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Research Article

Analysis of the Monthly and Annual Change of Soil Moisture and Evaporation in Iraq

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Abstract

The aim of this research is to know the relationship between surface soil moisture with real evaporation in Iraq during the 30 years period (1985-2014) in eight different stations (Mosul, Sulaimaniya, Tikrit, Baghdad, Rutba, Kut, Nukhayib, and Basrah) through the use of performance data to the National Oceanic and Atmospheric Administration (NOAA) and take advantage of the simple linear regression and the regression test and Spearman rho. The research shows Monthly and annual averages of real evaporation and surface soil moisture and the strong relationship is directly proportional to the evaporation and surface soil moisture and there is high correlation in the stations (Basrah, Kut, Nukhayib, and Rutba) while there is a medium correlation in the stations (Baghdad and Tikrit) and there's a low correlation in the stations (Sulaymaniya and Mosul).

Keywords: Soil moisture, Evaporation, Spearman rho, NOAA, Iraq.

الخلاصة

الهدف من هذا البحث هو معرفة العلاقة التي تربط رطوبة التربة السطحية مع التبخر الحقيقي في العراق خلال 30سنة للفترة (1985-2014) لثمان محطات مختلفة (الموصل, سليمانية, تكريت, بغداد, الرطبة, الكوت, النخيب, البصرة) من خلال استخدام بيانات الادارة الدولية للمحيطات والغلاف الجوي (NOAA) والاستفادة من الانحدار الخطي البسيط وميل الانحدار واختبار سبيرمان رو. حيث بين البحث المعدلات الشهرية والسنوية للتبخر الحقيقي ورطوبة التربة السطحية ونوعية العلاقة بين الاثنين حيث هنالك علاقة قوية طرديه تربط التبخر برطوبة التربة السطحية حيث يزداد التبخر بزيادة الرطوبة والعكس صحيح ويبين البحث نوعية الارتباط بين العاملين حيث هنالك ارتباط عالي في محطات (البصرة, الكوت, النخيب, الرطبة) بينما هنالك ارتباط متوسط في محطتي (بغداد وتكريت) وهنالك ارتباط قليل في محطتي (سليمانية والموصل).

Introduction

Evaporation is the water turned from liquid image to the gas phase in the water vapor image, or is the (net rate of water molecules in transition from a liquid to the atmosphere in the gaseous state and its units (mm/day) or (cm/day) or (inch/day)). Evaporation occurs by heating either naturally from the sun or artificially using any other source of energy and strength depends on evaporation (temperatures, relative humidity, wind and solar energy)[1][2].

The soil water content (soil moisture) can be defined as the percentage of moisture in the soil is the percentage of the weight of the water in the soil to dry weight of solids. The moisture content is the soil retain water in the form of moisture as possible from the plant absorbed a long time and allows for the process of chemical weathering of soil minerals continue what changes happen in the metallurgical, chemical and physical properties known to be out of soil evolution. Soil moisture is difficult to define because it means different things in different disciplines. For example, a farmer's concept of soil moisture is different from that of a water resource manager or a weather forecaster. Generally, however, soil moisture is the water that is held in the spaces between soil particles. Surface soil moisture is the water that is in the upper 10 cm of soil, whereas root zone soil moisture is the water that is available to

plants, which is generally considered to be in the upper 200 cm of soil[3][4]. The water is retained in the pores of the soil in the form of membranes surrounding the grains of the soil and the capillary water form clutched in the high-pores (water types in the soil) The free water or water gravity is fill in the blanks all counting after rain or irrigation and then pull of gravity to the bottom[5][6].

Materials and Methodologies

Data source and study areas

Took the Surface Soil Moisture data units (m^3 m^{-3}) and data of Evaporation units (mm/month) from the NOAA center[7]. It was in this work study different parts of Iraq, including the northern areas of Iraq (Sulaymaniya, Mosul) and areas of southern Iraq (Basrah) and middle and Western regions (Kut, Tikrit, Baghdad, Rutba and Nukhayib). See figure 1.

