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THE RELATIONSHIP BETWEEN WINDS AND RAINFALL OVER SELECTED STATIONS IN IRAQ

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Abstract

Rainfall and wind speed are important factors in the physical processes that occur in the atmosphere, such as the absorption and dispersion of solar radiation and the formation of precipitation, and therefore affect the radiation balance and the balance of water in the atmosphere. Therefore, precipitation is very important to humankind because it represents a pure source of water beside the Earth. Moreover, wind speed is of great importance in rainfall. The methods used in the study depend on the monthly and yearly mean of wind speed and rainfall which have taken from the European Mediterranean Weather Forecast (ECMWF) during the time period (2008-2018), for selected stations in Iraq (Mosul, Baghdad, Rutba, Basra). The greatest value of wind speed was recorded in Basra, the lowest value was recorded in Mosul, the highest value of rainfall in Mosul and the lowest value in Basra. The relationship between the monthly mean of wind speed and rainfall for eleven-years (2008-2018), is an inverse relationship for four selected stations in Iraq (Mosul, Baghdad, Rutba, and Basra).

Keywords: Rainfall, Wind speed, Climate changes, ECMWF, Iraq.

Introduction

Precipitation is one of the most important phenomena of the atmosphere, which has a strong impact on the distribution of the atmosphere at the global level, as well as on local weather, from the thermal energy that the atmosphere receives (which equals the net radiative energy loss). About 70 to 85 percent is latent heat emitted from the formation of precipitation, (Simpson, 1996). Precipitation is an important climatic element, as weather forecasters are concerned with linking flood and drought phenomena to the study of periods of increased and decreased Rainfall (Sajida, 2000). The wind speed is associated with more evaporation and the flow of latent heat from the ocean to the atmosphere (Raymond, 2003). The issue of rain and wind speed has caught the attention of many researchers if Goodison studied in 1978 that wind caused the largest systematic environmental error in measuring precipitation (Goodison, 1978) Another researcher explained that the amounts of precipitation are more prone to deflection through the air flow around (and above) the scale. The intensity of this deviation is related to the actual size. (Goodison, 1998) Whereas, the researcher indicated that it is possible to estimate rain events in the winter in cold areas under wind conditions with less than 100% Estimation. (Goodison, 1995). Many researchers have imposed that the hypothesis leads to a model in which the intensity of precipitation depends on the speed with which the air is forced to rise.

Which is in turn expressed by the speed of the horizontal wind and the mountain slope. Use Weston and Roy (Weston, 1994). An approach similar to the geographical rain model in Scotland, but were also considered a gradual decline in cloud water. Improved precipitation on a group of hills or mountains removes cloud water, resulting in less straightening improvement in winds. By supporting the assumptions presented in the models, they found that geographical reinforcement was well associated with wind speed, and that high humidity of at least 1.5 km of atmosphere was important. (Hill, 1981). The study aims to explain the relationship between wind speed and precipitation at selected stations from Iraq for a period of 11 years from the time period (2008-2018). All data is provided by the European Centre, which contains reliable data.

Materials and Methods

Data Source and Study Stations

This work was performed using monthly data on wind speed and rainfall was taken from the European Center for Medium-Range Weather Forecasts (ECMWF overview), this data was converted into an annual combined aggregate group to show the effect of the annual change. The stations (Mosul, Baghdad, Rutba, and Basra) were chosen for this research (North, Center, West, and South) as shown in Fig. 1, and Table 1.

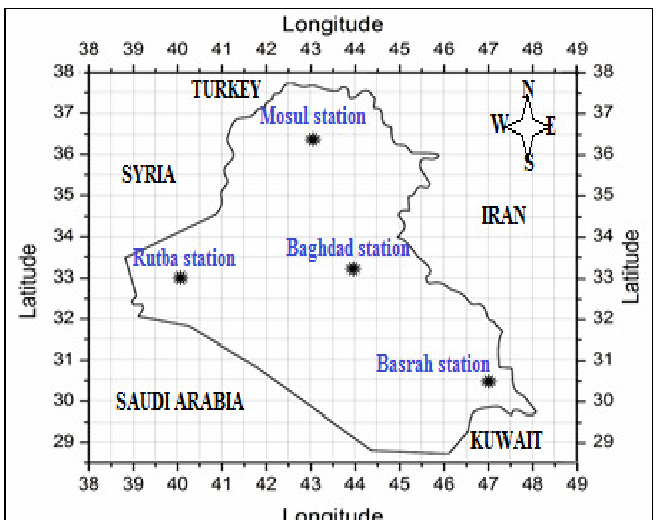

Fig. 1: The study stations.

