Features and Trends of Rainfall for Selected Stations in Iraq

Mohammed M. Jasem

Department of Atmospheric Science, College of Science, University of Al-Mustansyria, Baghdad, Iraq

تقديم البحث: 9/5/2011
قبول النشر: 26/9/2011

الخلاصة


تم تطبيق تحليل الأنحدار ذو الدرجة الأولى لاختبار سلوك الأمطار وأثاث أهمية معامل الأنحدار (RC) ببفرض أن تأسيس بيانات الأمطار لتوزيع t ( عند مستوى أهمية 90% و 95%) فقط لأجل معرفة ما إذا كان هناك أي تغيير في السلاسل الزمنية للأمطار. أظهرت النتائج بأن سلوك الأمطار مهم فقط عند المحطتين (بغداد، الرطبة). في فصول الربيع والخريف ترتبط سلاسل الأمطار تزايدية سنويًا عند محطات (البصرة والرطبة) وفصليًا عند جميع المحطات وفي فصول الخريف والشتاء فقط، في حين أن سلاسل الأمطار التناقصية تم تبسيطها سنويًا عند المحطتين (بغداد والموصل) وفصليًا عند جميع المحطات أيضاً وفى الفصول
ABSTRACT

In this paper, rainfall data were obtained for four weather stations within a time of (60) years: Baghdad (1941-2000), Basrah (1941-2000), Mousal (1941-2000) and Rutba (1941-2000). They were used to calculate the mean, amount and the variability of seasonal and annual rainfall at each station. First regression analysis was applied to examine the rainfall trend and the significance of the regression coefficient (RC) was verified by assuming fitting of rainfall data to the t-distribution (at significance levels of 90% and 95%) just to find out if there any significant change in the rainfall time series. The results show that the rainfall trend was only significant at stations (Baghdad, Rutba) in Spring and Autumn seasons respectively, but the positive rainfall trend was identified annually at stations (Basrah, Rutba) and seasonally at all stations in Autumn and Winter seasons only, whereas the negative rainfall trend was identified annually at stations (Baghdad, Mousal) and seasonally at all stations too and in the three seasons (Autumn, Winter and Spring). The significant trends in the seasonal and annual rainfall were hardly indicated, but the large variability of rainfall was observed in the seasons.
1. INTRODUCTION

Rainfall is a major factor in agriculture and in recent years interest has increased in learning about precipitation variability and predictability for periods of months to years[1]. The rainfall in Iraq characterized by unorganized distribution of both spatial and temporal. The annual and seasonal or even monthly mean rainfall varies considerably with years, addition to that, the recorded rainfall quantity in meteorological stations varies from location to another according to sea surface elevation and the geographical position of the meteorological station[2]. As a result, the rainfall trend is a current concern by researchers, administrators and farmers[3]. In the present study, monthly rainfall data recorded by Iraqi Meteorological Organization and Seismology (IMOS) at different locations during (60) years in Iraq were collected. Features (amount and variability) of the annual and seasonal rainfall were clarified and the recent trends of rainfall were examined by application of the first regression analysis to the collected data.

1. INTRODUCTION

Rainfall is a major factor in agriculture and in recent years interest has increased in learning about precipitation variability and predictability for periods of months to years[1]. The rainfall in Iraq characterized by unorganized distribution of both spatial and temporal. The annual and seasonal or even monthly mean rainfall varies considerably with years, addition
to that, the recorded rainfall quantity in meteorological stations varies from location to another according to sea surface elevation and the geographical position of the meteorological station[2]. As a result, the rainfall trend is a current concern by researchers, administrators and farmers[3]. In the present study, monthly rainfall data recorded by Iraqi Meteorological Organization and Seismology (IMOS) at different locations during (60) years in Iraq were collected. Features (amount and variability) of the annual and seasonal rainfall were clarified and the recent trends of rainfall were examined by application of the first regression analysis to the collected data.

2. MATERIAL AND METHODS

2.1. Stations and rainfall data collection

Stations where rainfall data were collected are listed in table 1, with their latitude and longitude and the duration of available data. Rainfall data of four stations throughout the country were collected in Iraq. The data were taken as monthly average rainfall.
Table 1: Geographical of meteorological stations investigated in this study.

