Asian Journal of Water, Environment and Pollution, Vol. 21, No. 1 (2024), pp. 25-33.
DOI 10.3233/AJW240005

Impact of Soil Temperature and Precipitation on Vegetation Cover Over Selected Stations in Iraq

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Received July 12, 2023; revised and accepted September 11, 2023

Abstract: Records of precipitation and soil temperature, two of the most significant climatic elements impacting vegetation cover, were gathered as annual and monthly data over a period of 20 years from the European Center for Long-term Numerical Weather Forecasts. The goal of this study was to ascertain the impact of plant cover on climatic variations. The study's final findings revealed that Mosul station had the greatest value of vegetation at 0.24 and Basra station had the lowest value at 0.15. The Mosul station recorded the maximum amount of precipitation, 1400 mm in the northern and central parts during the winter, and the lowest amount, 8 mm, during the fall and summer months in the districts west of the Rutba station. Using the Pearson test, it was discovered that the relationship between vegetation cover and soil temperature is inverse, and this, in turn, plays a significant role in the lack of vegetation cover in the southern regions because of nature. The desert of the region, as well as the lack of precipitation and high temperatures, is responsible for the region's lack of vegetation. The highest value reached by the soil temperature was in the year 2018 at the Basra station.

Key words: Vegetation cover (VEG.COV), precipitation, soil temperature, climate change, Iraq.

Introduction

Extreme climate change events have an impact on the environment, how vegetation reacts, and the long-term well-being of people. to support specialised conservation groups' management plans and restoration techniques for a variety of extreme climatic threats. Finding solutions in vegetation and climate responses and associated impacts in the wake of climate change and its devastating effects will help achieve sustainable planning outcomes. Key solutions and technologies for vegetation conservation must be identified (Afuye et al., 2021). Precipitation and soil temperature forecasting play an important role in Earth system science as it helps in understanding changes in vegetation and ecosystem (Li et al., 2022). Recently, a number of scientific investigations have been carried out to comprehend the connection between yearly precipitation and variations in rural and urban vegetation. The researchers found a correlation between urban land cover density and yearly precipitation that is positive. Using a 10-year time series to examine the observed land surface temperature and precipitation, this study examined the influence of change in plant types, to determine via satellites the link between plant cover and climatic changes.

Researchers (Yang et al., 2022) have invented a way to adapt the ecosystem to ensure the availability of water resources, which are important factors in the flourishing of vegetation without being affected by climatic changes for each region (Ortegón et al., 2022). The research team outlined how the loss of vegetation has a substantial effect on the rise in surface and soil temperatures, which is brought on by the release of several gases, which in turn negatively impacts both natural and human factors. The study concluded that in order to significantly preserve mankind from

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climate change, significant efforts must be made to limit urbanisation, lower pollution sources, and boost carbon sinks through afforestation (Kafy et al., 2022). In recent periods, many researchers and inventors have developed scientific programs used to model the impact of climate and land use to know the effects of changing vegetation cover and land on water resources in watersheds (Idrissou et al., 2022). Climate variability has a significant impact on changes in soil temperature and precipitation, which prompted many remote sensing scientists to know the change in land use and land cover on hydrological processes, which have a major role in desert and arid environments (Govender et al., 2022). The study of the ecology of global change in climatic networks has an important role in estimating the air temperature in open and closed areas and at certain heights above the surface of the earth, where the researcher found that through this study, analysis, and mapping of soil temperature and climatic variables that could contribute to changes in vegetation cover (Lembrechts et al., 2022). Others conducted a scientific study in which they reached several results showing the direct and indirect effects of urbanisation on the growth of vegetation cover. Tests over different areas showed that future change and the large population have positive and negative effects on the growth of vegetation cover (Zhang et al., 2022). A scientific researcher used the understanding of mining areas to understand the incoming changes, are they natural or human, as this study found the relationship between the partial coverage of plants and between geographical and climatic factors in an intense way, where he noticed that there is a close relationship between human factors and vegetation cover for repeated production activities and it can be considered as one of the important factors in these changes (Chen et al., 2022). The aim of this study is to know the climatic changes that affect the vegetation cover, and that it is possible in the future to conduct the right methods to reduce the indicators that negatively affect germination and to find appropriate solutions to reduce them.

