Spatial Variation of Monthly Temperatures as an Indicator of Climatic Change in Iraq

Basim Ibraheem Wahab

Al-Mustansiriyah University, College of Science, Department of Atmospheric Sciences

Received : 5 November 2015 ; Accepted :20 December 2015

Abstract

Climatic change is one of the most important topics at the world. Temperature plays a major role in detecting climate change. The aim's study is determining the spatial and temporal variation of the temperature through the period of about 72 years (1941 - 2013). The researcher choose (Mosul, Baghdad, Basra) stations to represent all of Iraq area. The study adopted the analysis method, and then determines the trend of temperature. It turned out. Through, the study that the world temperature tends to increase, which turned out to that it is better to divide the study period into two stages. To illustrate the extent, of the existence of differences, it has been turned out there is an increase in temperature, but the increase in the first period (1941 - 1976). Was less than a second term (1977 - 2013), there are also increasing in temperatures less direction from southern Iraq to the north.

Keyword: Maximum temperature, Minimum temperatures, Mann–Kendall, Trend, Baghdad.

Spatial Variation of Monthly Temperatures as an Indicator of Climatic Change in Iraq

Basim Ibraheem Wahab

في العراق التباين المكاني لدرجات الحرارة الشهرية بإعتبارها مؤشرا للتغيرات المناخية

باسم ابراهيم وهاب

الجامعة المستنصرية – كلية العلوم – قسم علوم الجو

المستخلص

تعتبر التغيرات المناخية احد اهم المواضيع في العالم ، تلعب درجة الحرارة دوراً رئيسياً في الكشف عن التغيرات المناخية . تهدف هذه الدراسة الى تحديد التباين المكاني والزماني لدرجة الحرارة لمدة 72 سنة (1941 – 2013) وقد قام الباحث باختيار محطات (الموصل ، بغداد ، البصرة) بحيث تشمل كل العراق . اعتمدت الدراسة المنهج التحليلي ، ومن ثم تحديد مسار درجات الحرارة . اتضح من خلال الدراسة أن المسار العالم لدرجات الحرارة يتجه نحو التزايد ، الامر الذي اتضح معه بأن من الافضل تقسيم مدة الدراسة الكاملة الى مرحلتين لتبيان مدى وجود فروقات من عدمها ، وقد اتضح أن المرحلتين كلتاهما سجلت بالمجمل تزايدا في درجات الحرارة ، لكن التزايد في المدة الاولى (1941 – 1976) كان أقل من المدة الثانية وهي (1977 – 2013) ، وان التزايد في درجات الحرارة يقل بالاتجاه من جنوب نحو الشمال.

كلمات مفتاحية: درجات الحرارة العظمى، درجات الحرارة الصغرى، مان- كاندل، الميل، بغداد.

Introduction

Global warming is the most significant environmental problem at the world is experiencing today as concluded by the Inter-Governmental Panel on Climate Change IPCC Reports. Climate scientists have concluded that the earth's surface air temperature warmed to about (0.6 - 0.2) ˚C during the 20th century, accompanied by changes in the hydrologic cycle.Temperature plays a major role in detecting climate change brought about by urbanization and industrialization . Atmospheric warming affects in (air temperature, lands, and water resources, which in turn affects patterns of precipitation and evaporation**.** Greenhouse gases are atmospheric gases such as carbon dioxide, methane, and nitrous oxide.[1]. Several long-term temperature studies have done on different scales, which show that there is a temperature increase globally [2]. They showed that the rate of annual warming for global land areas over the 1901-2000 periods was 0.078˚C per decade. In addition, as in

which showed that the surface temperature of the Earth increased by 0.6˚C - 0.8˚C during the 20th Century. [3]

Previous studies:

In study.That temperatures, rates, especially at winter months, have increased, up to 3˚C. Within a period of (25 years), where it was in 1972 about 6˚C increased to 9˚C, in 1997. It became clear, through the study, the influence of temperature on expansion of desertification in the world, surveyed by reducing the amount of precipitation connecting rain to the earth's surface, and thus, the resulting benefit is less than it was in 1972 [4].

Another study, explained extremism in temperatures for selected Iraqi stations, and it found that the (moderate warm , cold waves) , are more observed compared at Iraq compared with the intense waves, even that the medium waves cold and warm waves are more observed at Iraq compared with long waves[5].

A study.About the general trends of repeating the heat waves at Basra, (1961-2000). It is found that the temporal dimension of these waves, associated with a weather conditions, prevailing of pressure systems, especially Indian seasonal thermal depression, and the thermal depressions repeat at the upper atmosphere, it turns out that, there is an increasing of the frequency of heat waves, through the recent years at Basra. Another studies [6], Study showed that, the summer temperatures had increased during the last 3 decades of the 20Th. Century, while the mean annual temperature records had a warming trend,

Over the 1939 to 1989 period over Turkey [7][8], And a significant warming trend, after the years 1957 and 1967 for the minimum and maximum temperatures in Jordan [9]. In addition, a study [10] showed that, the maximum yearly temperature was persistently exceeding its mean value during the last two decades and a considerable warming temperature trend and the rainfall decrease were the main reasons of the aridity in the Middle East, which should considered for rural development, and water resources management in Iraq. Another study [11] showed that there was a statistically significant temperature increase of 0.07 ˚C /decade over Kuwait during the period 1950-1990. The variability of wintertime, surface air

temperature (SAT). Of 24 observing sites in the KSA based on time series over thirty one years, (1978-2008) [12] , showed that, there was a warming trend in winter temperature during, the last 2 decades, at most sites and there was a significant warming trend, after the year 1997 with a rate of 0.03 ˚C /year. Through the study [13]. About (Aspects of climatic change at Garmyan area) for the period (1972 – 2009) , showed that the rate of temperature has been increased to about 3 ˚C especially in winter because it was about 6 ˚C at 1972 , but it increased to 9 ˚C , that effected on water cycle and rainfall through evaporation process .

