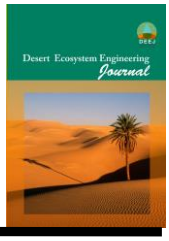
DEEJ (2023) 12 (39) 23-42

University of Kashan

Desert Ecosystem Engineering Journal

Journal homepage: http://deej.kashanu.ac.ir



Investigation and prediction of climate changes using the approach of General Circulation Models (GCMs) in the western provinces of Iran

Mehran Akbarzadeh,[1] Hamid Nouri,[2]* Samar Mortazavi,[3] Behnaz attaeian[4]

Received: 03/10/20223 Accepted: 03/03/2024

Extended Abstract

Introduction: Considering its pervasive influence on live creatures, climate change is currently considered one of the most crucial challenges facing human societies, the investigation of which is of great significance. Moreover, climate change exerts an adverse influence on biological resources, the natural environment, and water sources, causing various environmental, social, and economic consequences. Therefore, this study sought to investigate and predict the parameters involved in climate change, including maximum temperature, precipitation, and average temperature under the RCP2.6, RCP4.5, and RCP8.5 scenarios.

Furthermore, the applicability of the SDSM model was tested on eleven western provinces of Iran. To this end, first, the predictive variables such as temperature and precipitation were downscaled using combined regression techniques and a small-scale stochastic weather generator, and the required data were collected from the site of the monitoring station. Then, variations in maximum temperature, average temperature, and precipitation for the 2021-2036 and 2036-2100 periods were compared to those of the baseline period (1990-2020). The SDSM model was then validated and its accuracy was assessed using metrics such as MSE, MAPE, RMSE, and MAE.

Materials and methods: On the other hand, to verify the accuracy, the data collected for the 1990-2020 period were taken as the actual and observed values, followed by the performance of some simulations with the same data to gauge and measure the accuracy of the extracted data for the 2021-2035 and 2036-2100 periods and compare it with the baseline period (1990-2005). Finally, after confirming the collected data against the actual data of the respective years and determining the accuracy of the four validation methods, the verification process was extended to cover the 1990-2020, 2021-2035, and 2036-2100 periods.

Result: The results of the study indicated that the application of the SDSM model led to a reduction in the required accuracy needed for investigating and simulating climate change. Accordingly, the highest MSE, MAPE, RMSE, and MAE values were found under the second scenario (RCP4.5) in Jolfa station (in terms of maximum temperature), Urmia station (in terms of precipitation), Nahavand station (in terms of precipitation), and Zarrineh station (in terms of precipitation), whose reported values were 0.01, 16.90, 0.10, and 0.10, respectively. On the other hand, the lowest values belonged to the second scenario, whose values were reported to be 0.00, 0.41, 0.00, and 0.00, respectively.

Moreover, the results obtained from the application of the SDSM downscaling model to the investigation of precipitation under RCP2.6, RCP4.5, and RCP8.5 scenarios revealed that compared to the other two scenarios, the first scenario (RCP2.6) had a higher level of accuracy in predicting precipitation for 2021-2035 and 2036-2100 periods with a small margin of error, simulating precipitation more closely to the observed data in most cases. Furthermore, the model's predictive outcomes suggested that compared to the baseline period, precipitation would undergo changes throughout the 2021-2035 period, ranging from 2.50% to 3.86%.

[1]. Mehran Akbarzadeh, Ph.D. student of environment, Malayer University, Malayer, Iran

[2]. Hamid Nouri, Associate Professor, Department of Natural Resources and Watershed Management, Malayer University, Malayer, Hamadan, Iran climatology.hnouri52@gmail.com

[3]. Samar Mortazavi, Assistant Professor, Department of Natural Resources and Environment, Malayer University, Malayer, Hamadan, Iran

[4]. Behnaz attaeian, Assistant Professor, Department of Natural Resources and Watershed Management, Malayer University, Malayer, Hamadan, Iran

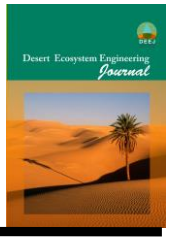
doi: 10.22052/DEEJ.2024.253424.1019

DEEJ (2023) 11 (37) 1-14

University of Kashan

Desert Ecosystem Engineering Journal

Journal homepage: http://deej.kashanu.ac.ir



Similarly, it was found that compared to the baseline period the changes would range from 10.02% to 15.73% during the 2036-2100 period.

On the other hand, the most significant alterations in precipitation levels were expected to occur in the Iranian Eastern Azerbaijan and Western Azerbaijan provinces. In this regard, the analysis of maximum temperature rates throughout the 2021-2035 period showed that compared to the baseline period, the rise in the maximum temperature across the study region would range from 0.20 to 0.89 degrees. Similarly, the maximum temperature rate would increase from 0.86 to 0.89 degrees during the 2036-2100, compared to that of the baseline data. However, the most substantial changes in the maximum temperature rate were expected to occur in the southern part of the Iranian Fars province and the bordering areas of Kermanshah province.

Discussion and Conclusion: As for the average temperature rates, the study found that the temperature would increase from 0.05% to 5.07% during the first time period, and from 4.47% to 5.05% throughout the second period. However, while the least significant alterations in the studied parameters belonged to the RCP2.6 scenario, the most notable changes were found under the RCP8.5 scenario. Moreover, precipitation changes were investigated in forty stations across eleven Iranian provinces throughout the 2021-2035 and 2036-2100 periods, proving a reduction in precipitation rate within both periods, with the decrease being more conspicuous in the second period (2036-2100) under all three severity scenarios.

Furthermore, climatic assessments at the station level indicated that the study area would experience a considerable rise in the maximum temperature rate throughout both study periods, with the second period (2036-2100) being expected to witness a more substantial temperature rise. In this regard, all three scenarios showed that the range of increase in the maximum temperature rate would vary from 3.99% to 4.16%, indicating a significant temperature rise in the study area over the coming years.

The regions investigated in the current study play a crucial role in supplying water to the central and western Iranian provinces. The regions are also known as significant hubs for agricultural production. Therefore, any changes in weather and climatic parameters in these areas may lead to increased uncertainty in future predictions and planning, requiring the identification of the areas susceptible to risks caused by prospective extreme climate changes. Thus, it is necessary to develop and implement management and operational plans to deal with such changes and to devise the required strategies to mitigate the consequences of those changes and ensure adaptability to the new conditions.

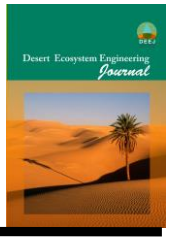
Keywords: Climate Change, Precipitation Changes, GCM, SDSM.

DEEJ (2023) 12 (39) 23-42

University of Kashan

Desert Ecosystem Engineering Journal

Journal homepage: http://deej.kashanu.ac.ir



DEEJ (2023) 11 (37) 1-14

University of Kashan

Desert Ecosystem Engineering Journal

Journal homepage: http://deej.kashanu.ac.ir