Materials and Methods

Data

The data for this study were obtained from European Center for Numerical Weather Forecasts for a period (2000-2020) (http://www.ecmwf.int/about/overview/), which included monthly and time averages of soil temperature, precipitation, and vegetation cover to show the extent of the monthly and annual impact for each of the selected regions (Al-Taai et al., 2020). The data taken from the European Center has been processed and converted from unreadable files to readable files, and this process is carried out using the MATLAB program, each station is sorted from the other and distributed according to latitude and longitude, and therefore it can be dealt with after placing it in the Excel file, and then it is used Sigma plot program for graphs. It is a programme that contains many tests that were used in this study, such as the Spearman, Pearson test, etc., and the charts were used to show the relationship between each of the two variables and the extent of the increase and decrease in each region. It has been used previously in many scientific types of research and the Excel program was also used to compare the four stations (Nassif et al., 2021).

Statistical Analysis

Simple linear regression (SLR): Simple linear regression is a statistical method by which we can extract relationships between two continuous variables, correlation analysis between two climatic components. This type of data is called Two-variable data, the point is to see if we can use a linear mathematical model to describe the correlation (relationship) between the two variables. Use a known value to estimate another value, in addition to knowing the strength of the Relation of vegetation cover with (precipitation, ST) as in the equation below (Di Leo et al., 2020; Padua, 2000):

$$y = mx + b \tag{1}$$

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

Consider m is the slope and b is the y-intercept (y-value when $x = 0$), in a linear mathematical equation (David, 2000). The data is processed and transformed from a text file into a readable file, using a specific programming language, where the data is filtered and divided into areas that are easy to use in multiple ways, where the factors that affect vegetation cover are identified and also contribute to finding solutions that ensure the germination and growth of crops, and it depends on finding the values of the regression and (P) (Mengistu, 2021; Williams, 1992). The Pearson test was used to determine the strength of the correlation between one variable on another since there are values that are within a specific range, the correlation coefficient between –1 and 1. If the sign is negative, it means that the relationship is inverse and on the contrary, if the value is deferred, it means that the relationship is direct (Marwan, 2000; Nassif et al., 2020). The equation for Pearson's coefficient is expressed by the following relationship (Vignal et al., 2021):

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x}) - (y_i - \bar{y})}{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}} \quad (3)$$

Results

Annual Vegetation Cover, Precipitation, and Soil Temperature

The results of Figure 1 showed the annual analysis of different stations that covered the study area by analyzing three different climatic elements to show the annual variation from one region to another. The results indicated that the rates of veg. cover increased in the Mosul station is 0.24 because this area enjoys an abundance of water and geographical nature and a decrease in temperatures due to the abundance of precipitation. The rate of evaporation was found to be more than the rate of precipitation; moreover, the amount of precipitation was observed to be maximum in the Mosul station with a value of 1400 mm. It is one of the factors that help in the availability and growth of agricultural areas. The lowest value of precipitation can be obtained in the Basra station, which reaches 214 mm, due to the desert nature of the southern regions, and these harsh environmental factors negatively affect the vegetation cover. The main reason for this noticeable rise in soil temperature, which reaches 28°C, as is evident in the Basra station, is due to the lack of rain and the increase in evaporation processes as a result of the chemical and natural processes of the soil, which is reflected in the growth of crops and the lack of germination in the south and central regions.

The Comparison of Monthly Values Between Study Stations

Figure 2 shows the comparison between the monthly average of vegetation cover, soil temperature and precipitation, and knowledge of the increase and decrease due to climatic changes and natural factors for each of the atmospheric elements. When comparing the Baghdad station with the three stations in the study area (Mosul, Ruba, and Basra), it was noticed that the vegetation cover had the greatest value in December, January, and February, and the minimum value of veg. cover observed in June, July, and August due to the rise in temperatures and the abundance of desertification due to soil erosion and lack of precipitation. As for precipitation, when comparing the monthly values, it was found that the winter and the fall seasons show the highest rainfall values for the study area, and the maximum values of ST were in the summer. The highest

