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Research Paper

Impact of vegetation cover on climate change for different regions in Iraq

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ABSTRACT

Vegetation determines the percentage of soil covered with green vegetation. Spatial and temporal changes of vegetation occur in the same year due to plant cycle, crop harvesting, animal grazing, and plant pruning. To understand the expected changes in the climatic elements of the atmosphere and water, changes in the behavior of temperature, relative humidity, and vegetation cover were studied. Meteorological data obtained from the European Center for Medium-range Weather Forecast, which includes average monthly and annual temperatures, dew point, and relative humidity during the period (1988-2018) for selected stations in Iraq. Several results were reached, including that the highest value of vegetation cover for four selected stations during the study period recorded in Baghdad station was more than 0.9, and the lowest value observed in Basra station (< 0.4). The highest relative humidity value was recorded in the Mosul station where it covered 69% in the northern and central regions of the country specifically in the winter season, and 18% in the western regions of the Rutba station in the spring and autumn season. And 13% in the southern regions in the summer as has been seen at the Basra station. When using Spearman's test, it was found that the strength of the correlation was strong between relative humidity and vegetation cover and the relationship was positive between them, in contrast to the relationship between vegetation cover and temperature. Finally, it was found that the spring and autumn seasons were characterized by dense vegetation cover, and this period was important for plant growth due to the availability of appropriate weather and environmental conditions.

Key words: Vegetation cover (VEG.COV), relative humidity, temperature, Iraq

Temperature and relative humidity are important climatic variables in determining the nature of vegetation, as they are widely used in scientific research related to the environment and climate (Li *et al.,* 2018). Vegetation cover is one of the important factors in ecology to know the relationship between vegetation cover and link it to different atmospheric variables such as temperature and humidity (Liu *et al.* 2020). Many researchers presented various studies in which vegetative and desert areas were used to show the effect of temperatures on vegetation cover and the division of vegetation types based on the effect of cooling and heating by analyzing these variables in different places of the study area (Jin *et al*., 2020). And other studies carried out by many scientists showed the use of several tests through which high temperatures can be reduced by increasing the number of green spaces in areas that lack plants to make urban areas cooler (Davtalab *et al.,* 2020). Bhavsar and Patel (2016) found strong correlation between Kc and NDVI. The NDVI also offers scope to distinguish between biotic and abiotic stresses (Das *et al*., 2013). Researchers have shown through several studies the extent of the difference in relative humidity compared to temperatures in areas with open spaces in urban areas by using several different places and seasons to show the spatial-temporal analysis on the scale of vegetation (Yang *et al.,* 2020). The researcher showed a sophisticated and in-depth scientific study on how to change the landscape of natural vegetation, which is linked to an increase in population numbers, as this leads to the erosion of agricultural spaces, which leads to an increase in surface temperatures and thus negatively affects the vegetation cover (Nimish *et al.,* 2020). Several previous studies explored important factors that could affect the speed of germination through the use of several climatic variables, including temperature and relative humidity, and comparing their effectiveness at night and day, and this is what the scientist has done (Cox *et al,*. 2020). Other research presented by many researchers shows that temperature and relative humidity have a significant impact on human-environmental comfort through their impact on vegetation cover in building areas and green spaces in urban areas, as scientists considered them as important factors in establishing an integrated ecosystem in conjunction with climate regulation or minimization of the temperatures in these

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areas (Kuang, 2020). The working paper presented by (Fanourakis *et al.,* 2020), showed the extent to which plant leaves are affected and the behavior of subsidence when exposed to high humidity for long periods, as this contributes to the slow growth of these leaves and clogging of the stomata during the germination process, which explains the extent to which vegetation is affected by high relative humidity. The main objective of this study was to reach solutions and results to address the problem of warming and high relative humidity by strengthening the vegetation cover of the selected areas and achieving sustainable development through increasing afforestation and getting rid of human impacts on the environment.

MATERIALS AND METHODS

The meteorological data was taken from the European Center for Medium-range Weather Forecast (ECMWF 2020).which included total monthly mean relative humidity, temperatures, and vegetation cover. For 31 consecutive years, it has been converted into annual and seasonal averages to show the extent of climatic changes from one region to another and according to the seasons of the year (Muter *et al.,* 2020).

Data source

The data were taken in the form of an NC file and converted to an Excel file using Matlab program, where the data is sorted for each area and converted from an unreadable file to a file that contains data that is easy to deal with, then the Sigma plot was used, which is a program that draws the charts required according to the studied areas and to find the relationship between them (Al-Taai *et al.,* 2020). As for the geographical maps, seasonal data of temperature, relative humidity, and vegetation cover were taken for selected stations for spatial analysis The Kriging method was used to configure fulfillment in ArcGIS version 10.4.1. The maps were drawn by converting the geographical coordinates of all sample locations into global Mercator Transverse Coordinates.