Table 1: Longitude, latitude and elevations above sea level for study stations in Iraq.

Study Stations	Longitude (^oE)	Latitude (^oN)	Elevations above sea level in meter
Mosul	43.2	36.3	223.5
Baghdad	44.5	33.3	31.7
Rutba	40.3	33	630.8
Basra	47.5	30.5	2.4

Statistical Used

Simple Linear Regression (SLR)

Several available statistical operations were performed where *Sigmaplot* program was used to calculate the slope value and the P-value by Simple Linear Regression (SLR) method in order to predict the relationship between precipitation and wind speed. SLR is the study of the relationship between two variables to arrive at a linear relationship between these two variables, where the data is supposed to be distributed naturally. To know the value of the regression, the slope is calculated from the following equation (NASA, 2012) programs for charts and data analysis through which it is possible to draw time series charts for each introverted variable and find the relationship between each variable by calculating the slope value and the value of P-value (David, 2000) (Williams *et al.,* 1992) As for the probability value, P-value is a statistical term, which is a number or number used to evaluate the statistics, and it is a value that appears if the factor is actually affecting or not?

$$\overline{Y} = a + bx \qquad ...(1)$$

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

Pearson's correlation coefficient (r)

The Pearson Moment Correlation matrix is a series of scatter graphs that plot the associations between all possible combinations of variables. The first row of the matrix represents the first set of variables or the first column of data, the second row of the matrix represents the second set of variables or the second data column, and the third row of the matrix represents the third set of variables or third data column. The X and Y data for the graphs correspond to the column and row of the graph in the matrix. For example, the X data for the graphs in the first row of the matrix is taken from the second column of tested data, and the Y data is taken from the first column of tested data. The X data for the graphs in the second row of the matrix is taken from the first column of tested data, and the Y data is taken from the second column of tested data. The X data for the graphs in the third row of the matrix is taken from the second column of tested data, and the Y data is taken from the third column of tested data, etc. The number of graph rows in the matrix is equal to the number of data columns being tested. (Sigmaplot, 2013). The Pearson correlation coefficient (r) is used to measure the strength of a linear association between two variables, where the value *r* = 1 means a perfect positive correlation and the value *r* = -1 means a perfect negative correlation. So, for example, you could use this test to find out whether people's height and weight are correlated (they will be - the taller people are, the heavier they're likely to be (Levesque, 2007) Requirements for Pearson's correlation coefficient

- Scale of measurement should be interval or ratio
- Variables should be approximately normally distributed
- The association should be linear
- There should be no outliers in the data.

$$r = \frac{\sum_{i=1}^{n}\left(x_i - \overline{x}\right) - \left(y_i - \overline{y}\right)}{\sqrt{\sum_{i=1}^{n}\left(x_i - \overline{x}\right)^2}\sqrt{\sum_{i=1}^{n}\left(y_i - \overline{y}\right)^2}} \qquad ...(3)$$

Results and Discussions

Analysis of the Monthly Mean of Rainfall for the Selected Stations

Fig. 2, shows the monthly mean of the rainfall for the stations of Mosul, Baghdad, Rutba, and Basra. For eleven years from (2008-2018), was noted that the Mosul station has the highest value of rainfall 557 mm/month during December, and Baghdad Station has the highest value of rainfall reaching 412 mm/month during the month of November, and the highest value of station rainfall Rutba is 173 mm/month in March, and the highest value of Basra Station is 245 mm/month during November.

Was noted from the figure that the highest value of rainfall occurred during the winter for all stations and that the lowest value occurred during the summer for all cities. The Mosul station has the highest value for the amount of rain in December.

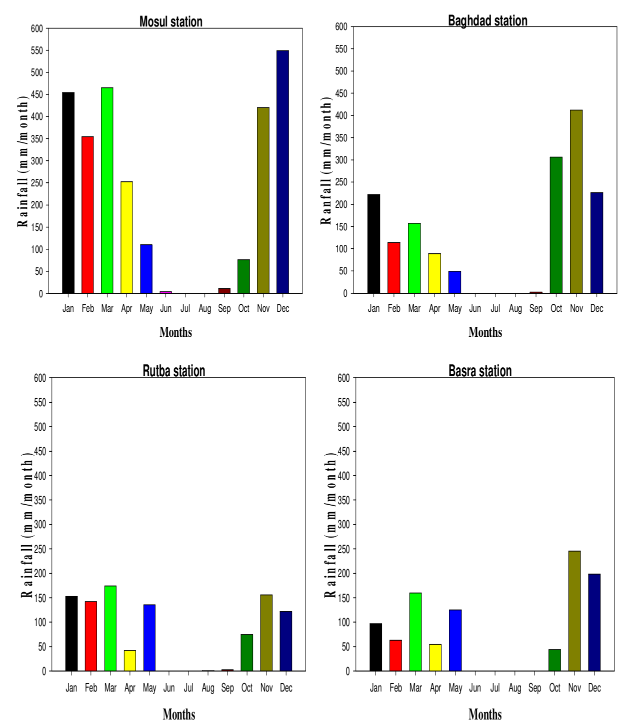

Fig. 2: The monthly mean of Rainfall for four selected stations for eleven years.

