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Influence of Rainfall on Soil Water Content in Iraq

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***Abstract* – Soil Water content plays an important role in global hydrological cycles and regional climate of development weather patterns, plus its take part on production of precipitation and climate change. The aim of this research is to find out, influence of Rainfall on Soil Water Content in Iraq during 31 years at months (October, November, December, January, February, March, April and May).**

Work was carried out with the monthly data of temperature and soil water content taken from (ECMWF), specifically model (ERA-Interim) for the period from 1979 to 2009 through the use of statistical techniques such as simple linear regression and correlation coefficient. The results 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. Pearson test showed there is an moderate to high positive relationship in (Baghdad, Basrah) at months (November, December, January and February), Except Basrah there are no linear relationship at November, when rainfall increasing will be increase the volumetric soil water content and this is evident from the values slope and values of the correlation coefficient. In the months (October, March, April and May), there is no linear relationship between volumetric soil water content and total rainfall. But in Mosul and Rutbahas recorded the highest values of the correlation coefficients were of medium to high values for all months, except March in Mosul and (November, May)in Rutba, there is no linear relationship. Volumetric soil water content depends on the amount of rainfall and the intensity of evaporation as well as the nomination, since the heavy rainfall may cause significant increase in the volumetric soil water content and extends this effect to the months that followed, therefore, the heavy rainfall helps to recharge groundwater and increase the flow of running water.

***Keywords* – Rainfall, Volumetric Soil Water Content, Correlation Coefficient, Pearson Test, Iraq.**

I. INTRODUCTION

Plays the water content of the soil plays an important role in both the global hydrological cycles and regional [1] [2], and serves as chairman on a large scale in many of the environmental studies, including meteorology, hydrology, agriculture and climate change. The effect on the soil surface, especially at a depth of one to two meters, which is the key to the interaction between the Earth and the atmosphere, and is one of the key variables that control the exchange of water and thermal energy between the land surface and the atmosphere through evaporation and transpiration vegetation. Owns this variable multiple links with variables of meteorology other, which makes it effective in terms of predictive dramatically, and can determine the value of the water content of the soil through (i) field measurements, (ii) predictive models, (iii) remote sensing [3], and is known content water the soil that the amount of moisture (or water) inside the pores of the soil and on the surface of the soil particles attributed to the mass of the soil dry completely [4]. Despite being a layer of very small compared with the total amount of global water but they are very important in many of the basic processes of many hydrologists, chemistry and biology, which is an important variable is used in many applications such as (Numerical weather and monitor global climate change and forecasting in runoff and modeling evaporation), so it's important to careful monitoring and assessment of spatial and temporal variations of the water content of the soil [5].

Can get the contrast and the effect of the water content of the soil and reach the various practical applications through continuous monitoring and modeling of hydrological processes, Examples of these applications are as follows :

1) Deviation between the actual values and the desired water content of the soil is critical to the operation of water resources and political decision-making and management .
2) Predict climatic changes and ritual, such as rainfall and temperature by estimating water and heat transfer between the land surface and atmospheric process flow .
3) Flood forecasting on the basis of the spatial distribution of the degree of saturation of the soil surface .
4) Irrigation development through knowledge of spatial and temporal distribution of the water content of the soil .
5) Urban and Rural Planning, which is before choosing the type of farms and crops, which are primarily based on the level of soil moisture in order to maximize the economic, environmental and social benefit .
6) Predict global climate change through the continuation or change in the proportion of high or low water content of the soil.
7) Agricultural applications by estimating the growth of grass in knowing the water content of the soil .
8) Other environmental processes through hydrological modeling and prediction of erosion. [6] [7]

The movement of water in the soil is saturated is the process of non-linear and non-homogeneous [8], and is affected by climatic factors and environmental, such as precipitation and evaporation, vegetation and soil properties, and is controlled in the distribution of water in the soil by precipitation and evaporation, and the relationship with the clear air temperature and humidity, It can be vegetation as a shield objected rainfall and can cause dehydration due to the process of evaporation and

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transpiration vegetation [9]. Lead intensity rainfall and repeated an important role in determining the movement of water in the soil in terms of the operations of the leak and the nomination, and thus the quantity and timing [10], leakage and filtering can alter the heterogeneity of soil texture and porosity and water content [11]. For example, when the amount of water content is high, the movement of water calamity lead to soil erosion and increase the size of the pores, and when the amount of water content in a few, they lead to the porosity of the pores, and affect soil porosity and size in the movement of water and the soil's ability to retain [12].

Is divided soil into four levels according to the divisions of the European Centre for predicting the ceremonial medium term (ECMWF) European Centre for Medium-range Weather Forecasts and by project (TESSEL) Tiled ECMWF Scheme for Surface Exchange over Land first level, a surface layer of the soil and be at depth (0 -0.07 meters) and symbolized by the symbol SWVL1 the second level is also a layer close to the surface of the earth and be at depth (0.07-0.28 meters), and symbolized by the symbol SWVL2 the third level shall be at a depth of (0.28-1 meters) and has the symbol SWVL3 the level the fourth shall be at a depth of (1-2.89 meters), and has the symbol SWVL4, and measured data units volumetric (m^3 m^{-3}) so it is called the (Volumetric soil water content) [13], has been taking the average readings for the levels four of the soil water content data for volumetric soil for the purpose of studying the relationship between volumetric soilwater content and rainfall. It was the study of volumetric soilwater content and the levels of the four regions (Baghdad, Basrah, Mosul and Rutba) [14].

The research aims to study the effect of rainfall on the volumetric soilwater content for months (January, February, March, April, May, October, November, December) during the period of time is (31) years stretching from (1979) to (2009) areas (Baghdad, Basrah, Mosul and Rutba) through the use of statistical techniques.

II. Data and Study Area

Work was performed with monthly data for the total of the rainfall and the volumetric soil water content to study areas and taken from the European Centre (ECMWF), specifically model (ERA- Interim) ECMWF Re Analyses [15], has been transforming data into an integrated set monthly for the purpose of showing the effect of the monthly change .

Was selected areas (Baghdad, Basrah, Mosul and Rutba) of this accident (central, south, north, west) Iraq respectively, as shown in Figure 1, it consists soil of this region of the four types of soils as described in details and specifications study areas in Table 1, according to the classification of the FAO / UNESCO in 1962 [16].

