

VARIATION OF WEATHER ELEMENTS DURING DIFFERENT SEASONS IN IRAQ

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Abstract

Atmospheric elements affect both daily human life and global economic systems. For example, climate change affects the universe's economy and human life through unexpected disasters, water pollution, and rising temperatures records. Unfortunately, recent years showed a noticeable increase in temperature that could be classified as a direct threat to human life and the ecosystem of this planet. Collection and analysis of meteorological data is the main step to predict or analyse weather conditions (on long or short-term scales). Thus, this study focuses on the analysis of trends for various weather elements over the centre of Iraq because of its importance in many applications such as aviation or agriculture planning. So this study used data from the European Centre for medium-range weather forecasting (ECMWF), which is considered as a very important wide and huge storage of atmospheric data that can be used in several branches of meteorological studies. The studied elements were temperature, rainfall, pressure, relative humidity, wind speed, and wind directions. This study covers 36 years (from 1980 to 2016), which is long enough to analyse the exact variation in studied weather elements for a long time scale. Results showed that the most fluctuated elements over the study period are temperature and rainfall; weather temperature increased over the study period while the rate of rainfall decreased with the annual average rate of about 100 mm. Other elements did not show significant changes over the study period. Generally, the results showed that the study area has low pressure with 1015 HPA during December and January months while the lowest pressure was 955 HPA during July; also the area of study has dry weather and high wind speed during the summer season, while humid weather with relatively low-speed wind during winter and the prevailing wind is northwest with a speed of 6 m/s.

Keywords: Atmospheric elements, Iraq, Meteorological, Weather.

1. Introduction

Daily life on planet Earth is closely related to the atmosphere; therefore, it changed largely after the industrial revolution. Many types of research showed that the air temperature is increased continuously by more than 1° celsius since the beginning of the last century, which exerted high impacts on the manner of living of mankind from its effects on agriculture and oil consumptions [1-4]. For example, the construction styles (for buildings) have been dramatically changed to accommodate the high temperatures [5-7], water consumption has increased dramatically (from 1 to more than 4 trillion m³) [8-11], and water pollution rate was also increased along several years because 80% of wasted water is backed to rivers [12-14].

Many modern studies show that most of the atmospheric heating appeared in the last fifteen years because of the increase in human activity [15-18], such as the wide increase in urbanisation [19-23], agriculture [24-28] and industry [29-33], so both temperature and sea level are increased in the twentieth century [34-36]. Some of these studies were carried out to investigate the activity of atmospheric elements as a function of human activities [37-42], while the rest was analysis studies [43-48]. For example, Zakaria et al. [49] studied the change in weather temperatures and rainfall over the whole region of Iraq, and they proposed a scenario to simulate the change in both temperature increase and rainfall rates over the studied period.

Bilal et al. [50] investigated the trend of temperature for the period from 1941 to 2000, and they found that the rate of temperature was clearly increased during the April-June period, while it decreased during November. He et al. [51] tried to calculate the first high-resolution meteorological forcing dataset for land process studies over China depending on studying the variation of weather elements over china and by using numbers of the modern method of calculations and interpolations.

In this context, the present study checks out trends of various weather elements over the centre of Iraq, which has warm, dry summer with wet cooled winter using data from the European Centre for medium-range weather forecasting (ECMWF). Studied elements were weather temperature, rainfall, pressure, relative humidity, and prevailing wind. This study analysed 36 years period (from 1980 to 2016), which is long enough to analyse the exact variation in studied weather elements for a long time scale.

2. Methodology

Weather elements values were obtained from the European Centre for medium-range weather forecasting (ECMWF) due to the lack of available data from local Iraqi stations, and these data were collected from many weather stations all over the world and then reanalysed by many types to correct the missing points of the grid. The collected data is from 1980 to 2016 with no missing data, and then the study calculated the annual averages to get 26 values for all studied variables; and they included the values of temperature in Celsius, relative humidity percentages, pressure in hPa, wind speed in m/s, wind direction and rainfall in mm for the whole region of the study region which showed on Fig. 1. Data analysis was conducted using a fast speed, accurate, and reliable computer to analyse the changes in several parameters.