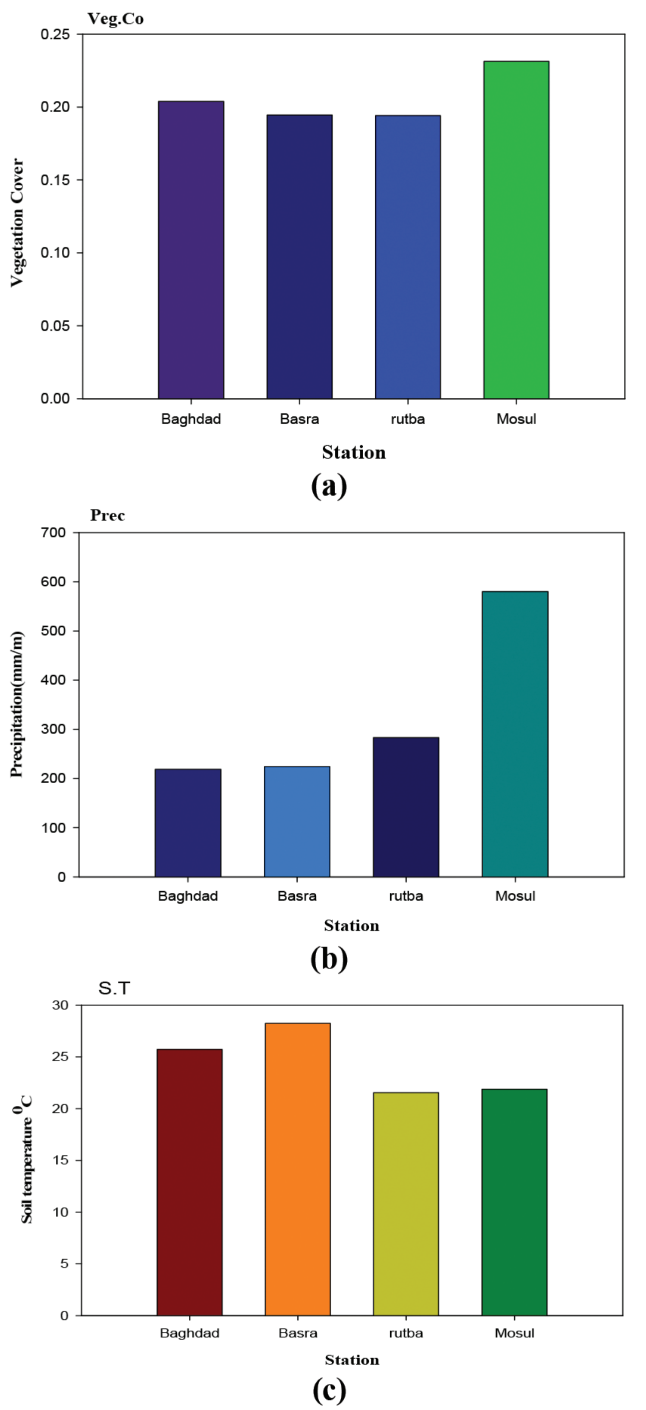
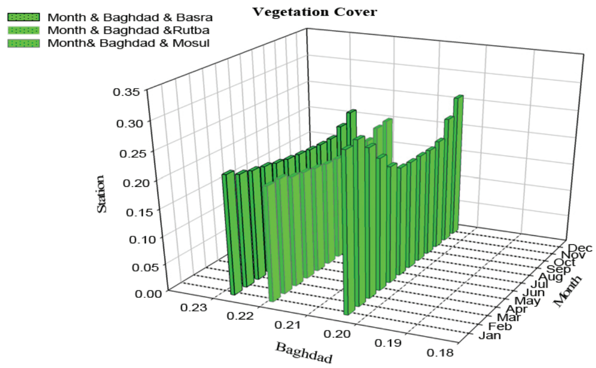
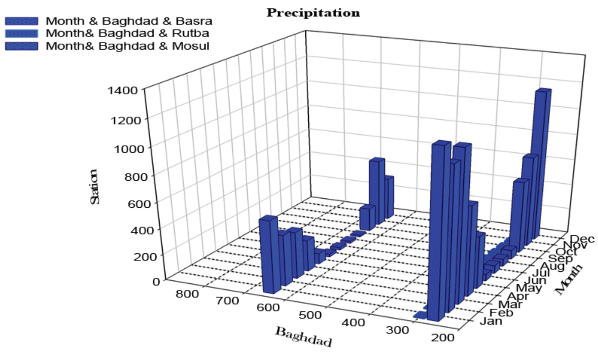


