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EVOLUTION OF THE RAINY DAYS NUMBER IN ALGERIA FROM 1947 TO 2007

Meddi Mohamed, Talia Amel

[1]Ecole Nationale Supérieure d'Hydraulique de Blida, LGEE, Bp. 31 Blida ALGERIA
E-mail m.meddi@ensh.dz

Abstract

In this work, the study of the trend and variability of the number of rainy days at different thresholds (0.1, 1 and 10 mm) in Northern Algeria was carried out. It was based on 14 rainfall stations with acceptable observation series. In order to do it, the non-parametric test of Pettitt, Buishand statistics, the Bayesian method of Lee and Heghinian and the nonparametric segmentation procedure of hydrometeorological series of Hubert were used to study the trend of the series of the number of rainy days for the three thresholds. These showed that there is a negatif trend in the number of rainy days during the decade 1970- 1980 for most of the rainfall stations studied, except the area in the Extreme East. This downward trend in rainfall requires consideration from the decision makers to better manage the ever decreasing water resources in the face of an increasing water demand.

Keywords: trend and variability; number of rainy days; thresholds; northern Algeria

1. INTRODUCTION

The frequency and severity of water deficiency states are taking worldwide dimension of the first order. In Algeria, the lack of this blue gold became worrisome confirming the various expertises from hypothesis and using different methods which have all concluded that our country will confront in the next few years this almost endemic shortage. In recent decades, significant rainfall deficit are recorded in central and western Algeria (Meddi et al., 2003; Meddi et al. 2009). This observation was also made in the Maghreb countries and the Mediterranean basin. Through that, it is imperative to identify the different changes in the temporal and spatial evolution of daily rainfall characterized by their number of rainy days at different scales and different thresholds. This evolution caused, these last years, catastrophic floods around the world, in the Mediterranean region (Pujol et al., 2007), Asia, Africa and the Maghreb countries which leads the researchers and observers to question whether they were the result of climate change or other factors. Algeria was characterized by catastrophic floods in recent years. Many regions of the country are constantly threatened by these catastrophic floods. These floods caused many damage in cities, companies and homes.

Floods are the most common natural disasters in the world. More than 500 million people are affected by floods around the world. In Europe, for example, floods caused 700 fatalities and economic losses totaling at least € 25 billion between 1998 and 2006.

During 1988-97, floods accounted for about one-third of all natural catastrophes, caused more than half of all deaths from catastrophes and were responsible for one-third of overall economic losses from catastrophes (FAO, 2002). An increasing number of people are being severely affected by floods - more than 130 million between 1993 and 1997 (FAO, 2002).

In Algeria, floods caused 87 fatalities, 1500 stricken families and 31 stricken municipalities between September and October 2008. Flooding in Ghardaia region, October 2008, resulted in 43 fatalities and material damage estimated at almost € 250 million. For the region of Bechar, also in October 2008, floods caused damage to infrastructures, i.e., 30 engineering structures and 50 km of damaged roads (€ 300 million), in addition to huge losses in the agricultural sector estimated at € 50 million (1510 goats, 955 sheep, a loss of 102 ha of growing vegetables, 1500 palms…). The floods that affected Bab El Oued district (Algiers) in 2001 caused 733 victims and left some 30 000 people homeless, in addition to material damage. In October 1994, floods across the country resulted in 60 fatalities and left hundreds missing during 10 days of bad weather. These numbers show the seriousness of this phenomenon.

In this work, the study of the temporal evolution of the number of rainy days at different thresholds (0.1, 1 and 10 mm) of 14 rainfall stations across northern Algeria was carried out.

2 MATERIALS AND METHODS

2.1. Presentation of the study area

The study area covers approximately 381 000 km^2, of which 200 000 km^2 consist of plains and plateaus. It is located between 9° East and approximately 3° West.

