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# Estimation of Monthly Mean Reference Evapotranspiration by Using Artificial Neural Network Models in Basrah City, South of Iraq

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ABSTRACT

The main objective of this study is to evaluate the comparative performance of three artificial neural network techniques (radial basis functions "RBF", multilayer perceptron "MLP", and group method of data handling "GMDH") based approach with the Penman–Monteith "PM" method for determining the group reference evapotranspiration "$ET_0$" on monthly basis in Basrah City, south of Iraq. Climate information extends over 22 years (1991- 2012), monthly records of maximum temperature (Tmax), mean temperature (Tmean), minimum temperature (Tmin), wind speed (U) and relative humidity (RH) are used in this research. The architecture of artificial neural network models is performed during the process of training. The efficiency of trained model is checked by using the testing data, which is not used in the process of training. The evaluating of the artificial neural model performance is carried out by using cross-validation, a set of rows for each validation fold is determined randomly after stratification on the target variable "$ET_0$". Various set of climate inputs variables are used for creating nine artificial neural network models. The efficiency of artificial neural network models with two predictor variables (Tmean & U) for simulating $ET_0$ is highly efficient according to the evaluation criteria. There is a significant improvement in the results of all artificial neural network models when using three input combination variables (Tmean, U, & RH) compared with the models that have only two-climate variables. Artificial neural network models especially (RBF, MLP, and GMDH) are efficient and powerful techniques for simulating $ET_0$.

## 1. Introduction

There is no easy way for distinguishing between evaporation and transpiration, two processes occur simultaneously. Regardless of the availability of water in topsoil, the evaporation is determined from crop soil by the part of the solar radiation that reaches the soil surface [1]. During the growing period of the crop as the crop evolves and the crop canopy is more and more shaded than the land area, this part of evaporation is decrease. Water is mostly lost when the crop is small, but after some time, transpiration becomes the main process when the crop develops and covers the soil completely [2]. The main weather factors affecting evapotranspiration are air temperature, humidity, radiation, and wind speed. The reference evapotranspiration ($ET_0$) is the rate of evapotranspiration from a reference surface, as the water is abundant. The reference surface can be expressed as a hypothetical grass crop with certain properties [2].

The estimation of evapotranspiration (ET) is one of the main tasks in calculating the water budget; this is the second largest element after precipitation [2]; therefore, estimating the quantity of ET is a key factor in the management of scarce water resources. The importance of estimating the amount of ET in hydrological and agricultural studies led to the development of different methodologies and techniques for estimating this value. Lysimeter filed instrument or water balance approach are used for estimating $ET_0$ as a direct method of measurement, it can also be measured indirectly through climate information [3]. However, the high operating costs is the drawback of the lysimeter. Moreover, there are numerous errors affecting the accuracy of the measurements. Differences in the thermal, wind and radiological system between the lysimeter and its surroundings [4] in addition to managing the lysimeter, it can affect the measurements. Due to these difficulties in estimating $ET_0$, indirect $ET_0$ estimation methodology that primarily relies on the ease of capturing

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