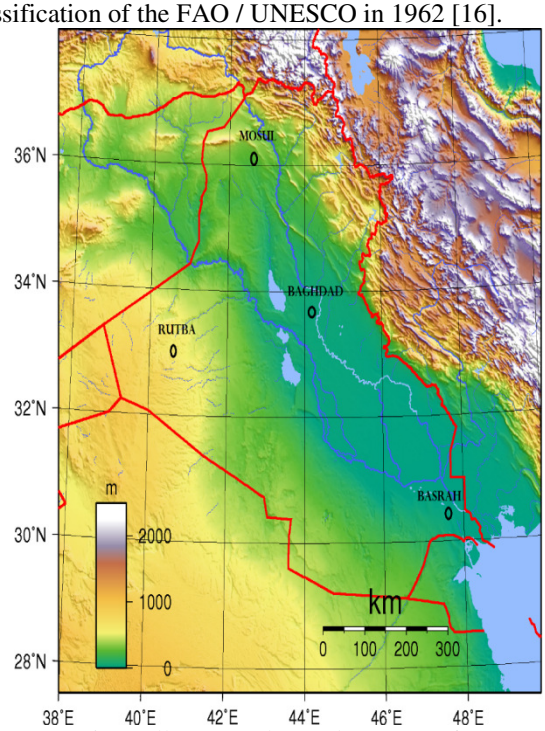

Fig.1. Illustrates the study areas [16].

Table 1: Study areas and details and specifications of the soil [16].

Zone	Elevation Above Sea Level (m)	Latitude (North)		Longitude (East)		Soil Type	Specifications
		Degree	Minutes	Degree	Minutes		
Baghdad	31.7	33”	14’	44”	34’	Silty clay loams and alluvial mud (Silty clay)	Medium soils tissue formed by the accumulation of soil for long periods due to flooding of the Tigris and Euphrates as a result of erosion and corrosion.
Basrah	2.4	30”	34’	47”	47’	Sand	Soil local fabric composed of coarse rock itself because of mechanical weathering with some gypsum and some salts.
Mosul	223.5	36”	19’	43”	09’	Red-brown soil (Reddish brown)	Coarse texture and often derived from the same rocks contain few organic materials and characterized as unfit for cultivation.
Rutba	630.8	33”	00’	40”	15’	Sand	Coarse fabric stabilized because of the vegetation during the ice age characterized by the high proportion of soil compounds lime.

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III. Method of Analysis

Among the many statistical tests available has been selected test Pearson for this work, has been selected regression analysis and in particular the simple linear regression to predict the relationship between the volumetric soil water content and the total rainfall, was the use of SPSS statistical software, which is a shortcut to (Statistical Package for the Social Sciences) to calculate the tests on the data and rain water content and program Sigma Plot to calculate the value of a mile gradient and the value of p-value in a manner simple linear regression.

A. The correlation coefficient

The correlation coefficient is a number between -1 and 1, which shows a linear relationship between two variables and the direction of that relationship, and the so-called correlation coefficient of Pearson correlation coefficient, and the correlation coefficient is calculated by the following equation [17]:

$$r = \frac{\sum_{i-1}^{x}(X_i-\bar{X})(Y_i-\bar{Y})}{(n-1)S_xS_y} \quad (1)$$

$\bar{X}$:The arithmetic mean of the datax_1, x_2,..., x_n

$\bar{Y}$: The arithmetic mean of the datay_1, y_2,...,y_n

S_x: The standard deviation of the data x_1, x_2,...,x_n

S_y: The standard deviation of the data y_1, y_2,...,y_n

B. Simple Linear Regression

Simple linear regression is the study of the relationship between two variables just to get to a linear relationship (i.e., the equation of a straight line) between these two variables, a parametric test as it is assumed that the data are distributed normally distributed and to learn the value of the gradient is calculated slope gradient through the following linear equation: [18]

$$Y = a + bx \quad (2)$$

$$b = \frac{\sum_{i=1}^{n}(X_i-\bar{X})-(Y_i-\bar{Y})}{\sum_{i=1}^{n}(X_i-\bar{X})^2} \quad (3)$$

b: Slope and show a mile straight line (Y = a + bx).

a: Constant gradient and show the value of the lump of Y-axis of the straight (Y = a + bx).

IV. Results and Discussion

A. Behavior Rainfall

Data were analyzed total rainfall during the study period of four selected areas of Iraq. The results showed that the highest level of total rainfall recorded in Mosul in March, while in Basrah and Baghdad has recorded the greatest value to the total rainfall in the month of January, and the variability in Rutba in the month of November and February, as evident in Figure 2.

B. The relationship between rainfall and volumetric water content of the soil

Figures 3, 4 and Table 2, the relationship between rainfall and the volumetric soilwater content for the city of Baghdad and Basrah, which is a positive relationship medium to high in the months (November, December, January, February), except Basrah there is no linear relationship in the month of November, where increasing volumetric soilwater content to increase rainfall, and this

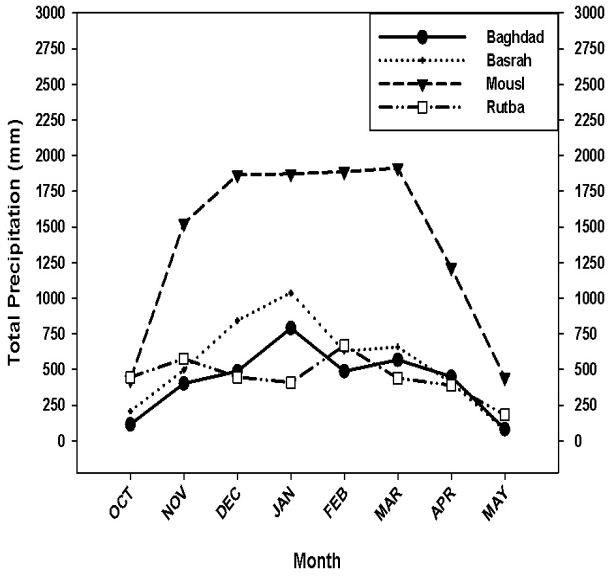


Fig.2. Total rainfall during the study period of four selected areas of Iraq.

is evident from the values of correlation coefficients and the values of a slope, which note that the highest value of the correlation coefficient Pearson was equal to 0.7 for the city of Baghdad in the month of November and the lowest value of the correlation coefficient Pearson is 0.05 in the month of October to the city of Baghdad as well, and this is also evident from the values of a slope and positive values of p-value low-lying. In the months (October, March, April, May), there is no linear relationship between volumetric water content of the soil and the total number of rainfall. But in Mosul and Rutba has recorded the highest values of the correlation coefficients were high values of medium to high for all months, the study except for the month of March for the city of Mosul and the month you refer first of May to the city of Rutba, there is no linear relationship as explained in Figures5, 6 and Table 2. The reason is to increase the process of evaporation of water from the soil due to the high temperature and low amount of rainfall in these months compared with other months.