The coastline covers approximately 1622 km. it is characterized by a mild climate, humidity is relatively high and rainfall varies from 400 mm in the West to 1000 mm in the East. The Tell Atlas begins in the West by the heights of Djebel Tessala (1061 m), that borders on the North the plain of Sidi Bel Abbes, followed by the Djebels of: Daya (1417 m), Saïda (1288 m), Frenda (1132 m), El Ouencheriss (1985 m), Dahra (1071 m) and Zekkar (1579 m). A series of mountain formed by the Telian Atlas (1972 m) begins in the East of djebel Zekkar and we found the Kabylie heights (Djurdjura, 2328 m) east of it. The Tell Atlas is also formed by coastal plains such as: Oran, Mitidja and Annaba Plains and inland plains such as: Tlemcen, Sidi Bel Abbess and Sersou plains.

2.2. Data

Table 1 shows the 14 rainfall stations selected for this study: location, altitude and measurement time. The density and distribution of stations allow a study of daily rainfall at the regional scale: this density of stations have quite long term observations, but it is insufficient to determine the local and regional daily rainfall nuances, especially that we should mention the discontinuity and gaps in the observation series. A work consists on filling the gaps contained in the measurement series.

Table 1 List of stations used for the study

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Stations	Lambert coordinates		Altitude
	X (km)	Y(km)	Z (m)
Pont CW7 (Hadjout)	475,85	358,85	59
Tizi Ouzou ANRH	620,90	380,25	195
Birmandreis ANRH	531,10	382,80	140
Ain El Assel	1005,65	400,05	35
Guelma: lycée MBM	924,10	361,40	280
Batna ferme EXP	814,70	257,35	1040
Ain Roua	722,90	399,95	1100
Jijel secteur	774,10	396,15	5
Tlelat	219,80	245,75	280
Essenia	200,80	266,15	90
Beni Bahdel	115,00	164,60	666
Bouhanifia Bge	248,15	225,05	306
Annaba	951,10	411,35	80
Dar El Beida			

2.3. METHODS

To study the significance of the break point selected, several statistical tests for detecting the break dates were used. For this, we have treated all the information contained in the time series selected. « Break » should be understood as a change in the probability of the time series at a given time (Lubès et al., 1994). Here we recall their basis.

The nonparametric test of Pettitt examines the existence of a break at an unknown time of the series from a formulation derived from that of Mann-Whitney (Dagnélie, 1970). This test is more particularly sensitive to a change of average, and if the null hypothesis of homogeneity of the series is rejected, it provides an estimation of the break date.

The statistics of Buishand (Buishand, 1982, 1984) is parametric assuming normality of the series, non autocorrelation and constancy of the variance on all sides of an eventual breakpoint. This test is efficient to detect a break in the middle of a series, but it does not provide an estimate of the breakpoint.

The Bayesian method of Lee and Heghinian is a parametric approach that requires a normal distribution of the variables studied. It is assumed a break in average at an unknown time. The prior distribution of the break moment is uniform, and given this information and data, the method produces the a posteriori probability distribution of the break moment.

The procedure of nonparametric segmentation of hydrometeorological series (Hubert et Carbonnel, 1989) is appropriate to search multiple changes of the average in a series.

Its principle is to "divide" the series into several segments so that the average calculated in any segment be significantly different from the average (or) neighbouring segment(s) by applying the Scheffé test which provides contrast (Dagnélie, 1970).

3 RESULTS AND DISCUSSION

3.1. Concentration of maximum daily rainfall at the monthly scale

The frequencies of occurrence of this rainfall, per month and per station, were used in order to study their concentrations. Histograms (from Fig.1 to Fig.3) show that the occurrence of this rainfall varies considerably from one month to another.

For the stations of central and western Algeria, the maximum rainfall is concentrated in the winter months and then the frequency of occurrence of this rainfall decreases considerably in the months of spring. For the stations located in the east, the concentration appears either in spring (February) or winter but with a greater frequency of occurrence over several months (October, November, December).