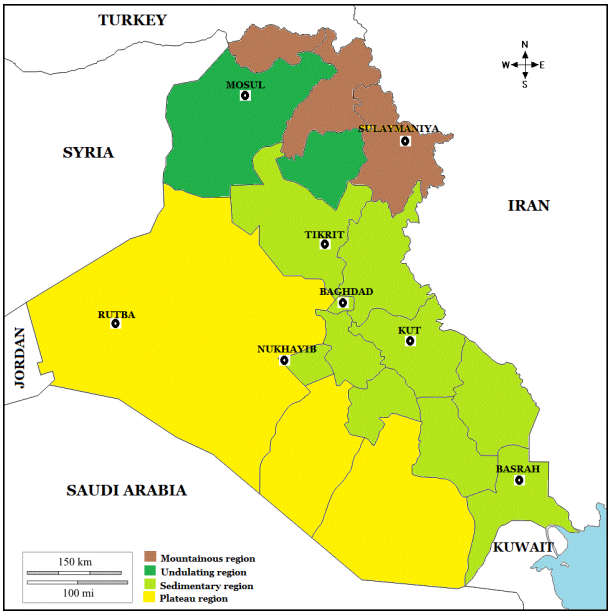

Figure 1: Map of Iraq, explaining the study areas[8] .

Statistical methods used

Conducted numerous statistical tests available has been selected analysis Simple linear regression and use the value of probabilistic P-Value and Spearman rho test to determine the shape of the relationship:

Simple linear regression (SLR)

Use Linear Regression when:

1. We want to predict a trend in data, or predict the value of a variable from the value of another variable, by fitting a straight line through the data.
2. We know there is exactly one independent variable.

The independent variable is the known, or predicted, variable, such as time or temperature. When the independent variable is varied, it produces a corresponding value for the dependent, or response, variable. If you know there is more than one independent variable, use multiple linear regression[9]:

$$\bar{Y} = a + b\bar{X} \quad (1)$$

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

Where, (b) is the slope of the regression, (a) is the constant gradient and demonstrate the value of the cross of axis ($\bar{Y}$) for Straight line, the (X_i = 1, 2… n), ($\bar{X}$) is the variable.

- Probability-Value

The P-value is the probability of being wrong in concluding that there is a true association between the variables (i.e., the probability of falsely rejecting the null hypothesis, or committing a type I error). The smaller the P-value, the greater the probability that the variables are correlated. Traditionally, you can conclude that the independent variable can be used to predict the dependent variable when P < 0.05[11].

- Spearman rho test

Use Spearman Rank Order Correlation when:

1. You want to measure the strength of association between pairs of variables without
2. Specifying which variable is dependent or independent.

The residuals (distances of the data points from the regression line) are not normally distributed with constant variance. If you want to assume that the value of one variable affects the other, use some form of regression. If you need to find the correlation of normally distributed data, use the parametric Pearson Product Moment Correlation, and (r_s) is given by the following equation[12]:

$$r_s = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n(n^2\text{-}1)} \quad (3)$$

Where, (r_s) is the Spearman rho coefficient statistical ranks, (d_i) the value of the order, if the value of (n) is large can choose the value of (r_s) to their importance by calculating the value of (t_s) which is given by the following equation:

$$t_s = r_s \sqrt{\frac{n-2}{1-{r_s}^2}} \quad (4)$$

Through the Table 1. Can determine the value of the degree of correlation and interpretation of test.

Table 1: The degree of correlation and interpretation of test transactions [12] .

Value	Correlation	Interpretation
Less 0.2	Few	No relation
0.2-0.4	Low	Small
0.4-0.7	Medium	Acceptable
0.7-0.9	High	Special
0.9-1	Very high	Strong

The Results and Discussion

The monthly average of E and SSM

Through the Figures 2 and 3 the monthly average in the, evaporation and surface soil moisture, this can be seen the convergence of evaporation and soil moisture values through all the study areas.