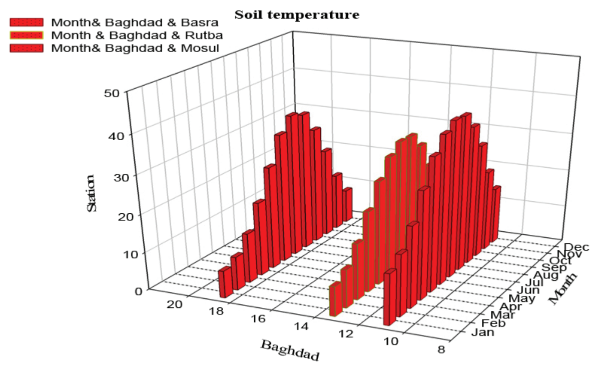
Figure 1: The Yearly mean of (a) Veg. Cov., (b) precipitation, and (c) ST for selected stations over Iraq for the period (2000-2020).



(a)



(b)



(c)

Figure 2: Compare the average monthly of (a) vegetation cover (b) precipitation, and (c) soil temperature over Iraq (2000-2020).

value was found in the summer due to solar radiation and the increase in pollution in recent years, as well as global warming.

Vegetation Cover and Precipitation

Figures 3 and 4 show the annual relationship between (Vegetation Cover) and precipitation above the four selected stations, where it is noticeable that vegetation cover is high during winter by 69% in the northern regions due to the availability of climatic conditions represented by abundant rainfall, which leads to an increase in the expansion of green spaces and a clear decrease in temperatures in terms of affecting the plant, which directly or indirectly controls the processes and functions that occur in all plants, as well as radiation because of its significant role in collecting solar energy that helps in the process of forming the cover vegan. Also, note that there is a relationship between light requirements and soil temperature in the production of many crops. It is possible to note that the highest rainy year was in 2016 and the same year we note the increase in vegetation cover with a value greater than 0.22 for four stations.

Vegetation Cover and Soil Temperature

Figure 5 and Figure 6, show that the relationship between vegetation cover and soil temperature (ST) is a state of variation, as it was found that soil temperature has a major role through its interaction with other terrestrial factors in influencing the plant and has great importance in determining the geographical distribution of plants on the ground. Soil temperature depends on the thermal and water flow of the soil, The final results showed that (ST) values increased in Basra station with values ranging from 30-35C° in June, July, and August, and during twenty years it was found that 2019 recorded the highest value of soil temperature, as for vegetation the lowest value was observed in the summer season >0.11 in Mosul and Rutba stations, this value was for the year 2012 due to weather conditions, geographical location, and physical and chemical factors affecting these northern and western regions.

Relationship Between Vegetation Cover (Precipitation and Soil Temperature)

In Figure 7 and Figure 8, the results of Pearson's test showed that the strength of correlation between vegetation cover and rainfall is strong for all stations selected in Iraq, and the relationship is positive for 20 years. The test results in Table 1 indicate that the highest correlation coefficient in Pearson's test is 0.9 for all stations except Rutba where the value of the correlation coefficient for this station is 0.8. It was concluded that the correlation between soil temperature and vegetation cover is inverse as a result of the large increase in temperatures due to global warming resulting from pollution and soil erosion.

