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Study of the Synoptic Analysis for Surface Potential Evaporation and Soil Moisture in Iraq

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Abstract: ***The Potential (Latent) Evaporation is one of the most important elements of the water budget as well as the energy balance because Potential Evaporation is important in practical applications such as agriculture and irrigation projects, and Soil Water Content (Soil Moisture) plays an important role in both global and regional Hydrological cycles. In This Search was study the synoptic analysis of the monthly average data for surface potential evaporation and surface soil moisture of eight different stations in Iraq (Mosul, Sulaymaniyah, Tikrit, Baghdad, Rutba, Kut, Nukhayib, Basrah) for 30 years (1985-2014) from NOAA. The data were processed using some statistical techniques such as simple linear regression and the Spearman Rho correlation coefficient. The results showed that there is an increase in the values of surface potential evaporation in hot months and a decrease in the cold months of the year and vice versa surface soil moisture values. An inverse relationship between surface potential evaporation and surface soil moisture. For the total annual surface potential evaporation was at Kut station and then Sulaymaniya station and the lowest value was in Mosul station and then Nukhayib station and the highest value of the total annual average of surface soil moisture was at Sulaymaniyah station and lowest value in the Nukhayib station.***

Keywords: Surface soil moisture, Surface potential evaporation, Spearman rho, NOAA, Iraq

1. Introduction

Can be defined Potential Evaporation (PE) is controlled by evaporation on the climate through runoff indefinite, or measuring the ability of the atmosphere on the water removed from the surface of the soil through evaporation and transpiration, either Actual Evaporation (AE) is the amount of water that is actually removed from the surface through evaporation and transpiration operations and will always be less than Potential Evaporation [1], see Fig. 1.

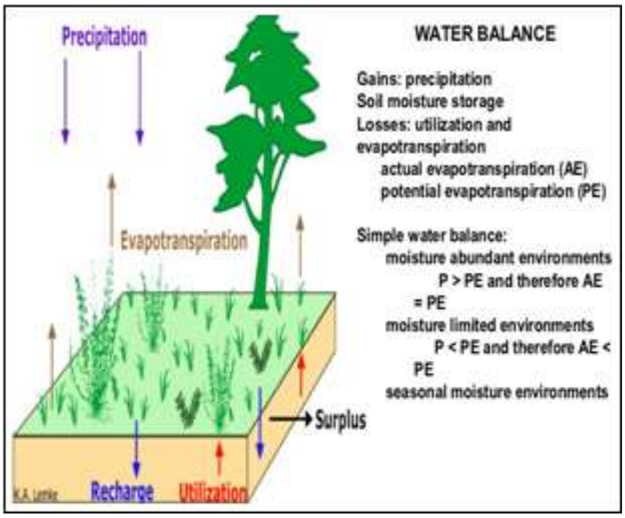


Figure 1: The Water Balance [1].

There are several factors that affect the Potential evaporation They (solar radiation as the most important influences meteorology and temperatures, relative humidity and wind speed as well as other factors that influence indirectly as the level of water and preprocessing air and iceberg soil temperature and the outpouring underlying sensible heat) is the Potential evaporation important factors in air operations, where he contributes to the formation of clouds and precipitation process is where one of the most important determinants of water cycle in nature and therefore the measurement of the amount of Potential evaporation necessary to assess water requirements as well as the urgent need for its own account when planning irrigation projects [2], [3]. The water content of the soil is variable head on a large scale in many environmental studies, including meteorological, hydrological, agriculture, climate change and affect the surface of the soil, especially at a depth of (1-2) meters, between the land and atmosphere interact key and is one of the key variables that control the exchange water and thermal energy between the surface and the atmosphere through evaporation and plant transpiration and has this variable multiple links with variables meteorology other, making it effective in terms of predictive dramatically [4], in spite of being a very small layer compared to the amount the world's total water but very important in many of the basic processes of many of the hydrological and chemists and neighborhoods is an important variable used in many applications (such as numerical weather forecasts and monitoring of global climate change and forecasting in runoff and modeling of evaporation) so it's important to close monitoring and assessment of spatial and temporal variations of the water content of the soil [5], [6].

Agriculture is the most sector economic impact of severe weather events such as droughts and rely many other economic sectors in the community on Agroecosystems that are specific form of air-conditioned eco-systems of humans for food production, so the drought can have a lot of economic and social negative effects, such as loss of income in the agriculture and food industries and the high costs of large water production techniques such as irrigation systems [7].

Through continuous monitoring and modeling of hydrological processes can be obtained on the variation and the impact of the water content of the soil and reach practical applications are examples of these applications as follows

[8], [9]:

1) The deviation between the actual values and the desired water content of the soil is critical to the process of water resources and to take political and administrative decisions.
2) Predict climate change and ritual, such as rainfall and temperature by estimating water and heat transfer between the earth's surface and atmospheric process flow.
3) Flood forecasting on the spatial distribution of the degree of saturation of the soil surface basis.
4) Irrigation development through knowledge of the spatial and temporal distribution of water content of the soil.
5) Rural and urban 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, social and environmental benefits.
6) Prediction of global climate change through the continuation or change in the high or low water content of the soil ratio.
7) Agricultural applications by estimating the plant growth in knowing the water content of the soil.
8) Other environmental processes through hydrological modeling and prediction of erosion.

2. Material and Methods

2.1 Statistical analysis

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**

Is the study of the relationship between two variables only accessible to a linear relationship (i.e. a straight line equation) between these two variables, a parametric test as it is assumed that the data are distributed normally distributed and to find out the value of the regression slope of the regression is calculated by the following linear equation [10]:

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

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

Where b: slope of the regression and found a slope straight line in equation (1), a: a constant gradient and demonstrate the value of the lump of axis Y¯for Straight line.