Study Area and general climate:

Iraq is located in a sub-tropical, which is dominated, Mediterranean climatic region, Iraq lies approximately between, 39 - 48 E, and between 29^{o} 5` - 37$^{o}$ 22`N [14]. Bordered by Turkey to the north and Iran to the east, Syria, Jordan and Saudi Arabia to the west and the Arabian Gulf and Kuwait from Iraq south .His area of 435 052 square kilometers. Surface sections of Iraq divided into :- (the alluvial plain, covers about quarter of the, or about (132 500 square kilometers), the desert plateau is situated in the west of Iraq covering less than half the area of Iraq, or (168 552 square kilometers) and a height ranging between (100 -1000) meters and intervention, including the island area. Iraq climate characterized with hot dry summers and cool rainy winter. Iraq Climate is continental subtropical and the arid season extends for more than seven months. , Solar radiation duration time reaches 12 hours / day, and a temperature of up to shade more than 45 ˚C, (at summer temperature at the shadow reaches more than 45 ˚C) maybe more than (48 ˚C) at both of (July and august , while it could be reached below than 0 ˚C at winter , since that the range could be 48 ˚C [15].

Data and Trend Detection:

The study aims to determine the effect of Temperature in climate change, by comparing the values and characteristics of this climate component and spatial variability within a period of up to (72) .Through a comparison between the three chosen stations (Mosul, Baghdad, and Basra). As it represents all of Iraq, Fig.1shows the study stations.

Spatial Variation of Monthly Temperatures as an Indicator of Climatic Change in Iraq

Basim Ibraheem Wahab

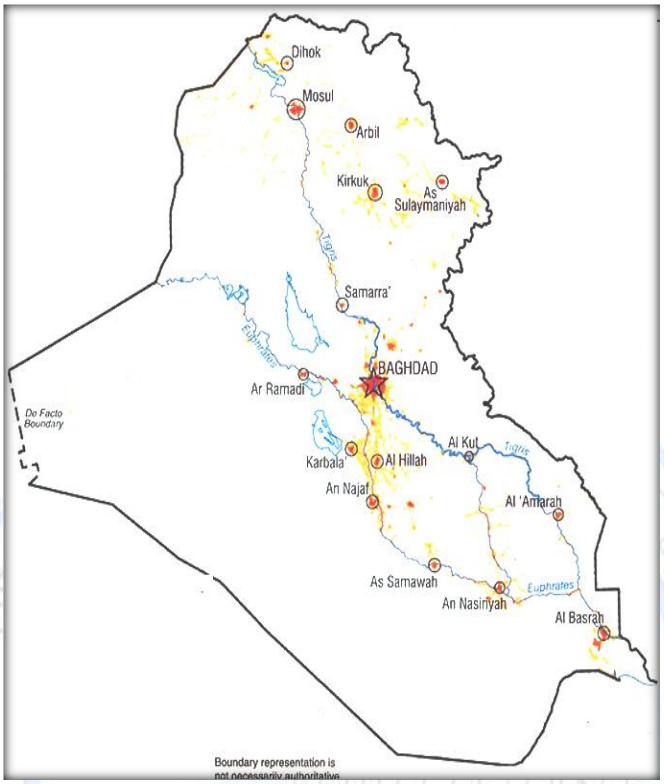

Fig.1 geographical locations of the meteorological stations

Trends detected in the time series of all the data indices analyzed by means of the Mann–Kendall (MK) test. Which was commonly using for hydrologic data analysis can be using to detect trends that are monotonic but not necessarily linear. The Mann–Kendall method has been suggesting by the World Meteorological Organization (WMO) to assess the trend in Environmental data time-series [16] [17]. The MK method assumes that the time series under research are stable, independent and random with equal probability distribution. This test consists of comparing each value of the time-series with the others remaining, always in sequential order. The number of times that the remaining terms are greater than that under Analysis is counted [16] The Mann–Kendall statistic is giving by:

$$s = \sum_{\mathrm{i}=2}^{\mathrm{n}} \sum_{j=1}^{n} sign(\, xi - xj) \qquad \ldots\ldots\ldots\ldots\ldots (1)$$

Where n is the length of the data set, i x and j x are two generic sequential data values, and the function $sign\ (\ xi - xj)$ assumes the following values:

$$sign(xi - xj) = \begin{cases} 1, if\ (\ xi - xj) > 0 \\ 0, if\ (\ xi - xj) = 0 \\ -1, if(xi - xj) < 0 \end{cases} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

The S statistic therefore represents the number of positive differences minus the number of negative differences found in analyzed time series. Under the null of that there is no trend in the data no correlation between considered variable and time, each ordering of the data set is equally likely. Under this hypothesis, the statistic S is approximately, normally distributed with the mean E(S) and the variance, $Var(S)$) as follows:

$$0) = S(\ E$$

$$Var(S) = \frac{1}{18}\left[n(n-1)(2n=5) - \sum_{p-1}^{q} tp(tp-1)(2tp+5)\right] \ldots (3)$$