Fig. 1. A map showing the Iraq country, which is the area of study.

3. Results and Discussion

After making some calculations of monthly means, and trying to show the difference in the values of pressure, temperature, relative humidity as well as rainfall rate for the period from 1980 to 2016, the result shows that Iraq has high pressure on its centre during the winter season and low pressure during the summer season, and this mentioned by focusing on (Fig. 2(a)); also it could be noticed that the pressure values are fluctuating around the mean value in the middle of the summer season (July) and during the winter season (especially during December and January), and this may because of the nature of topography of this place, and it is worth to mention that some studies agree with this finding result [8]. The results also showed that the value of temperature was ranging between 10°C and 15°C during the winter months (December to February), while during the summer season, it fluctuated between 35°C and 40°C (June to August) (Fig. 2(b)). Generally, the average temperature was below 10°C during winter, and it increases to the vicinity of 40°C during the summer season, and these rates of temperature correspond with nearby areas of countries around Iraq [11]; also, the result showed that the average value of the relative humidity is less in summer than it in winter on (Fig. 2(c)). The average rainfall was negligible in summer and relatively high in winter. Its values fluctuated from one year to another with no well know trends, and this is clearly shown from (Fig. 2(d)) along all the study years, which shows the rapid fluctuation of rainfall.

When seeking about the behaviour of atmospheric variables fluctuations, the study plotted a histogram shape of these variables, and the result shows that the highest pressure was 1015 HPA (Hecto Pascals) during December and January months, while the lowest pressure was 955 HPA during July, and the warmest months were found on July and August, and this is clearly shown in (Fig. 3(a)) and (Fig. 3(b)), this may occur because of the lag time between the highest solar radiation at 22 June and the highest temperature, where these differences between them may reach 23 days, and this means that the highest temperature is at the

middle of July. By examining the data for six months (from October to May), it was found that the value of the relative humidity was 25%, and this is because warm air can carry more water vapour in comparison with cooled air during winter. Data on rainfall rates showed that the season of rain is extending from October to May, and the highest rainfall rate happens in the middle of January, and all of these results are clearly shown on (Fig. 3(c)) and (Fig. 3(d)).

Also, wind data plotted in Fig. 3(e) and Fig. 3(f) show the wind speed was about 4 m/s, and that happens during summer with a prevailing direction to the northwest because of the north wind that blows over the Arabian Gulf and comes over Iraq with more energy obtained from the large area of water.