- **Probability-value**

It is purely a statistical term, which is a number or the number of measurements used to evaluate the statistical value of a show that was a contrast factor it is an influential factor or not really? If the P-Value is less than 0.05, the contrast factor it is an influential factor in the variable that we are trying to study the change may consider factor affecting even the value of P-Value equal to 0.1 but that exceeds 0.1 this factor should be removed from the form it is ineffective [11].

- **Spearman rho test grades**

It is a test of a set of observed data (xi = 1,2,……,n) is based on the null hypothesis that is, all xi values are independent and have the same distribution and to calculate the Spearman Rho coefficient statistical ranks (rs) must convert the original model to the ranks mediated arranged in descending order in terms of amount and then the value of the account through di (di = ki-i) where the (i = 1,2,…..,n) and rs is given by the following [12]:

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

If the value of n large can choose the value of rs to their importance by calculating the value of ts which is given by the equation:

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

If the value of ts false calculated within the trusted boundary for the selection of a dual party from this we conclude that there is no trend in the data series and through the Table 1. Can determine the value of the degree of correlation and interpretation of test transactions.

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

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

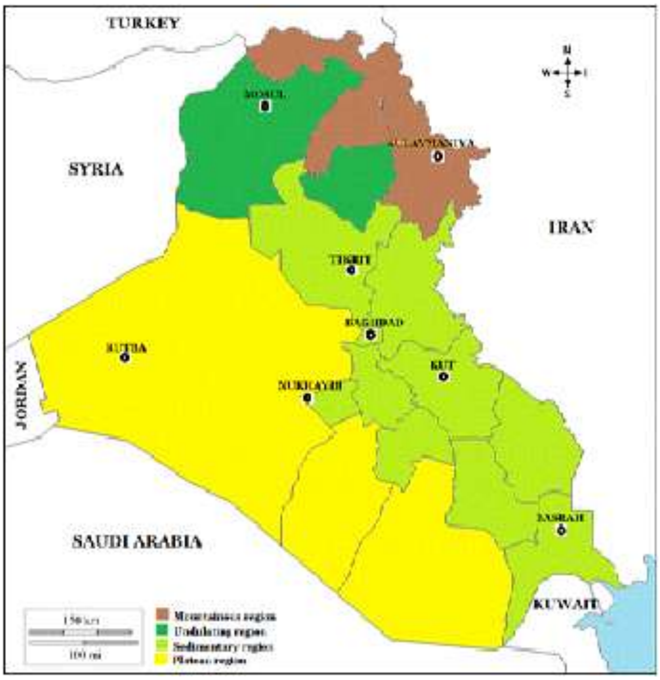


Figure 2: Map of Iraq, explaining the study areas [14]

2.2 Data source and study areas

Took the Surface Soil Moisture data units ($m^3\ m^{-3}$) and data of the Surface Potential Evaporation units (W/m^2) from the

National Oceanic and Atmospheric Administration (NOAA) for 30 years (1985-2014) in the form of maps Synoptic and processed statistically [13]. 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 Fig. 2.

3. The Results and Discussion

3.1 The monthly synoptic analysis for SPE and SSM

Through the Fig. 3 and 4, the monthly synoptic analysis in the surface potential evaporation and surface soil moisture respectively, as can be seen rising Surface Potential Evaporation in southern areas and declining in the northern areas and vice versa in the monthly synoptic analysis of the Surface Soil Moisture.