Where *n* is the length of the times-series, t_p is the number of ties for the p^{th} value and *q* is the number of tied values equals values. The second term represents an adjustment for tied or censored data. The standardized test statistic Z is given by:[17]

$$Z = \begin{cases} \frac{S-1}{\sqrt{Var(S)}} & if\ S > 0 \\ 0 & if\ S = 0 \quad \ldots \\ \frac{S+1}{\sqrt{Var(S)}} & if\ S < 0 \end{cases} \quad \ldots\ldots\ldots\ldots (4)$$

A positive Z indicates an increasing trend in the time-series, while a negative Z indicates a decreasing trend. The presence of a statistically significant trend is evaluating using the Z value.

The data used in the search that include the monthly rates temperatures obtained from (General Meteorological Organization and Seismology unpublished data) [18] for the period (1941-2013) for the three stations (Mosul, Baghdad, Basra) the researcher has objected to the problem of the presence of missing data values for the years 2003 and 2004. Lost data even if a few percentages can cause problems in the analysis lead to erroneous conclusions drawn. There are several ways to estimate missing values in meteorological data. To deal with lost data model was used (Box-Jenkins Box-Jenkins) A linear model to predict the use of the most time-series data lost during the past three decades, Box Jenkins ARIMA model uses past values of one variable to predict the values in the future. So it classified as a single variable model and Box models can divided - to Jenkins models: such as (Self-Regression model (SR)), and the moving average model .A (q) [19] [20]. Table (1) shows the location of the three stations for the longitude and latitude and height above sea level [21].

Table (1) the study areas and the longitude and latitude sites [21]

Station Name	station code	longitude	Latitude	Height above sea level
Mosul	608	43.09	36.19	223
Baghdad	650	44.24	33.18	31
Basra	689	47.47	30.31	2

This study is based on a problem with a remark in the presence of high temperatures, but the feature of this rise is not a specific time and place, (is it increasing or decreasing?). The relationships between this course and between climate changes are unclear. Therefore, the study adopted analytical methodology to link data for the years studied, and then determine the temperature trend then compared to the recipe temperatures for each station. In addition, determine the trend to find the value of Q (˚C /year) using the Mann-Kendall test. The value of positive Q (˚C /year) indicates an increasing trend in the temperatures and negative value indicates a tendency to decrease in temperature increase rates, so it was extracted values data

Q for temperature. To study stations. For the first of two periods, (1941- 1976). A period of 36 years, and the second (1977 - 2013) for 37 years, which set out in the Table 2.

Table 2. Q and Z values to study evidence of the three stations values

	Q (˚C /year)	Q (˚C /year)	Z (1941-1976)	Z (1977-2013)
Mosul	**0.007**	**0.045**	**0.46**	**3.82**
Baghdad	**- 0.019**	**0.048**	**- 1.31**	**5.05**
Basra	**0.007**	**0.065**	**0.68**	**4.71**

Table (2) showed significant warming trend after an analysis of the data. That there is an increase in temperature values, however, the levels of this increase did not specify. Therefore, the researcher resorted to statistical analysis using the (Mann-Kendall test). Which indicates that, the first period (1941 - 1976), has been characterizing by the increase in temperatures, of up to 0.25˚C; it means that temperatures have been increasing during this period, at a rate of a quarter degree. On the other hand when analyzing the characteristics of the amount of increase in the period that followed between (1977- 2013) using the same test, It shows that the rate of increase was 1.62 ˚C in Mosul station 1.78 ˚C in Baghdad station and 2.4 ˚C in Basra station. The study shows that the stations indicated an increase in temperature with, different values of this increase in each of the three stations. The search record another result that the rate of increase get reduced toward of northern of Iraq , where the increase was in Basra higher than Baghdad, and in Baghdad higher than Mosul It should be noting.

The lack of compatibility, in the direction and path temperatures, for the first period between (1941- 1976), where Mosul and Basra stations, recording an increasing temperature values. While, Baghdad station, recording a decrease in the increasing temperature values taken as a negative sign value. The reason behind that is the amount of change in the increasing temperatures reached values. Lower than the general trend, while keeping the fact that this general characteristic is the increasing temperatures in stations. As shown in Table 2.

Spatial Variation of Monthly Temperatures as an Indicator of Climatic Change in Iraq

Basim Ibraheem Wahab

Results and Discussion

1- Monthly analysis of the temperatures values for the three stations.

Monthly average temperature for period (1941-2013) for the stations (Mosul, Baghdad, and Basra) shown in Table 3.