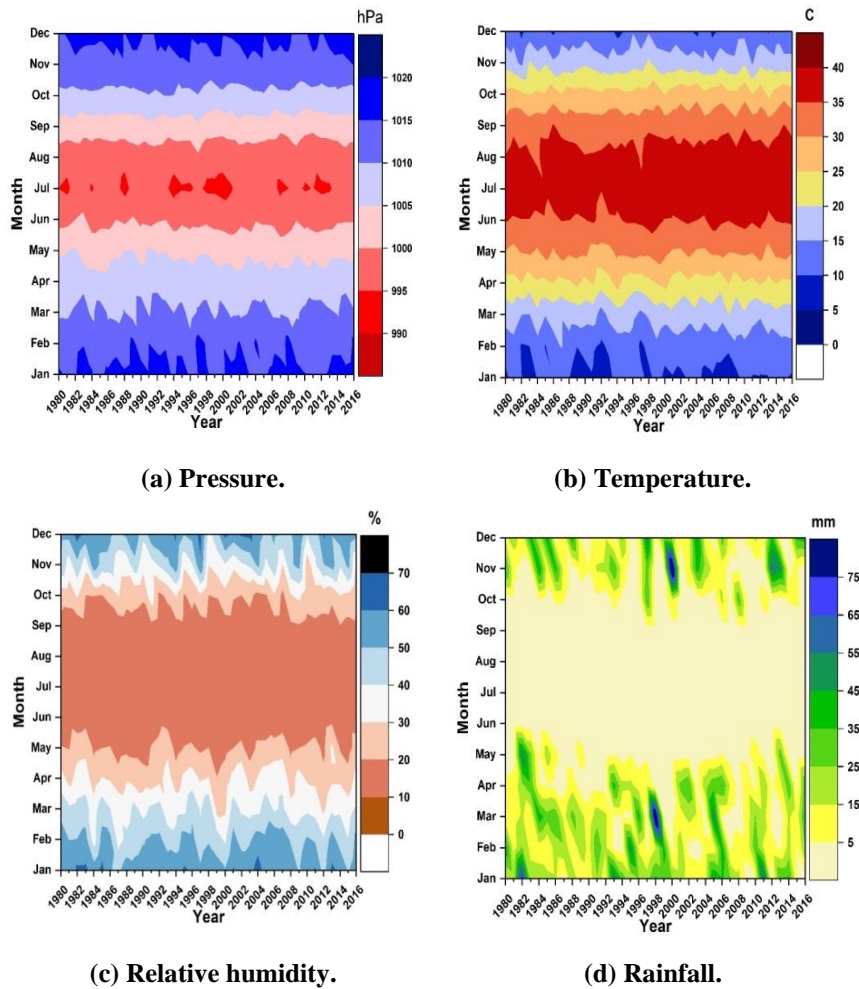


Fig. 2. Atmospheric temperature, pressure, relative humidity and rainfall rate over Iraq.

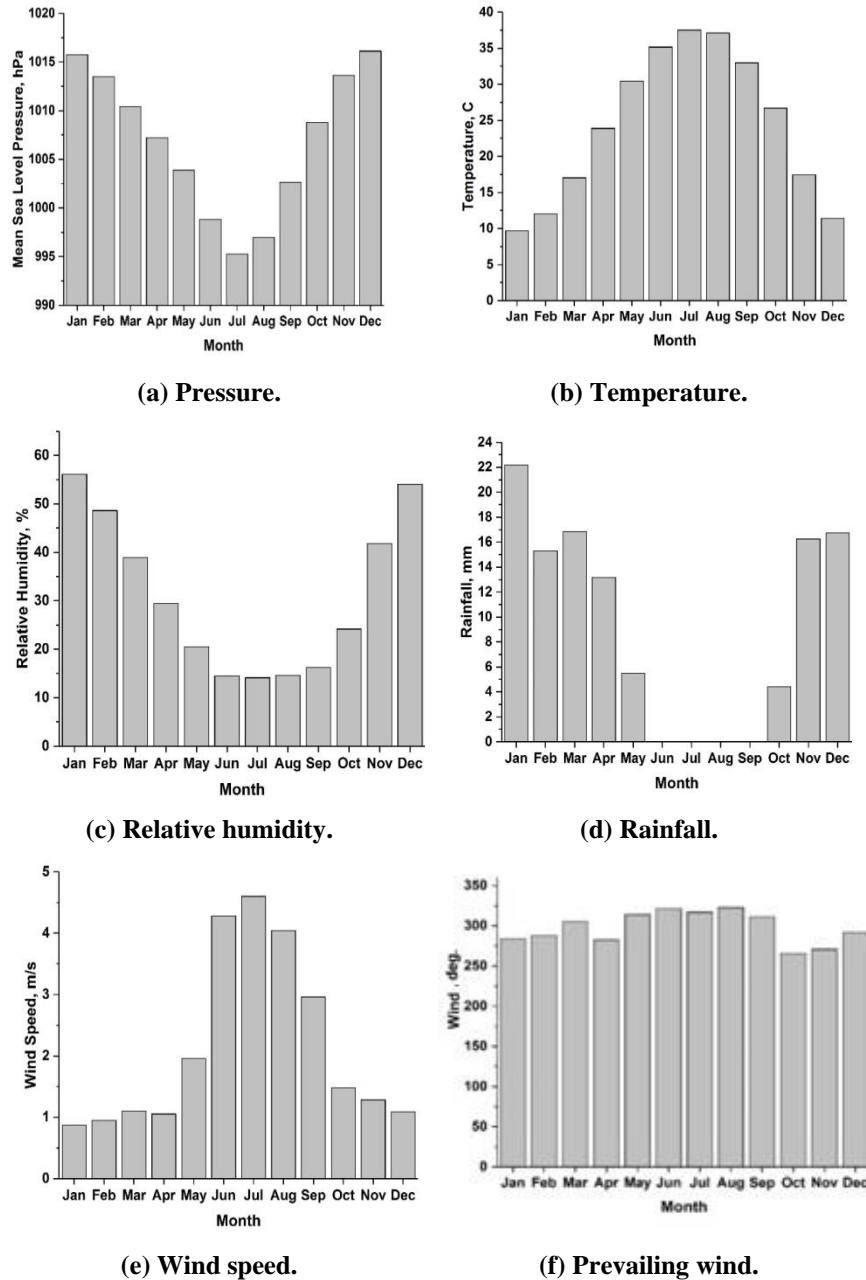
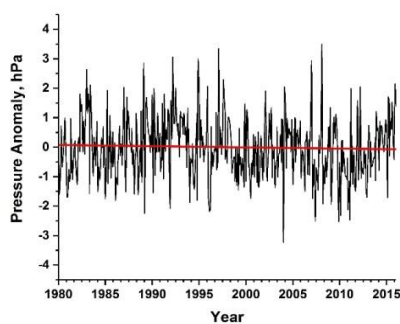