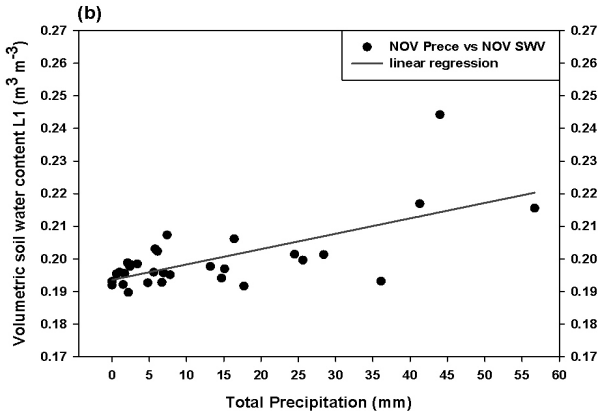
C. variation volumetric water content of the soil with the total rainfall

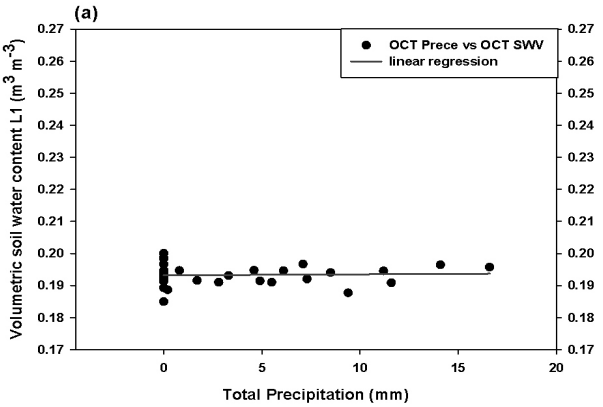
Figure 7 shows the behavior of the rate of variation of volumetric water content of the soil synchronize with the amount of rainfall for a selected group of years for the city of Baghdad, namely, (1980.1989, 1990.1993, 1997, 1998.2005, and 2006). For example, in the month of January of 1980, we note an increase in the amount of the volumetric soilwater content with a few in the amount of rainfall, and the reason to increase the amount of rainfall in the month of December, which leads to the retention of soil water to the month of January in addition to the lack of evaporation due to low surface air temperature, and note that too in the month of March of the same year, where the amount of rainfall (4.5 mm) with retention of soil water by high compared with the rainfall and due to the increased amount of rainfall in the month of February, which also helps to provide the soil with water to months

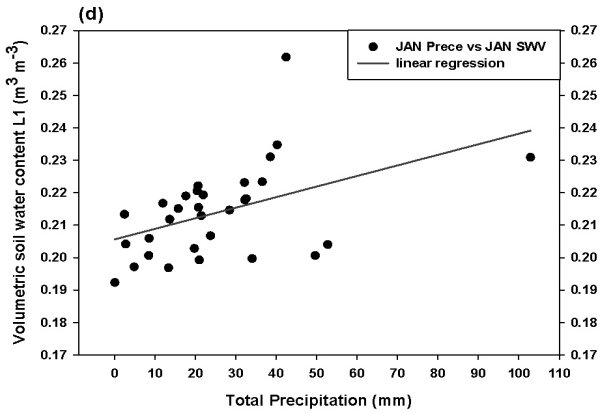
subsequent, and note that too in the month of February of the year 1989, and in the month of January of 1990, and in the month of February of the year 1993, and in the month of November of 1997, and in the month of December and the month of February of 1998, and in the month of February of the year 2005 and the year 2006.

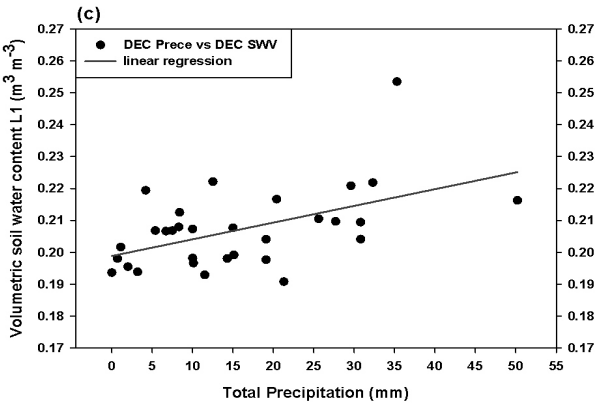
Table 2: The relationship between rainfall and volumetric water content of the soil for eight months for a period of 31 years

Months	Baghdad					Basrah				
	r	Degree of Correlation	Slope	P-value	Relation ship	r	Degree of Correlation	Slope	P-value	Relation ship
October	0.05	Light	0.00003	0.8	No	0.07	Light	0.00003	0.7	No
November	0.7	High	0.0005	<0.0001	Linear	0.2	Low	0.0001	0.1	No
December	0.5	Medium	0.0005	0.003	Linear	0.6	Medium	0.0004	0.001	Linear
January	0.5	Medium	0.0003	0.009	Linear	0.5	Medium	0.0004	0.002	Linear
February	0.5	Medium	0.0006	0.002	Linear	0.6	Medium	0.0003	0.0001	Linear
March	0.3	Low	0.0002	0.1	No	0.1	Light	0.00004	0.5	No
April	0.2	Low	0.0001	0.2	No	0.3	Low	0.0001	0.06	No
May	0.2	Low	0.0002	0.3	No	0.08	Light	-0.0001	0.7	No
Months	Mosul					Rutba				
	r	Degree of Correlation	Slope	P-value	Relation ship	r	Degree of Correlation	Slope	P-value	Relation ship
October	0.6	Medium	0.0002	0.001	Linear	0.3	Low	0.00005	0.05	No
November	0.6	Medium	0.0003	<0.0001	Linear	0.5	Medium	0.0002	0.007	Linear
December	0.6	Medium	0.0003	0.0006	Linear	0.5	Medium	0.0003	0.007	Linear
January	0.6	Medium	0.0003	0.0003	Linear	0.7	High	0.0006	<0.0001	Linear
February	0.7	High	0.0005	<0.0001	Linear	0.5	Medium	0.0001	0.003	Linear
March	0.2	Low	0.0001	0.2	No	0.6	Medium	0.0003	0.0002	Linear
April	0.5	Medium	0.0003	0.001	Linear	0.6	Medium	0.0002	0.001	Linear
May	0.5	Medium	0.0003	0.003	Linear	0.3	Low	0.0001	0.08	No