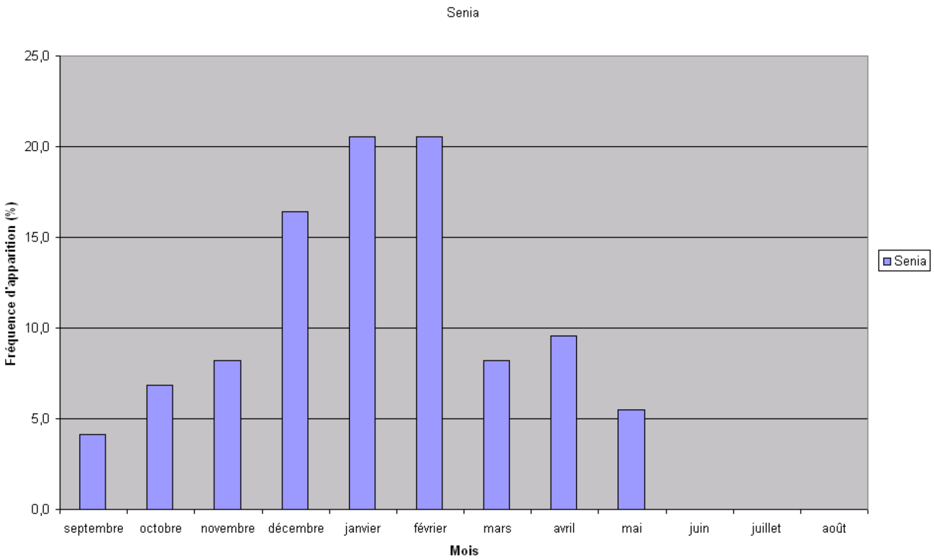

Figure 1 Number maximum daily rainfall occurrence per month for the station of Oran Senia

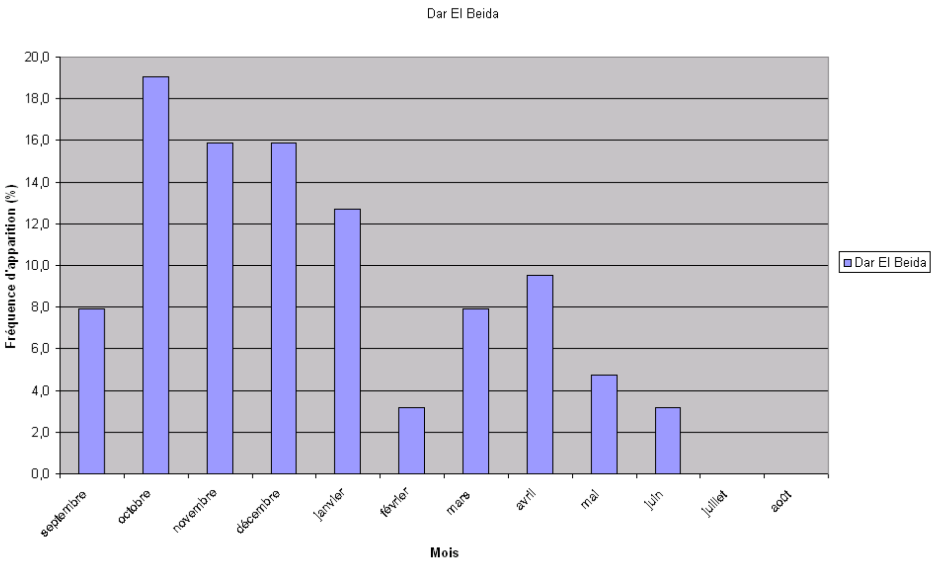

Figure 2 Number maximum daily rainfall occurrence per month for the station of Dar El Beida