Fig. 3. Histogram shape for the number of atmospheric variables.

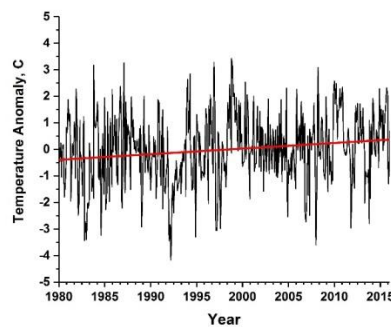
It was also noticed that extreme weather changes happen many times over the year, and most of these events happen during winter while it is less during summer. To show the effects of global warming on the centre of Iraq, the variance was calculated for the studied weather elements over the studied period, (Fig. 4(a))

shows a time fluctuation analysis of these variances, where the pressure fluctuating between -3 HPA and +3 HPA with no well-knowing trends, while the temperature was fluctuating between -4 C° and +4 C° with a noticeable increase in trend on (Fig. 4(b)). The relative humidity fluctuated between -15% and +15% with no clear trends, and the variance of rainfall is too complicated to be summarised as a part of a study, but in general, it was slowly decreasing over the last 37 years of study, and they are clearly shown on (Fig. 4(c)) and (Fig. 4(d)). The results also showed that wind speed and direction had a positive trend, and it clearly is shown on (Fig. 4(e)) and (Fig. 4(f)), this is considered as not normal, and this may be because of the effects of the prevailing winds on this place (south-west wind that blows over the region). The fluctuation of the studied variable over time for annual rainfall over the 37 years showed that it was about 110m and it fluctuated from one year to another, dry years were 1992, 1997, 2007, and 2010, as it is shown in Fig. 5, and this result was a little differed from some studies in this work. In order to show the prevailing wind, the study draws a wind rose shape based on the same given data, and the result indicates that the highest effect of wind speed is located between 1 m s^{-1} and 4 m s^{-1} , and the prevailing wind direction is the northwest, and this is clearly shown on Fig. 6, this may occur because of the topography of surrounding areas around Iraq.

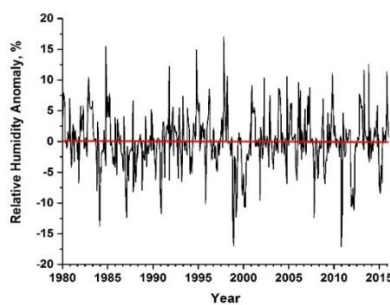
To achieve more accurate monitoring of weather conditions, sensors and remote monitoring technologies could be the solution. The recent studies demonstrated the effectiveness of wireless monitoring technology in many fields, such as pollution monitoring [52, 53], communication [54, 55], structural health [56-58] and chemical movement within solid materials [59, 60].