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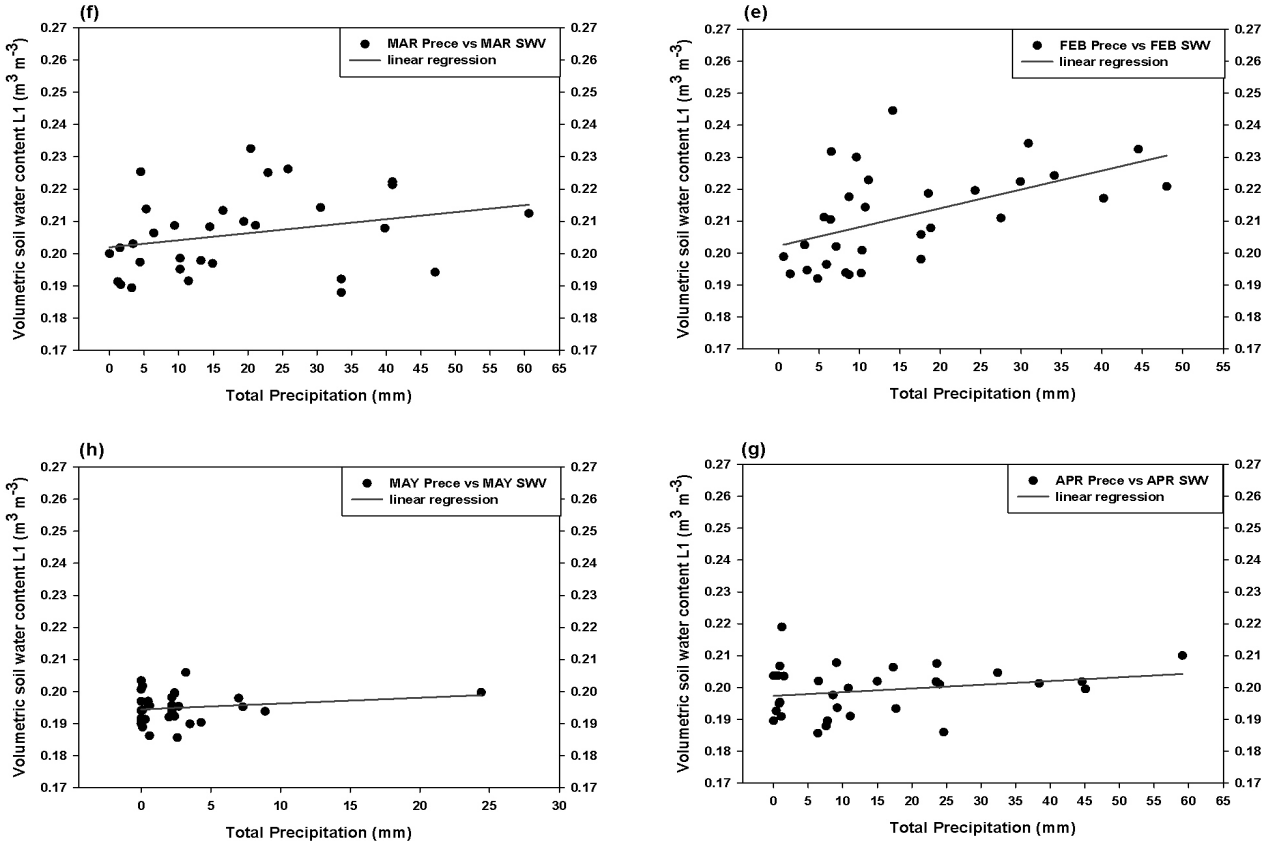
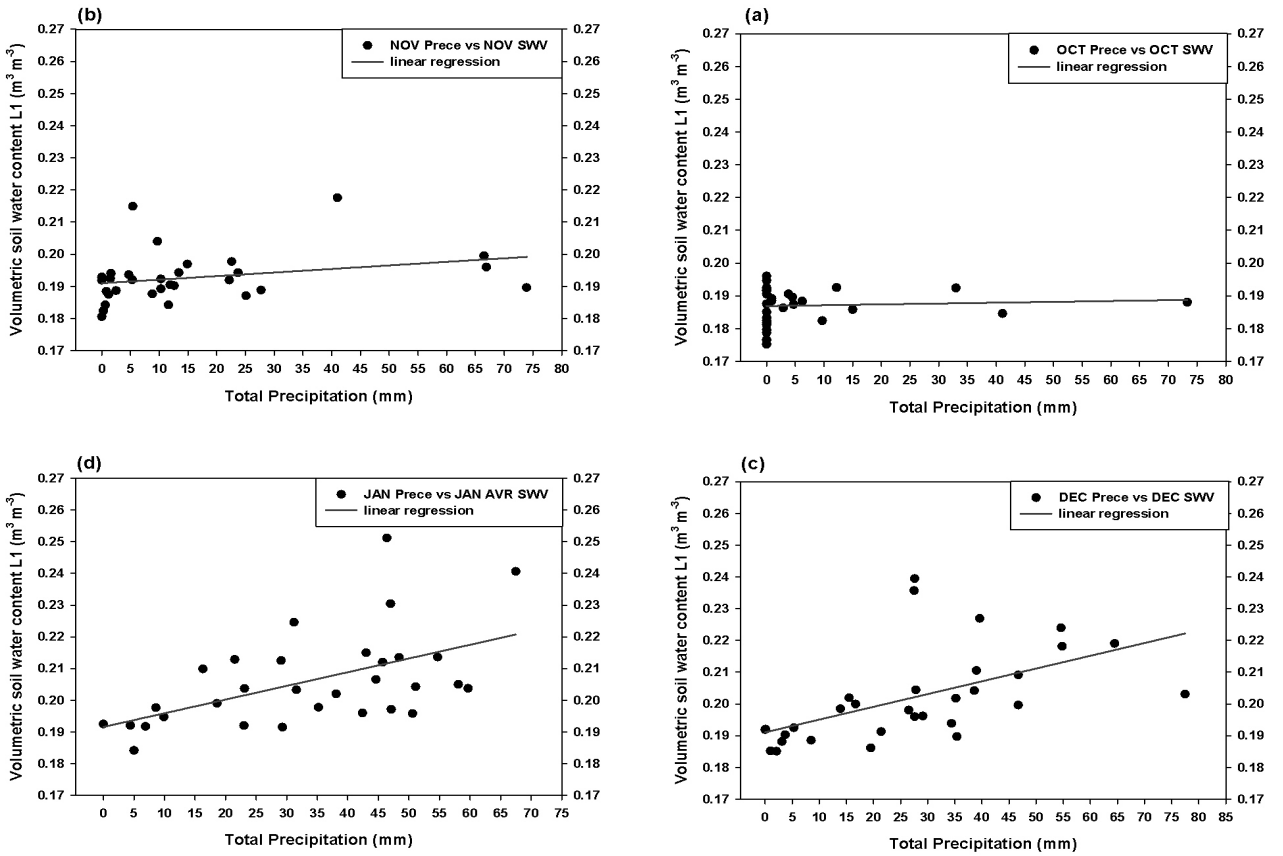


Fig.3. The relationship between the volumetric water content of the soil and the total rainfall for the city of Baghdad for months: (a) October, (b) November, (c) December, (d) January, (e) February, (f) March, (g) April, (h) May.