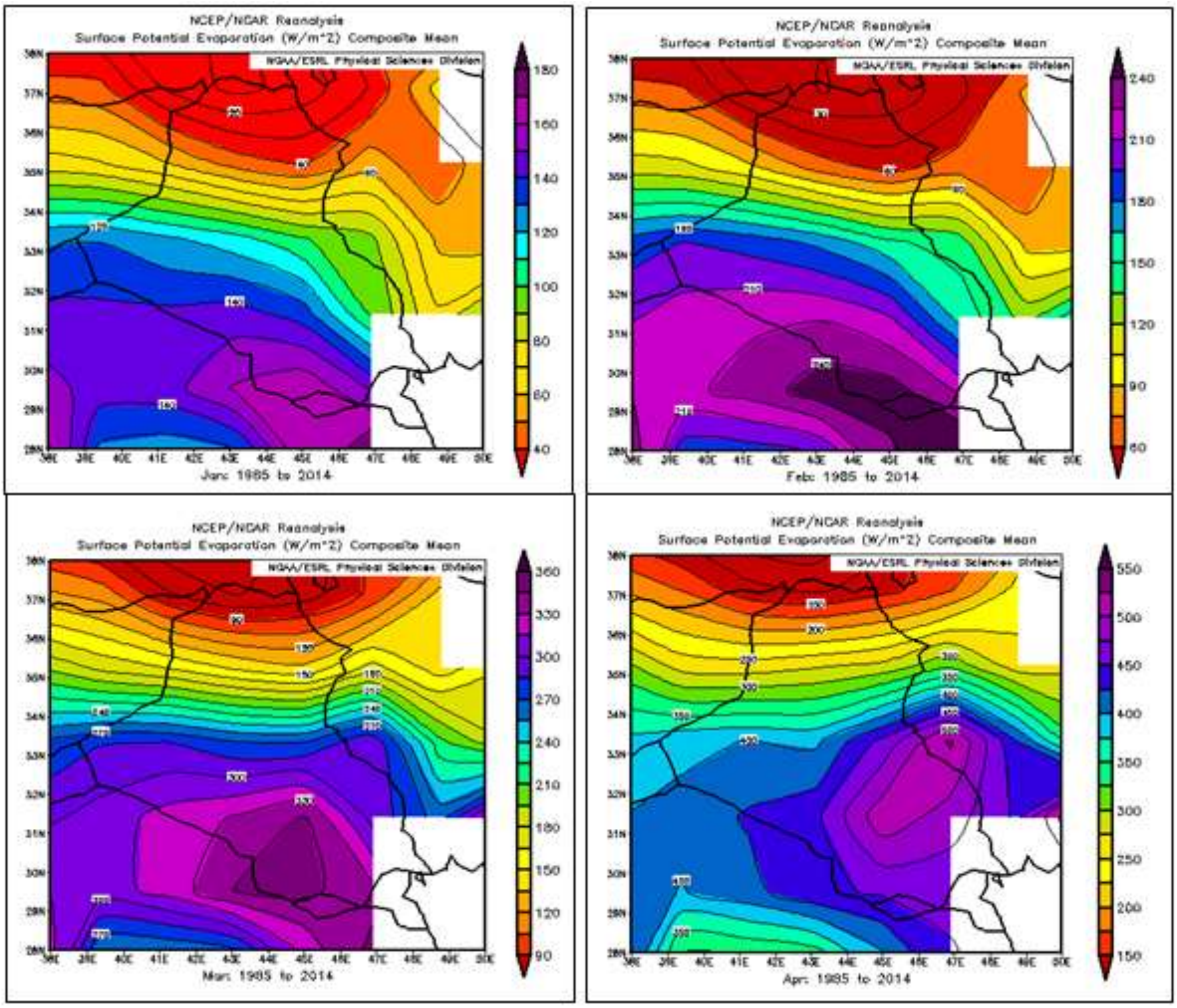
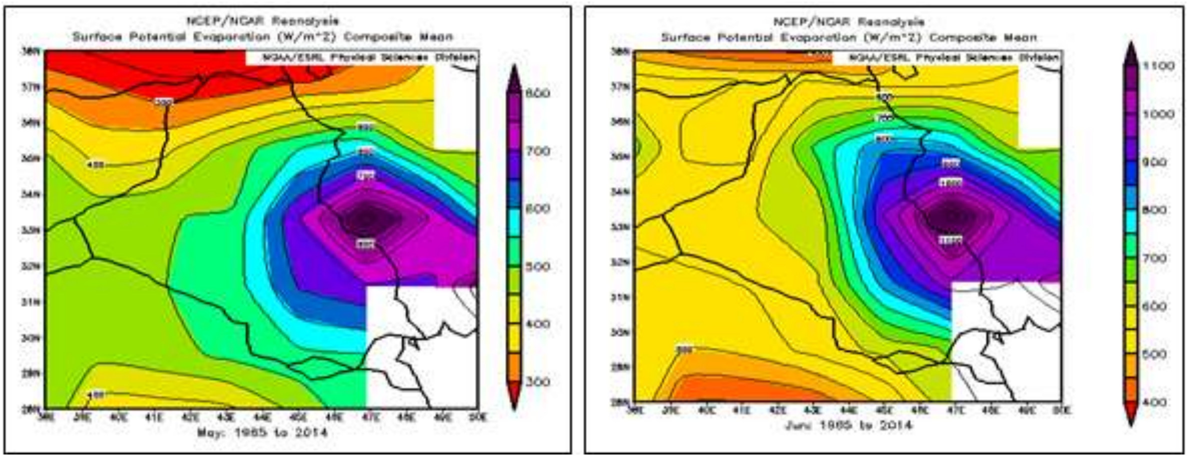
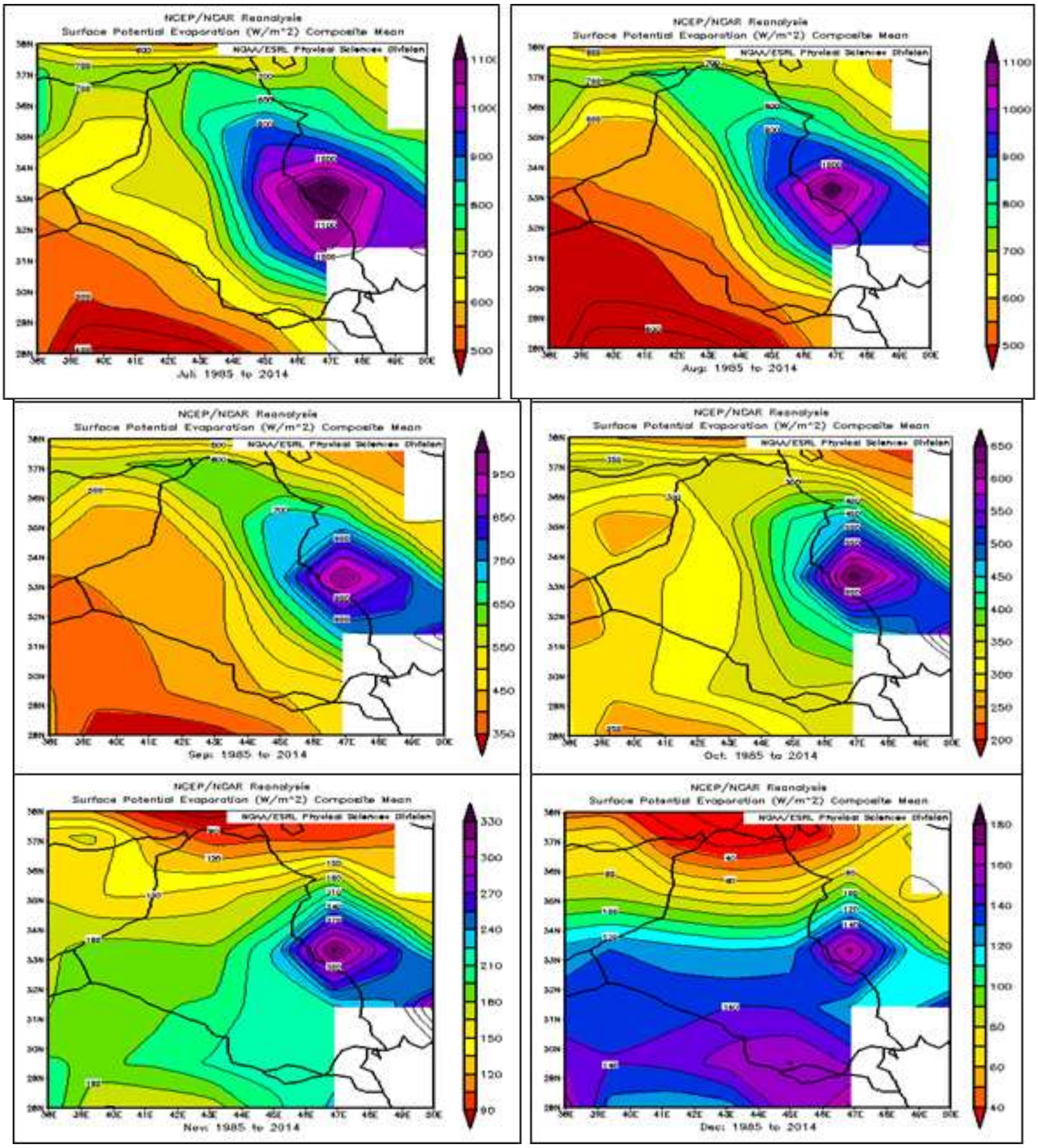


