Estimation Daily Evaporation Employing Neural Network for Abu-garib Station, Baghdad,Iraq

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Abstract- Evaporation is one of important parameter to determine crop water requirement especially in arid and semi-arid regions, therefore the accurate calculation of this factor is employed for research's such as water balance, irrigation system design, and water resource management is very important for these applications, In order to calculate the daily evaporation values, direct measurement or neural network models can be employed for the regions which there is no direct measurements tools. In this paper the daily evaporation has been estimated by using daily temperature, relative humidity, wind velocity, sunshine hours, and evaporation data in Abu-garib Automatic weather station employing Neural Network training using daily data used four years and network testing takes one year. In this approach , a MLP layer network with a hidden layer and sigmoid function has been employed. The results show the powerful capability and high accuracy of artificial neural networks in calculating of daily evaporation. Best model for estimation of evaporation is neural network have MSE (0.1515), AE (0.2892) and R (0.9909).

Index Terms- Artificial, Neural, Evaporation, Baghdad.

I. Introduction

Actual evaporation is the amount of water which is evaporated a normal day which means that if for instance the soil runs out of water, the actual evaporation is the amount of water which has been evaporated, and not the amount of water which could have been evaporated if the soil had an infinite amount of water to evaporate. Because of the variability of region and seasons, water managers who are responsible for planning and adjudicating the distribution of water resources need to have a thorough understanding of the evapotranspiration process and knowledge about the spatial and temporal rates of evapotranspiration [1].

The problem of measuring evaporation from open water surfaces, and transpiration from different types of vegetation, has been a central problem in hydrology for many years. In terms of the hydrological cycle and the water balance, evaporation and transpiration make up the second largest component. Errors in estimating evaporative loss, therefore, assume great significance, for example, in the calculation of groundwater recharge. Difficulties in understanding the physical nature of the evaporation process, together with ambiguous results from the various types of instrument designed to measure evaporation directly (such as evaporation pans and evaporimeter), led to the development of empirical techniques for estimating evaporation, using generally available climatic data [2].

In the last two decades, the estimation methods have been successfully used in modeling pan evaporation. Terzi and Erol Keskin (2005) used Gene Expression Programming (GEP) for modeling evaporation as a function of air temperature, solar radiation, and relative humidity [3]. Shirsath, and Singh (2010) presented application of artificial neural networks (ANN), statistical regression and climate based model for estimating of daily pan evaporation [4]. Kumar et al (2012) developed artificial neural networks (ANN) and adaptive neurofuzzy inference system (ANFIS) models were developed to forecast monthly potential evaporation in Pantagar, U.S. Nagar (India) based on four explanatory climatic factors (relative humidity, solar radiation, temperature, and wind speed) [5]. The main aim of this paper attempted to evaluate the employing of network model for daily evaporation estimation using different meteorological input of Abu-grab region in Baghdad City.

II. Methodology

The daily values of the global solar radiation on horizontal surface G, sunshine duration S, maximum and minimum air temperature, relative maximum and minimum, Atmospheric pressure for a period of four years (2012-2015) were obtained from ministry of agriculture – agro-meteorology center (Abu-grab station)

A Multilayer perceptron (MLP) neural network was used in present study, with seven input variables. The following is an outline of the procedure used in the development of the MLP model:

1. Input and target values were normalize, in the range -1 to 1.
2. Create training and validation sub-datasets.
3. MLP neural network was created.
4. The MLP neural network was trained
5. Estimating output values
6. The performance of the neural network was checked by comparing the output values with target values.

III. Artificial Neural Network Application

An MLP neural network model is developed for estimating daily mean of evaporation for Abugrab station. The evaporation data from Abu-grab station are used for training the neural networks. One of the more important tasks in ANN estimating is the selection of the input variables. In this study, the input parameters are used as Variable for each model (Model 1-6).Inputs for the network are global solar radiation on horizontal surface G, sunshine duration S, maximum and minimum air

temperature, relative maximum and minimum, Atmospheric pressure for a period of four years (2012-2015) the output was the daily evaporation values. In this work, inputs and outputs data are firstly normalized in the (0.1) range and then returned to original values after simulation by Forecaster XL which is used for the implementation of the MLP network. For the training of network, the Forecaster XL was performed under excel 2007 environment. The structure of the neural network is shown in figure (1).