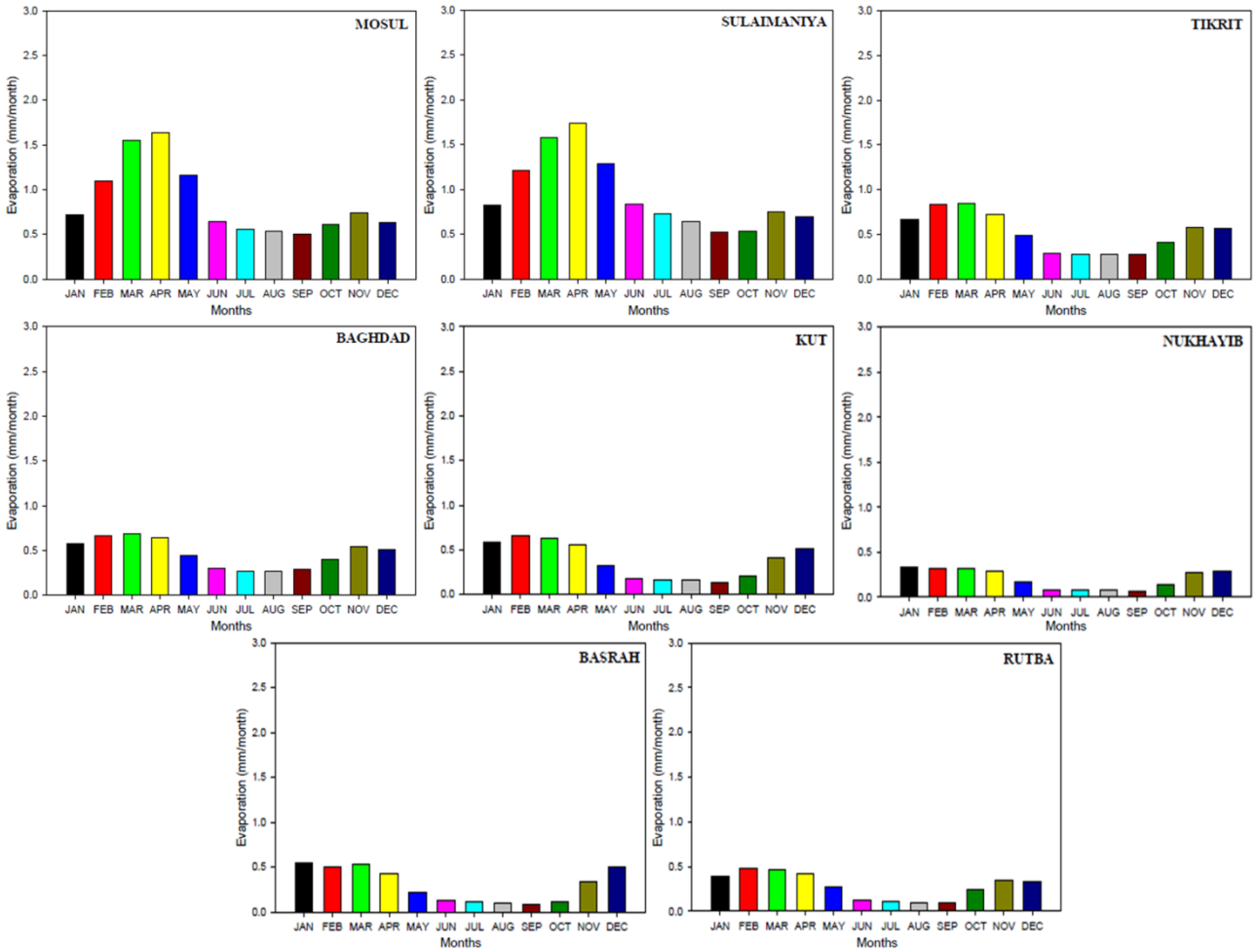

Figure 2: The monthly average of evaporation for eight different stations in Iraq and for the period (1985-2014).