Figure 3: The monthly synoptic analysis of surface potential evaporation for thirty years (1985-2014) in Iraq.





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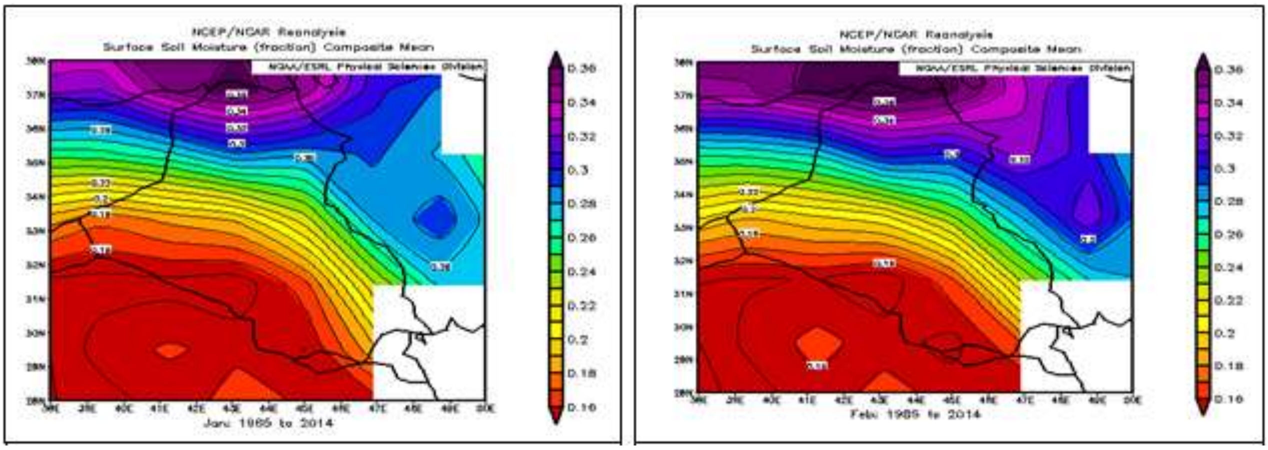