Analysis of the monthly Mean of Wind Speed for the Selected Stations

Fig. 3, shows the monthly wind speed graph for the Mosul, Baghdad, Rutba, and Basra stations. For the period from (2008-2018) was noted that the Basra station has the highest value of wind speed more than 6 m/s during July, and the Baghdad station has the highest value of wind speed, reaching 5 m/s during August, and the highest value of wind speed reached in Rutba station is 4 m/s in July, and the highest value for Mosul station is 2 m/s in July. Was noted from the figure that the highest value of wind speed occurred during the summer for all stations and that the lowest value occurred during the winter for all cities. Basra station has the highest value of wind speed in July.

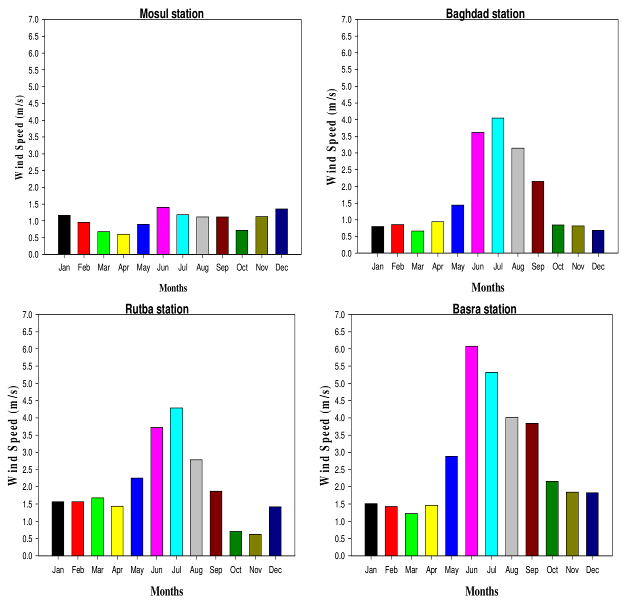

Fig. 3: The monthly mean of Wind Speed for four selected stations for eleven year.

Analysis of the Total Annual Mean of Wind Speed, and Rainfall for four Selected Stations

Fig. 4, shows that the largest annual mean annual value of wind speed was greater than 3 m/s at Basra Station, while the lowest value was recorded at Mosul Station 1 m/s for ten years between the selected stations. As for the amount of rain, the highest value was recorded at the Mosul Station, and it was 488 mm/year, while the lowest value was in Basra Station 84 mm/year for a period of ten consecutive years.

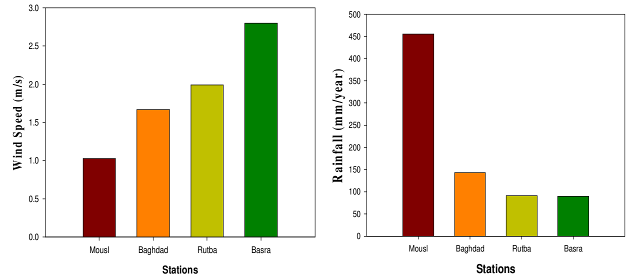

Fig. 4: The total annual mean of Rainfall and Wind Speed for four selected stations for the period (2008-2018).

The Annual change of the Wind Speed and Rainfall for Four Selected Stations

Fig. 5, shows that the largest value of precipitation was in Mosul Station 453 mm/year for 2013 due to this region enjoying a climate characterized by low temperature and the nature of the geographical area that leads to the fall of amounts of rain, followed by the Baghdad station where the amount of rain was greater than 290 mm/year for the year 2013 Rutba plant recorded the rain amount 141 mm/year for the year 2013 and the lowest recorded value in Basra Station 135 mm/year for the year 2015 due to the climate of the southern region, which is characterized by high temperatures and dryness of the region, which reduces rainfall. As for the wind speed, the largest value was recorded in the Basra station, which was greater than 3m/s, because the desert and dry region are characterized by strong winds and the lowest value was recorded in the Mosul 1 m/s station because of the climate in the northern region, where the winds in this region are weak. Therefore, the inverse relationship between rainfall and wind speed.

