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# EFFECT OF VARIATION OF RAINFALL, SOIL MOISTURE AND EVAPORATION IN BAGHDAD CITY

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## Abstract

The Volumetric Soil Water Content (VSWC), Evaporation and precipitation are important factors in determining the phenomenon of desertification and agricultural drought, as precipitation and water content play an important role in determining the date of flower growth. Surface evaporation and water Taken from the European Center within the time period (ECMWF) for the eleventh time period (2008-2019), for the region of Baghdad the highest water content and precipitation value was recorded in December and January and the lowest value was recorded in July and August. The greatest value of evaporation was recorded in July and August. The relationship between the volumetric water content of the soil and evaporation is an inverse relationship for eleven years for the Baghdad station proofing are also associated with climate-related evolution in terms of precipitation production and the evolution of weather patterns. The methods used in the study depend on the monthly, annual and seasonal average of the from the volumetric water content of soil, Evaporation and precipitation.

***Key words:*** Rainfall, Volumetric Soil Water Content, Evaporation, ECMWF, Baghdad

## Introduction

Arid ecosystems are consideration for over a third of the Earth's land surface, which productivity is particularly sensitive to precipitation inputs delivered as discrete pulses. The nature of this regime supports the great diversity and healthy ecosystem functioning characteristic of these semiarid ecosystems. The result is a precipitation ecosystems characterized by frequent small precipitation events (<5 mm) interspersed with infrequent larger events (>20 mm) (Cavanaugh, 2011). Since water is a major factor of many processes in dryland ecosystems, a slight shift in seasonal precipitation and/or the frequency of extreme rain events could potentially lead to main ecological impacts. Thus, in order for us to predict how these regimes may respond to future climate change, we must have an understanding of how atmospheric, plant, and soil elements interact and also understand how variation in vegetation cover and soil types may bring changes in soil water distribution (Reynolds, 2000). Land-atmosphere feedback, if it exists and understood, could contribute to the skill of long-term weather forecasts, including forecasts of dryness or floods. The full feedback cycle can be split into three parts: the moistening of the soil by rainfall, the enhancement of subsequent evaporation by the moister soil, and the enhancement of precipitation by the evaporation (Koster, 2003). Large volumes of water can be lost through evaporation under hot weather conditions, in low precipitation regions, thereby low surface water levels.

The rate of water evaporation can be evaluated from different variables using either a direct or indirect way. Among the direct approaches, measuring evaporation from a Class a pan (1.22m diameter×0.25m depth, located 0.15m above the soil surface) is the most widespread process. This method can achieve precise evaporation evaluates over time, but it does not require the expensive processes of pans and meteorological stations installation since it is considered a cheap and easy way (Khosravia, 2019). The land–atmosphere boundaries in most GCMs are described by soil-vegetation-atmosphere transfer (SVAT) charts that compute fluxes of heat, moisture and momentum from climate and soil moisture (Harris, 2004). The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2007) projects strong changes in climate across the Middle East and North Africa. Temperature increases combined with substantial decreases in precipitation are projected so

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higher evapotranspiration demand, strictly stress the water resources in the region (Terink, 2013). Previous observational studies on the effects of evaporations and precipitation, in a previous paper (Al-Taai, *et al.,* 2014) they find out showed that the highest value of the total rainfall recorded in Mosul at March, while in Basrah and Baghdad has recorded the greatest value to the total rainfall at January, and the variability in Rutbaat November and February, (Miralles *et al.,* 2011) presented in sights into that rainfall interception plays an important role in the partition of precipitation into evaporation and water available for runoff at a continental scale, (Findell *et al.,* 2011).

They developed and applied physically based, objective metrics for quantifying the impacts of surface evaporative and sensible heat ûuxes on the frequency and intensity of convective rainfall during summer, using North American reanalysis data. (Cavanaugh *et al.,* 2011) presented measure evapotranspiration (ET) using eddy ygh = covariance, whole plant T using the heat-balance sap ûow, and soil moisture at several depths. During the dry period preceding the summer monsoon, both ET and soil moisture were very low. In this study the data collected from the European Center for Medium Range Weather Forecasts (ECMWF) including monthly average data on the water content of VSWC soil, EV evaporation and rainfall P for Baghdad station.