Table 3. Monthly average temperature for the period (1941-2013)

	Jan.	Fab	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Mosul	6.9	8.91	12.7	17.9	24.5	30.9	34.3	33.4	28.4	21.2	13.5	8.44
Baghdad	9.6	12.2	16.6	22.4	28.6	32.8	35.0	34.3	30.5	24.3	16.5	11.0
Basra	12.4	14.8	19.2	25.0	31.1	34.4	35.9	35.5	32.2	26.9	19.5	13.8
Baghdad - Mosul	2.8	2.6	2.6	2.6	2.5	1.6	0.9	1.2	1.7	2.6	3	2.8
Basra - Baghdad	2.7	3.2	3.9	4.5	4.1	1.9	0.7	0.90	2.1	3.1	3	2.56

Generally illustrated the path of temperature ' the values are homogeneous to be low in winter and increases in trend follow summer , And then re-fall in autumn, But at the same time it gives a clear perception that the values of temperatures in the south of Iraq are higher than in the center and north. As in Baghdad and Basra stations. The highest values of the three stations were recording in July and the lowest rates in January, which is illustrating in Fig 2. However, it is clear that there is a difference in another place seems clear when take the difference between the values of months, table 3 shows the difference between each of the stations (Mosul and Baghdad) and stations (Baghdad and Basra). As it seems that the difference is greater when take the rate of months of winter and spring. Fig. 3 shows difference between temperature values decrease between May and Sep. The highest values of the difference recorded at (Mar. Apr. Oct, Nov.). Moreover, there is another result, (that you can specify the difference between the stations of Baghdad and Basra values, lower when compared to the difference between values of Baghdad and Mosul stations. The difference between Mosul and Baghdad curve is, greater than between Basra and Baghdad. In addition,

the highest difference between Mosul and Baghdad stations record in March, while the highest difference between Basra and Baghdad on Nov.

Illustrated in Fig.3, It can be due to a Mosul's situation in northern Baghdad, and Mosul located at sea level highest compared to Baghdad, the deference's is clearer at March. While the big difference between Baghdad and Basra, is clear on Nov. Because Basra locate near to the Arabian Gulf and its Influenced by arrival the Seasonal Indian depression.

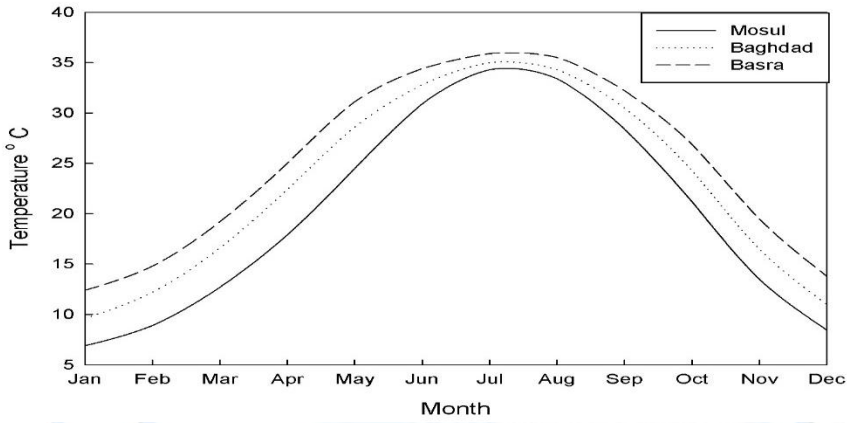

Figure (2) temporal and spatial variation of temperatures path at the study stations

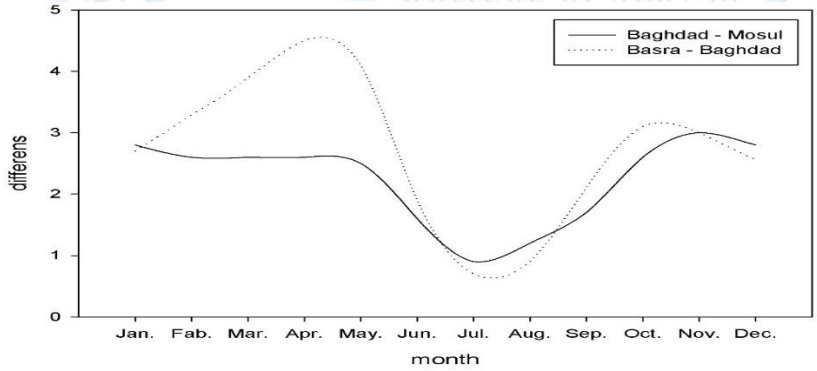

Fig. 3 the difference between the temperatures values at studied stations

2- The annual analysis of the values of temperatures in the study stations.

Values that determine the annual rate path's feature of the temperatures in the three stations (Mosul - Baghdad - Basra) for a period (72 years) present in Table 4, Where Basra station recorded higher rates than other stations. In addition, the path of the lowest values has taken

the same direction, as it recorded the lowest temperature in Mosul, Baghdad and Basra. Other results that can be observed , is recording maximum rate of temperatures in 2010 at the three stations , which illustrated in teble.5 , which explains the general path is increasing that temperature tend to takes , it was appears from results the linear regression of the temperature data of the three stations, as follows. increase in the values of the temperature in Mosul station of 19.7 ˚C at 1941 to 20.5˚C at 2013 , and at Baghdad station, it was 22.4˚C in 1941 to 23.3˚C in 2013 , and at Basra, it was 24.6 ˚C in 1941 to 25.6 ˚C 2013 .

The Linear regression was 0.8 ˚C in Mosul 0.9 ˚C in Baghdad and in Basra 1.0 ˚C and 95% confidence level. This refers to a trend to increase the temperature of the stations through the duration of the study mentioned and shown in Fig. 4. However, they differed in the year that recorded minimum temperatures, in Mosul the minimum annual rate during the period (1941 - 2013) in 1992, In Baghdad Station record minimum rate in 1974, while in Basra station, the minimum rate in 1943 for the same period as shown in the Table 5. If we followed to extract the difference between maximum and minimum, temperatures value for each station.

