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Climate Change's Effects on Future Water Supply for Irrigation and Hydropower Generation

Xi Liu*

Department of Blue and Green Development, Shandong University, Weihai, 264209, China

Abstract

The Omo-gibe basin in Ethiopia's streamflow, seasonal distribution, and amount of precipitation were expected to be affected by climate change in this study. A quantile mapping approach were used to statistically downscale and bias-correct climate change projections made using data from fifteen regional climate models (RCMs) participating in the Coordinated Regional Climate Reduction Experiment (CORDEX)-Africa. Temperature and precipitation projections were made using the RCP 8.5 and RCP 4.5 emission scenarios. In the near future (2025-2050), medium future (2051-2075), and distant future (2076-2100), climate and streamflow estimates from a mean ensemble of RCMs were compared to the reference (1989–2019). To establish if a change is statistically significant and to identify trends in temperature, precipitation, and streamflow, Mann-Kendall (MK) trend testing was utilised. The hydrological SWAT (Soil and Water Assessment Tool) model was employed to project the effects of climate change on streamflow. The emission scenarios predicted significant positive (increasing) temperature changes but significant negative (declining) precipitation and streamflow changes, respectively, according to RCP4.5 and RCP8.5.

Keywords: Water supply • Streamflow • Hydropower generation • Irrigation

Introduction

Precipitation, temperature, and streamflows across river basins have all been significantly impacted by climate change on a local, regional, and global scale. Much attention has been paid to trend analysis of these meteorological and hydrological variables to help with change prediction and management of water resources for a range of sectors and applications. To evaluate both long-term and short-term trends in temperature, precipitation, and streamflow data, it is necessary to understand these hydroclimatic variables, regardless of whether a change is statistically significant or not, and to detect trends in changes due to the future impact of climate change. It is crucial to look at the streamflow in the riverbasin as well as the water supply both now and in the future. The development and management of water resources, long-term economic development, and the assessment of the future impact and behaviour of climate change all depend on the regional and temporal distribution of temperature, precipitation, and streamflow patterns [1,2].

With three cascading dams, Gilgal Gibe I, Gibe II, and Gibe III, the Omo-Gibe River is one of Ethiopia's most significant river systems and provides 45% of the nation's hydroelectric electricity. Water restrictions for hydropower production and other purposes in the Omo-Gibe Riverbasin have been brought on by climate change over the past ten years. The Omo-Gibe River Basin's Gibe III dam, according to the Ethiopian government, created a 476 megawatt energy deficit as a result of the effects of climate change, which were disclosed in May 2019. Predicting and quantifying how future climate change will affect precipitation frequency, amount, seasonality, and streamflow amplitude in the Omo-Gibe River watershed is crucial [3].

***Address for Correspondence:** Xi Liu, Department of Blue and Green Development, Shandong University, Weihai 264209, China; E-mail: liuxi@12sdu.edu.cn*

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Description

In this study, the probable effects of climate change on future rainfall, seasonal distribution, and streamflow of the Omo-Gibe River were estimated and projected. Using a multi-model ensemble of GCMs to RCMs models statistical downscaled and quantile mapping bias-corrected climate data, this is based onprecipitation and temperature estimates under the RCP 4.5 and 8.5 climate change scenarios. The Soil Water Assessment Tool (SWAT) hydrological model receives data from streamflow simulation and projection utilising RCMs models. By using the Mann-Kendall (MK) trend test, it is possible to determine whether a change is statistically significant and to spot a shift in the trend of hydroclimatic variables as a result of potential climate change effects. The development of suitable and efficient climate change adaptation methods depends on an understanding of the effects of future climate change on precipitation, seasonal distribution, and streamflow. Additionally, it is necessary for long-term water resource sustainability, choices for mitigating and adapting to climate change, and effective management of water resources in the future. This makes it possible for planners, politicians, legislators, and policymakers to make better decisions and plan future projects to mitigate the effects of climate change within the basin. It also benefits water managers, river basin planners, government agencies, river basin administrations, and engineers [4].

With the help of the trend and Kendall software packages, changes in streamflow, precipitation, and statistical significance of change were evaluated. Determine whether hydrometeorological time series data are increasing, decreasing, or staying constant over time using this technique for pattern recognition and analysis. All trend detection, evaluation, and historical time series analysis of trend changes and change points were verified using a Github project. These CRAN package libraries offer free software downloads and comprehensive user manuals in addition to being publicly accessible via the CRAN repository and Github version control system. The primary hydrologic variable that may be utilised to simulate how different hydrologic cycle and process components will react to future climate change is river basin streamflow. The SWAT model was used to simulate and forecast the yearly, seasonal, and monthly fluctuations in streamflow of the most sensitive parameter responses to streamflow magnitude and streamflow-relevant factors were used to calibrate the SWAT model [5].

Conclusion

The Zadoks scale was used to examine the phenology of wheat. Crop growth and development stages were noted, with the corresponding stage being visible in 50% of the plants. The phenological phases, including maturation, senescence, and the emergence, commencement, and termination of anthesis, were noted. Twenty plants were tagged in each of the three replications after emergence. Following seedling emergence, a randomly chosen 1 m^2 area from each replicate was harvested and dried to a consistent weight for 48 hours at 70°C to quantify crop growth. Although there were hardly any infestations of pests and diseases, weeds were successfully managed by the use of herbicides. Typically a significant statistically rising trend. At the eleven meteorological gauging stations, the temperature time-series data from the nine meteorological stations showed a significant level (0.05) upward trend, while the results from the time-series data from the two meteorological gauging stations showed a significant upward trend and two stations found no statistically significant monotonic trend change.

Acknowledgement

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Conflict of Interest

None.

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