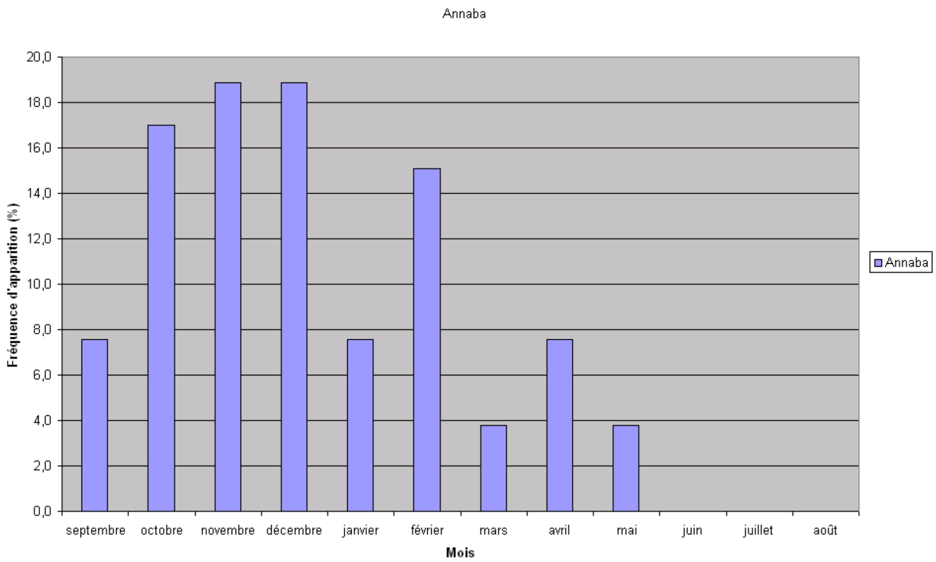

Figure 3 Number maximum daily rainfall occurrence per month for the station of Annaba

3.2. Study of the evolution of daily rainfall

Several studies have addressed the issue of the evolution of rainfall regimes in Algeria (Meddi et al., 2004; Matari et al., 2002). These studies focused on a possible change in the evolution of rainfall at different scales in the mid-seventies. However, no specific date was detected as the beginning of the trend. For that reason, we assumed 1974 as a break point of daily precipitation.

Applied to each site, the tests cited above generally give consistent results at least in terms of the recognition of an heterogeneity in the series, even if the estimates of the breaks in the average given by many tests differ sometimes by a few years (Table 2).

Table 2. Results of different statistical test for detecting the break applied to the maximum daily rainfall.

Station	***Study period***	***Segmentation of Pierre Hubert***	***Buishand***	***Pettitt***	***Lee and Heghinian***
Annaba	**1950-1998**	**-**	**accepted**	**-**	**1998**
Dar el Baida	**1936-1998**	**1973**	**rejected**	**1956**	**1952**
Senia	**1927-1998**	**1970**	**rejected**	**1943**	**1935**
Bouhanifia bge.	**1967-1998**	**-**	**accepted**	**-**	**1995**
Beni Bahdel	**1941-2002**	**1974**	**rejected**	**1974**	**1974**
Guelma	**1967-2003**	**1975**	**rejected**	**1975**	**1975**
Batna ferme EXP	**1929-2003**	**-**	**accepted**	**-**	**2001**
Ain el Assel	**1967-2003**	**-**	**accepted**	**-**	**2000**
Jijel secteur	**1968-2003**	**-**	**accepted**	**-**	**1963**
Ain Roua	**1969-2002**	**-**	**accepted**	**-**	**2001**
Birmandrais ANRH	**1967-2004**	**1973**	**rejected**	**1973**	**1973**
Pont CW (Hadjout)	**1972-2003**	**1986**	**rejected**	**1986**	**1986**

From the results obtained, we have noted that in the regions of eastern Algeria, no significant break was detected. Furthermore, no break in the rainfall series was highlighted by a similar study in central Tunisia with the same statistical tools (Kingumbi et al., 2001).

For the rest of the Algerian territory and for all tests, the break occurred during the decade 1970-1980 and this is when the decrease of daily rainfall became a reality.

This break, as a decrease of daily rainfall, gives us a time to think about better managing the constantly decreasing water resource in the face of an increasing water demand.