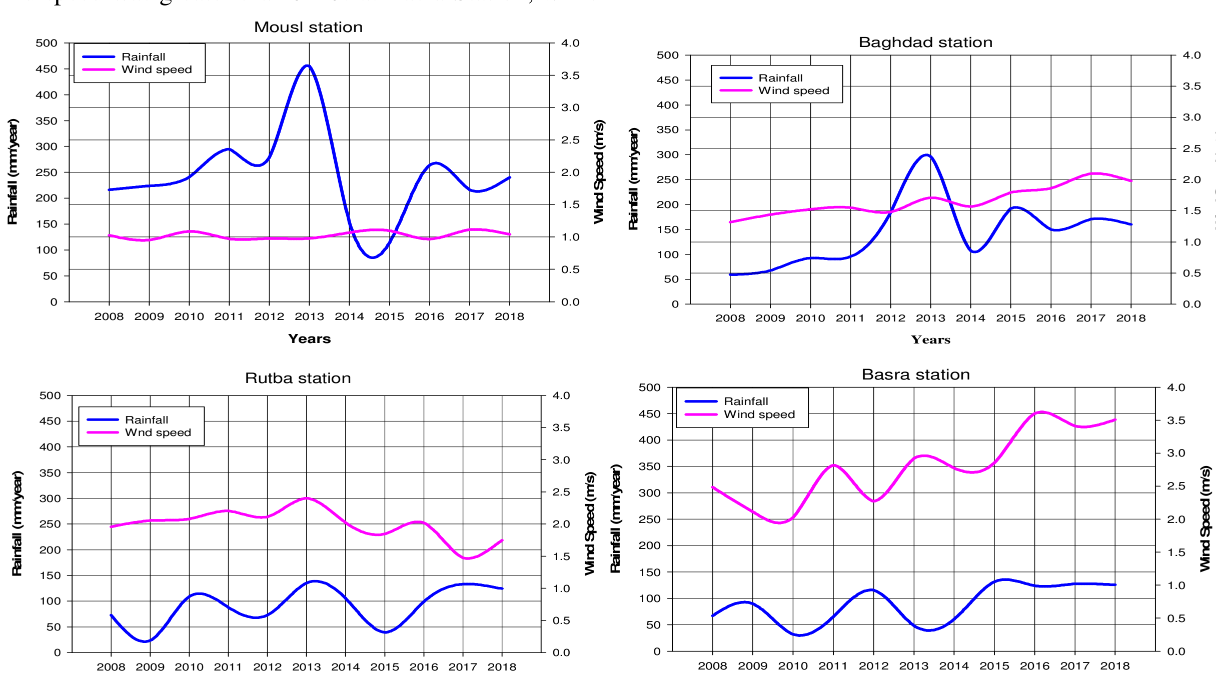

Fig. 5: The Annual change of the Rainfall and Wind Speed for four selected stations from year (2008-2018).

Analysis of the Annual Wind Rose for Four Selected Stations

Fig. 6, shows that the wind can blow from any direction, but the fastest winds in the Basra station blow the wind from the northwest direction more quickly 5 m/s. As for the Baghdad station, the fast winds can blow from the southwest direction because the wind speed is in this direction relatively high, at a value of 2 m/s, as for Rutba station, the wind blows from the western side with a wind speed of 3 m/s. Finally, the Mosul region was noted that the wind blows from the southeast direction, wind speed is 1 m/s.

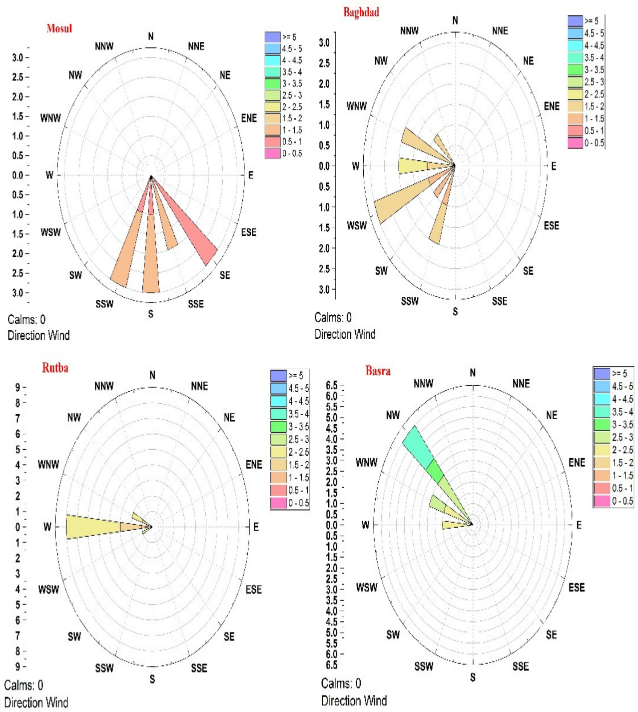

Fig. 6 :.The Wind Rose for the Annual mean of Winds (speed, direction), for four Selected Stations