## Methodology

### The Study Area

The work was performed with monthly average data on the water content of VSWC soil, EV evaporation and rainfall P, and were taken from the European Center for Medium Range Weather Forecasts (ECMWF). This data was converted into an annual, medium and integrated set to show the effect of the annual change. The data was processed by Matlab and drawn by Sigma Plot. The Baghdad station was chosen, as shown in Fig. 1.

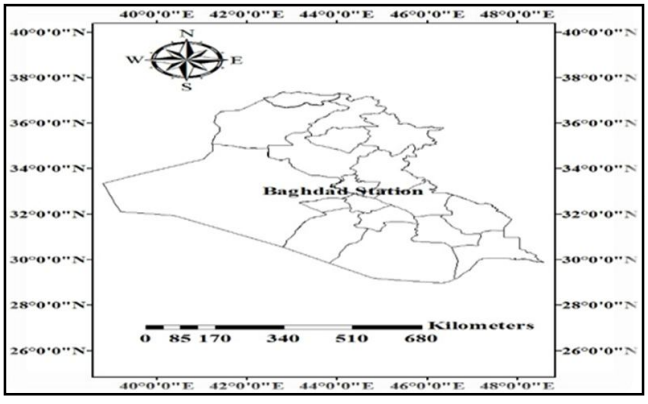



**Fig. 1:** The study stations.

### Statistical Used

#### Simple Linear Regression (SLR)

Is several available statistical operations were performed where Sigma plot program was used to calculate the slope value and the P-value by Simple Linear Regression (SLR) method in order to predict the relationship between precipitation and wind speed? SLR is the study of the relationship between two variables to arrive at a linear relationship between these two variables, where the data is supposed to be distributed naturally. To know the value of the regression, the slope is calculated from the following equation: (Seidenglanz, 2012).

$$\overline{Y} = a + bx \tag{1}$$

$$b = \frac{\sum_{i=1}^{n}\left(X_i - \overline{X}\right) - \left(Y_i - \overline{Y}\right)}{\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2} \tag{2}$$

Whereas: (b) is the slope and shows the slope of the straight line, (a) is constant and shows the value of the section of the unit of the line, *Equation (1)*. As for the probability value, P-value is a statistical term, which is a number or number used to evaluate the statistics, and it is a value that appears if the factor is actually affecting or not? After converting data from NC-file format to (TXT-file), the Fortran language (which is a multi-use programming language and after isolating and filtering data for each region separately in the form of (TXT-file)) is used and from which the calculations were performed and then using the *Sigmaplot* program which is a group among the scientific programs for charts and data analysis through which it is possible to draw time series charts for each introverted variable and find the relationship between each variable and the VSWC by calculating the slope value and the value of P-value (Seidenglanz, 2012) (David, 2000).

### Pearson's Correlation Coefficient (r)

The Pearson's test is moment correlation matrix is a series of scatter graphs that plot the associations between all possible combinations of variables. The first row of the matrix represents the first set of variables or the first column of data, the second row of the matrix represents the second set of variables or the second data column, and the third row of the matrix represents the third set of variables or third data column. The X and Y data for the graphs correspond to the column and row of the graph in the matrix. For example, the X data for the graphs in the first row of the matrix is taken from the second column of tested data and the Y data is taken from the first column of tested data. The X data for the graphs in the second row of the matrix is taken from the first column of tested

