

Research Article

Rainy Season Assessment of Azraq Basin in Eastern Jordan

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Abstract: This study considers the rainfall pattern in the Azraq basin in the Eastern part of Jordan. Azraq Basin is an extensive inland drainage system lying in the steppe and desert to the east of Jordan. The Azraq area is around 17,000 km², which accounts for about 15% of the country's total area, stretching from the lava peaks of Jebel Arab in southern Syria to Wadi Sirhan in northern Saudi Arabia. The Basin is considered part of the desert where the annual precipitation is estimated to be less than 150 mm/year and some areas receiving as little as 50 mm rainfall annually. Dry and hot climate during the summer and very cold winter with little rain falls in the form of thunderstorms and is similar to the continental climate of the desert climate where the big difference in temperature between day and night. The study aimed at assessing the rainy season's conditions in the basin. The data for three rain gauges with monthly records of rainfall between (1960-2010) are used in the analysis. These stations are: Azraq, Um Alquttein and Deir Alkahf stations. The rainy seasons in the study area seem to get shorter and shifted in their start. The highest percentage of rain falls in the middle stage of the season (i.e., between December and February). This percentage is getting increased for Azraq and Deir Alkahf stations; however Um Alquttein shows a cyclic pattern of rainfall during the different seasons.

Keywords: Arid lands, Azraq basin, Jordan, rainfall pattern

INTRODUCTION

Jordan as a country suffers from water shortage where the per capita water share is 145 m³/capita.year and over 90% of the country receives less than 200 mm of rainfall per annum (Raddad, 2005). Azraq basin that is considered as the study area is located within this vulnerable zone of low rainfall. Rainfall is characterized by fluctuation from season to season in terms of volumes and seasons' length.

Azraq Basin is an extensive inland drainage system lying in the steppe and desert to the east of Jordan. The Azraq area is around 17,000 km², which accounts for about 15% of the country's total area, stretching from the lava peaks of Jebel Druze in southern Syria to Wadi Sirhan in northern Saudi Arabia. The Basin is considered part of the desert where the annual precipitation is estimated to be less than 150 mm/year and some areas receiving as little as 50 mm rainfall annually. Dry and hot climate during the summer and very cold winter with little rain falls in the form of thunderstorms. And is similar to the continental climate of the desert climate where the big difference in temperature between day and night.

Harrison (2009) indicates that the climate change major impact in Jordan is estimated to be increased drought. Increased drought is a result of year-round changes in temperature. The estimated change is

3±0.5°C in winter and 4.5±1°C in summer by the end of the 21st century. There is little or no change in precipitation to offset these large increases in temperature. This highlights the concept of adaptation of mitigation measures and pro-active management strategies to overcome the climate change and increased drought in Jordan as whole and the study area in particular.

The study aimed at assessing the rainy seasons conditions in the basin using three meteorological stations with monthly rainfall records between 1960-2010 were used in the study. They are: Um Alquttein, Azraq and Deir Alkahf. Figure 1 shows the location of these stations in Azraq Basin.

Smadi and Zghoul (2006) examined changes, trends and fluctuations in the total rainfall and number of rainy days at Amman Airport Meteorological station in Jordan between 1922 and 2003. They found out that a sudden change and shift in the average total rainfall and annual number of rainy days that occurred in the year 1957.

Daily temperature, rainfall and global irradiance at three locations in Jordan Valley were analyzed by Cohen and Stanhill (1996), who found out that there is a significant decreasing trend in annual maximum mean temperatures, no significant trends in annual rainfall and increasing (but inconsistent) trend in the annual mean minimum temperatures.