The Relationship between Rainfall and Wind Speed for Four Selected Stations

The relationship between the monthly mean of rainfall and wind speed is the inverse relationship, as there can be any correlation between wind speed and rain but in humid conditions where strong winds increase evaporation and reduce relative humidity and thus less rain in dry conditions and this is what was discovered in Basra station, and Thus, the relationship between wind speed and rainfall as in Fig. 7 and Table 2., the relationship between rainfall and wind speed is very negative in most of the study stations.

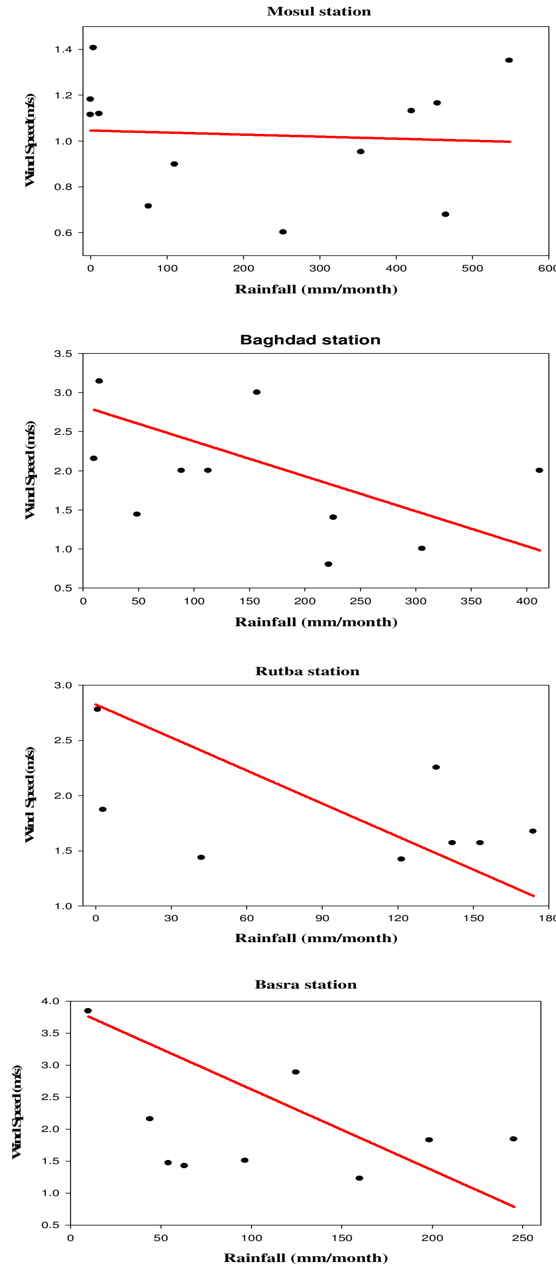

Fig. 7: The Relationship between the monthly mean of Rainfall and wind speed for four Selected Stations

Table 2: Pearson's correlation coefficient test and Simple linear regression results for the Rainfall and Wind speed for four selected stations in Iraq (Mosul, Baghdad, Rutba, and Basra).

Stations	Relationship	Pearson's correlation coefficient		Simple Linear Regression (SLR)	
		Correlation coefficient (r)	Correlation degree	P-Value	Interpret the relationship
Mosul	Rainfall & Wind Speed	0.07	Low	0.0001	Linear
Baghdad	Rainfall & Wind Speed	0.7	High	0.0001	Linear
Rutba	Rainfall & Wind Speed	0.6	High	0.0001	Linear
Basra	Rainfall & Wind Speed	0.6	High	0.0001	Linear

Conclusions

- Basra station has the highest wind speed valuesthan other stations, especially in the summer, while the Mosul station has the lowest wind speed values, for monthly and yearly mean.
- Mosul Station has the highest rainfall values from other stations, especially in the winter, while Basra Station has the lowest rainfall values,
- The prevailing winds are the northwestern winds, and the highest speed in summer is greater than 6 m/s.
- The inverse relationship between wind speed and rainfall.

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