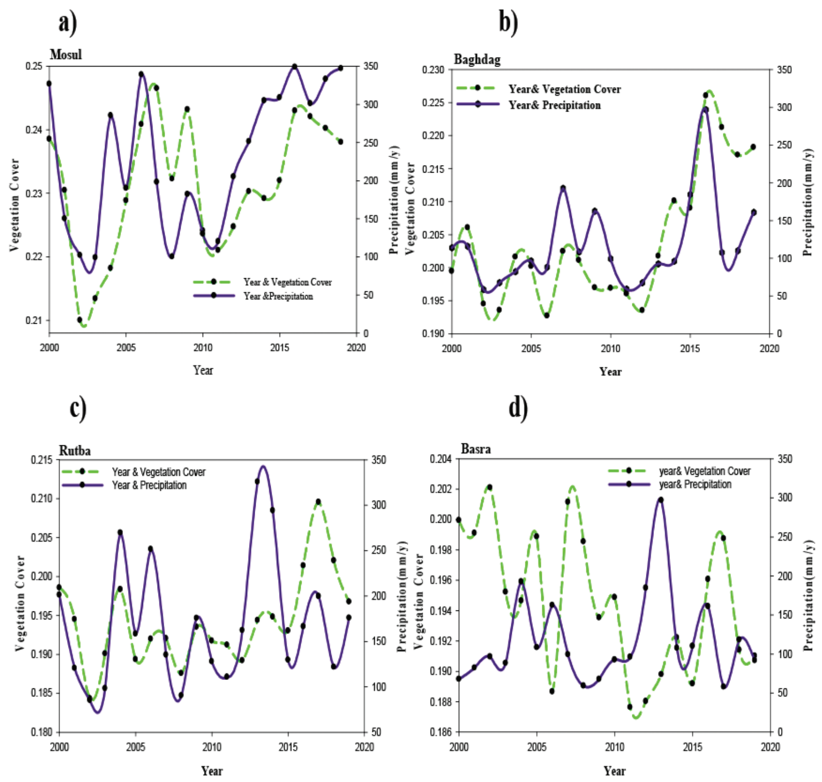


Figure 3: The annual relationship between vegetation cover and precipitation for Iraq weather stations over Iraq: (a) Mosul, (b) Baghdad, (c) Rutba and (d) Basra.

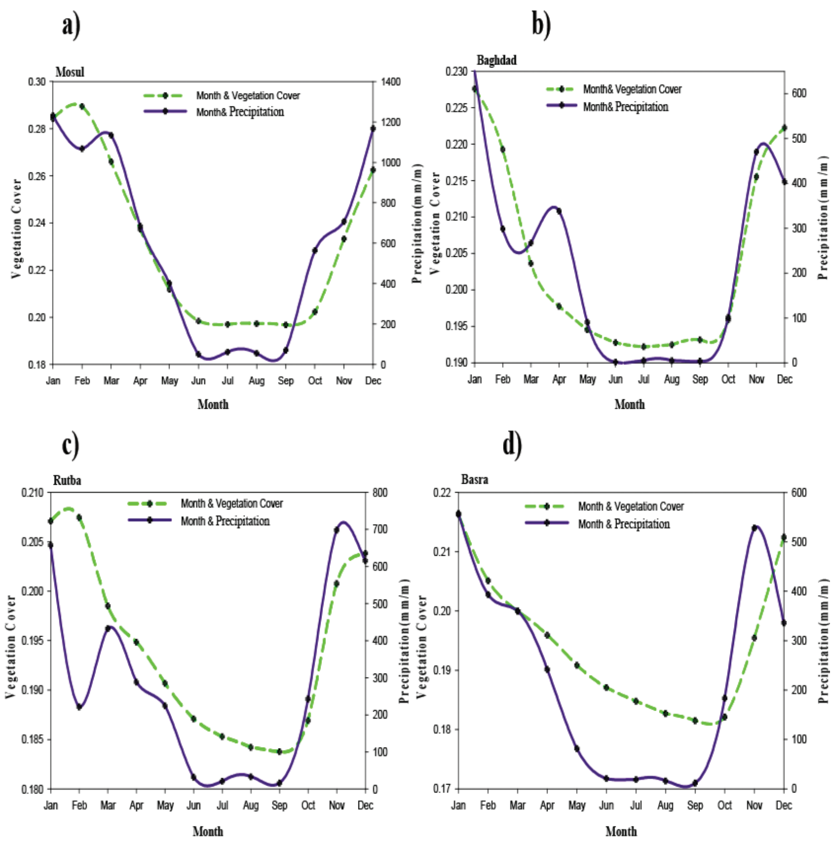


Figure 4:The Monthly Mean (Vegetation Cover) and precipitation for four selected stations of Iraq: (a) Mosul, (b) Baghdad, (c) Rutba and (d) Basra.