Simple linear regression (SLR)

Several available statistical operations have been carried out, where the Sigma scheme program was used to calculate the slope value and the P-value by simple linear regression (SLR) method to predict the relationship between vegetation cover and (RH, Temp). The equation below can be used to find out the simple linear regression value (Padua 2020):

$$\bar{Y} = a + bx \qquad \text{Eq. 1}$$

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

Whereas: ‘b’ it is the slope and shows if the line is straight, ‘a’ is constant and shows the value of the section of the unit of the line, Eq. 1 (David, 2000).

The P-value is a statistical concept that is used to indicate the probabilistic value and the number that results is used in statistical evaluations in many arithmetic operations. This value is extracted by converting the existing data from an unreadable file to a file that is easy to use in the form of an Excel file after applying many operations The software uses, and then uses the Sigma pilot program, which is a program that includes many charts and analyzes many data, through which it is possible to draw time series charts for each variable and find the relationship between each variable and Vegetation Coverage (VEG.COV) and calculate the slope and linear regression value simply (Mengistu, 2021).

Pearson test

The Pearson correlation coefficient (r) is a matrix called the instantaneous correlation matrix. This test includes a series of scatter plots that draw the correlation between two or more variables individually or in the form of groups, which was reached by knowing the type of correlation if it was strong, weak, or medium. Where it includes two rows, the first row represents the first set of variables or the first column of data, while the second row includes the second set of variables, and the third row of the matrix represents the third set of variables or the third data column. In the matrix. For example, the X-axis data for the graphs in the first row of the matrix is taken from the second column of the selected data, and the Y data is taken from the first column of the selected data. The X data of the graphs in the second row of the matrix is taken from the first column of the selected data, and the Y data is taken from the second column of the selected data. The data X of the graphs in the third row of the matrix is from the second column of the selected data, the data Y is from the third column of the tested data, etc. The number of graph rows in the matrix equals the number of columns of data being tested. (Abbood *et al.,* 2021; Al-Timimi *et al.,* 2020) Usually, we use Pearson’s correlation coefficient (r) to find out the strength of the correlation between two variables, if the top of the correlation t = 1 fully positive correlation and if the value of the correlation = -1, this means that there is a completely negative correlation. (Nassif *et al.,* 2021):

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

RESULTS AND DISCUSSION

Annual vegetation cover, relative humidity and temperature

Fig. 1 shows the annual average of four selected stations. These stations were chosen to illustrate the climatic changes that differ from one region to another, as well as the geographical nature of each region. The largest value of vegetation cover was in Baghdad station which amounted to more than 0.9, followed by Mosul station 0.8 because these areas have a lot of agricultural lands, forests, rain, and little evaporation. The lowest value was recorded at the Basra station at 0.5. As for the relative humidity, the largest value was in the Mosul station at 45%, where the relative humidity increases in these areas due to a large number of water bodies so that they maintain temperatures, as they are close between night and day, and the lowest value in the Basra station is 33% because this station is characterized by drought Or semi-dry, which increases the evaporation processes and reduces the relative humidity due to the lack of vegetation cover. We note that during 30 years, the Basra station reached a maximum temperature of 55ºC due to the large discrepancy between temperatures between night and day. The

Table 1 : Pearson test for relative humidity, temperature, and vegetation cover for four selected stations in Iraq (Mosul, Baghdad, Rutba, and Basra).

Stations	Relationship	Pearson's test		(SLR)	
		Correlation coefficient (r)	Correlation degree	P-Value	Interpret the relationship
Mosul	RH & VEG	0.13	V. High positive	0.9	Non-Linear
	T &VEG	0.2	Low positive	0.3	Linear
Baghdad	RH &VEG	0.1	Low positive	0.6	Non Linear
	T & VEG	0.03	Low positive	0.9	Non Linear
Rutba	RH & VEG	0.7	V. High positive	0.05	Linear
	T & VEG	0.8	V. High positive	0.001	Linear
Basrah	RH & VEG	0.8	V. High positive	0.001	Linear
	T & VEG	0.6	V. High positive	0.09	Linear