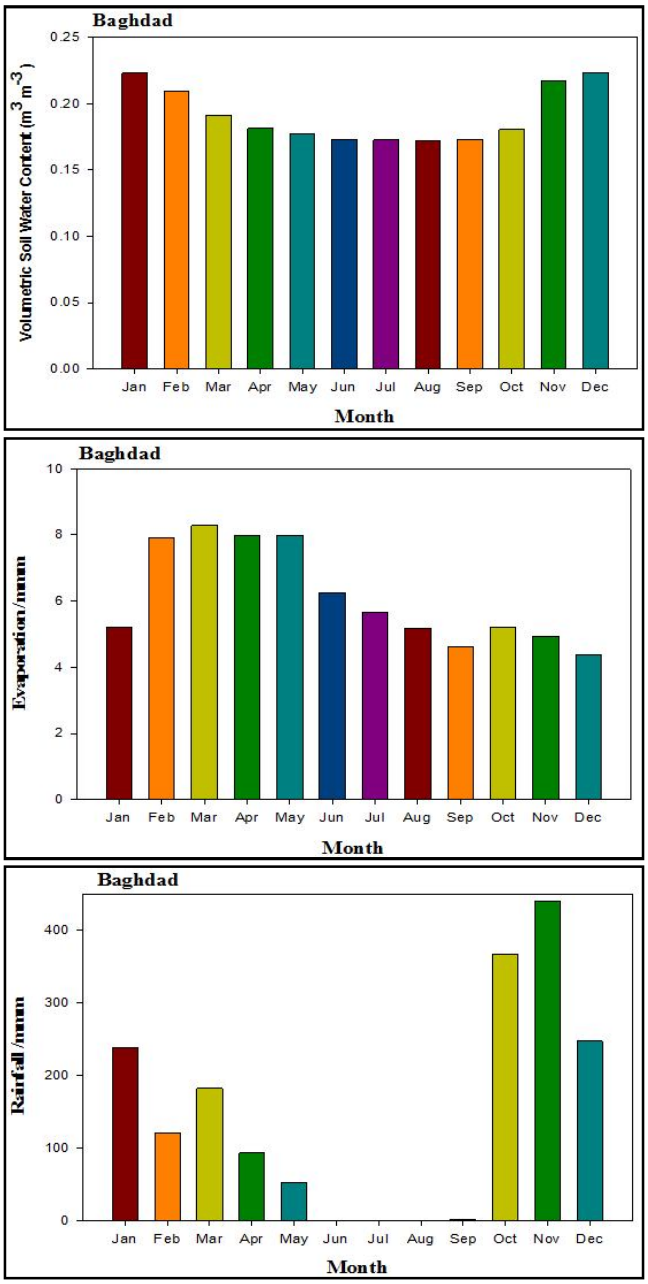



**Fig. 2:** The Monthly Mean of VSWC EV and Rainfall for a period (2008-2019) Over Baghdad Station.

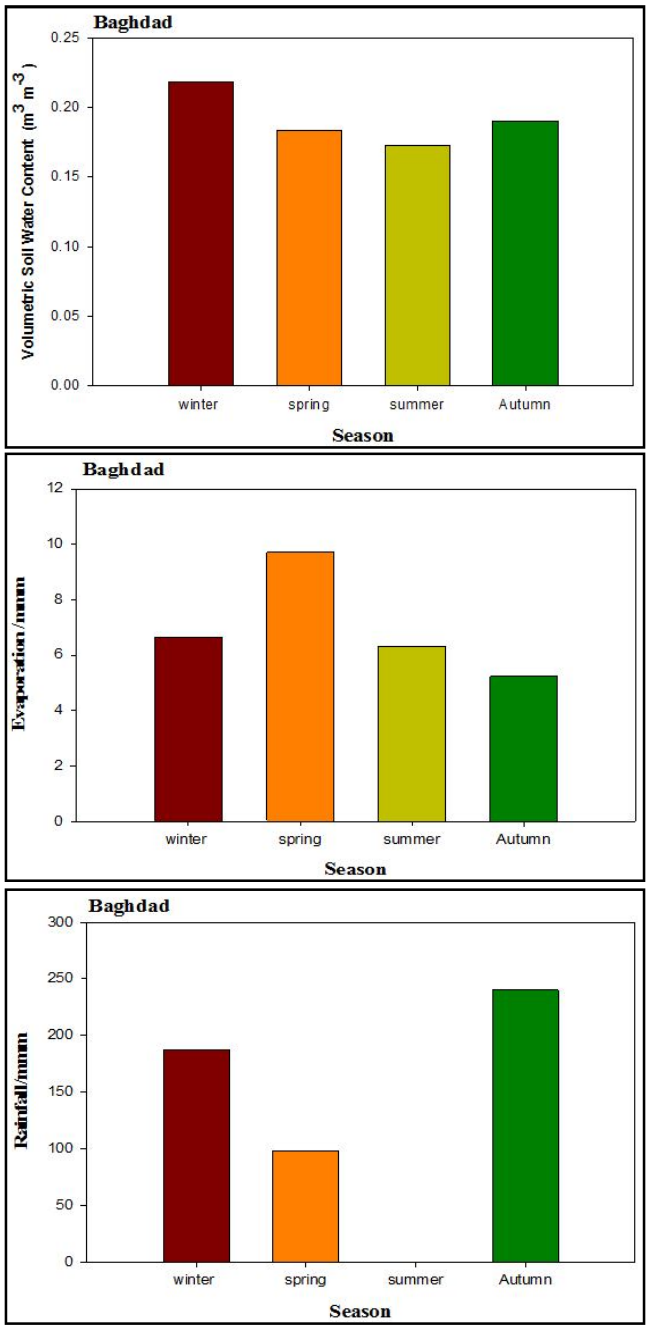



**Fig. 3:** The Analysis Behavior of the Seasonally Mean of VSWC, EV and Rainfall data for a period (2008-2019) Over Baghdad Station.

data, and the Y data is taken from the second column of tested data. The X data for the graphs in the third row of the matrix is taken from the second column of tested data, and the Y data is taken from the third column of tested data, etc. The number of graph rows in the matrix is equal to the number of data columns being tested (Williams, 1992). The Pearson correlation coefficient (r) is used to measure the strength of a linear association between two variables, where the value r = 1 means a perfect positive correlation and the value r = -1 means a perfect negative correlation. So, for example, you could use this test to find out whether people's height and weight are correlated. The requirements for Pearson's correlation coefficient test: (Levesque, 2007).

· Scale of measurement should be interval or ratio.

· Variables should be approximately normally distributed.

· The association should be linear.

· There should be no outliers in the data.