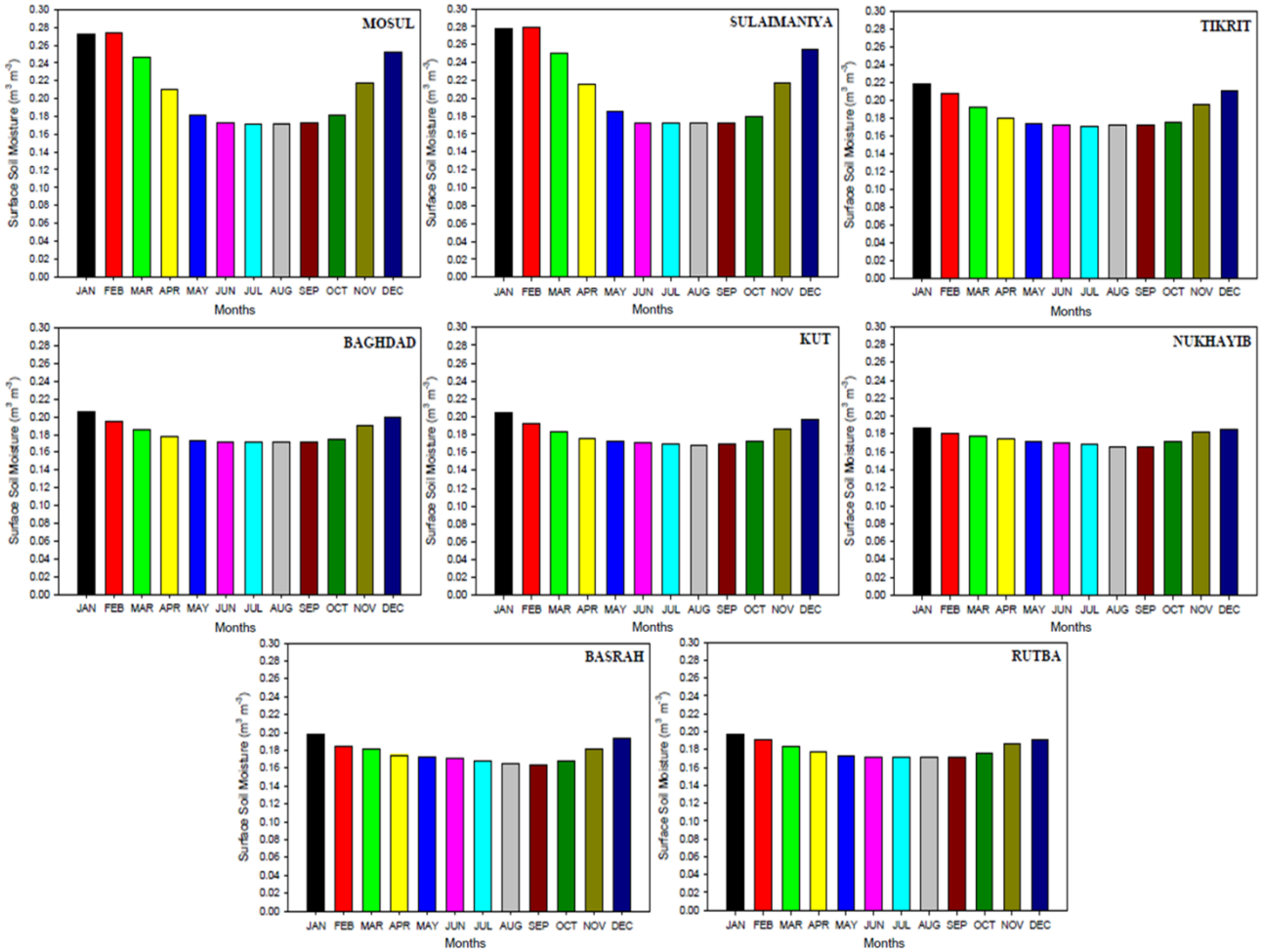

Figure 3: The monthly average of soil moisture for eight different stations in Iraq and for the period (1985-2014).

The annual change of E and SSM

Through the Figure 4, shows the annual change of evaporation with surface soil moisture for eight different stations in Iraq (Mosul, Sulaimaniya, Tikrit, Baghdad, Rutba, Kut, Nukhayib, Basrah) during the time period from 1985 to 2014. It notes the existence of a changing relationship between them where increasing values of evaporation in stations where the increasing values of surface soil moisture, and vice versa.

The average total annual for E and SSM in Iraq

The Figure 5 shows the average total annual evaporation and surface soil moisture of eight different stations in Iraq for thirty years (1985-2014) can be seen high evaporation and surface soil moisture in cold stations depending on the temperatures, solar radiation and location.