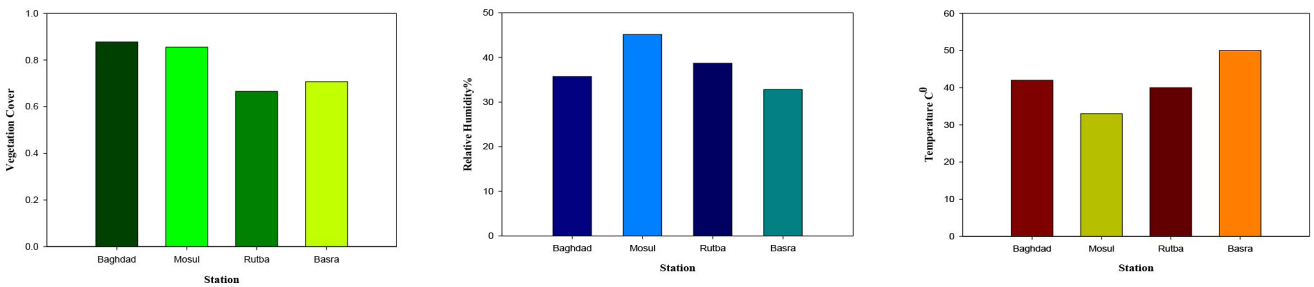

Fig.1: The annual vegetation cover, relative humidity and temperature or selected stations over Iraq for the period 1988-2018

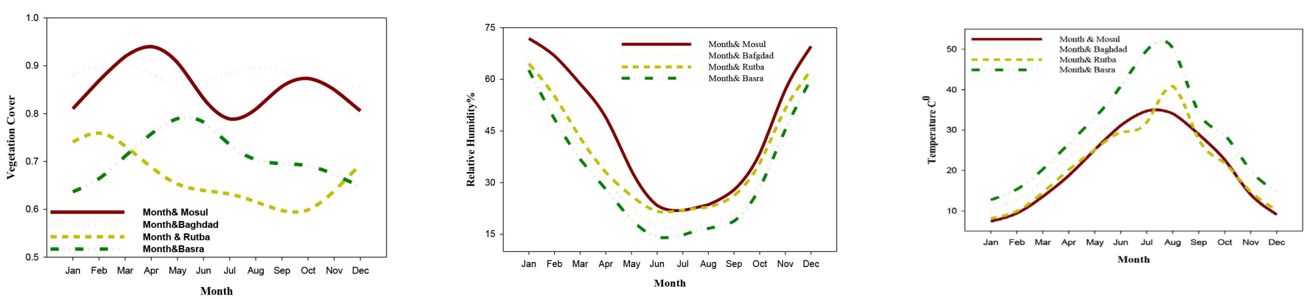

Fig. 2 : The monthly mean of the vegetation cover, temperature, and relative humidity for four stations over Iraq for the period 1988-2018

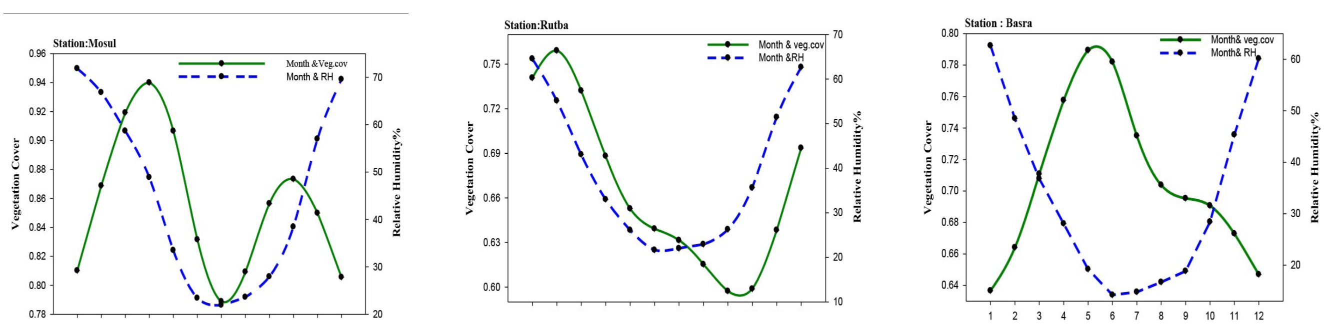

Fig. 3: The relationship between vegetation cover and relative humidity over selected stations

reason for this discrepancy is the absence of vegetation and water cover in those deserts, in addition to the low relative humidity in the air. The temperature reached 20º C in the Rutba and Mosul stations.

Analysis of the monthly values

Fig. 2 shows that the highest value of vegetation cover was in Mosul station in March, April, and October with a value