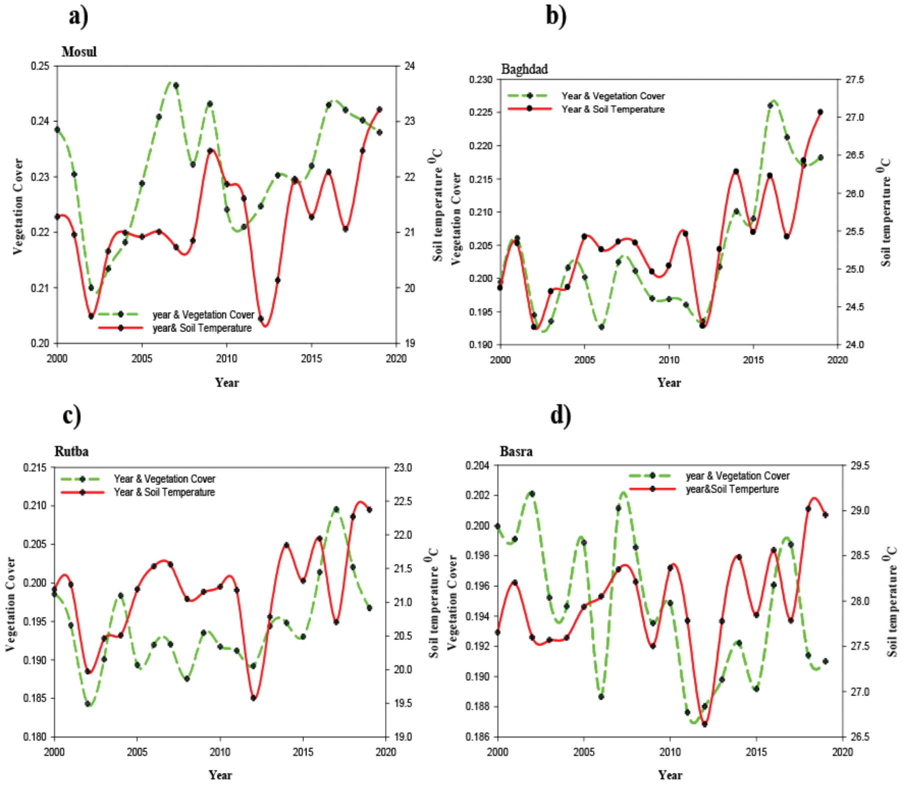


Figure 5: The graph of vegetation cover and soil temperature for automatic weather stations (a) Mosul, (b) Baghdad, (c) Rutba and (d) Basra.