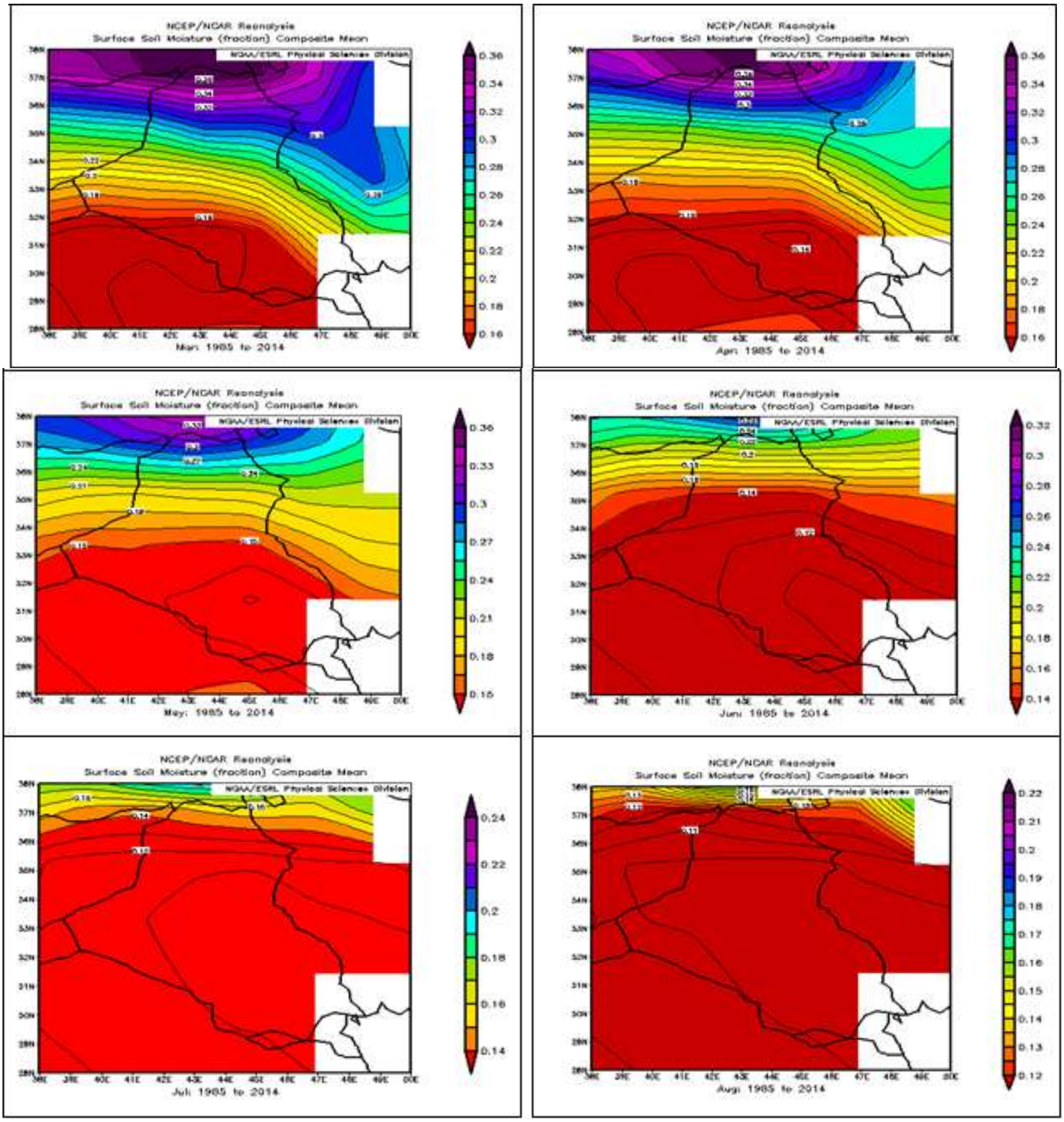
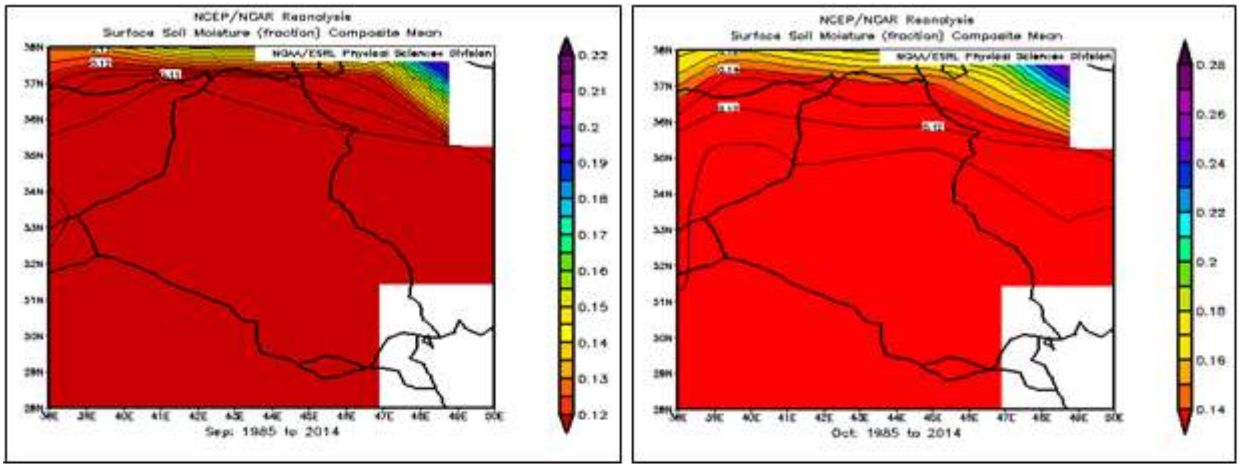
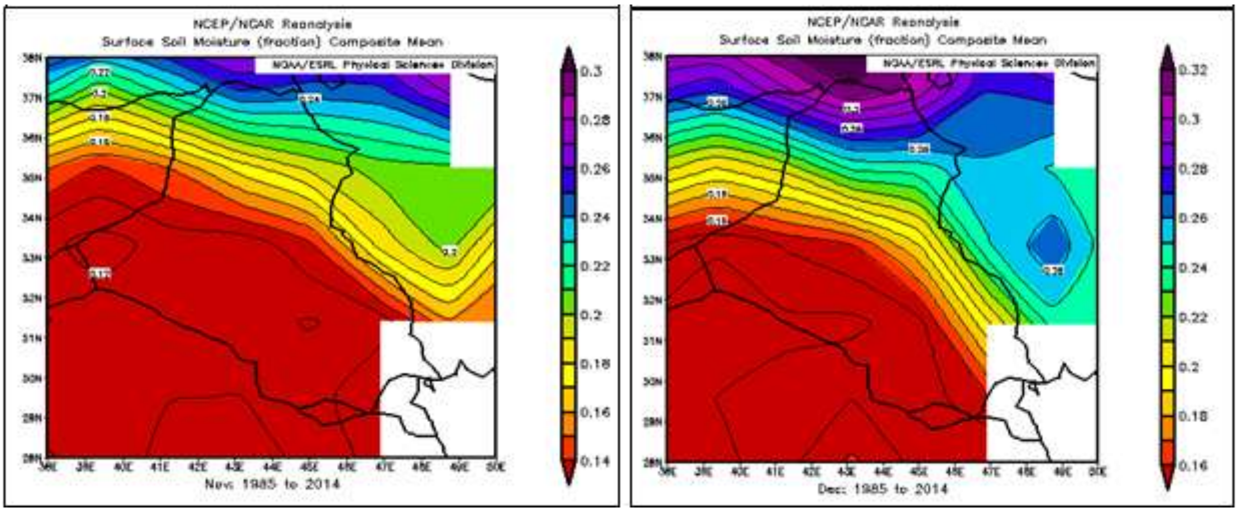


