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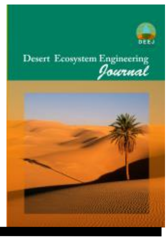

Investigating Meteorological and Hydrological Drought in Zarrineh River Basin

Maliheh Rahvareh[1], Baharak Motamedvaziri[2] *, Alireza Moghaddamnia[3], and Ali Moridi [4]

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Extended Abstract

Introduction: Affecting the hydrologic cycle, climate change may increase the chances of natural hazards occurrence, including drought, which is considered as one of the most destructive types of such hazards. On the other hand, considering the increasing trend of global temperature and its impact on local climates, climate change is predicted to alter the frequency and intensity of extreme events such as drought. Meanwhile, General Circulation Models (GCMs) have been used in recent decades to predict future climate changes under different emission scenarios, and various drought monitoring indicators have been developed to assess drought.

Zarrineh River basin is regarded as one of the main sub-basins supplying the inflow of water to Lake Urmia, which is threatened by numerous long-term droughts. Therefore, as the drying of the lake may bring about a wide range of economic, social, and environmental consequences for the region, monitoring drought and implementing water resources management programs play pivotal roles in preventing the lake to get dried.

Material and methods: Located northwest of Iran, Zarrineh River basin covers an area of 12512 km2, being bounded by Iranian West and East Azerbaijan provinces and the Kurdistan province. This study used the meteorological data, including precipitation rate, and minimum and maximum daily temperature collected from four synoptic stations during the 1990-2018 period to simulate runoff. Also, the monthly runoff rate was collected from five hydrometric stations during the 1996-2017 period to calibrate and validate the SWAT model. Moreover, the data obtained from the general circulation model (HADGEM2-ES) and statistical downscaling methods (CCT) were used to simulate precipitation and temperature under RCP2.6 and RCP8.5 emission scenarios for the future period (2025-2049). Finally, the SPI was applied to evaluate the meteorological drought in the base and the future periods, and the SRI obtained from the outputs of the SWAT model was used to evaluate the hydrological drought.

1. Ph.D Student of Watershed Management Science and Engineering, Faculty of Natural Resources and Environment, Science and Research Branch, Islamic Azad University, Tehran
2. Associate Professor, Department of Nature Engineering, Faculty of Natural Resources and Environment, Science and Research Branch, Islamic Azad University, Tehran; bmvaziri@gmail.com
3. Associate Professor, Department of Reclamation of Arid and Mountainous Regions, Faculty of Natural Resources, College of Agriculture and Natural Resources, University of Tehran, karaj.
4. Assistant professor, Faculty of Civil, Water and Environmental Engineering, Shahid Beheshti University, Tehran
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Results: The data collected from five hydrometric stations were parameterized and calibrated on discontinuous stream networks. Accordingly, it was found that the R^2 values varied from 0.52 and 0.70 for calibration and from 0.44 to 0.73 for validation. However, the NSE values varied from 0.52 to 0.64 for calibration and from 0.42 to 0.64 for the validation stage. Moreover, the model's outputs were found to be satisfactory for most hydrometric stations, indicating the applicability of the SWAT model to the ZRB.

On the other hand, based on the CCT model under the RCP8.5, the results of temperature and precipitation variations throughout the 2025-2049 period indicated that compared to the observation period, annual precipitation would decrease by 2.9% in the future period, and the annual minimum and maximum temperature rates would increase by 2.4°C and 3.6°C, respectively. Furthermore, the analysis of the annual temperature and precipitation changes under the RCP2.6 revealed that compared to the observation period, the precipitation rate would increase by 3.6%, and the annual minimum and maximum temperature would increase by 1.8°C and 3°C, respectively.

Moreover, the results of the SPI analysis for the future period under the RCP8.5 indicated the occurrence of the extreme drought event. However, while the frequency of severe drought did not change significantly for the future period under both scenarios, the frequency of moderate drought decreased for the future period compared to the base period. On the other hand, the most extreme hydrological drought in terms of the SRI was observed in basin 9 during the base period (equal to -3.02). It was also found that the most hydrological drought occurred in basins 10 and 2 throughout the base period. Furthermore, the most extreme hydrological drought for the future period was found as -4.13 in sub-basin 8 under the RCP8.5, which is greater than that of the base period.

Discussion and conclusion: The results suggested the satisfactory applicability of the SWAT model for simulating runoff in Zarrineh River basin, as the model considers almost all the physical conditions of the basin for the simulation process, possessing a wide variety of inputs to do so. The results of the analysis of temperature changes for the future period showed that the average minimum and maximum annual temperature would increase in the basin.

Moreover, the results of the analysis of annual temperature and precipitation changes under the RCP2.6 revealed that compared to the observation period, the precipitation rate would increase by 3.6%, and the annual minimum and maximum temperature rate would increase by 1.8°C and 3°C in future, respectively. On the other hand, according to the results of SPI and SRI analysis for the future period, it was found that the intensity of meteorological and hydrological drought would increase on average in the basin under both scenarios (RCP2.6 and RCP8.5). Also, the results of the RCP8.5 suggested the possibility of a more severe drought compared to the RCP8.5.

Considering an increase in minimum and maximum temperature found for the future period, we can expect an increase in the evaporation rate, probably leading to an increase in the severity of drought and a decrease in water resources of the Zarrineh River basin, which, in turn, will reduce the discharge of the basin's water flow to the Urmia Lake.

Keywords: Climate Change, Drought, Zarrineh River Basin, SPI, SRI, SWAT.