<table>
<thead>
<tr>
<th>Station no.</th>
<th>Stations</th>
<th>Rainfall data duration</th>
<th>Latitude (°N)</th>
<th>Longitude (°E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40650</td>
<td>Baghdad</td>
<td>1941 to 2000</td>
<td>33.14</td>
<td>43.34</td>
</tr>
<tr>
<td>40689</td>
<td>Basrah</td>
<td>1941 to 2000</td>
<td>30.34</td>
<td>47.47</td>
</tr>
<tr>
<td>40608</td>
<td>Mosul</td>
<td>1941 to 2000</td>
<td>36.19</td>
<td>43.09</td>
</tr>
<tr>
<td>40642</td>
<td>Rutba</td>
<td>1941 to 2000</td>
<td>33.00</td>
<td>40.15</td>
</tr>
</tbody>
</table>

Fig.1: Study Area and Location of the four weather Stations in Iraq [4].
2.2. Statistical analysis

The average and coefficient of variation of annual and seasonal rainfall [Autumn (September to November), winter (December to February) and spring (March to May)] at different stations were calculated from the equations below [5]:

\[ X = \frac{\sum X}{N} \]  
(1)

The standard formulation of coefficient of variation (CV), the ratio of the standard deviation to the mean, the CV is often presented as the given ratio multiplied by 100 as follows:

\[ CV = \frac{s}{\bar{X}} \times 100 \]  
(2)

The higher the CV, the greater the dispersion in the variable.

Among many statistical tests available to detect trend in a time series, the first regression equation method were chosen for the present work and The formula for such a line is as follows:

\[ Y = a + b X \]  
(3)

Where: \( y \) = the predicted value of the dependent variable \( (y) \).
\[ a = \] a constant, the point at which the line crosses the Y axis when \( X = 0 \).
\[ b = \] a coefficient representing the "slope" of the line (RC) which is represent the trend line.
\[ X = \] the observed value of the independent variable.
To test the significance of the regression coefficient (RC) at 90% and 95% levels respectively, we used the student t-distribution formula as follows[6]:

\[ t_s = \frac{r \sqrt{N-2}}{\sqrt{1-r^2}} \] 

Where \( t_s \) = is the computed t-test or statistical test, \( N-2 \) = numbers of collected data mines degree of freedom 2, \( r \) = correlation value. If the computed (t) lie within the desired confidence limits of the two-tailed test, we can conclude that there is no trend in the data series.

3. Results and discussion

The average and coefficient of variation of rainfall, and the regression coefficient of the first regression equation between the rainfall amount and the year are given in table 2, also the figures 2 through 5 illustrate the rainfall trends for annual and seasonal rainfall data throughout (60) years for all stations under the study:
Table 2: Average and coefficient of variation, and regression coefficient of the first regression equation in rainfall during (60) years at different stations in Iraq.

<table>
<thead>
<tr>
<th>Stations</th>
<th>Annual</th>
<th>Autumn (September to November)</th>
<th>Winter (December to February)</th>
<th>Spring (March to May)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ave (mm)</td>
<td>CV %</td>
<td>RC mmy$^{-1}$</td>
<td>Ave (mm)</td>
</tr>
<tr>
<td>Baghdad</td>
<td>8396</td>
<td>44</td>
<td>-0.41</td>
<td>1120</td>
</tr>
<tr>
<td>Basrah</td>
<td>8699</td>
<td>43</td>
<td>0.15</td>
<td>1388</td>
</tr>
<tr>
<td>Mosul</td>
<td>23626</td>
<td>33</td>
<td>-0.66</td>
<td>3146</td>
</tr>
<tr>
<td>Rutba</td>
<td>7135</td>
<td>47</td>
<td>0.4</td>
<td>1533</td>
</tr>
</tbody>
</table>

Ave: average ; CV: coefficient of variation ; RC: regression coefficient in the first regression equation

* means significance at 90% level.