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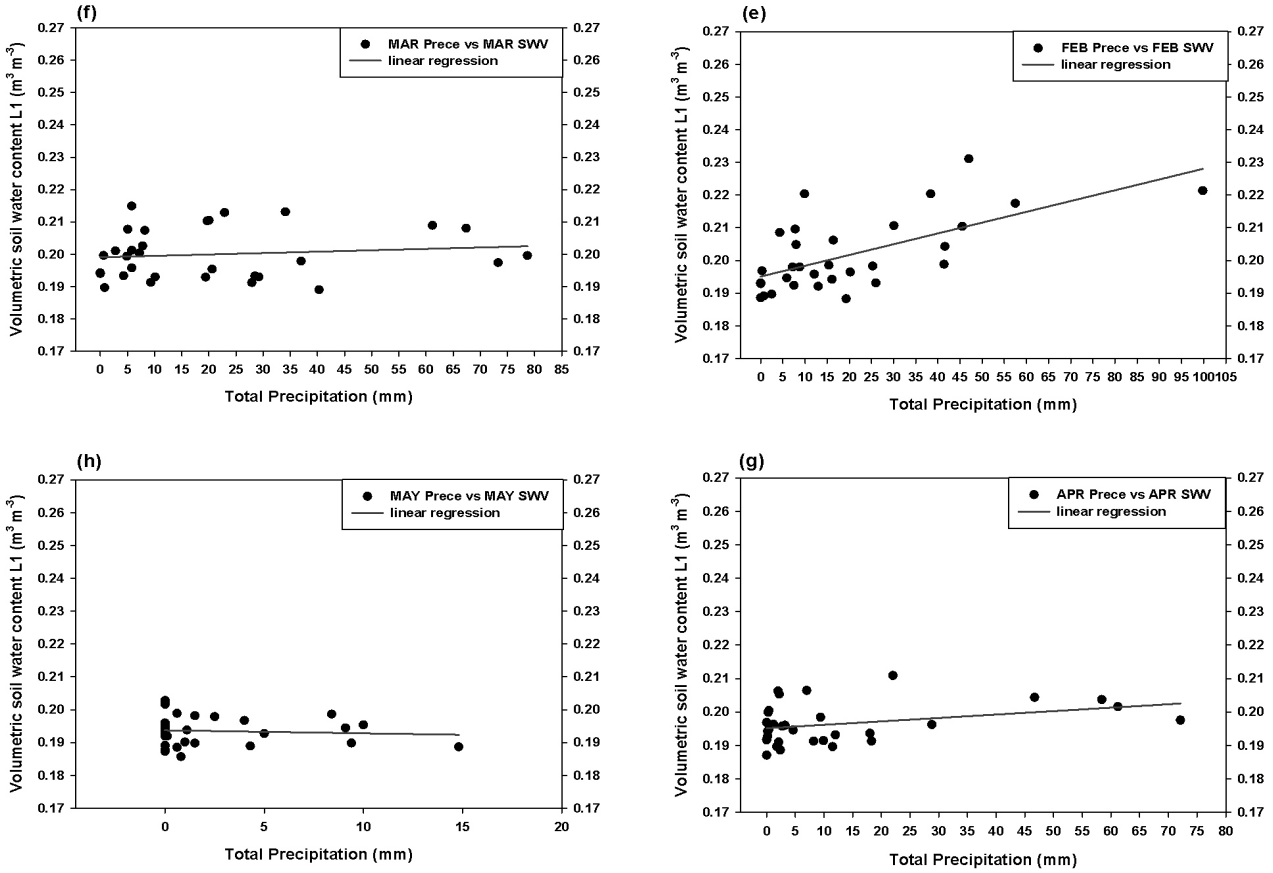
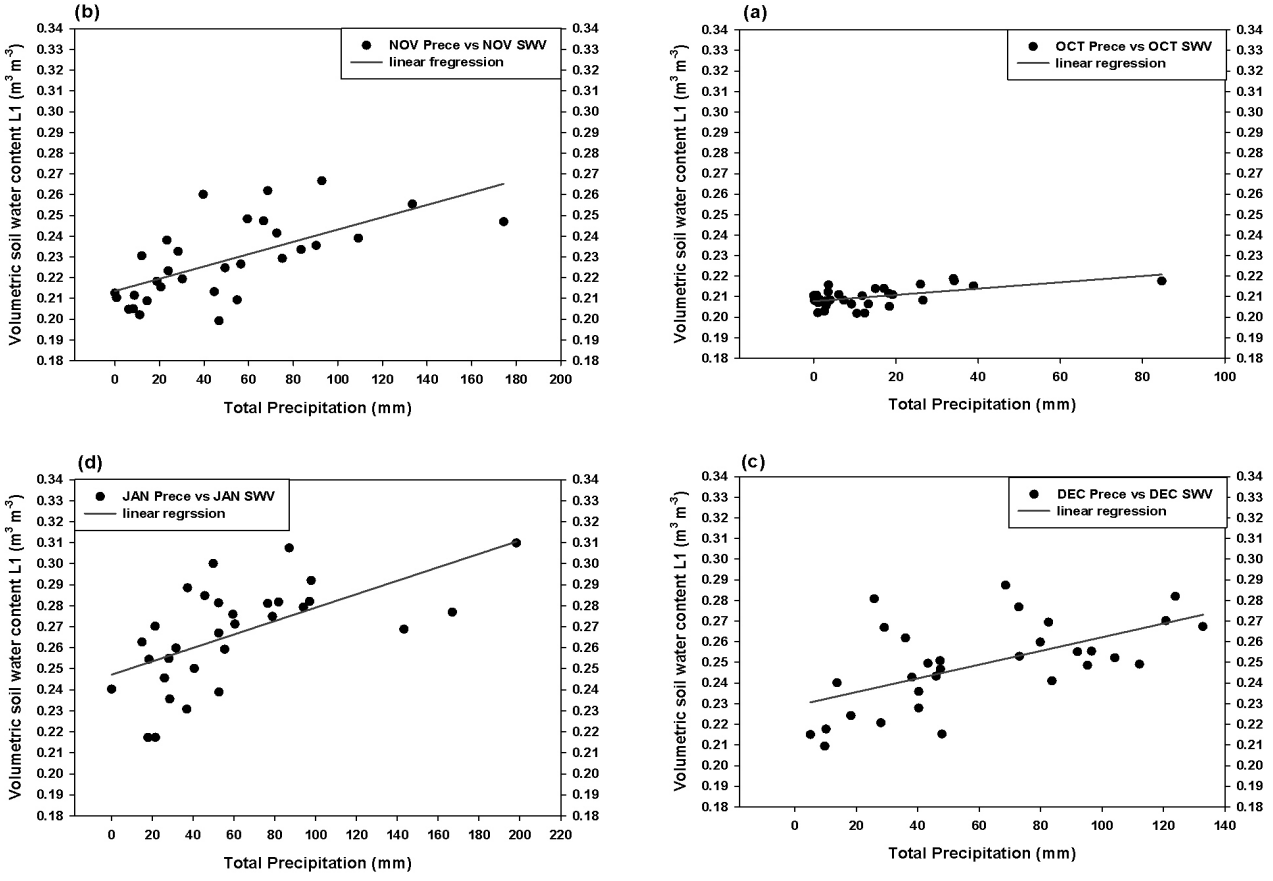