Figure 4: The monthly synoptic analysis of surface soil moisture for thirty years (1985-2014) in Iraq.





Followed the Figure 4

3.2 The annual change of SPE and SSM

In the Fig. 5, shows the annual change of surface potential 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 surface potential evaporation in stations where the decreasing values of surface soil moisture, and vice versa.

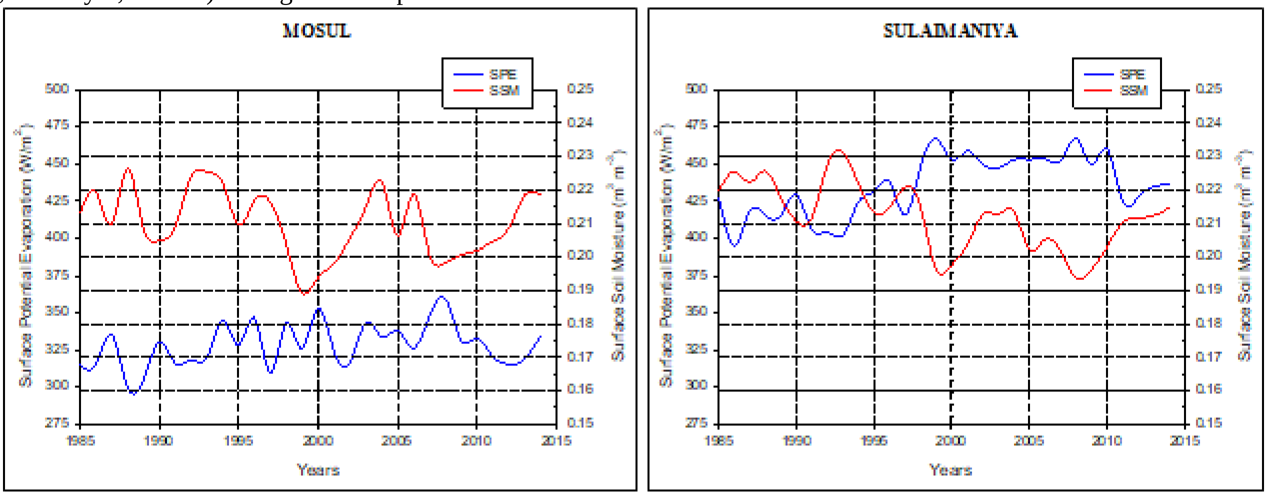
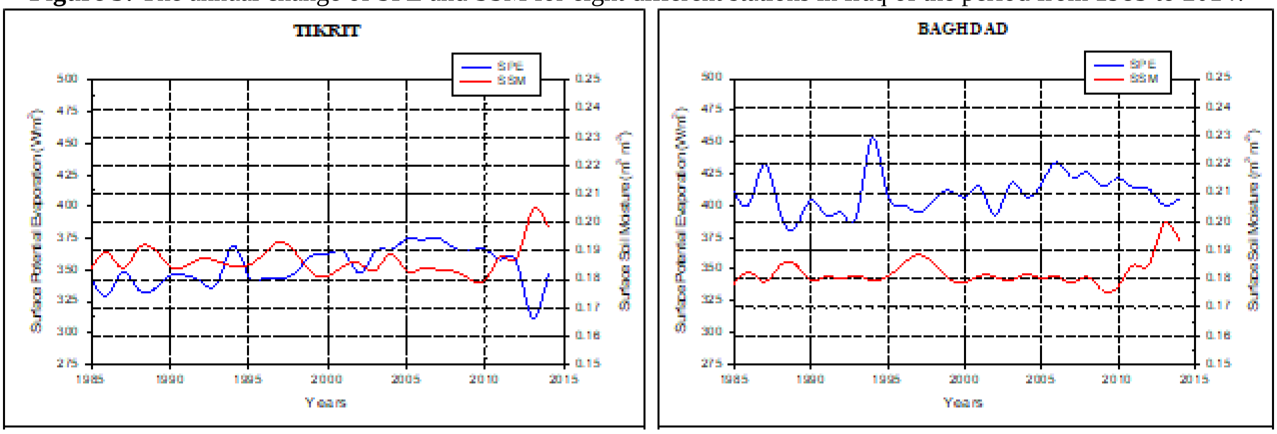
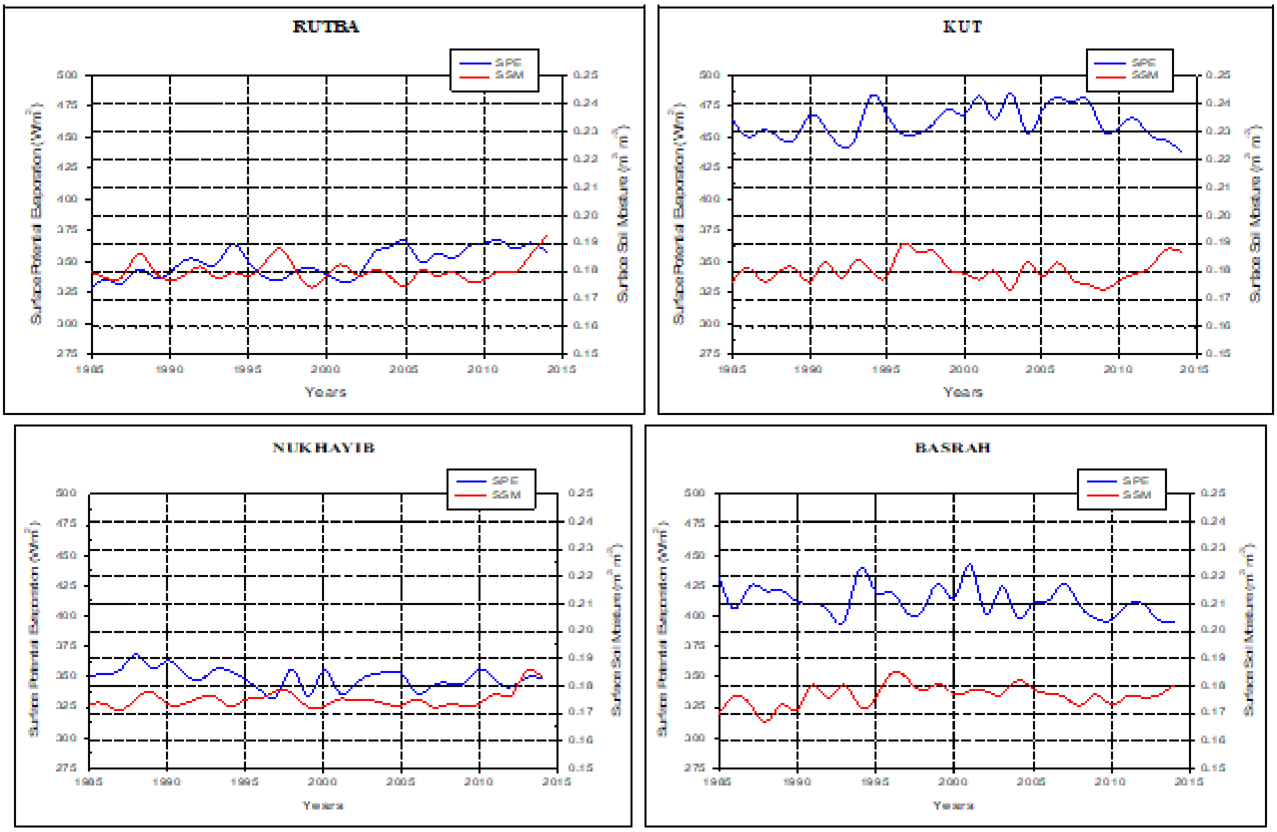