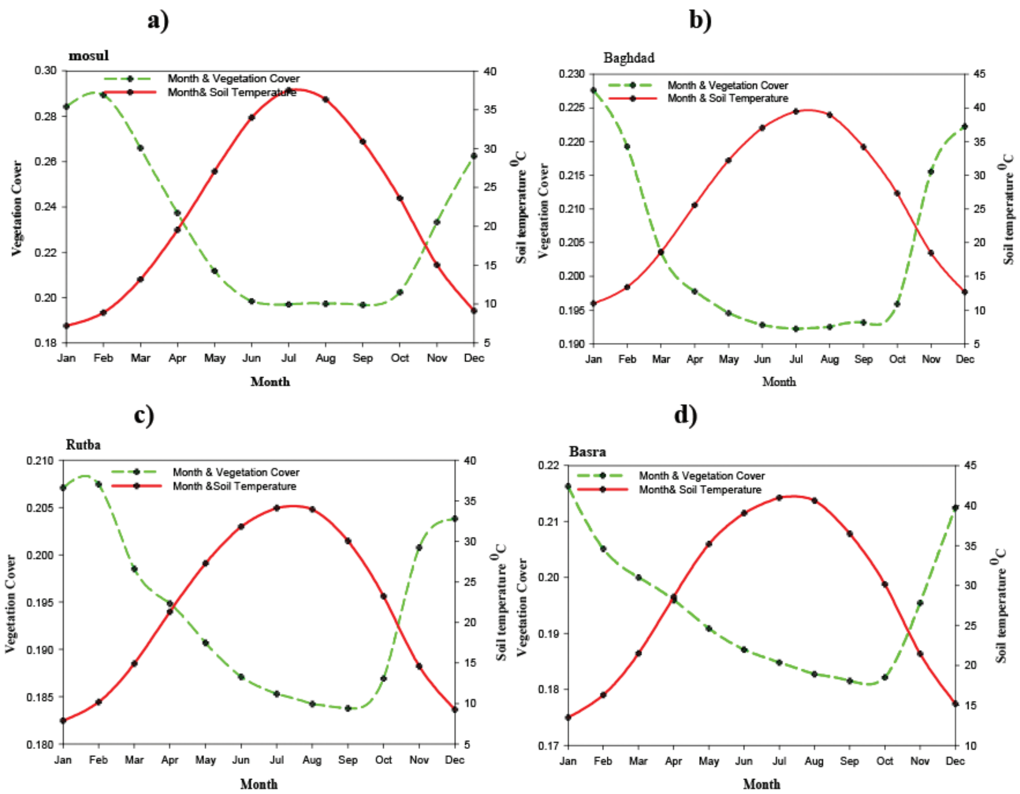


Figure 6: The graph of vegetation cover and soil temperature for four stations of Iraq: (a) Mosul, (b) Baghdad, (c) Rutba and (d) Basra.

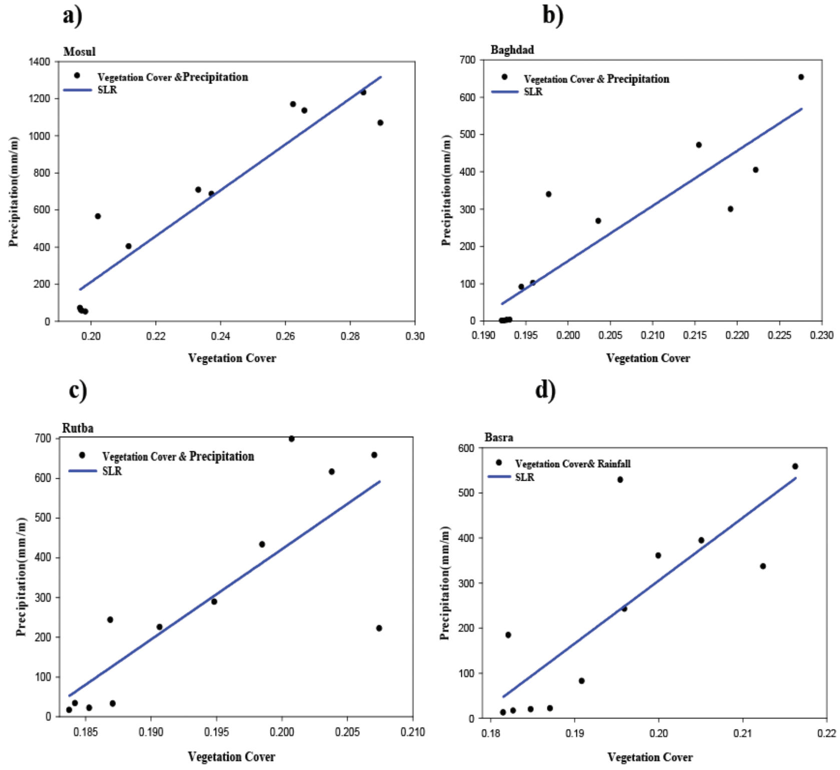


Figure 7: The relationship between the monthly mean of precipitation and Vegetation Cover of Iraq Station: (a) Mosul, (b) Baghdad, (c) Rutba and (d) Basra.