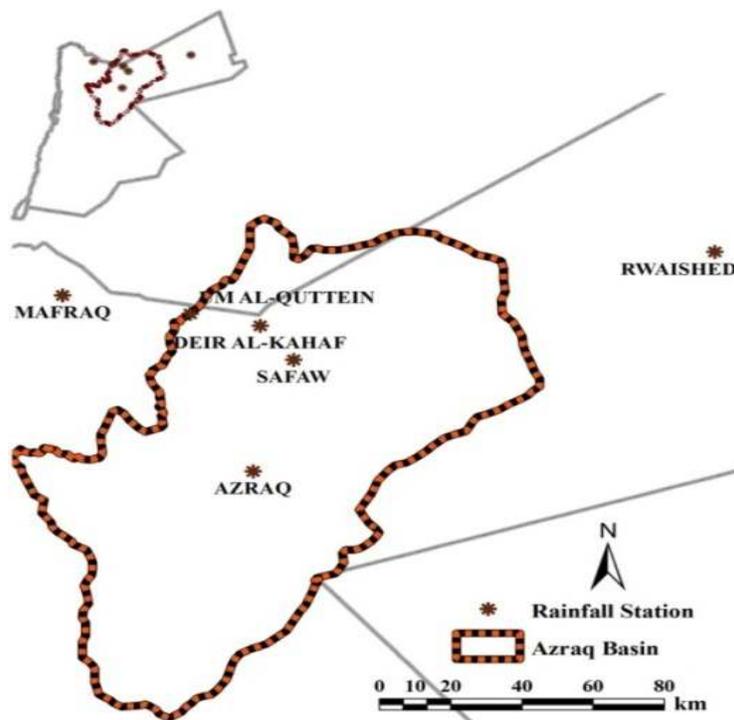


Fig. 1: Location map of the study area

Six meteorological stations in Jordan were examined for climate change impacts by Hamdi *et al.* (2009). The authors attempted to detect the climate change using several tests and found out that the minimum air temperature has increased since the seventies of the last century. This increase indicates a slight change in the regional climate including rainfall records that have been fluctuating at all stations with no significant increase or decrease in the trend.

MATERIALS AND METHODS

The rainfall season in Jordan extends between the months September to May. For the purpose of analysis, the season is divided into three parts: the first is for the months September, October and November (SON), the second part is for the months December, January and February (DJF) and the last part is for the months March, April and May (MAM). The rainfall for each part is calculated as a percentage of the total annual in every year and these percentages are plotted against the years of records. The general trends of the rainfall distribution of the three parts are analyzed for the three rainfall stations named: Um Alquttein, Azraq and Deir Alkahf to find if there is any change in the rainfall distribution along the rainfall period.

Table 1: Summary of the stations used in the study

| Station | Date established | Avg. annual rainfall (mm) | S.D. of rainfall (mm) |
|--------------|------------------|---------------------------|-----------------------|
| Um Alquttein | 1948 | 138.42 | 75.62 |
| Deir Alkahf | 1964 | 109.49 | 62.87 |
| Azraq | 1969 | 53.91 | 33.49 |

Avg.: Average; S.D.: Standard deviation

The three stations used in the study area have monthly rainfall records starting from 1948 for Um Alquttein and 1969 for Azraq. Table 1 shows a summary of the used rainfall records in these stations.

RESULTS AND DISCUSSION

The percentage of each part of the rainfall season SON, DJF and MAM is plotted for the years of records for each station (Fig. 2 to 4). In all three stations, records showed that the percentage for the three parts is close to each other (between 30 and 40%) for the years between 1960s and 1990s. In Azraq and Deir Alkahf where records started after 1960s, the results showed that after 1990s, the middle part of the rainy season (DJF) started to get more percentage of the annual rainfall that reaches in average more than 60% in Azraq Station (Fig. 2) and 50% in Deir Alkahf Station (Fig. 3) where the other two parts, the start of the season (SON) and the last part of the season (MAM), percentages started to shrink to less than 20%.

For the third station, Um Alquttein, the rainfall records started late 1940s. Although, the plot for the percentages of the three parts of the rainfall season (Fig. 4) didn't show very clear trend as shown in the other two stations but it can be found that the percentages before 1960 are in favor of the middle part of the rainfall season, DJF. The same trend is showed for the records after 1990s with close percentages for the period between 1960s and 1990s.

The results for stations Azraq and Deir Alkahf shows that there is a change in the rainfall distribution across the rainy season. The change is that while before