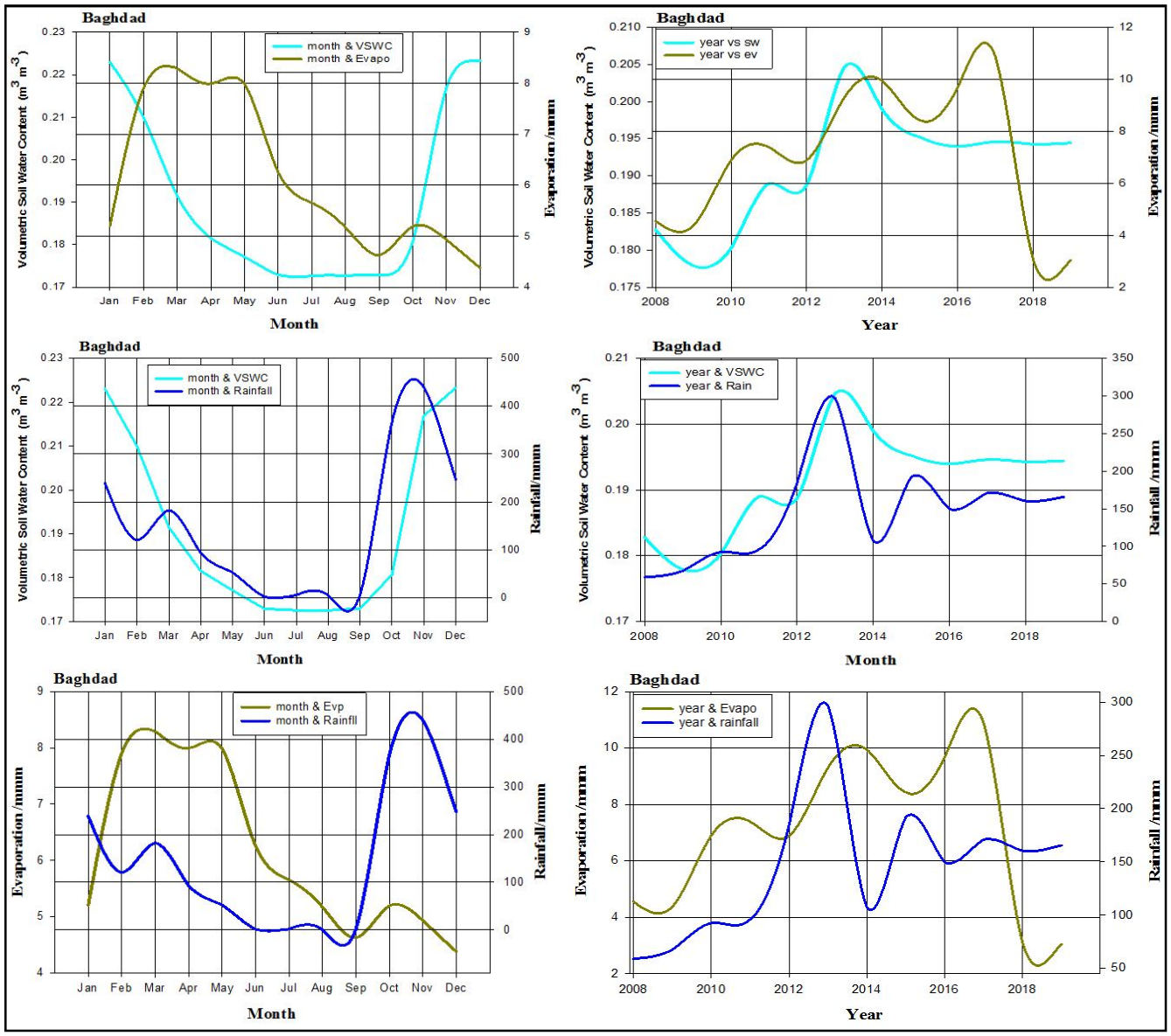



**Fig. 3:** Behavior Analysis the Monthly and yearly Mean of VSWC, EV and Rainfall for a period (2008-2019) over Baghdad stations.

$$r = \frac{\sum_{i=1}^{n}\left(X_i - \overline{X}\right) - \left(Y_i - \overline{Y}\right)}{\sqrt{\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2}\sqrt{\sum_{i=1}^{n}\left(Y_i - \overline{Y}\right)^2}} \quad (3)$$

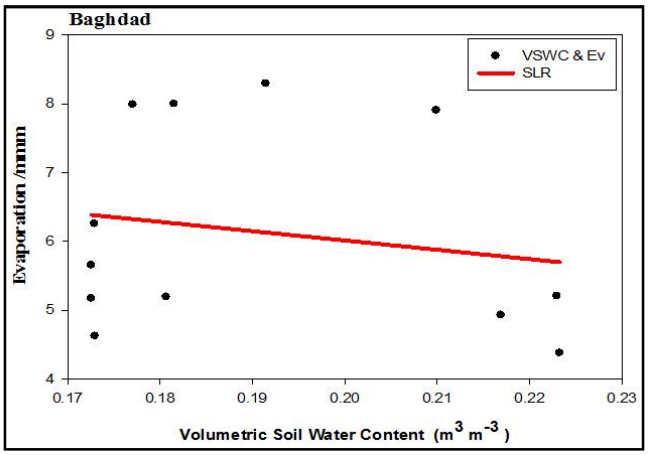
## Results and Discussion

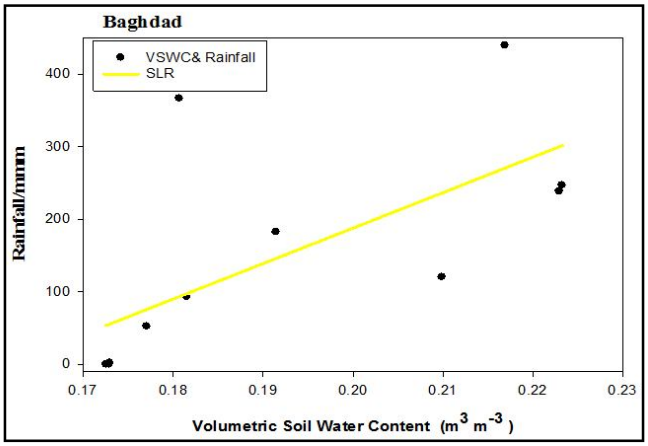
### Behavior Analysis the Monthly Mean of VSWC and Evaporation and Rainfall over Baghdad Station