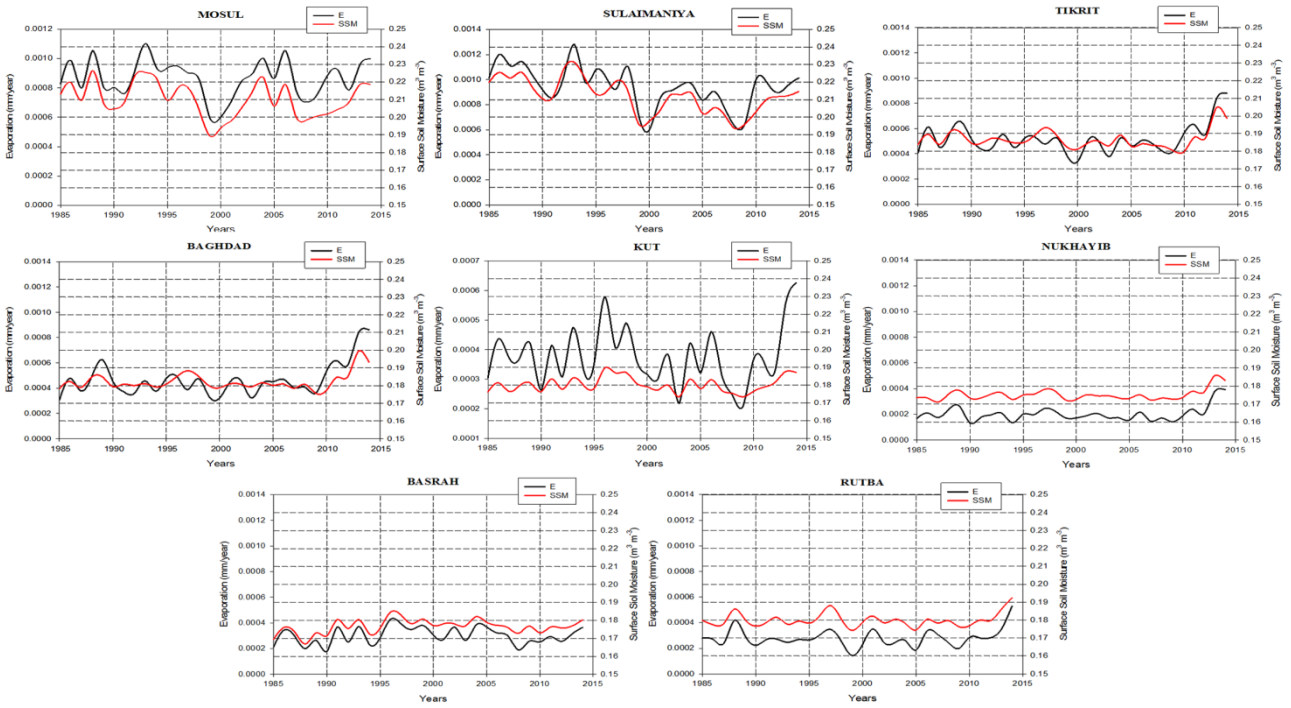

Figure 4: shows the annual change of evaporation with surface soil moisture for 8 stations.

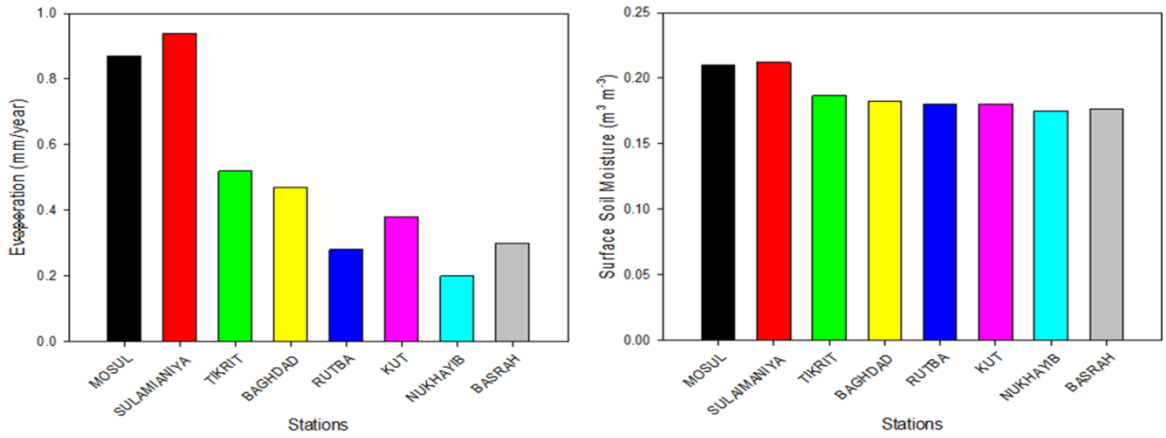

Figure 5: The average total annual evaporation and surface soil moisture of 8 stations.