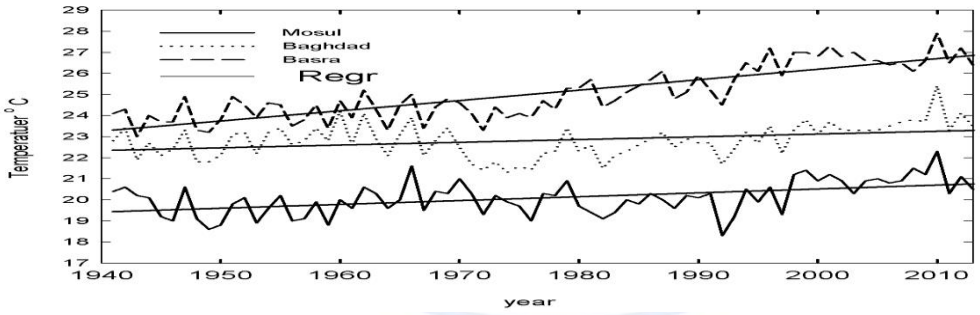

Fig (4) path of temperatures in Iraq a period of study in the study stations.

Table (4) the average of temperature through (1941 – 2013) at studied stations

series								d	Basra
1	1941	20.4	22.8	24.1	38	1978	20.2	22.3	24.3
2	1942	20.6	23.4	24.3	38	1979	20.9	23.4	25.3
3	1943	20.2	21.9	23.0	39	1980	19.7	22.3	25.3
4	1944	20.1	22.7	24.0	40	1981	19.4	22.6	25.7
5	1945	19.2	22.1	23.7	41	1982	19.1	21.5	24.4
6	1946	19	22.4	23.7	42	1983	19.4	22.1	24.7
7	1947	20.6	23.3	24.9	43	1984	20	22.3	25.1
8	1948	19.1	21.8	23.3	44	1985	19.8	22.6	25.4
9	1949	18.6	21.8	23.2	45	1986	20.3	22.9	25.7
10	1950	18.8	22.1	23.8	46	1987	20	23.2	26.1
11	1951	19.8	23.1	24.9	47	1988	19.6	22.5	24.8
12	1952	20.1	23.2	24.5	49	1989	20.2	22.9	25.1
13	1953	18.9	22.2	23.9	49	1990	20.1	22.7	25.9
14	1954	19.6	23.2	24.6	50	1991	20.3	22.7	25.2
15	1955	20.2	23.4	24.5	51	1992	18.3	21.7	24.5
16	1956	19	22.6	23.5	52	1993	19.2	22.4	25.7
17	1957	19.1	22.8	23.8	53	1994	20.5	23.2	26.5
18	1958	19.9	23.4	24.5	54	1995	19.9	22.7	26.1

19	1959	18.8	22.8	23.4	55	1996	20.6	23.5	27.2
20	1960	20	24.2	24.7	56	1997	19.3	22.2	25.9
21	1961	19.6	22.6	23.9	57	1998	21.2	23.3	27.0
22	1962	20.6	24.1	25.2	58	1999	21.4	23.8	27.0
23	1963	20.3	22.9	24.3	59	2000	20.9	23.1	26.8
24	1964	19.6	22.1	23.3	60	2001	21.2	23.7	27.3
25	1965	20	23.1	24.5	61	2002	20.9	23.3	26.8
26	1966	21.6	23.9	25.0	62	2003	20.3	23.3	27.0
27	1967	19.5	22.1	23.4	63	2004	20.9	23.3	26.6
28	1968	20.4	22.8	24.4	64	2005	21	23.3	26.6
28	1969	20.3	23.4	24.8	65	2006	20.8	23.5	26.4
30	1970	21	22.5	24.6	66	2007	20.9	23.7	26.5
31	1971	20.3	21.7	24.1	67	2008	21.5	23.8	26.1
32	1972	19.3	21.4	23.3	68	2009	21.2	23.7	26.6
33	1973	20.2	21.8	24.4	69	2010	22.3	25.4	27.9
34	1974	19.9	21.3	23.9	70	2011	20.3	23.3	26.5
35	1975	19.7	21.6	24.1	71	2012	21.1	24.1	27.2
36	1976	19	21.4	23.9	72	2013	20.5	23.5	26.4
37	1977	20.3	22.2	24.7					

Table (5) maximum and minimum temperature of the annual rates and years Date

station	Max	year	Min	Year	Difference
Mosul	22.308	2010	18.308	1992	4
Baghdad	25.4	2010	21.3	1974	4.1
Basra	27.9	2010	23	1943	4.9

It turned out that the differences recorded in Mosul reached to (4) degrees between 1992 and 2010. The increase was in favor 2010,

in Baghdad station, was 4.1 degrees between 1974 and 2010, It is also in favor 2010, and in Basra station, the biggest difference reaches to about (4.9) degree between (1943 – 2010), which is also in favor 2010 which is illustrated in Fig.(5) .

