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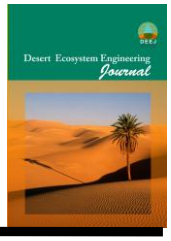

Investigating the Effect of Climate Change on Future Temperature, Precipitation, and Droughts Using BNU-ESM and HadGEM2 Models

Ali Azareh[1], Elham Rafiei Sarooi[2]*, Meysam Jafari [3]

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Extended Abstract

Introduction: while global Climate Models (GCMs) are designed to assess climate change, they can only simulate large-scale atmospheric circulation model data. Therefore, these models' results need to be downscaled, for which there are different methods such as dynamical and statistical ones.

This study sought to investigate the effect of climate change on temperature, precipitation parameters, and drought in 2050-2031 and 2070-2051 periods in Khatam city using two general circulations models, namely BNU-ESM and HadGEM2. Moreover, as using only one downscaling model to achieve a perspective concerning the future climate of the study area with the slightest uncertainty does not seem logical, LARS-WG and Change Factor (Delta) were used as two downscaling models under RCP2.6, RCP4.5, and RCP8.5 scenarios.

Material and methods: The Khatam city is located south of the Yazd province, Iran. In this study, the data obtained from the synoptic station of Marvast were applied. The historical data from 1996 to 2017 comprised the daily temperature and precipitation. Moreover, the data collected from two large-scale models including HadGEM2-ES and BNU-ESM and two statistical downscaling methods, i.e., LARS-WG and Change Factor (CF), were applied to simulate precipitation, temperature, and drought in Khatam city under three scenarios including RCP2.6, RCP4.5, and RCP8.5 in 2031-2050 and 2051-2070 periods. Also, statistical indices such as R2, RMSE, and NSE were used to evaluate the accuracy of the CF method and the LARS-WG model. To assess the drought in the baseline period (1996-2017) and the two future periods, the standardized precipitation index (SPI) was used based on a 24-month scale.

1. Department of Geography, University of Jiroft, Kerman.
2. Department of Ecological Engineering, Faculty of Natural Resources, University of Jiroft, Kerman; ellrafiei@ujiroft.ac.ir
3. Ph.D Student of Watershed Management Engineering, Faculty of Natural Resources, University of Tehran
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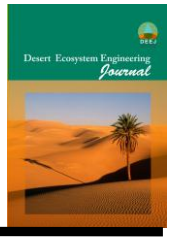

Results: The results of temperature variations regarding 2031 to 2050 and 2051 to 2070 periods indicated that based on the LARS-WG model, the Khatam city would be affected by global warming, with temperature changes suggesting a 1.75, 1.94, and 2.12 °C increase from 2031 to 2050, and 2.07, 2.71, and 3.87 °C from 2051 to 2070 under the scenarios of RCP2.6, RCP4.5, and RCP8, respectively.
The results concerning annual precipitation variations based on the LARS-WG model showed that precipitation would be decreased by 6.1, 14.2, and 35.2% from 2030 to 2051, and by 26.8%, 35.5., and 51.5% from 2051 to 2070 under RCP2.6, RCP4.5, and RCP8.5 scenarios, respectively. Also, investigating annual temperature and precipitation changes based on the BNU-ESM model suggested an increase in temperature by 1.06, 1.83, and 2.13 °C from 2031 to 2050, and by 1.084, 1.94, and 2.82 °C from 2051 to 2070 under the RCP2.6, RCP4.5, and RCP8 scenarios, respectively.

The results of annual precipitation variations based on the BNU-ESM model showed that precipitation would decrease by 14, 22.1, and 32.9% from 2030 to 2051 and 24.2%, 33.9, and 48.1% during 2051 to 2070 under RCP2.6, RCP4.5, and RCP8.5 scenarios, respectively. It should be noted that after determining the climatic parameters for future periods, the SPI values for future periods and three scenarios can be determined.
Moreover, the results indicated an increase in meteorological drought based on the HadGEM2 and BNU-ESM models for the two future periods under all scenarios compared to the baseline period. Also, the BNU-ESM showed higher drought compared to the HadGEM2 model.

Discussion and conclusion: as mentioned earlier, both downscaling models used in this study had a high accuracy in predicting future precipitation and temperature, which is consistent with the results found by Sadidi et al. (2020) in Kerman province, and the findings reported by Panahi and Khorramabadi (2020) in East Azerbaijan province. The study's findings concerning the two future periods' temperature changes in both models indicated that the Khatam city would be affected by global warming, indicating an increase in temperature from 2031 to 2050 and from 2051 to 2070 under RCP2.6, RCP4.5, and RCP8.5 scenarios, respectively. Also, results regarding the precipitation changes in both models suggested a decrease in precipitation from 2031 to 2050 and from 2051 to 2070 under RCP2.6, RCP4.5, and RCP8.5 scenarios, respectively, with the greatest decrease, occurred under the RCP 8.5 scenario, that is in accordance with the results found of Givati et al. (2019) in the upstream of the Jordan River. Moreover, the current study's results indicated the possibility of more severe droughts in future simulated periods by the LARS-WG downscaling model and CF method, which is compatible with the findings reported by Lucas and Et al. (2008), Lebedzki (2006), and Saleh Pourjam et al. (2014). It could be argued that the increase in the severity of drought in future periods is due to the increase in temperature and decrease in precipitation, which is also confirmed by the results found by Node Farahani et al. (2015). According to this study's results concerning the comparison of the two GCM models, it could be said that the BNU-ESM model can predict the lowest precipitation, the highest temperature, and the highest number of years regarding the severe drought compared to the HadGEM2 model.

Keywords: RCP scenarios, Drought, Change Factor, LARS-WG, Khatam city.