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Rainfalls Modeling During the Last 35 Years in Sidi Bel Abbes

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Abstract: ***The study of variations in rainfall north western Algeria in North Africa along the Mediterranean Sea showed that there is a clear trend in increasing precipitations. We went from a semi-arid climate period early in the 80s to a sub-humid climate period starting from the late 90s. The increase is due to an amplification of the evaporation phenomena which is the direct consequence of the rising ocean temperatures. This excess of humidity would spill over areas that received less water before. Nevertheless the trend is fairly recent from the geological point of view, and other future studies could confirm or not these results.***

Keywords: Rainfalls, Modeling, Sidi Bel Abbes**.**

1. Introduction

The North Africa is a region bordered to the north and the east by the Mediterranean Sea and west by the North Atlantic Ocean. South arid expanses of the Sahara desert are a limit that has long been very difficult to overcome. It suffers fresh influences from the North Atlantic while polar streams provide essential humidity and where hot and dry Saharan air masses cross it and reach even northern Europe. Therefore, water resources are very vulnerable to climatic variations and semi arid regions characters dominate the "Island of the sunset" or "Maghreb" with albeit some wet islets or very wet plots and almost an arid south.

The climate of our region of northwestern Algeria remains relatively warm with a cold or even a cool season which concentrate the bulk of the rain of the year and a hot dry season characterized by the occurrence of heat waves and almost total absence of rain [1-3]. However, in recent decades, there has been an increase in temperatures and a consequence of the total evaporation and unfortunately a significant drop in precipitation and water flows [4-6].

Rainfall has always been characterized by fluctuations, which vary from year to year. It was always very difficult to achieve a sufficiently reliable model that sets a correct relationship between years and this precipitation [7]. Nevertheless, in accordance with standard meteorological agencies and devices, it appears a global trend that seems to be repeated in a cadence of thirty years. So we thought about establishing and developing a model that would symbolize the rainfall in our region, like other researchers do for other areas [8-12].

It seems that the rainfall in our area tend to increase according to some local scientists while models established in the long term by others would show a drying trend with this climate change that seems rampant today.

2. Materials and methods.

Polar flows that outcome from the Strait of Gibraltar bring the bulk of the precipitation that will drop our region. These same flows that dispense most of their wetness in Spain fail to overflow the Sierra Nevada in Spain and do not have time to recharge over the Mediterranean so they approach the Algerian west coast almost dry while those who cross over inlet come loaded by humidity in the central and eastern Algeria and northern Tunisia so that these regions are markedly wetter than western Algeria and eastern Morocco. Nevertheless, some raindrops reaches us from the southern monsoon succeeding to cross the 2,500 km of the Sahara to come watering us as a very refreshing rain, but they remain exceptional as the distance to cross is too large. These occurrences are responsible of the reddish rain water coming Paris or London or even fertilizing the great Amazon basin in South America.

Then, Sidi Bel Abbes is a large industrial city in the middle of an agricultural region with a strong cereals propensity. It is located north west of Algeria at the North West Africa 56 km south from the Mediterranean Sea.
Our area is at an average elevation of 470 m and is bordered to the north by the Tessala chain mountainous screen culminating at 1068 m at Jebel Attouche. Southern the Dhaya Sierra Mountains rises proudly over 1431 m.

Figure 1. Sidi Bel Abbes location.

To the west the Sebaa Chioukh (or Seven Sages) mountains do poorly with their 710 m and east Beni Chougran reaches 900 m with difficulty.
Sidi Bel Abbes lies therefore at the bottom of the river valley of Wadi Mekerra and is for that reason often subject to heavy flooding of this unpredictable river.
Thus, our region mainly receives its northwest rains due to polar flows that borrow the furrow above the Alboran Sea at the extreme south west of the Mediterranean basin.
They extend from September to late May although some almost June are also quite humid. The really dry months are July and August. Nevertheless, these rains are not very important and some "humid" months are also very dry without a drop of rain.
Rainfall data were offered by the Algerian National Office of Meteorology. We began our study by examining these data in an algebraic point of view in order to develop mathematical model that would give the overall trend of rainfalls in our region.