Fig.4. The relationship between the volumetric water content of the soil and the total rainfall for the city of Basrah for months: (a) October, (b) November, (c) December, (d) January, (e) February, (f) March, (g) April, (h) May.



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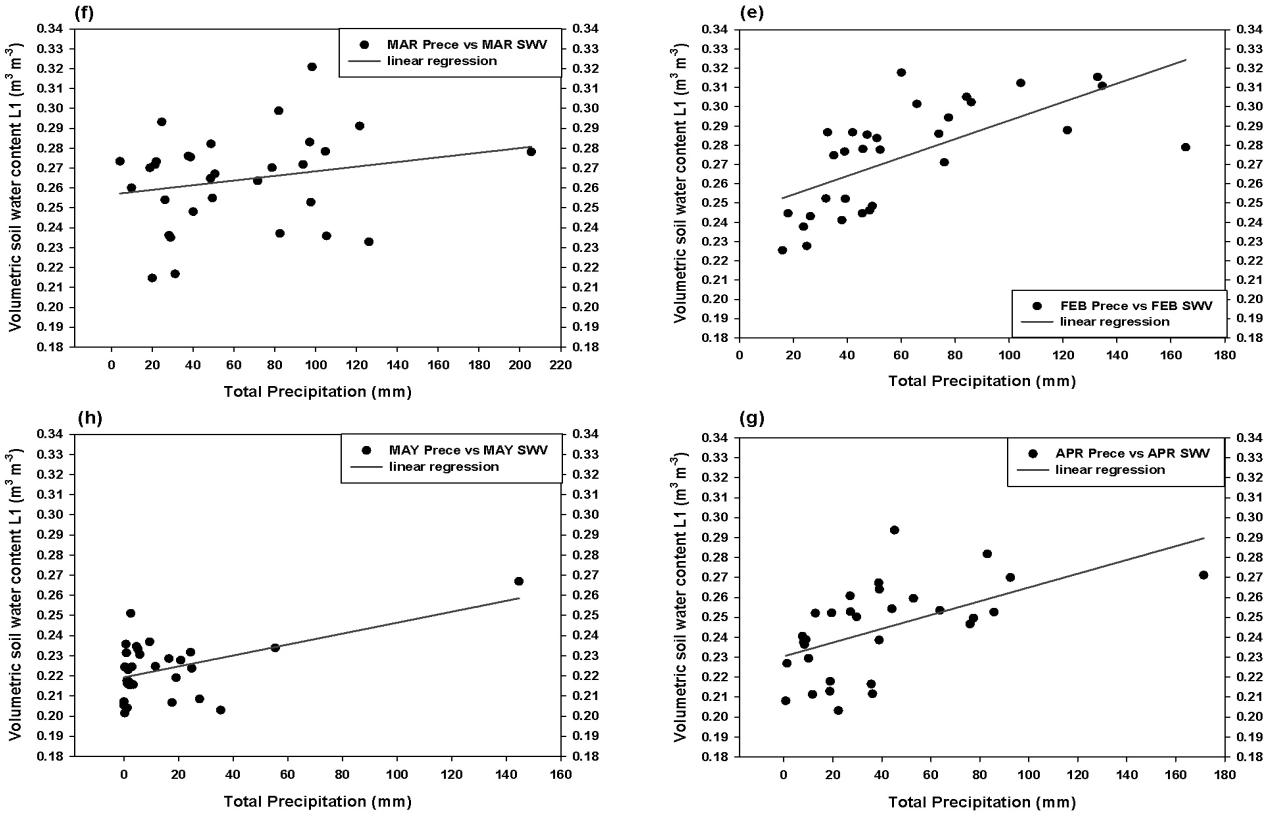
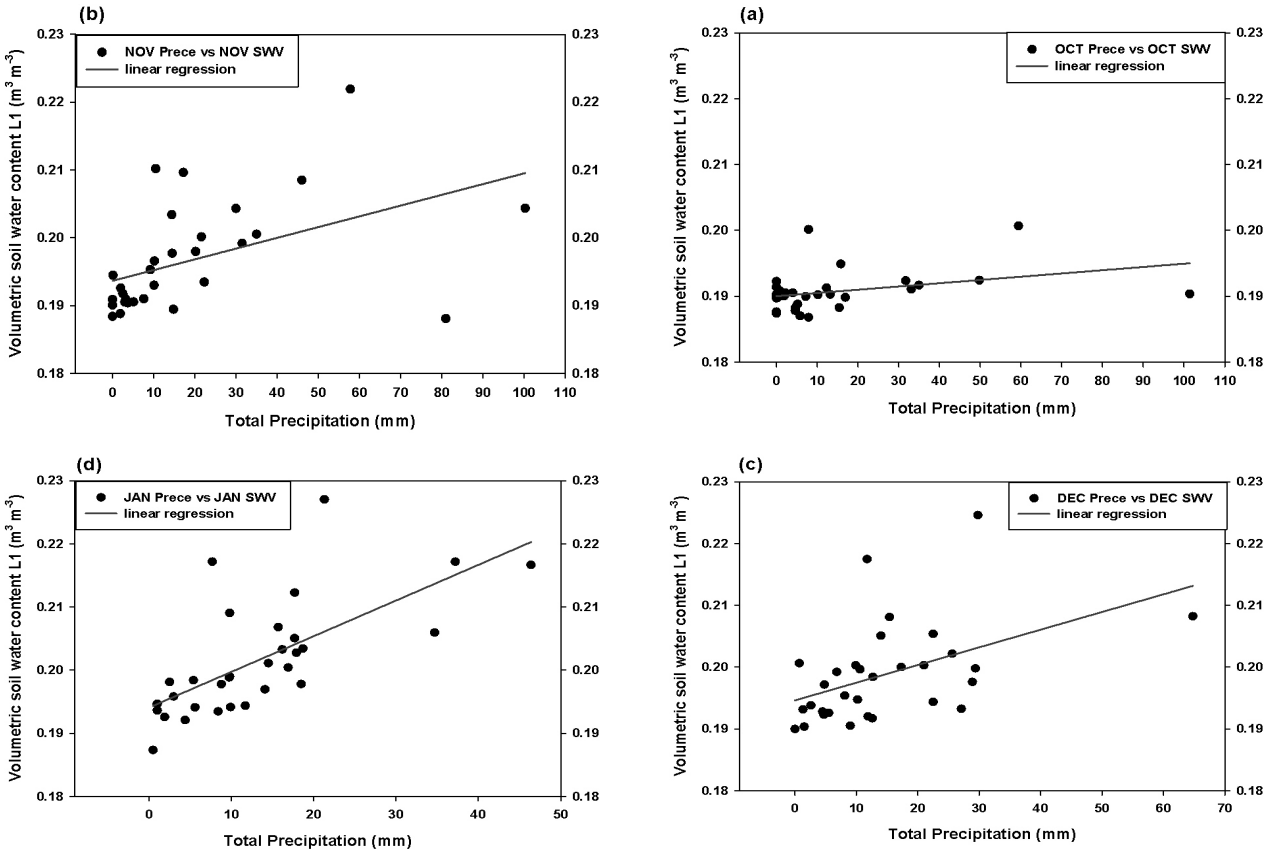