Figure 5: The annual change of SPE and SSM for eight different stations in Iraq of the period from 1985 to 2014.





Followed the Figure 5

3.3 The total annual average for SPE and SSM in Iraq

The Fig. 6, shows the average total annual surface potential evaporation and surface soil moisture respectively, for eight different stations in Iraq over thirty years (1985-2014),

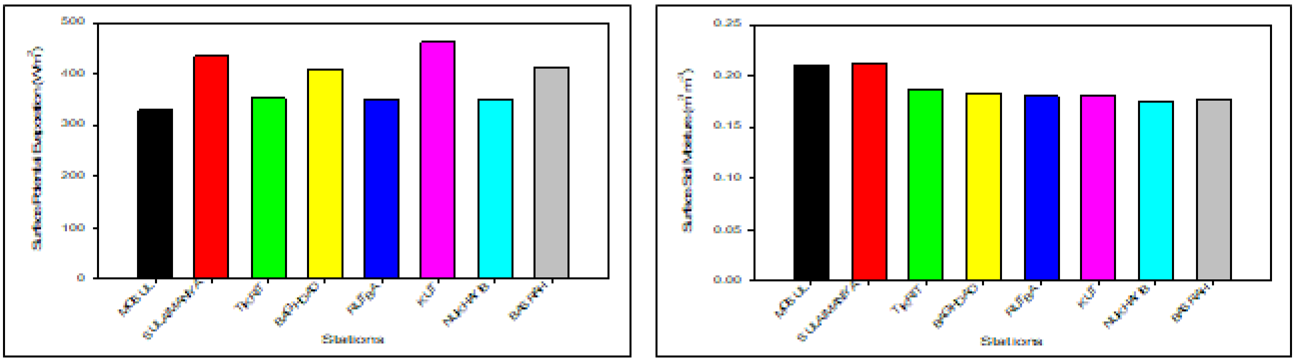


Figure 6: The average total annual for SPE and SSM of eight different stations in Iraq over thirty years (1985-2014)

3.4 The relationship between SPE and SSM

The Fig. 7, illustrates the relationship between the surface potential evaporation and surface soil moisture where they were taking the monthly average for the thirty year period (1985-2014) to eight different stations in Iraq (Mosul, Sulaimaniya, Tikrit, Baghdad, Rutba, Kut, Nukhayib, Basrah). And it found that there is a strong inverse correlation between them, and the Table 2, shows the strength of this relationship.