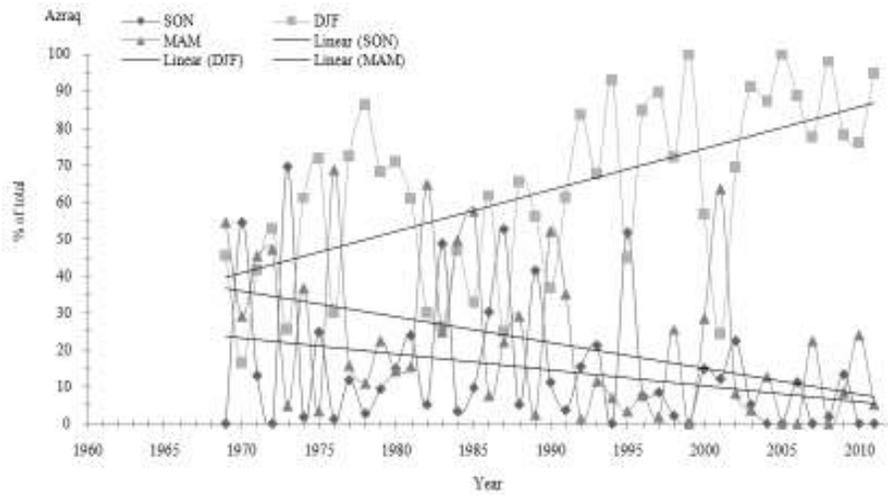


Fig. 2: Seasonal rainfall percentage for Azraq station between 1969 and 2010

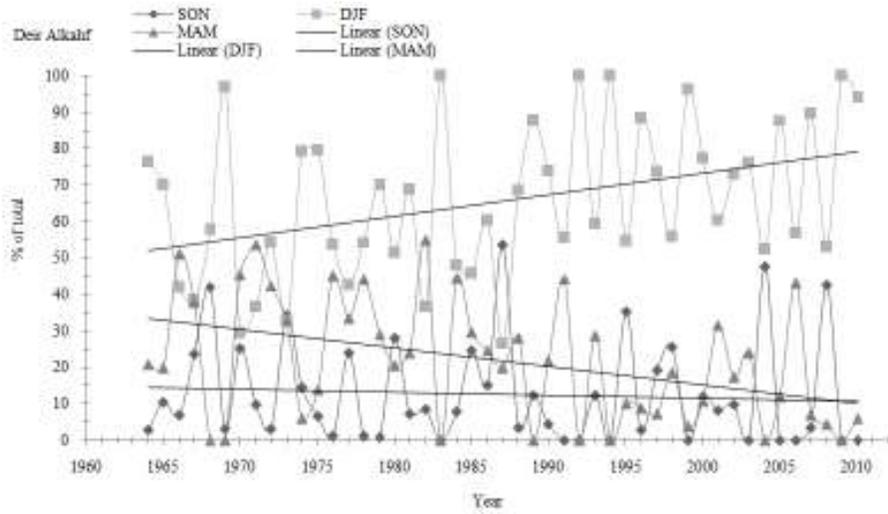


Fig. 3: Seasonal rainfall percentage for Deir Alkahf station between 1964 and 2010

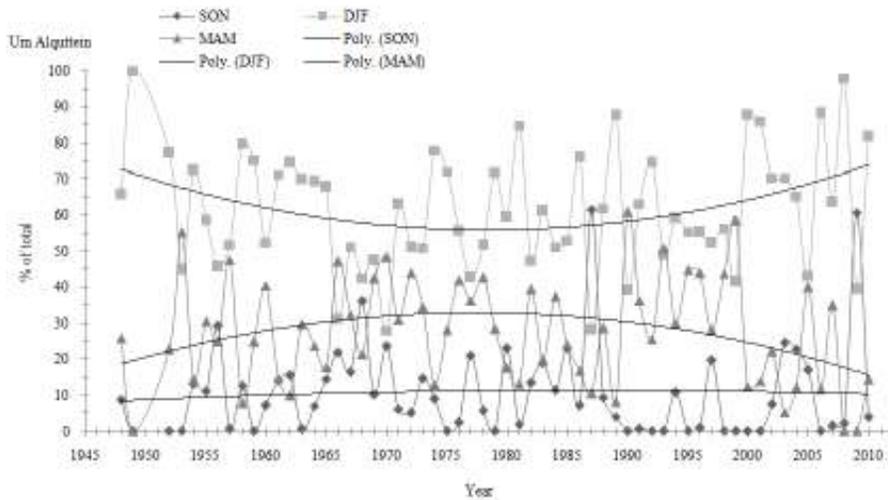


Fig. 4: Seasonal rainfall percentage for Um Alquttein station between 1948 and 2010

1990s the rainfall is evenly distributed over the period of rainy months it started to be concentrated in shorter period in the middle of the rainy period with most of the rainfall falls on the months of December, January and February. This could be referred to climate change and shift in the seasons.

On the other hands, results for Um Alquttein station showed some trends of seasonal cycles with rainfall concentration in the middle part of the rainy season (DJF) in 1940s to mid-1960s, even distribution across rainy season between mid-1960 to early 1990s and again rainfall concentration in the middle part of the rainy season (DJF) after then.

In conclusion, the analysis of rainfall distribution across the rainy months showed trends of shift in the rainfall distribution. This could be a result of climate change or just a natural climate cycle for the area. The results that argue a climate change are clearer as shown in Fig. 2 and 3 where the results that argue climate cycle as in Fig. 4 showed weak trend. Further analysis for stations with longer rainfall records could proof any of these arguments.

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