Fig.5. The relationship between the volumetric water content of the soil and the total rainfall for the city of Mosul for months: (a) October, (b) November, (c) December, (d) January, (e) February, (f) March, (g) April, (h) May.



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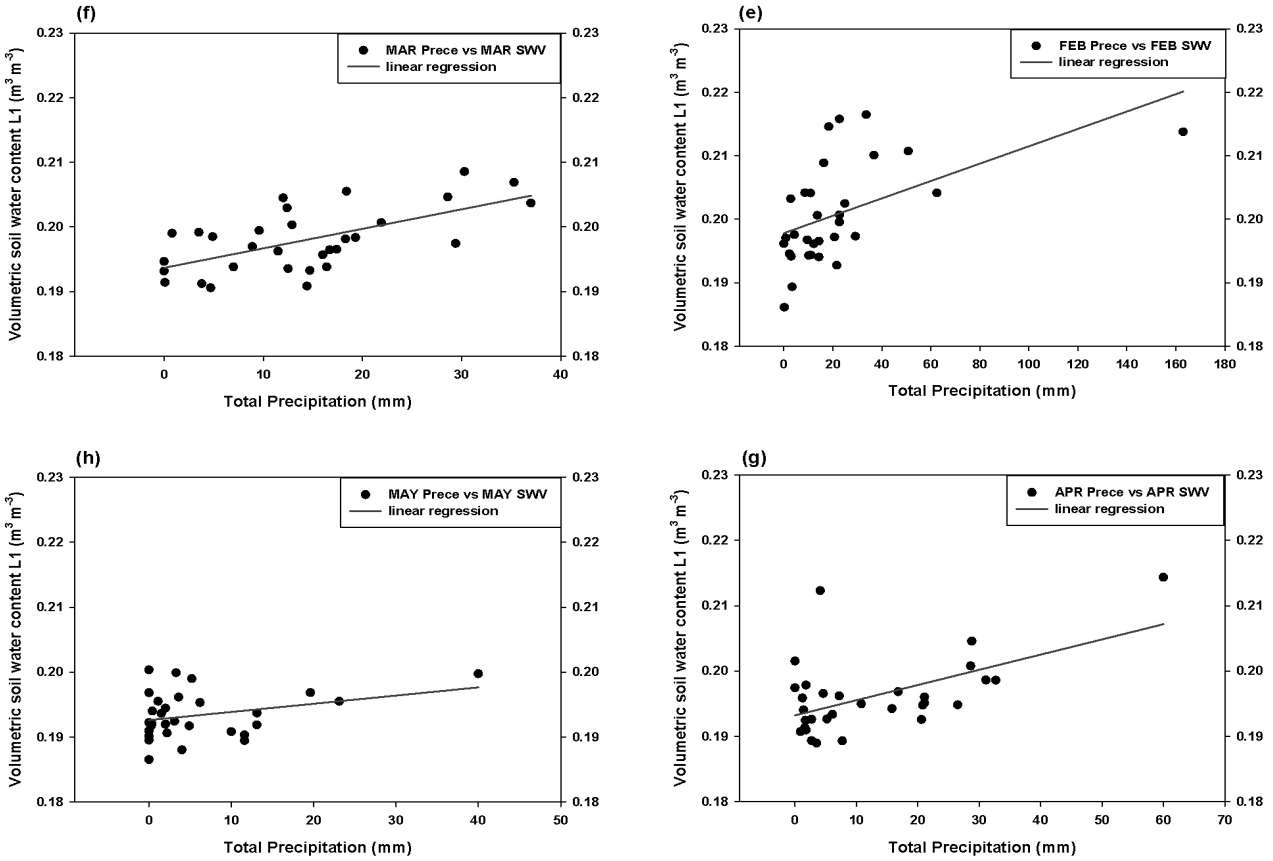
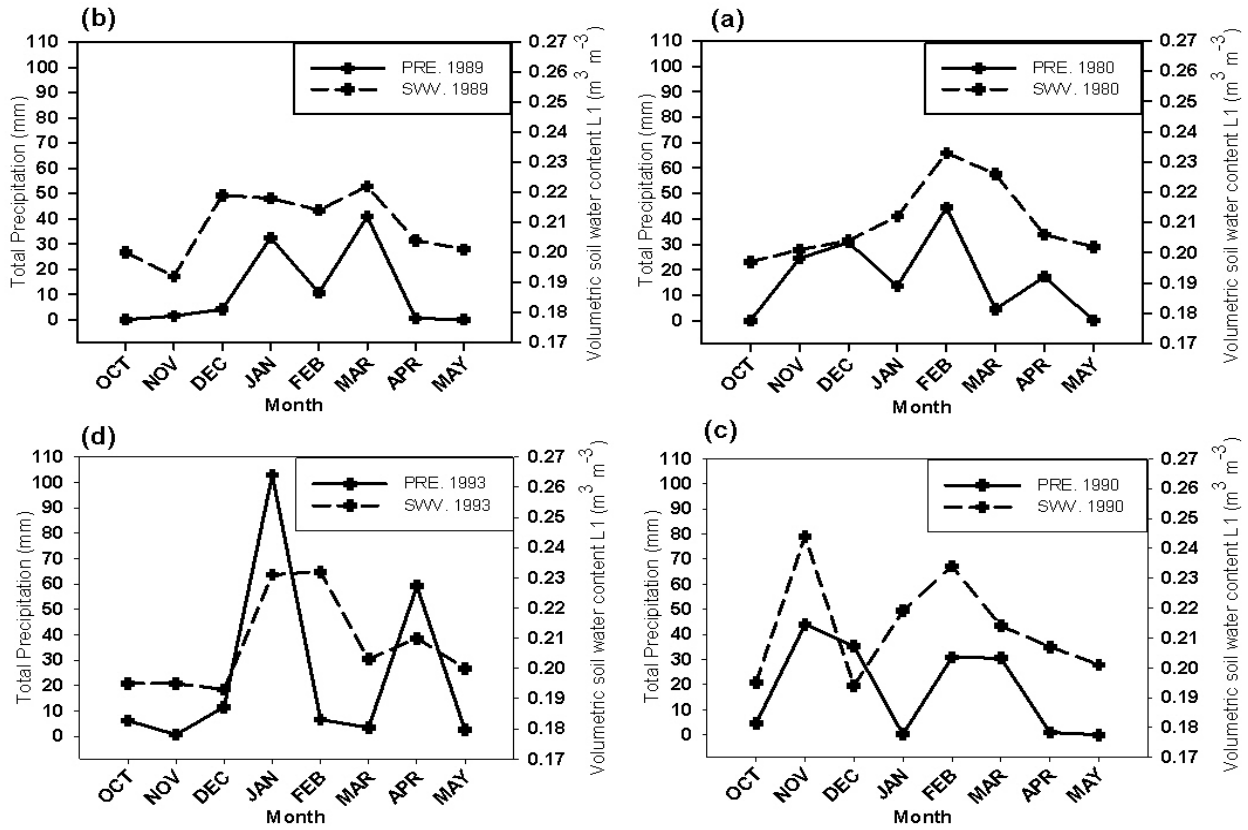