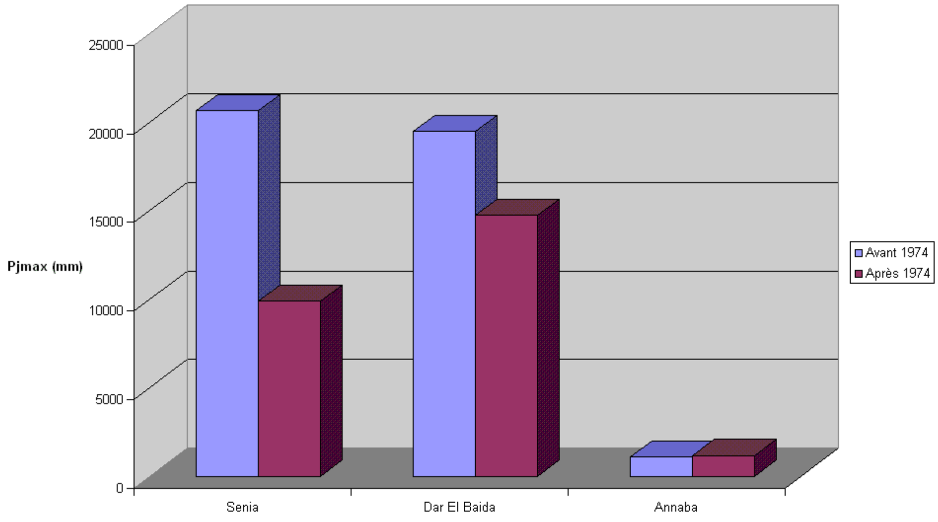

Figure 4 comparison of maximum daily rainfall before and after 1974

When comparing daily precipitation (the number of rainy days greater than 0.1 mm, 1 mm and 10 mm) before and after 1974 (from Fig 4 to Fig 7), we deduced that the daily precipitation, in the centre and west, have recorded a significant decrease. While in the east, this rainfall knew an increase in the number of rainy days above a threshold and we have noticed that the maximum daily rainfall passed from 1086 mm before 1974 to 1160 mm after 1974 at the station of Annaba.

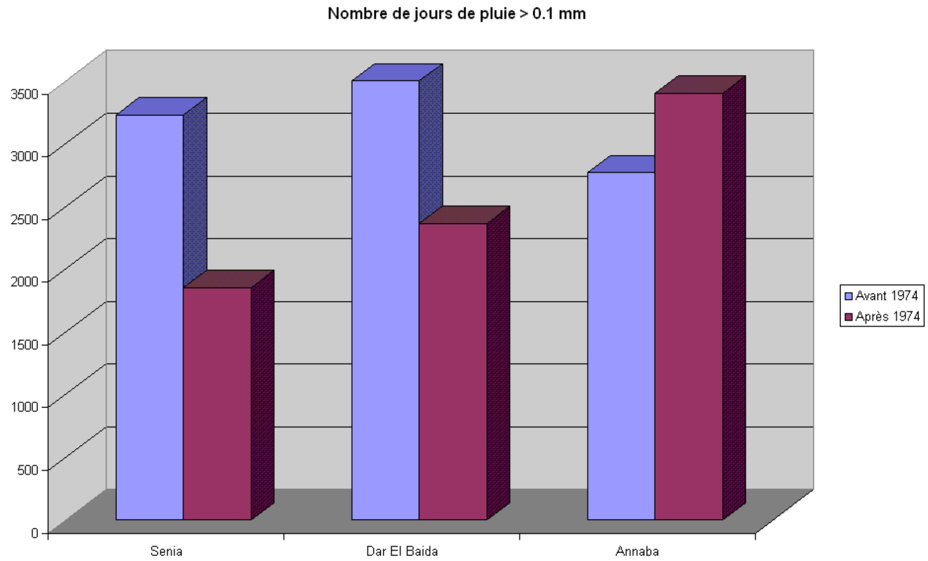

Figure 5. comparison of the number of rainfall above 0.1 mm before and after 1974