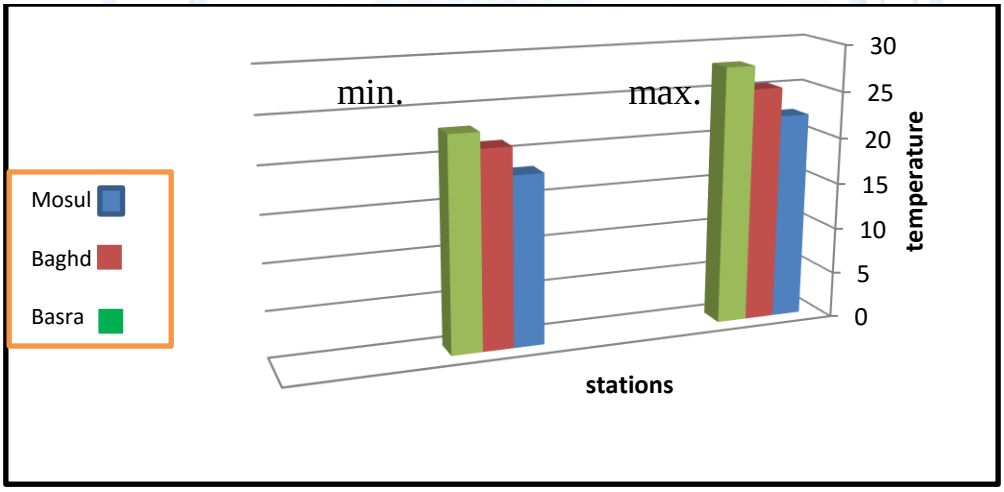

Fig. 5 variance value of Maximum and Minimum temperature at studied stations

3- Monthly analysis of the values of maximum and minimum temperature.

It can be determine the path trait, of monthly maximum and minimum temperatures, for the three stations. Table 6, shows the increasing in trend of temperature from winter towards summer. Which is illustrated that the trend temperature, increase from winter, towards summer. As in Figures (6 and 7).

Table (6) path of maximum and minimum monthly temperatures

Months	Mosul			Baghdad			Basra		
	Max	Min.	Avr.	Max	Min.	Avr..	Max	Min.	Avr..
Jan.	10.8	2.6	6.7	13.7	4.4	9.05	15.5	7.2	11.35
Fab.	13.5	4.7	9.1	15.4	8.4	11.9	18	11.1	14.55
Mar.	17.4	9.3	13.35	21.1	13	17.05	22.6	15.6	19.1
Apr.	22.9	14.2	18.55	25.8	18.8	22.3	29.8	13.5	21.65
May.	27.6	20.8	24.2	31.5	25	28.25	34.9	27.1	31
Jun.	33.3	28.4	30.85	35.1	30	32.55	38.5	30.9	34.7
Jul.	37.4	32.1	34.75	37.7	32.8	35.25	40.4	32.6	36.5
Aug.	35.9	30	32.95	37.8	31.2	34.5	39.8	31.9	35.85
Sep.	33	25.4	29.2	33	28.3	30.65	35.6	28.3	31.95
Oct.	24.1	17.3	20.7	27.1	16.9	22	30	22.6	26.3
Nov.	17.3	9.4	13.35	19.4	11.7	15.55	22.1	15.6	18.85
Dec.	12	4.7	8.35	14.1	7	10.55	17.5	10.1	13.8

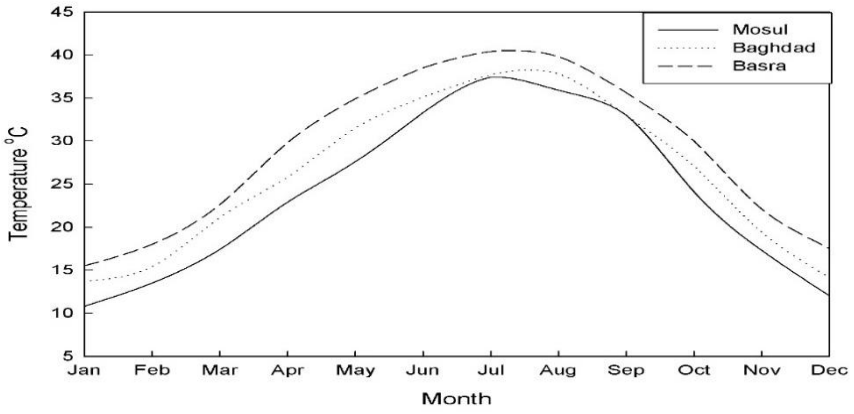

Fig. (6) Trend of maximum monthly temperatures at studied stations

Spatial Variation of Monthly Temperatures as an Indicator of Climatic Change in Iraq

Basim Ibraheem Wahab

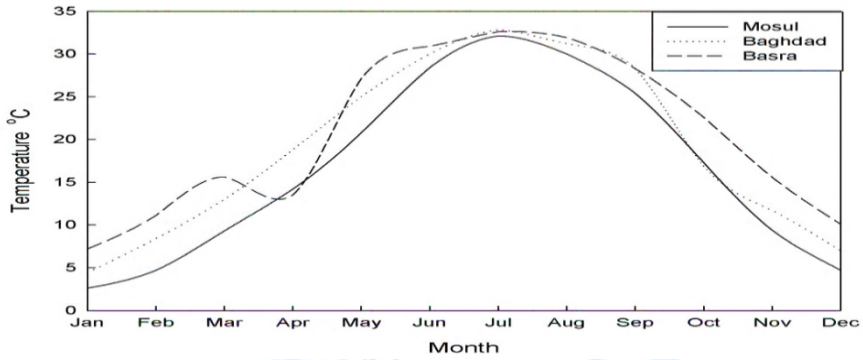

Fig.7 Trend of minimum monthly temperatures at studied stations

4- Annual analysis of maximum and minimum temperatures.