In this Fig. 2, the monthly average of VSWC, EV, and precipitation over the Baghdad station, where the observed VSWC was higher during November and December and lower in July and August, due to higher temperatures and increased evaporation, which leads to a decrease in the water content For soil. While an increase in the value of evaporation was observed during March and April due to less rainfall and higher temperatures, and less in September and December, it indicated that the rate of precipitation increased during October and November due to lower temperatures and less evaporation in March and April due to several factors, including What is related to the climate change occurring in the Atmosphere.

### Analysis the Season Mean of VSWC and Evaporation and Rainfall over Baghdad Station

In this Fig. 3, the seasonal average of VSWC, Ev, and Rainfall is shown over Baghdad station, where it was observed that VSWC is higher during the winter season and lower in the summer and this is due to more rainfall and lower temperatures in the winter season. The presence of slow currents in winter redistributes air from



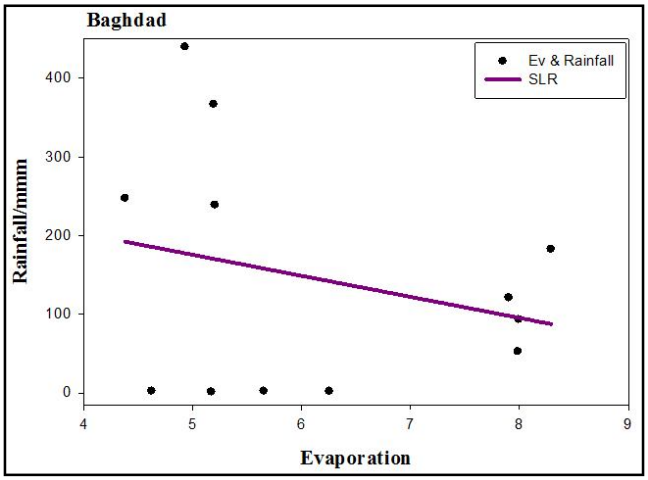




**Fig. 4:** The Relationship between the monthly Mean of VSWC and EV over Baghdad station.

the tropics to regions above the tropics. While it was observed that EV was high in the spring and less in the winter, while the Rainfall was high during the autumn and lower in the summer due to lower temperatures and less Evaporation, this is due to astronomical and meteorological parameters.

**The Relationship between The Monthly Mean 11 years of VSWC, EV and Rainfall over Baghdad station**

Fig. 4 shows that the relationship of evaporation with water content is an inverse relationship, as evaporation is directly affected by solar radiation and surface air temperature, that is, when the air temperature increases, evaporation increases. Table 1 shows p-value values. There is a low inverse correlation, while the high correlation is noticeable through the relationship between water content and precipitation.

## Conclusions

· The greatest value for water content was recorded in winter and the largest value for evaporation in spring.

· The highest value of water content and precipitation was recorded in 2013 and the highest value of evaporation was in 2017.

· The relationship between water content and evaporation is largely reversed for 11 years.

· The relationship between precipitation and water content is very positive.

## Acknowledgement

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**Table 1:** The relationship between VSWC, EV and R for the monthly mean 11 years over Baghdad station.

| Monthly Mean | Spearman rho | | Linear regression Simple | |
|---|---|---|---|---|
| 5 years | R | Correlation degree | P-value | Interpretation of relationship |
| EV vs VSWC | 0.1900 | Low positive correlation | 0.5543 | Non Linear Relation |
| Rvs VSWC | 0.6756 | Very high positive correlation | 0.0159 | Linear Relation |
| EV vs R | 0.2633 | Low inverse correlation | 0.4084 | Linear Relation |

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