The relationship between E and SSM

The Figure 6 illustrates the relationship between the evaporation and surface soil moisture where they were taking the monthly average for thirty-years (1985-2014) to eight different stations in

Table 2: The Spearman rho test results and SLR

Station	SLR		Spearman	
	P-V	Interp.	r_s	Correl.
Mosul	0.25	Non-L	0.3	Low
Sulaymaniya	0.23	Non-L	0.3	Low
Tikrit	0.01	Linear	0.6	Medium
Baghdad	0.01	Linear	0.6	Medium
Rutba	0.00	Linear	0.7	High
Kut	0.00	Linear	0.8	High
Nukhayib	0.00	Linear	0.8	High
Basrah	0.00	Linear	0.8	High

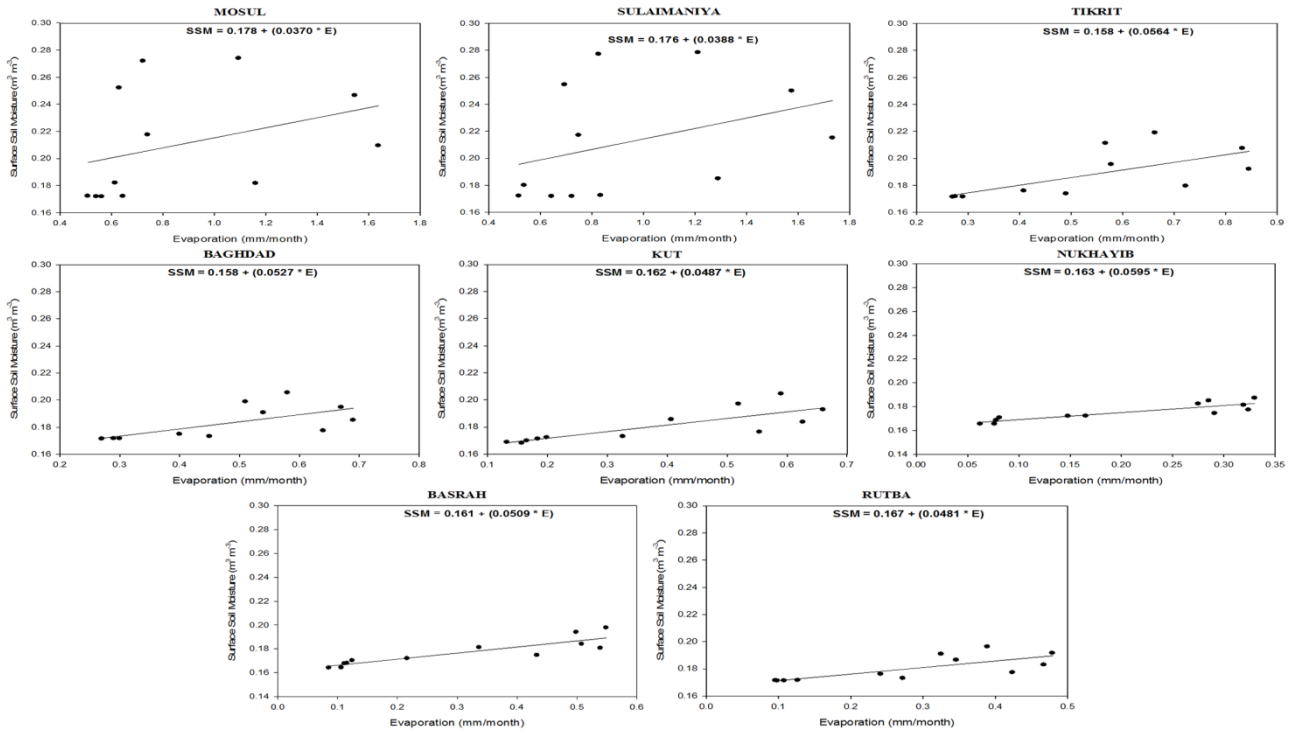

Figure 6: The relationship between the evaporation and surface soil moisture of 8 stations.

Conclusions

It can be summarized the following conclusions:

1. Lower monthly average of SSM in the southern stations and increase in the northern stations of Iraq.
2. The monthly average of SSM decreased in the hot months and increased in the cold months.
3. Lower monthly average of E in the southern stations and increase in the northern stations of Iraq.
4. Low monthly average of E in hot months and increase in cold months.
5. The highest value of the total annual average of E was at Sulaymaniya station and the lowest value was in Nukhayib station.
6. The highest value of the total annual average of SSM was at Sulaymaniya station and the lowest value was in Nukhayib station.
7. There is a positive relationship between E and SSM.

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