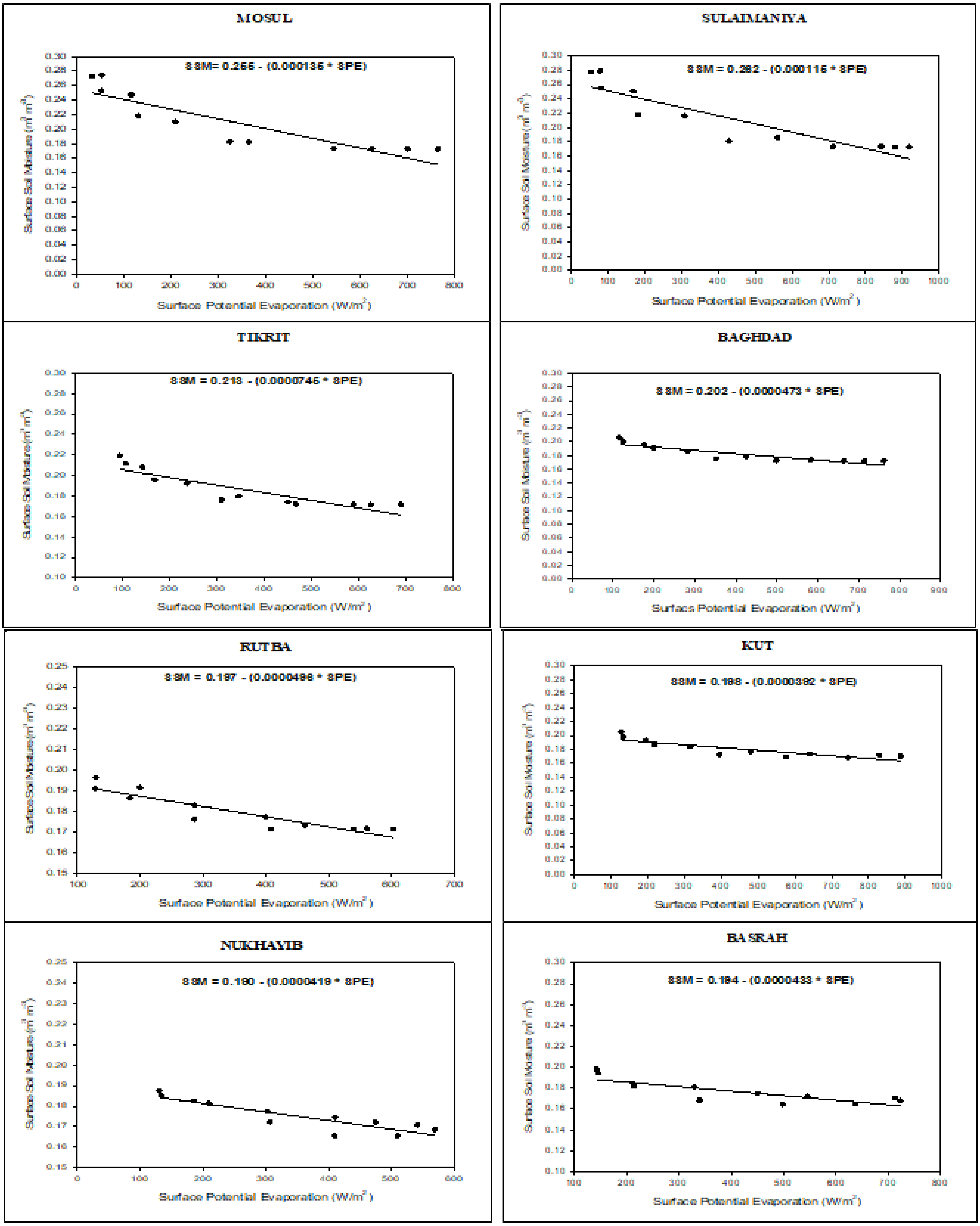


Figure 7: The relationship between the SPE and SSM of eight different stations in Iraq for the period (1985-2014).

Table 2: Spearman rho test results and Simple Linear Regression (SLR) to find the strength of the relationship between the SPE and SSM

Stations	*SLR*		*Spearman rho*	
	P-value	*Relation*	r_s	*Correlation*
Mosul	0.0001	Linear	-0.89	High-inverse
Sulaymaniya	0.0001	Linear	-0.91	High-inverse
Tikrit	0.0001	Linear	-0.89	High-inverse
Baghdad	0.0001	Linear	-0.89	High-inverse
Rutba	0.0001	Linear	-0.92	High-inverse
Kut	0.0002	Linear	-0.87	High-inverse
Nukhayib	0.0001	Linear	-0.89	High-inverse
Basrah	0.0009	Linear	-0.83	High-inverse

4. Conclusions

1) Increase the monthly average of SPE in the southern stations and a decrease in the northern stations of Iraq.
2) Increase the monthly average of SPE in hot months and decrease in cold months.
3) A lower monthly average of SSM in the southern stations and increase in the northern stations of Iraq.
4) The monthly average of SSM decreased in the hot months and increased in the cold months.
5) The highest value of the total annual average of SPE was at Kut station and then Sulaymaniya station and the lowest value was in Mosul station and then 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 strong inverse relationship between SPE and SSM.

5. Acknowledgment

I'd like to acknowledge a debt of gratitude to the National Oceanic and Atmospheric Administration (NOAA), to prefer and help us get the data Surface Soil Moisture in unit (m^3m^{-3}) and data of the Surface Potential Evaporation in units (W/m^2) and for the years from 1985 to 2014.

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