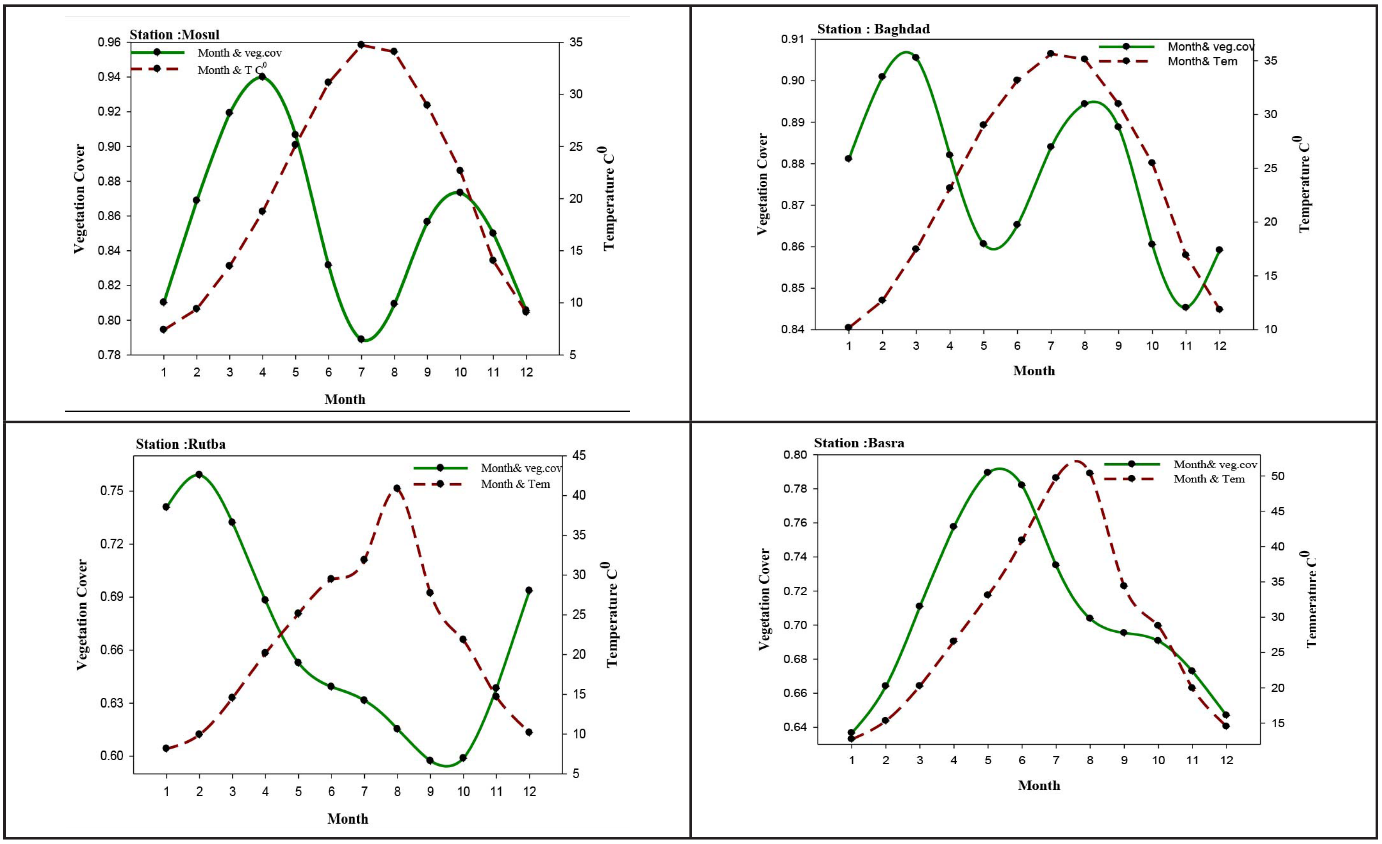

Fig. 4: Relationship between vegetation cover and temperature over selected stations in Iraq

of 0.8 because this station has evergreen areas of grassland and agricultural land because it affects the weather and climate, and the lowest. She was in the wet station during September and October. As for the relative humidity, its highest value was in the Mosul station, reaching 72% in December and January, and the lowest in June, July, and August in the Basra station (13%). Temperature plays an important role in climatic and environmental changes that affect human comfort through the apparent rise in some areas, and the maximum value of temperatures was recorded in June, July, and August in Basra station at 50° C due to desertification and soil erosion. The increase in evaporation caused a decrease in the vegetation cover in this region, and the lowest value was observed in Baghdad and Mosul in December and January at 35°C.

Relationship between vegetation cover and relative humidity

Fig. 3 shows that the highest value of vegetation cover was in Mosul station (0.9) in March and April due to rainfall and lack of solar radiation. In the city of Baghdad, the highest vegetation cover was observed at 0.9 for April and September, and the highest value of vegetation cover was recorded in Rutba station (0.8) In March, the lowest value was recorded in the Basra station at 0.5 in July and August, as for the relative humidity, the highest value was recorded in the Mosul station, which covered 72%.In the province of Mosul from the northern regions of the study area, and the lowest value recorded in the Basra station was 62%, which shows that the relationship between relative humidity and vegetation cover is positive.