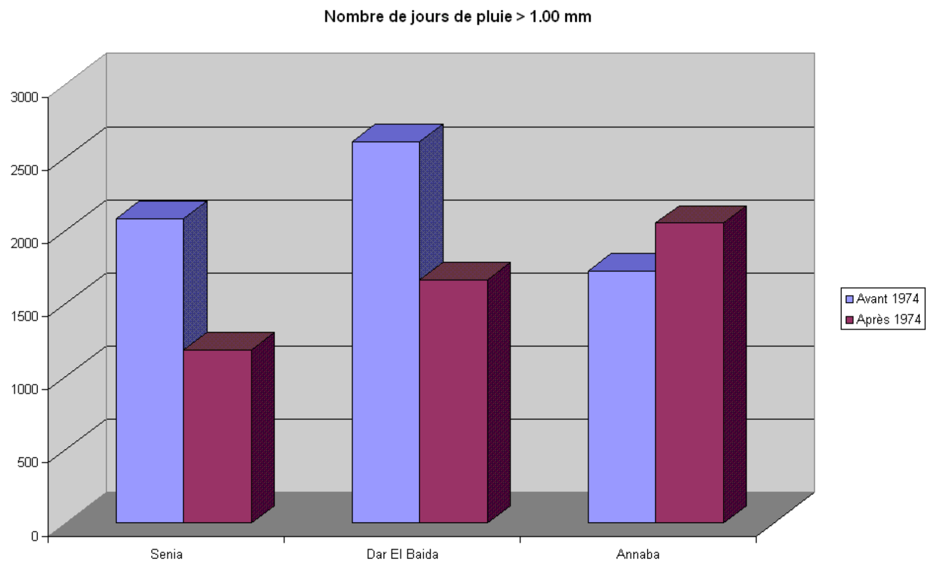

Figure 6. comparison of the number of days of rainfall above 1 mm before and after 1974

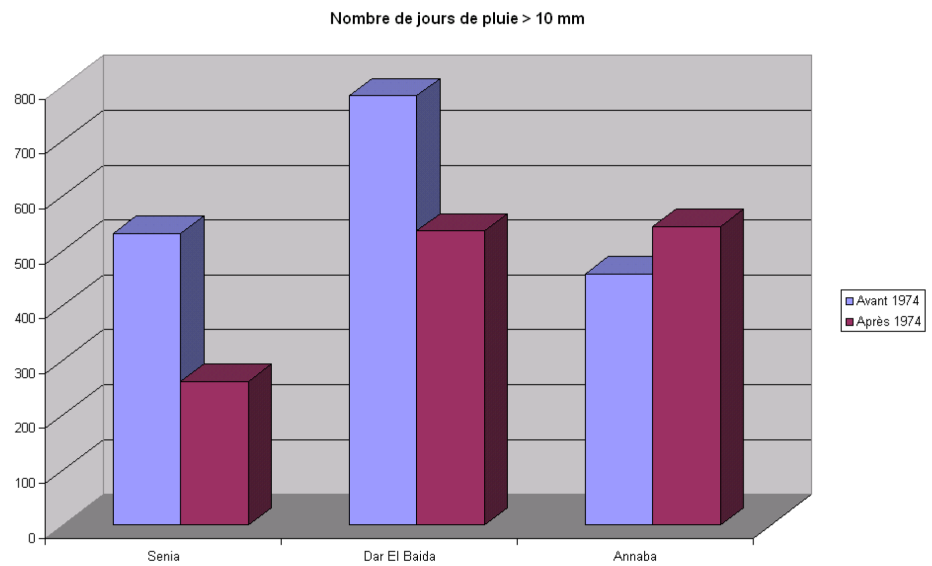

Figure 7 comparison of the number of rainfall days above 10 mm before and after 1974

The conclusions made above are based on a graphical analysis of the observation series.

4. CONCLUSION

Many questions can be asked about the causes, consequences or even the existence of rainfall variability in Algeria. The first question is about a possible change in rainfall. It is difficult to advance a general trend even if the annual, seasonal, monthly and daily distribution of rainfall over the past decades was particularly irregular from one year to the other. The studied area is characterized by a large area, Algeria therefore offers a wide range of climates which vary with the distance from the sea, increasingly hot and dry. This makes it difficult to interpret and generalize the results obtained. The study of the break detection allowed us to locate a modification of rainfall regime during the decade 1970-1980 for most of the studied rainfall stations. Except the area in the Extreme East. In a similar study conducted in central Tunisia with the same statistical tools, no break in the rainfall series was highlighted (Kingumbi et al., 2001). Therefore, the change of regime that occurred in Algeria in the past two decades has saved the eastern area of the country. However, it is the role of climatologists and meteorologists to find the causes for this phenomenon.

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