It became clear from the foregoing that the maximum and minimum temperatures values have taken a similar path at studied stations. When analyzing whether maximum or minimum temperatures. In order to clear status annual spatial variation. Between the study stations. The table 6 shows that the path taken by the temperature tends to increase.

Table 6 Annual's path of maximum and minimum temperatures at studied stations

Month	Mosul				Baghdad				Basra			
	Max	year	Min	year	Max	year	Min	year	Max	year	Min	year
Jan.	10.8	2010	2.6	1964	13.7	2010	4.4	1964	15.5	2010	7.2	1964
Fab	13.5	2009	4.7	1959	15.4	1987	8.4	1959	18	2010-1963	11.1	1959
Mar.	17.4	2008	9.3	1945	21.1	2008	13	1943	22.6	1969	15.6	1943
Apr.	22.9	2008	14.2	1949	25.8	1989	18.8	1949	29.8	2000	13.5	1943
May	27.6	1999	20.8	1963	31.5	2007	25	1963	34.9	2012	27.1	1963
Jun.	33.3	1998	28.4	1950	35.1	2006,2010	30	1998	38.5	1998	30.9	1949
Jul.	37.4	2000	32.1	1976	37.7	2012	32.8	1976	40.4	2012	32.6	1949
Aug.	35.9	2006	28.4	1950	37.8	2010	31.2	1984	39.8	1998,2000,2011	31.9	1944
Sep.	33	1982	25.4	1949	33	2010	28.3	1961	35.6	2010	28.3	1949
Oct.	24.1	2010	17.3	1975	27.1	2010	16.9	1943	30	2002	22.6	1948
Nov.	17.3	1998	9.4	1978	19.4	1983	11.7	1978	22.1	1998	15.6	1978
Dec.	12	2001	4.7	1953	14.1	1996,2009	7	1953	17.5	1996	10.1	1972

5- Analysis of The relationship between the maximum and minimum temperatures ranges of different years.

Showing, through the Table 6 that, the maximum and minimum temperatures, values vary spatially and temporally. It has been identified attribute this discrepancy. It remains to be analyzed range between maximum and minimum temperatures. This characteristic can be determined from the Table 7. In general, there are no specific pattern for the general path of ranges between maximum and minimum. As if to say, that Baghdad is higher than the other two stations, or vice versa. However, it noted that, range is during the winter and autumn higher than during the summer. It can be say that, the reason for this is due to the great temperature contrast, between night and day during the winter, Compared in the summer. Therefore, the range be less in summer. In addition, variation of pressure systems, that effecting on Iraq is larger during the winter than summer. Which is diversity, of the pressure systems prevailing less? On the other hand, we find that, the thermal extent that record in Baghdad. To some extent, it's less of it compared to the Mosul and Basra stations. Table 7 .The reason could be due to topographic variation, which is in Mosul bigger than in Baghdad. As for, southern location of Basra and it is affected of the Sudanese Trough. Greater degree of Baghdad. Contributed to be, a range of temperature in Basra highest than Baghdad in most months.

Table (7) ranges values maximum and minimum temperatures during (1941 - 2013)

station	Jan.	Fab	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Mosul	7.3	7.9	6.8	7.6	7.5	5.3	4.9	6.8	8.7	8.1	8.8	8.2
Baghdad	7.1	7.7	10.2	4.7	6.6	4.9	5.1	6.5	7	8.1	7	9.3
Basra	7.4	6.5	7.4	7.3	7.9	7.8	7.6	7.8	16.3	7	6.9	8.3

Conclusions

1- The difference in temperature is greater if we take the rates of the winter and spring months, while the difference between the values of the stations is reducing in summer. In addition, the differences between the values of temperature decrease between May and September. While the highest values of the difference recorded a (Mar. Apr., Oct., Nov.). In addition, the difference between values Baghdad and Basra lowers than the difference between the values of Baghdad and Mosul. As the difference between Mosul and Baghdad curve is largest than between Basra and Baghdad. Highest difference temperatures, between Mosul and Baghdad record at March. While the highest difference between Basra and Baghdad recorded at November.

2- Basra station recorded highest rates among other stations, and the path of lowest values has taken the same trend, in other words, the lowest temperature was record in Mosul then, Baghdad and at last Basra. The three stations agreed the highest rate recorded temperature in 2010. In addition, general path between the temperatures tend to increase, but they varied in the year recording a minimum temperature. In Mosul, a minimum recorded an annual rate during the study period (1941 - 2013) in 1992. In Baghdad station, record in 1974 while, in Basra station a minimum rate record in 1943.

3- Illustrated, the lowest difference in the annual rate was (4) ˚C in Mosul, between(1992 – 2010). The increase was in favor of 2010. At Baghdad, the increasing comes to be about (4.1) ˚C, between(1974 – 2010), and even at 2010. At Basra, where the difference was biggest it comes to be about (4.9) ˚C, between (1943 – 2010) , and it is also, even at 2010.

4- Characterized general path, increasing temperatures In addition, that the result value of the increase during the first period (1941- 1976) at Mosul and Basra reached 0.25 ˚C, that means the increase is equal to (quarter Celsius degree) during the first 36 years. While, the outcome of the increase at second period, (1977 - 2013), estimated to about 1.62 ˚C at Mosul, 1.72 ˚C at Baghdad and 2.4 ˚C at Basra.