Vegetation cover and temperature

Fig. 4 shows that the maximum monthly average temperature in Basra station was 50 degrees Celsius in June, July, and August and Rutba station was the second city in terms of temperature rising to 40 degrees Celsius in August, and the lowest temperature value during 31 years was In the Mosul station, 32 degrees Celsius, the noticeable rise in temperature for the city of Basra had a significant impact on the vegetation cover in the southern regions, where we note that the lowest value of the vegetation cover was 0.7, due to the city of Basra enjoying a desert climate far from water bodies. The desert is very cold in winter, and hot in summer. The highest value of vegetation cover was monitored at a monthly rate of 0.9 in Mosul station due to the large presence of water bodies that control high temperatures and humidity in summer season, and for this reason, the climate of Mosul city has been characterized by moderate temperatures in summer, and warm in winter, and finally it was concluded that the relationship between temperature and vegetation is of inverse in nature.

In Fig.5 and Fig. 6 while using Pearson's test, it was found that the correlation coefficient between relative humidity and vegetation cover has a strong correlation for all the stations except for Baghdad station due to the erosion of agricultural areas and vegetation cover، Overpopulation and desertification. (Table 1) has shown that the highest value of vegetation cover and relative humidity was 0.13 in Mosul station and the lowest was in Baghdad station. As for temperature and vegetation cover concerned, the highest value was 0.9 in the Basra station, and the lowest value

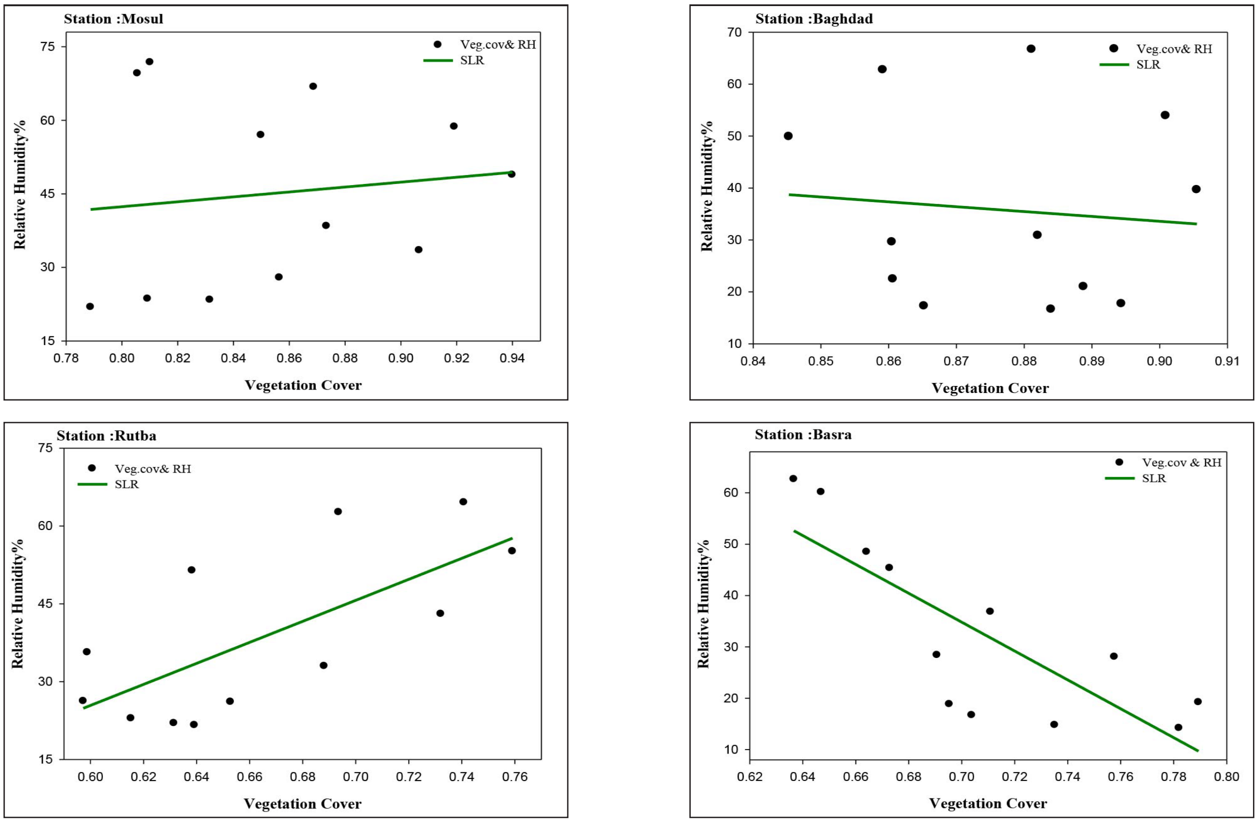

Fig. 5: Relationship between the monthly average of RH and veg. cover using the pearson correlation coefficient.