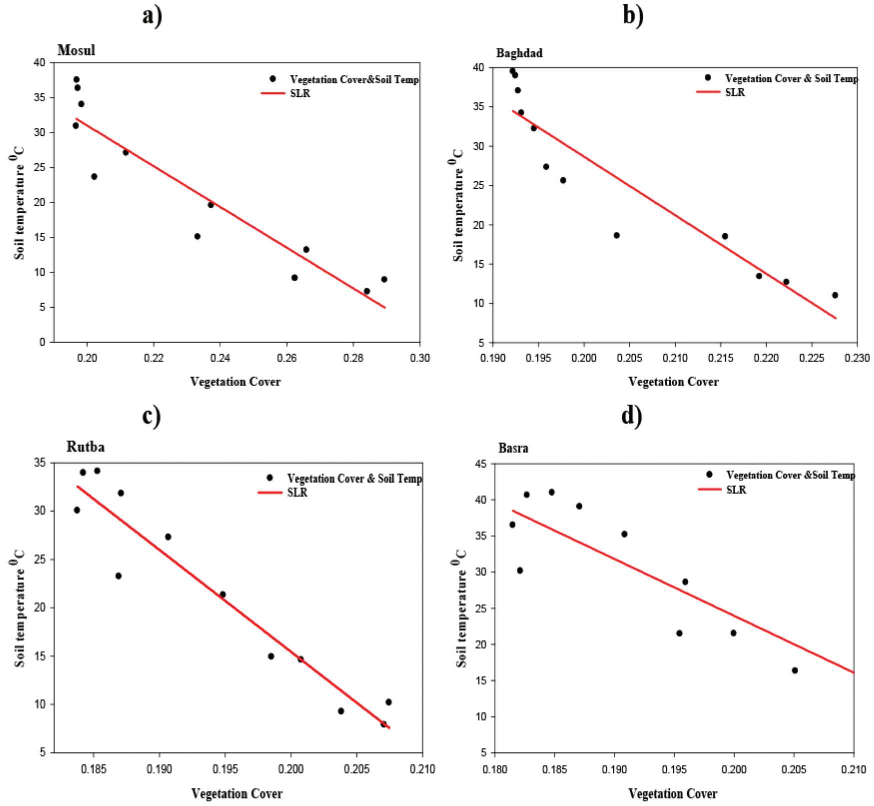


Figure 8: The relationship between the monthly mean of soil temperature and Vegetation Cover over Iraq: (a) Mosul, (b) Baghdad, (c) Rutba and (d) Basra.

Table 1: Correlation coefficient (r) and simple linear regression (SLR) for rainfall results and VEG.COV for Iraq Stations

Stations	*Relationship*	*Pearson's test*		*(SLR)*	
		Correlation coefficient (r)	*Correlation degree*	*P-Value*	*Interpret the relationship*
Mosul	R & VEG	0.9	V. High Positive	> 0.001	Linear
	ST & VEG	0.9	V. High Negative	> 0.001	Linear
Baghdad	R &VEG	0.9	V. High Positive	> 0001	Linear
	ST & VEG	0.9	V. High Negative	> 0.001	Linear
Rutba	R & VEG	0.8	V. High Positive	0.002	Linear
	ST & VEG	0.9	V. High Negative	> 0.001	Linear
Basrah	R & VEG	0.9	V. High Positive	0.002	Linear
	ST & VEG	0.9	V. High Negative	> 0.001	Linear

Conclusions

The maximum value of vegetation cover and precipitation was in the two stations of Mosul and Baghdad. The highest rainy year was 2016 when the amount of rain reached 1600 mm. Soil temperatures increased in the southern areas represented by Basra station, where soil temperatures ranged 30-35°C. Strong correlation strength for all stations between precipitation and vegetation.

Acknowledgements

Thanks and gratitude to the European Center for Medium-Range Weather Forecasting (ECMWF) DATASET https://www.ecmwf.int/en/forecasts/datasets, and we would also like to thank Mustansiriyah University https://uomustansiriyah.edu.iq for providing scientific support to accomplish this research.

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Asian Journal of Water, Environment and Pollution

Volume 20 Number 4 **July, 2023**

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