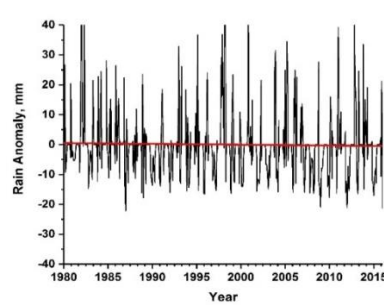
(a) Pressure.



(b) Temperature.



(c) Relative humidity.



(d) Rainfall.

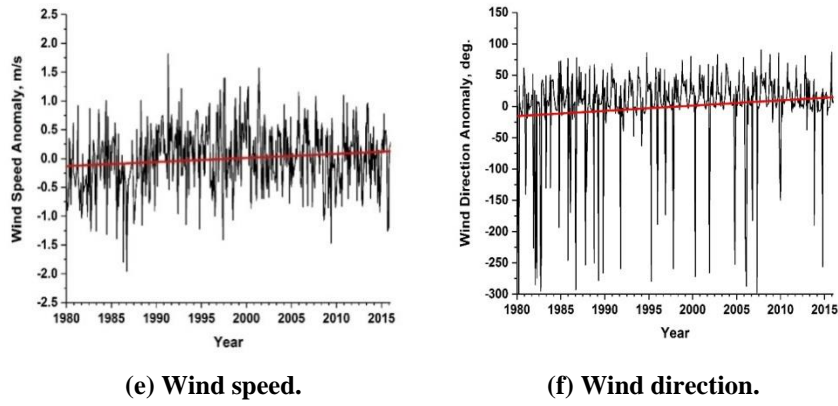


Fig. 4. Fluctuated trend for a number of atmospheric elements.

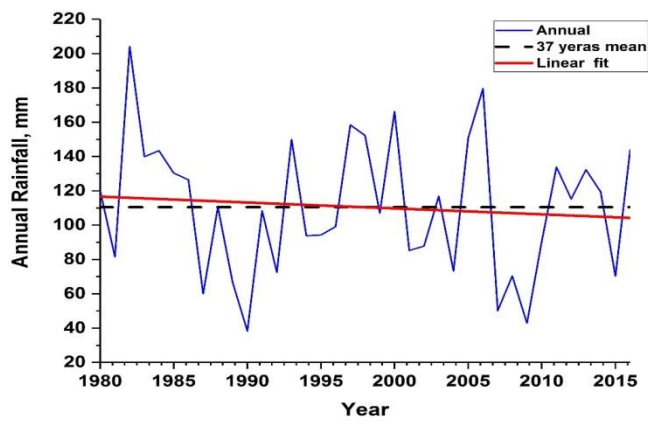


Fig. 5. The fluctuation of annual rainfall trend.

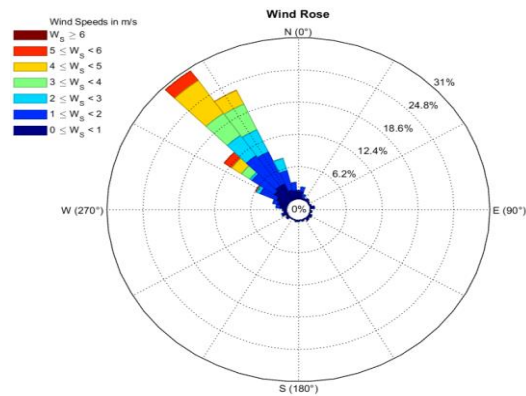


Fig. 6. The wind rose to describe the majority for wind speed and its direction.

4. Conclusions

This study concluded that:

- Iraq country is affected by its surroundings weather systems, such as the effects of high and low-pressure systems in winter and summer, respectively.
- The prevailing direction of the wind is northwest, with a speed of 6 m/s.
- The rainfall rate is about 100 mm (as of yearly average).
- The results of this study also indicated that the temperature follows an increasing trend, while the rainfall rate follows a decreasing trend. Other atmospheric parameters have no well-known behaviours.
- Temperature trend and the amount of rainfall rate is widely affected by global climate changes because the temperature trends become increase with all study years due to the global warming, and that leads to reduce the amount of rainfall over the study area.

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