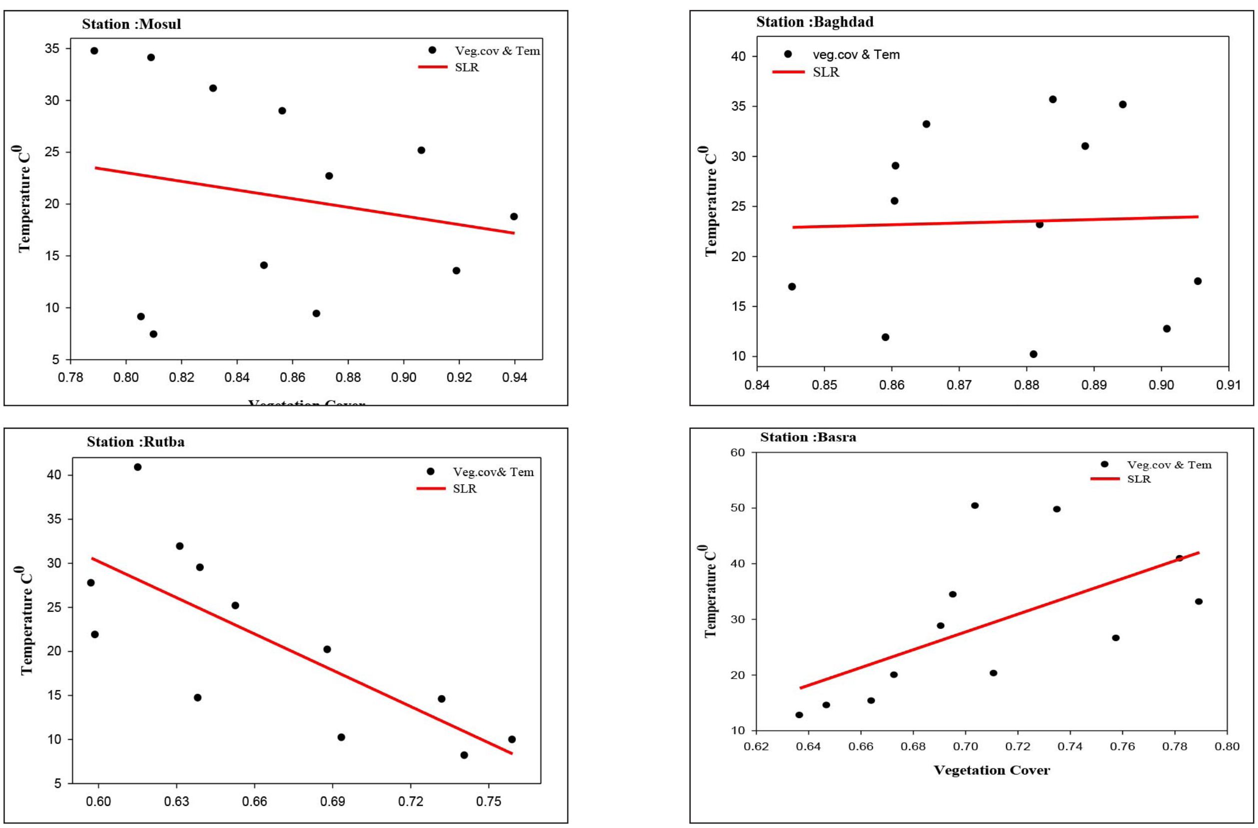

Fig. 6: Relationship between the monthly average between temp and veg. cover using Pearson correlation coefficient.

