarios from 2021 to 2050. Next, using this model setup, future climate and streamflow of YRB were simulated to assess the regional impact of climate change over the YRB. Then, the impact of climate changing on streamflow, evapotranspiration, and soil moisture were analyzed. Finally, the assessment of the impact of climate change on the water and food security resources were analyzed, based on the potential population growth trend and other social statistics data in the YRB region. The results show a general decrease of streamflow. Under a warmer future climate, more evaporation loss is expected in the summer which could offset the projected increase in summer precipitation, resulting in an overall decrease in streamflow and lower water levels from 2021 to 2050. There should be a suitable water resources planning to meet the demands of growing populations and future climate changing in this region.
Keywords: Statistical downscaling method, CMIP5, Water security, Yellow River Basin