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Assessing the Performance of SDSM Models in Downscaling Annual Precipitation and Temperature Values Simulated Via CANESM2 Model: A Case Study of East Azerbaijan Province

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Extended Abstract

Introduction: Covering an area of 45490 square kilometers, the East Azerbaijan province is located in the northwest corner of the Iranian plateau at the range of 45 degrees 7 minutes to 48 degrees 20 minutes' east longitude and 36 degrees 45 minutes to 39 degrees 26 minutes north latitude, being considered the 10th largest Iranian province. In general, the East Azerbaijan province is a mountainous region, about 40% of whose surface is mountainous, 2.28% of its surface is hilly, and 8.31% of its surface comprises of plains (including mountainous plains). Moreover, the province generally enjoys a cold and dry climate. However, the region has different climates due to its diverse topography. Affected by the cold northern and Siberian winds and the Mediterranean and Atlantic seas' humid winds, the province is a cold and mountainous region that is classified as a semi-arid region in terms of climate, whose average annual precipitation rate is 250-300 mm.

Research method
Introduction of SDSM Exponential Micro Scale Model
Weibel et al. (2005) used a multivariate regression model called SDSM to examine the effects of climate change on statistical downscaling, in which the station's daily forecast data (predicted), large-scale NCEP variables (predictor), and large-scale variables of general circulation models under various diffusion scenarios serve as inputs for future study periods. The predictor outputs have many variables. This study used the meteorological data collected from synoptic stations, NCEP data, and CANESM2 data under two RCP 2.6 and RCP 4.5 scenarios. The calibration of the model was performed using the NCEP data. Moreover, the temperature and precipitation rates of Tabriz, Mianeh, and Sarab stations were predicted for the three periods of 2020-2050, 2051-2080, and 2080-2100, which were then compared with the base period. It should be noted that the SDSM model performs better than other models because it combines both regression and probabilistic methods to produce meteorological data, and it is, therefore, one of the best models in this regard compared to other models.
Application of the SDSM model to the study basin

This study used the SDSM 5/3 model for statistical downscaling. It also used the data regarding the temperature and precipitation collected from three synoptic stations (Tabriz, Mianeh, Sarab), each of which contained 31 statistical years. The SDSM model is performed in several stages, including selecting predictor variables; calibration and validation; model performance review; developing climate scenarios for RCP 2/6 and RCP 4/5 and calibration.
Assessing the Performance of the SDSM Model

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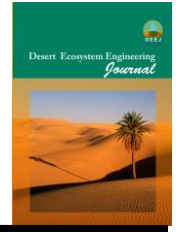2MSc. Student of Ecohydrology, Faculty of New Sciences and Technologies, University of Tehran

There are various statistical indices for evaluating the performance of observational data, prediction, and error values, including the Index of Agreement (d), Nash-Sutcliffe Performance Index (NSE), Second Root Mean Square Error (RMSE), and Mean Error Average (MAE). In Nash-Sutcliffe Index (NSE) whose variations range from infinite to minus one, the closer the data are to 1, the higher their accuracy would be (Nash et.al, 1970). On the other hand, the value of d ranges from one to zero; Accordingly, the closer the d values are to one, the higher the accuracy and agreement of the predicted and observed data would be. The average error values between the predicted and observed data are shown by RMSE and MAE.

Each of the aforementioned variables is calculated through the following equations.

$$d = 1 - \frac{\sum_{i=1}^{n}(Oi-Pi)^2}{\sum_{i=1}^{n}(|Pi-\bar{O}|+|Oi-\bar{O}|^2}$$ (1)

In equations (1), (2), (3), and (4) Oi and $\bar{O}$ are the observed data and their mean at the time i, respectively. Moreover, Pi is the value of the predicted data, and N represents the amount of data.

$$NSE = 1 - \frac{\sum_{i=1}^{n}(Oi-Pi)^2}{\sum_{i=1}^{n}(Oi-\bar{O})^2}$$ (2)

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(Oi-Pi)^2}{n}}$$ (3)

$$MAE = \frac{1}{n} \times \sum_{i=1}^{n}|Oi - Pi|$$ (4)

Calibration Stage

In this stage, the obtained results are improved by applying the correction coefficients, that is, the results are calibrated by correction coefficients. In equation (5), the $(\overline{Pr_m^{st}})$ correction coefficient is the average monthly precipitation data of the station, and $\overline{prm}^{COrdex}$ represents monthly precipitation data of Cordex (Ghonchepour et. al., 2019).

$$COeff_m = \frac{\overline{Pr_m^{st}}}{\overline{prm}^{COrdex}}$$ (5)

Results: The results obtained from the three meteorological stations indicated that compared to the observational period, the precipitation rate would increase in Tabriz and Mianeh stations and decrease in Sarab station in all three periods under both RCP 2.6 and RCP 4.5 scenarios. Moreover, the temperatures would decrease in Tabriz and Sarab stations in all three periods under both the RCP 2.6 and RCP 4.5 scenarios compared to the observational period, while it would increase in Mianeh station during the same period and under the same scenarios.

Discussion and Conclusion: The results of this study obtained from the SDSM outputs can be used in hydrological and environmental sectors. They can also be used for predicting climate parameters and assessing climate change, considering the fact that climate change affects water resources, human health, food, and agriculture. Therefore, the study's results could also be used in all of these sectors. On the other hand, as any decline in precipitation rate and increase in temperature would lead to quantitative and qualitative changes in water resources, the water uses plans need to be revised so that they can minimize the harmful effects of such variations.

Keywords: East Azerbaijan, Downscaling, SDSM, RCP 2.6, RCP 4.5, CANESM2.