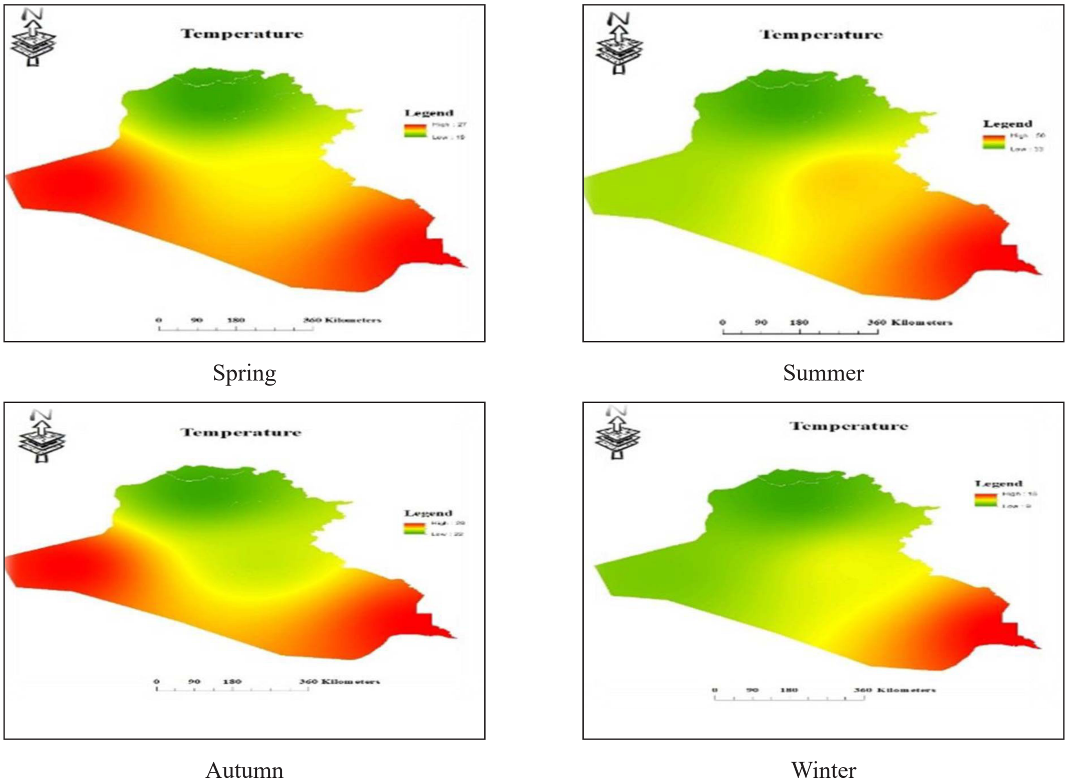

Fig. 7: The Spatial analysis of seasonal temperature (ºC) in Iraq

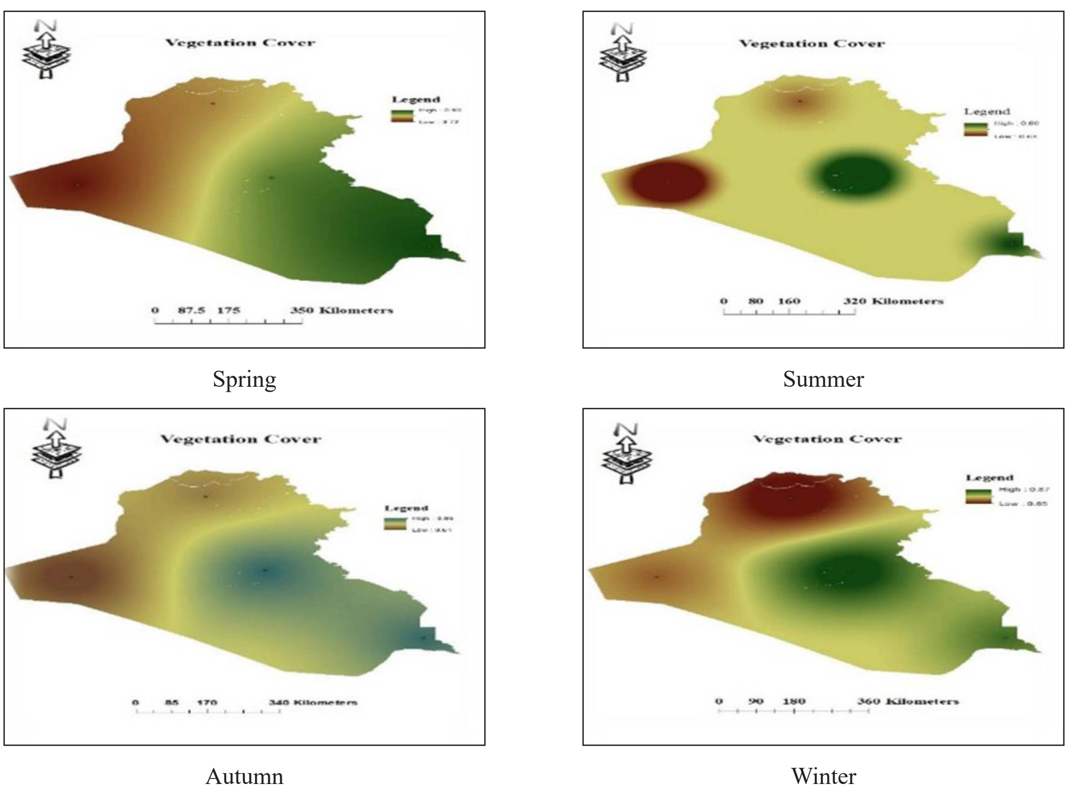

Fig. 8 : The Spatial analysis of seasonal vegetation cover in Iraq

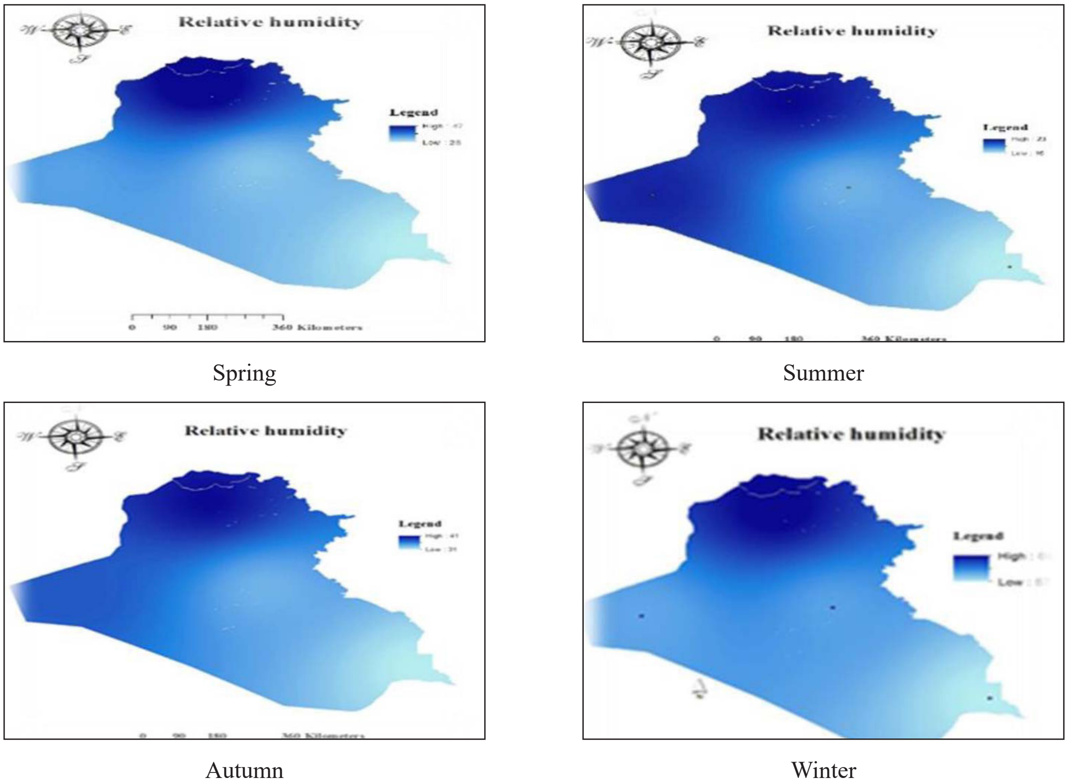

Fig. 9. Spatial analysis of seasonal relative humidity (%) over Iraq

(0.03) was recorded at Baghdad station. It may be concluded here that the relationship between vegetation cover and relative humidity was positive, and inverse with temperature.

Spatial analysis

To perform spatial analysis, digital map layers including RH (%), temp (ºC), and vegetation cover were generated by GIS using Kriging's interpolation configuration method in ArcGIS version 10.4.1. The mapping procedure began by converting the geographic coordinates of all sample locations into the global transverse Mercator coordinates. The spatial interpolation maps of the above means in the study area are shown in Fig. 7, 8, and 9, respectively. Fig. 7 has shown spatial analysis of temperatures in the four seasons in Iraq. In summer, the highest value of temperature was 55 ºC in the southern and central regions by (68%) and the lowest value was 13 ºC in the northern and western regions (32%). As for the winter season, the highest temperature value was recorded in the southern regions by 45%, and the lowest in the northern and western regions by 16%. As for the spring and autumn seasons, the highest value was in the southern and eastern regions (70%) and the lowest value was in the northern regions. Fig. 8 shows the spatial distribution of vegetation cover over Iraq. In winter, the highest value of vegetation cover was in the northern and central regions at 71% and the lowest value of vegetation cover in the southern and western regions was 23%. As for the autumn and spring seasons, the largest percentage was in the Mosul station in the northern and central regions by 33%, and the lowest in the western and southern regions by 15%.

Fig. 9 shows the spatial distribution of relative humidity in the four seasons over Iraq. In the spring, the highest value was concentrated in the northern regions with its value (55%) and the lowest value in the eastern regions (18%). As for the summer season, the highest value of relative humidity was in the southern regions (41%) and the lowest in the northern and eastern regions (17.3%). As for the autumn season, the value was highest in the southern regions (72%) and the lowest value in the eastern region (48%).

CONCLUSIONS

The highest monthly average of vegetation cover and relative humidity was in the Mosul station, while the lowest monthly average of temperatures was reported in the Basra station. The spatial analysis shows that the vegetation cover occupies 72% in spring and autumn in all the study stations. The relationship between temperature and vegetation cover was of inverse in nature. The correlation strength was weak between temperature and vegetation and strong between vegetation and relative humidity. The relationship was positive too between vegetation cover and relative humidity.

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Conflict of Interest Statement: The author (s) declares (s) that there is no conflict of interest.

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