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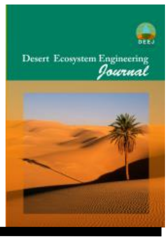

Estimating Daily Reference Evapotranspiration in Sistan Plain Using Ultra-Innovative Algorithms

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Extended Abstract

Introduction: Measuring the evapotranspiration rate plays an important role in the proper management of water resources, irrigation planning, and optimizing the allocation and distribution of water resources. There are different methods for measuring evapotranspiration, which is generally time-consuming and costly and requires a large bulk of meteorological data. However, new widely used methods have been introduced in recent years to solve this problem, among which are ultra-Innovative algorithms with high accuracy and speed that do not require extensive data. Therefore, this study sought to identify the most important parameters involved in measuring the daily evapotranspiration rate of the reference plant in Sistan plain using Gene Expression Programming and Deep Learning models.

Material and methods: located in the north of Sistan and Baluchestan province at the northern latitude $30^{\circ}.18'$ to $31^{\circ}.20'$ and the eastern longitude $61^{\circ}.10'$ to $61^{\circ}.50'$ Sistan plain has an average annual precipitation rate of 50 mm and an annual evaporation rate of 4000- 5000 mm, being considered as one of the super-arid areas based on the Dumarten drought index, whose environmental conditions are not suitable for cultivation. The climatic data used in this study were collected from the Zabol synoptic station, including maximum temperature, minimum temperature, average temperature, maximum relative humidity, minimum relative humidity, average relative humidity, sunny hours, wind speed, precipitation, and pan evaporation during the statistical period of 2009-2017.

Moreover, the accuracy of Gene Expression Programming and Deep Learning was compared to the FAO-Penman-Montith method. Accordingly, the GeneXproTools software (4.0) was used to run the Gene Expression Programming model and MATLAB software was used to run the Deep Learning model. Also, the data were divided into two categories, 80% of which were used for training and 20% of which were used to validate the

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model. Considering the fact that selecting appropriate and effective initial inputs improves performance Since in smart models, different combinations of meteorological data were considered as model inputs. Then, the best scenario was selected to predict evapotranspiration by evaluating the results of different scenarios and combinations. Furthermore, the Coefficient of determination (R^2) was used to calculate the correlation, mean absolute error value (MAE) was used to show the degree of consistency between the set of observed and predicted values, and the root mean square error (RMSE) (expressing the error intensity) was applied as evaluation criteria.

Results: The study's results indicated that Gene Expression Programming and Deep Learning Programming models were highly accurate in estimating evapotranspiration in all scenarios, with the Deep Learning model showing a higher accuracy in this regard than the Gene Expression one. Moreover, it was found that from among all the scenarios upon which the Deep Learning programming model was applied, the M5 scenario comprising of variables such as maximum temperature, minimum temperature, average temperature, maximum humidity, minimum humidity, average humidity, wind speed, and pan evaporation was the most accurate scenario with the lowest root mean square error (RMSE = 0.517) and the highest coefficient of determination ($R^2 = 0.996$). On the other hand, out of all scenarios to which the Gene Expression model was applied, the M1 scenario containing variables such as mean temperature, minimum temperature, maximum temperature, and maximum humidity was the most accurate one, with the highest coefficient of determination (R^2= 0.985) and the lowest root mean square error (RMSE = 0.985).

However, in the deep learning model, the lowest accuracy belonged to M15, M18, M1, and M16 scenarios with MAE values of 4.213, 3.131, 2.656, and 2.298, respectively, and the highest accuracy belonged to the M5, M6, M1, and M3 scenarios with MAE values of 0.399, 0.402, 0.422 and 0.422, respectively. In this model, all scenarios were overestimated. On the other hand, In the Gene Expression model, the lowest accuracy is related to M24, M15, M14, and M16 scenarios with MAE values equal to 4.621, 4.438, 3.198, and 2.355, respectively, and the highest accuracy is also related to M1, M3, M13 and M7 scenarios with MAE values equal to 0.683, 0.733, 0.780 and 0.991, respectively. In this model, all scenarios are overestimated. On the other hand, in the Gene Expression model, the lowest accuracy belonged to M24, M15, M14, and M16 scenarios whose MAE values were 4.621, 4.438, 3.198, and 2.355, respectively, and the highest accuracy belonged to M1, M3, M13, and M7 scenarios whose MAE values were 0.683, 0.733, 0.780, and 0.991, respectively. In this model, all scenarios were overestimated.

According to the outputs of the GEP model, mean temperature, minimum temperature, maximum temperature, and maximum humidity were the most important parameters involved in the prediction of reference evapotranspiration values. In the Gene Expression Programming model, the M1 was selected as the best scenario with the highest coefficient of explanation R^2= 0.985, the lowest error RMSE = 0.985, and MAE = 0.683, followed by the M3 and M7 scenarios. Moreover, in the Deep Learning model, the M5 scenario ranked first in predicting the reference evapotranspiration, followed by the M1 and M3 scenarios. Also, the high correlation between the estimated evapotranspiration of these models and the Fao-penman-montith method indicated that computational models can be used to estimate daily evapotranspiration when more limited data are available.

Discussion and Conclusion: The results showed that the evapotranspiration of the reference plant in the Sistan region can be determined in the shortest possible time (3 minutes and 26 seconds in the deep learning model) with acceptable accuracy using a few parameters (compared to the FAO method). Therefore, it is recommended that the Deep Learning model be applied in the Sistan region.

Keywords: Evapotranspiration, Deep learning model, GEP model.