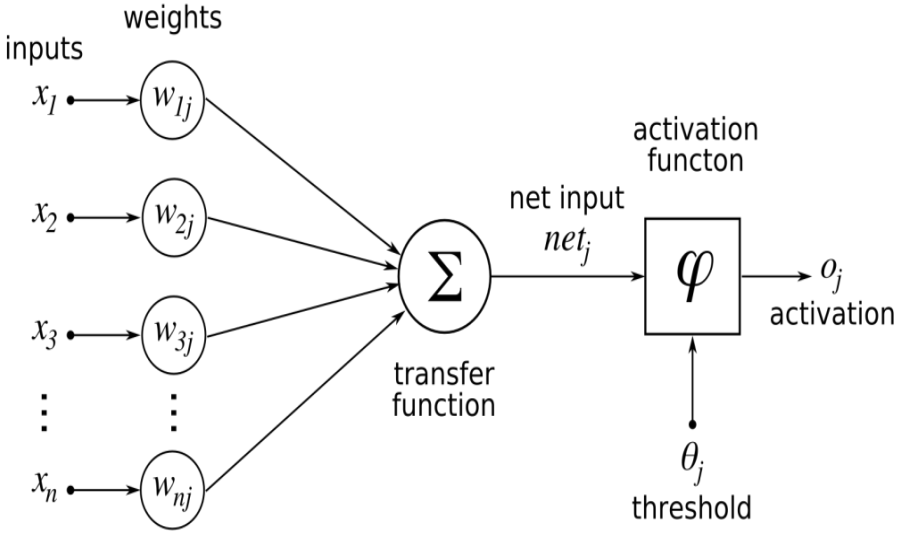


Fig1. Schematic diagram of neural network.

IV. Study Area and Climate Situation

Baghdad is the capital and the commercial center of Iraq, it is located on a vast plain bisected by the river Tigris as shown in Figure 2 , also it has Facilities of electrical power plants, oil refineries like Al-Dora refinery and tanneries and textile mills. The population of Baghdad in 2012 was approximately 7, 216, 040. Iraq's official statistical reports give the total land area as 438,446 km2, It is the largest city in Arab world (after Cairo/Egypt) and the second largest city in Western Asia (after Tehran/Iran). Baghdad is located on flat terrain with no hills or other obstruction around; it is surrounded by flat uncultivated desert, it has a subtropical arid climate according to Köppen climate classification and is, in terms of maximum temperatures, one of the hottest cities in the world. In the summer from June to August, the average maximum temperature is as high as 44 °C accompanied by blazing sunshine. Humidity is very low (usually under 10%) due to Baghdad's distance from the marshy Arabian Gulf, dust storms from the deserts to the west are a normal occurrence during the summer [6] Winters boast mild days and variable nights. From December to February, Baghdad has maximum temperatures averaging 15.5 to 18.5 °C, though highs above 21 °C. Morning temperatures can be chilly: the average January low is 3.8 °C. Annual rainfall, almost entirely confined to the period from November to March, averages around 150 mm, but has been as high as 338 mm and as low as 37 mm [7].

Figure (2): Map of Iraq with location of the study Area.