3. Results and discussion.

The results are confined in the figure 2 below.
We note that the rainfall recorded are of great asymmetry and a rainy year generally follows a dry year and vice versa. A first approximation is given by the straight whose equation would be:

$$P = 2.5 \times y + 290 \qquad (1)$$

The results show that there is a linear variation which is frankly growing. One could even speak of a constant increase in rainfall over this period. According to this straight one would be passed from a period with rainfall of 300 mm order to a phase where the latter can reach 400 mm. So we would be gone from a semi-arid climate zone to a sub-humid climatic area. That is the main result of this study.
Then, although one have not conducted a statistical study one have instead used a new approach using Newton interpolation which remains a rather original approach since one didn't already met in the scientific literature such a method.

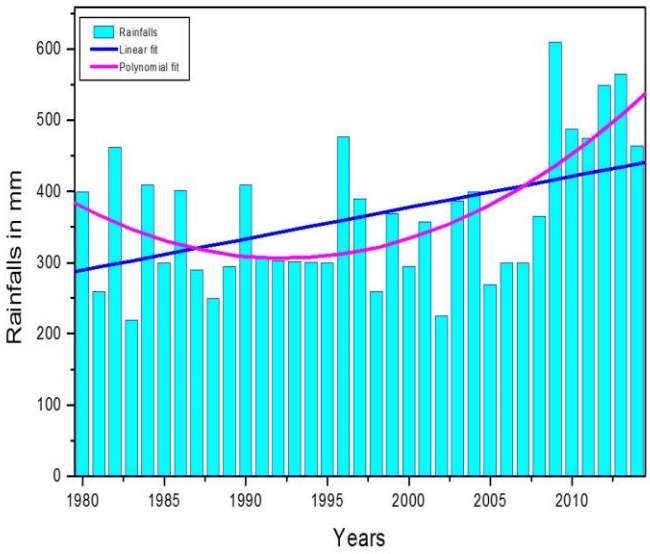

Figure 2. Precipitation trends during the 1980-2014 period.

Thus, by the data review and the establishment of Newton's formalism, we obtained the following polynomial:

$$P = -0.001\ x^2 + 2.38\ y - 367 \qquad (2)$$

This equation is due to the fact that this method involves the different relationships that exist between the evaluated data and uses the theorem of finite differences and then incorporating these results in the Newton polynomial we obtain a polynomial of number of data minus one degree.
This equation is not obtained by the direct interpolation method of Newton, but by a logical reduction of the polynomial degree of the initial equation since a 34 degree relationship which is the number of the years considered minus one seems to be very difficult to manipulate and above all enough complex in a human point of view. We also conducted successive approximations of this polynomial to center the results on the value of 367 that is the rainfall millimetrical mean on our time interval.
Note that this relationship is only valid if the differences between the data are constant, otherwise we would have used the Lagrange formalism which gives the same results. Parabolic perspective the relationship is certainly more accurate but also more ambiguous, because it has a concavity in the middle of the period. It is rising again in 1995 although this year is a year relatively "dry" with only 300mm compared to the global average of 367 mm calculated for this period.
Hayes et al. found the same result for 1996 [13] and same for H. HISDAL and LM TALLAKSEN for Denmark in the north of Europe [14]. However the main result that gives this relationship is the same as for the linear study since we have gone from a 400 mm of precipitation sub-humid to a more humid area with nearly 500 mm by interpolation.
This relationship also ensures the fact, notwithstanding the exact numerical values that the climate in North Africa while becoming warmer tends to become wetter.

Some researchers have found the same trends in global pluviometry [15-17], while others empowered an anthropogenic action on the Ocean [18-23] and others incriminate mainly the greenhouse effect [24, 25].
We presume that this increase in precipitation would be due mainly to an intense evaporation from the oceans and seas and that the higher the temperature will increase more this precipitation will tend to augment.

4. Conclusion.

The study of rainfall variations in our area of the city of Sidi Bel Abbes north western Algeria in North Africa along the Mediterranean Sea showed that there is a real increase in the intensity of these precipitations. We went from a semi-arid climate period in the 80s to a sub-humid period at the late 90s. This trend seems to be due to rising temperatures that would increase ocean temperatures and would promote greater evaporation. All this excess humidity would fall down over areas that received less water before. Nevertheless the trend being fairly recent in geological point of view, other future studies will confirm or not these results.

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