** means significance at 90% and 95% levels, respectively.

From table 2, and for the annual rainfall, we notice that the average at the four stations in Iraq ranged from (7135mm) (Rutba) to (23626mm) (Mosul) and tended to increase from the central region (Baghdad) to the southern (Basrah) and northern regions, while the coefficient of variation as index of rainfall variability ranged from (33%) to
(47%). The regression coefficient of the first regression equation, as index of the rainfall trend were positive at (Basrah, Rutba) and negative at (Baghdad, Mosul) as shown in figure (2) with no significant trend at all stations as shown in table (3).

For seasonal rainfall, we notice that the averages at all stations had a less rainfall amount in Autumn season and tended to increase in Winter season and back to decrease in Spring season, while witness the Autumn seasons the largest variability ranged from (77%) to (128%), large variability in Spring season ranged from (62%) to (86%) and less variability in Winter season ranged from (47%) to (56%). The regression coefficient as index of rainfall trend in Autumn season were negative at (Baghdad, Basrah) and positive trend at (Mosul, Ruta) as shown in figure (3) with significant trend at (90%) and (95%) levels respectively at Rutba only as shown in table (3), while in Winter season all stations had positive trend except for Mosul which had negative trend as shown in figure (4) with no significant trend as shown in table (3) and in Spring season all the stations had negative trends as shown in figure (5) with significant trend at (90%) level at Baghdad as shown in table (3).
Table 3: The values of computed t-test (statistical t-test) and its significance at levels 90% and 95%.

<table>
<thead>
<tr>
<th>stations</th>
<th>Annual (September to November)</th>
<th>Autumn (September to November)</th>
<th>Winter (December to February)</th>
<th>Spring (March to May)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$t_s$</td>
<td>$t_s$</td>
<td>$t_s$</td>
<td>$t_s$</td>
</tr>
<tr>
<td></td>
<td>significance levels</td>
<td>significance levels</td>
<td>significance levels</td>
<td>significance levels</td>
</tr>
<tr>
<td></td>
<td>90% 95%</td>
<td>90% 95%</td>
<td>90% 95%</td>
<td>90% 95%</td>
</tr>
<tr>
<td>Baghdad</td>
<td>-0.896 non non non</td>
<td>-0.423 non non non</td>
<td>0.38 non non non</td>
<td>-1.667 sign non non</td>
</tr>
<tr>
<td>Basrah</td>
<td>0.319 non non non</td>
<td>-0.098 non non non</td>
<td>1.525 non non non</td>
<td>-0.9 non non non</td>
</tr>
<tr>
<td>Mosul</td>
<td>-0.666 non non non</td>
<td>1.81 non non non</td>
<td>non non non non</td>
<td>-0.661 non non non</td>
</tr>
<tr>
<td>Rutha</td>
<td>0.97  non non non</td>
<td>2.368 sign sign</td>
<td>1.164 non non non</td>
<td>-1.176 non non non</td>
</tr>
</tbody>
</table>
Fig. 2: Annual rainfall trend for (60) for stations: (a) Baghdad, (b) Basrah, (c) Mosul and (d) Rutba
Fig. 3: Autumn season rainfall trend for (60) for stations: (a) Baghdad, (b) Basrah, (c) Mosul and (d) Rutba
Fig. 4: Winter season rainfall trend for (60) for stations: (a) Baghdad, (b) Basrah, (c) Mosul and (d) Rutba
Fig. 5: Spring season rainfall trend for (60) for stations: (a) Baghdad, (b) Basrah, (c) Mosul and (d) Rutba
4. CONCLUSIONS

The results show that the rainfall trend was only significant at stations (Baghdad, Rutba) in Spring and Autumn seasons respectively, but the positive rainfall trend was identified annually at stations (Basrah, Rutba) and seasonally at all stations in Autumn and Winter seasons only, whereas the negative rainfall trend was identified annually at stations (Baghdad, Mousal) and seasonally at all stations too and in the three seasons (Autumn, Winter and Spring). The significant trends in the seasonal and annual rainfall were hardly indicated, but that does not meaning that there is no significant changes in rainfall amounts.

REFERENCES