Fig.6. The relationship between the volumetric water content of the soil and the total rainfall for the city of Rutba for months: (a) October, (b) November, (c) December, (d) January, (e) February, (f) March, (g) April, (h) May.



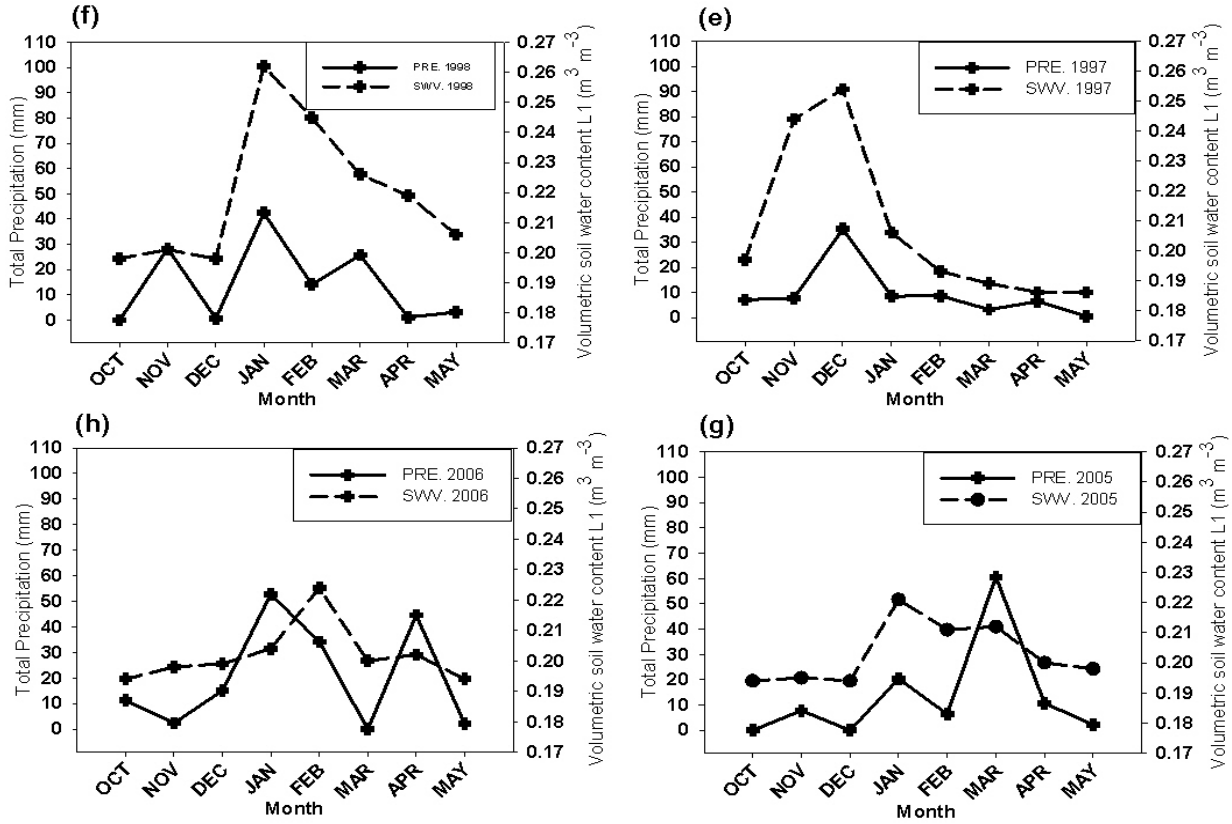


Fig.7. The relationship between volumetric water content of the soil and the total rainfall for the city of Baghdad for years: (a) 1980, (b) 1989, (c) 1990, (d) 1993, (e) 1997, (f) 1998, (g) 2005, (h) 2006.

V. CONCLUSION

Data were analyzed for total rainfall months (October, November, December, January, February, March, April, May), the four selected areas of Iraq, namely, (Baghdad, Basrah, Mosul, Rutba). The results showed that the highest level of total rainfall recorded in Mosul in March, while in Basrah and Baghdad has recorded the greatest value to the total rainfall in the month of January, and the variability in Rutba in the month of November and February. The relationship between rainfall and thevolumetric soil water content, it is a positive relationship medium to high in the months (November, December, January, February) with the exception of Basrah, there is no linear relationship in the month of November, where increasing thevolumetric soil water content withincreased rainfall, this is evident from the values of correlation coefficients and the values of a slope.Depends volumetric water content of the soil on the amount of rainfall and evaporation as well as the intensity of the nomination. It said heavy rains may cause a significant increase in the volumetric soil water content and extends this effect to the subsequent months, as in the month of January of 1980, as we note an increase in the amount of thevolumetric soil water contentwith a few in the amount of rainfall, and due to the increased amount of rainfall in the month of December, which leads to the retention of soil water to the month of January in addition to that, the lack of evaporation due to the low surface air temperature, so the heavy rainfall helps replenish groundwater and increase the flow of running water.

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