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Understand and Quantify Long-Term Hydroclimate Trends in the Highland Lakes Watersheds via Spatially Distributed Hydrological Modeling

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Abstract

The Highland Lakes on the Colorado River in Texas, specifically lakes Buchanan and Travis, supply water for the Austin metropolitan area. The population of the Austin area is projected to reach 4.5 million by 2040, which will lead to an increased water demand. The goal of this study is to generate a long-term hydroclimate dataset using hydrological modeling, and to examine the observed trends and their causes to help understand the changes in runoff in the lower Colorado River basin. The lower Colorado River basin includes the main stem of the Colorado River and four sub-watersheds – Pecan Bayou, San Saba River, Llano River and Pedernales River. The Distributed Hydrology Soil Vegetation Model (DHSVM) includes a 300-meter spatial resolution and a 12-hour time step from 1950-2018 to simulate soil moisture, evapotranspiration, runoff and streamflow. The model parameters are calibrated during the period of 1951-1990 by comparing the simulated streamflow with observed naturalized flows using three statistical criteria: relative bias (RB), coefficient of determination (R^2), and the Nash-Sutcliffe efficiency (NSE). The simulated streamflows are further validated against naturalized flows over the period of 1991-2015. The streamflow trends, along with other hydroclimate variables, are examined and compared across all watersheds during the study period. In addition, sensitivity analyses are conducted to evaluate how changing temperatures and precipitation will affect streamflow in the watersheds. This long-term hydroclimate dataset for the lower Colorado River basin not only provides a comprehensive understanding of historical trends, but also serves as a baseline for future analysis.

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Abstract Text:

The Highland Lakes on the Colorado River in Texas, specifically lakes Buchanan and Travis, supply water for the Austin metropolitan area. The population of the Austin area is projected to reach 4.5 million by 2040, which will lead to an increased water demand. The goal of this study is to generate a long-term hydroclimate dataset using hydrological modeling, and to examine the observed trends and their causes to help understand the changes in runoff in the lower Colorado River basin. The lower Colorado River basin includes the main stem of the Colorado River and four sub-watersheds – Pecan Bayou, San Saba River, Llano River and Pedernales River. The Distributed Hydrology Soil Vegetation Model (DHSVM) includes a 300-meter spatial resolution and a 12-hour time step from 1950-2018 to simulate soil moisture, evapotranspiration, runoff and streamflow. The model parameters are calibrated during the period of 1951-1990 by comparing the simulated streamflow with observed naturalized flows using three statistical criteria: relative bias (RB), coefficient of determination (R^2), and the Nash-Sutcliffe efficiency (NSE). The simulated streamflows are further validated against naturalized flows over the period of 1991-2015. The streamflow trends, along with other hydroclimate variables, are examined and compared across all watersheds during the study period. In addition, sensitivity analyses are conducted to evaluate how changing temperatures and precipitation will affect streamflow in the watersheds. This long-term hydroclimate dataset for the lower Colorado River basin not only provides a comprehensive understanding of historical trends, but also serves as a baseline for future analysis.

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