V. Result and Discussion

The performance of the artificial neural network models through the training, testing procedure were evaluated on the basis of the following statistical indicators: Absolute error (AE), Mean square error (MSE) and correlation coefficient (R) as shown in Tables 1. ANN model is superior to other ANN models because it has the smallest errors. The MSE are 0.1515. The coefficient of determination (R value) of ANN model 2 (in testing procure) are found to be 0.9909. ANN model 2 provides an accurate estimation of daily evaporation values of Abu-garib Station. Figure 3 compares the estimated values by ANN models against the measured values. The results indicate that most of the points fall along the diagonal line and the degree of the deviation from the diagonal line is small. So comparison results indicate

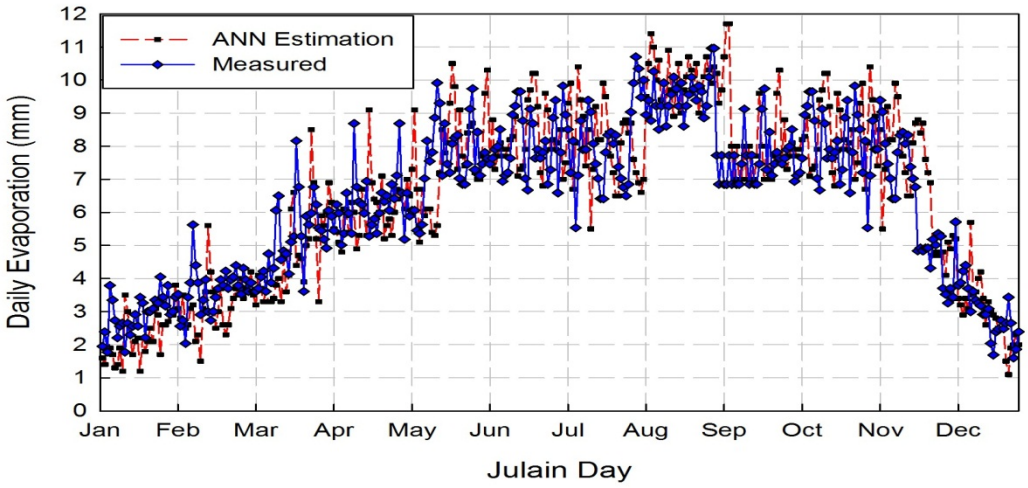
that ANN model provides the best results among the six models. That is, ANN model 2 is superior to the other ANN models, most of the points fall along the diagonal line. The estimated values have good agreement with the measured values. It can also be seen from the comparison of ANN model (1-6) that the dispersion degree of ANN model 2 is smaller than the other ANN models, which indicate that the ANN model 2 provided the best estimations among all the proposed models. The determination coefficient of ANN model 2 (R value) obtained for the data set is 0.9909. In this respect, the closer to unity is the coefficient of determination, the better estimation accuracy. To test the generalization of the ANN model, Tables 1-2 show that ANN has the minimum predictions errors in Abu-garb Station. Low values of prediction errors for Abu-garib Station confirm the ability of the neural network models to estimate daily evaporation values precisely. These results demonstrate the generalization capability of the neural network model and its ability to produce accurate estimates for Abu-garib Station which located in Baghdad city.

Table1. Statistical indicator for daily evaporation of ANN for training stage.

Model Number	R	AE	MSE
1	0.9874	0.2859	0.1484
2	0.9909	0.2320	0.1352
3	0.9912	0.1991	0.0954
4	0.9906	0.1991	0.0991
5	0.9885	0.2636	0.1351
6	0.9793	0.3455	0.2322

Table2. Statistical indicator for daily evaporation of ANN for testing stage.

Model Number	R	AE	MSE
1	0.9874	0.3732	0.4166
2	0.9909	0.2892	0.1515
3	0.9904	0.3085	0.3842
4	0.9906	0.2977	0.3410
5	0.9885	0.3684	0.3586
6	0.9793	0.5306	0.7204



Figure(3):Comparison between the measured and estimated daily evaporation using ANN for testing procedure

VI. Conclusion

The employing of neural network models for daily evaporation estimation for Abu-garib weather Station in Baghdad city has been investigated. The results of evaluation indicate that the neural network models based estimation technique for daily evaporation is powerful to estimate the daily evaporation than the empirical regression models proposed by other researchers. This study confirms the ability of the neural network models to estimate daily evaporation values precisely. Therefore, the present neural network model 2 may be convenient for estimating daily evaporation at any location in Iraq, employing limited weather data.

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