5- Linear regression value was 0.8 ˚C at Mosul, 0.9 ˚C at Baghdad, and 1.0 ˚C at Basra, in Confidence level of 95%. It has refers to, a trend to increase temperature for study stations for the period mentioned.

We can mark the existence of climatic change significantly through the following indicators:

1. The overall average temperature tends to increasing.

2. The minimum values of the temperature of the three stations recorded in the years leading up to 1975.

3. While the highest values recorded a in the years that followed in 1983, Meaning that temperatures are increasing, although, a range between the minimum and maximum temperature were few, But it is increasing**.**

References

1. IPCC (2007) , Climate Change 2007: Mitigation of Climate Change. In: Metz, B., Davidson, O.R., Bosch, P.R., Dave, R. and Meyer, L.A., Eds., Contribution of Working Group III to the 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge
2. Brohan, P., Kennedy, J.J., Harris, I., Tett, S.F.B. and Jones, P.D. (2006) Uncertainty Estimates in Regional and Global Observed Temperature Changes: A New Data Set from 1850. Journal of Geophysical Research Atmospheres, **111**, Article ID: D12106. http://dx.doi.org/10.1029/2005JD006548
3. Soon, W., Baliunas, S., Posmentier, E.S. and Okeke, P. (2000) "Variations of Solar Coronal Hole Area and Terrestrial Lower Tropospheric Air Temperature from 1979 to Mid-1998: Astronomical Forcing's of Change in Earth's Climate" ?New Astronomy, **4**, 563-579. http://dx.doi.org/10.1016/S1384-1076(00)0002-6
4. Alznkana, Dr. Laith Mohammed Mahmoud, 2012 "The effect of heat and rain on the spread of desertification in the district of Kalar", Journal of Strategic Studies, No. (71) Al-Mustansiriyah University.

5. Al-Zubaidi, Abdul Mujeeb Rezouki Freeh, 2013, "Extremism in Temperatures for Selected Stations in Iraq," Master Thesis unpublished, submitted to the Faculty of Education, Al-Mustansiriyah University - Department of Geography. (In Arabic)

6. Al-Fadhli, Saud Abdul, Aziz and Ahmed Jassim Hassan.2001, "general trends to repeat the heat waves in the province of Basra", Basra Literature magazine, Issue 57. (in Arabic) .

7. Aesawy, A.M. and Hasanean, H .M. 1998, "Annual and Seasonal Climatic Analysis of Surface Air Temperature Variations at Six Southern Mediterranean Stations". Theoretical and Applied Climatology, **55-61**, 68. http://dx.doi.org/10.1007/s007040050051

8. Kadioğlu, M. (1997) , "Trends in Surface Air Temperature Data over Turkey". International Journal of Climatology , **17**,511-520. http://dx.doi.org/10.1002/(SICI)1097-0088(199704)17:5<511::AID-JOC130>3.0.CO;2-0

9. Smadi, M. (2006), "Observed Abrupt Changes in Minimum and Maximum Temperatures in Jordan in the 20th Century" .American Journal of Environmental Sciences, **2**, 114-120. http://dx.doi.org/10.3844/ajessp.2006.114.120

10. El Nesr, M.N., Abu -Zreig, M.M. and Alazba, A.A. (2010), "Temperature Trends and Distribution in the Arabian Peninsula ". American Journal of Environmental Sciences, **6**, 191-203. http://dx.doi.org/10.3844/ajessp.2010.191.203

11. Al-Fahed, S., Al-Hawaj, O. and Chakroun, W. (1997), "The Recent Air Temperature Rise in Kuwait". Renewable Energy, **12**, 83-90.

12. Hasanean, H. and AL - Khalaf, A. (2012), "Variability of Wintertime Surface Air Temperature over the Kingdom of Saudi Arabia". Atmospheric and Climate Sciences, **2**, 307-321. http://dx.doi.org/10.4236/acs.2012.23028.

13. Layth Mahmood Alzangana and Ahlam Abdu Alkareem Alrubaii , Aspects of climatic change at Garmyan Area ,Gamyan magazine , No.309 .

14. Al-Bayati, Mustafa Sabri and Al-dori, Ahlam Ahmed Juma , "Classification Iraqi Climate" , the Iraqi Assembly Geographic magazine, Issue 45, June 2000, pp. 290-319. (in Arabic).

15. Al-Fahd, Yahya and Thana Abbas, 2011, "Agricultural Statistical Atlas road Map for Agricultural Development", GIS Center, the Central Bureau of Statistics. (in Arabic).

16. Hirsch, R.M., J.R. Slack, and R.A. Smith. 1982. "Techniques of trend analysis for monthly water quality data ", Water Resources Research 18(1):107-121.

17. Kendall, M.G. 1975."Rank Correlation Methods", 4th edition, Charles Griffin, London.

18. (General Meteorological Organization and Seismology unpublished data) (in Arabic).

19. George, J. (2006) :The Box-Jenkins forecasting technique. "Annual Review of Psychology", Vol. 62, No.9, pp.9-11

20. Box, G.E. and Jenkins, G.M (1976): "Time series analysis; Forecasting and control" .2nd edition, Prentice-Hall Inc., New Jersey, pp.220.

21. Hasson ,Ahmed . Fattah, Rashid, Emad Khuraibet and Arkan Abdullah Mozan, 2012, "Population growth and its Impact on Temperatures Recorded for Some Meteorology Stations in Iraq". (in Arabic).