

Comparative Study of Annual Precipitation between Oran Aerodrome (Algeria) and Marseille Marignane (France) Stations Located in the Mediterranean Basin

Mr. Dr BOUALEM ABDELKADER

Faculty of Natural and Life Sciences
University of Mostaganem (Algeria)

Option: Conservative management of water, soil and the environment

Received: September 18, 2021

Accepted: December 3, 2021

ABSTRACT

Over the past decade, the issue of climate change has been recognized as one of the major development issues at the local, regional and even international levels, alongside sustainable development, conservation and sustainable development of the protection of the environment. In fact, the current trend is to consider that climate change responses are an integral part of sustainable resource management decision-making. In the catchment area, it is recognized that measures are needed to improve the ability to adapt to rainfall variability and extreme events (floods and droughts). Drought can be considered at different scales: monthly, seasonal and annual. It becomes dangerous as soon as it persists two or three successive years. So, we also chose to study the persistence of drought on an annual and seasonal scale. In our work consists in doing the annual rainfall survey of the region of Oran Aerodrome and comparing with that of the region of Marseille Marignane in the period (2000-2017). To try to elucidate this problem, it is essential to analyze beforehand the term precipitation. We will try to answer some worrying and fundamental questions, among others:

How does the rainfall of two Mediterranean shores in space be evaluated?

Is there a decrease in rainfall during this last decade?

In this perspective, we contribute to studying rainfall by using statistical processing. For our work, we have chosen a methodology that is characterized as follows:

1. Collection of rainfall data and creation of a databank on the computer.

2. Preprocessing data:

- Wilcoxon test
- Normal fit test
- Coefficient of variation test
- Chi-square test

KEYWORDS: Hydrology, Climatology, Precipitation, Statistics, Marseille, Oran.

1. INTRODUCTION

The analysis of climate data consists of carrying out a statistical analysis of the data [4]. So as to show to quantify the spatio temporal variability of the climate.

This variability can be studied on the basis of the analysis of long time series, continuous and homogeneous, of climatic or agro-climatic variables over a period of 18 years [8], the current reference being the period 2000-2017 according to the two climatologically stations will be located in the Mediterranean basin, namely Oran aerodrome (Algeria) and Marseille Marignane (France).

2. MATERIALS AND METHODS

Precipitation in the Mediterranean basin has been specifically studied by the author [5]. For this purpose based on the database

To study and analyze the fluctuation in rainfall in the Mediterranean basin

Corresponding Author: Mr. Dr BOUALEM ABDELKADER, Faculty of Natural and Life Sciences, University of Mostaganem (Algeria), Option : Conservative management of water, soil and the environment. Email: boualem.abdel@yahoo.fr Phone: 0771923117

2.1. Collection of data

The monthly precipitation values were collected from the climate information station (France) and the national meteorological office (Oran) [7]. These values represent monthly totals taken from the original documents of the stations in our study.

2.2. Choice of study period

For our work, we have chosen the period available according to the weather stations.

Table. 1: Presentation of rainfall stations

Station	Geographical coordinates	Year of study
Oran Aérodrome	35°41'55,555" N 0°38'30" Ouest	2000-2017
Marseille Marignane	43°17'49Nord, 5°22'51"Est	2000-2017



Figure .1: Location of study areas

3. RESULTS AND DISCUSSIONS

3.1 Checking the homogeneity of the data

Any climatic or hydrological study [3] is based on the exploitation of data series collected over longer or shorter periods, continuous or discontinuous. The statistical methods of analysis of these series require homogeneity of their components, it is therefore necessary, before any use of the rainfall variables, to control their quality by the use of statistical and graphic tools, in order to reduce systematic errors which could affect them [2].

3.3.1. Wilcoxon test

It is a non-parametric test which uses the series of ranks of observations, instead of the series of their values. The Wilcoxon test is based on the following principle: If the sample X comes from the same population Y, the sample XUY (union of X and Y) is also derived from it.

We proceed as follows:

Let be a series of observations of length N from which two samples X and Y are drawn:
N₁ and N₂ are respectively the sizes of these samples, with N = N₁ + N₂ and N₁ ≤ N₂

We then classify the values of our series in ascending order. Thereafter, we will only be interested in the rank of each of the elements of the two samples in this series. If a value is repeated several times, we associate it with the corresponding mean rank.

We then calculate the sum W_x of the ranks of the elements of the first sample in the common series:
 $W_x = \sum \text{rank } x$

Wilcoxon has shown that, in the case where the two samples X and Y constitute a homogeneous series, the quantity W_x is between two limits W_{max} and W_{min} given by the following formulas:

$$W_{\min} = \frac{(N_1 + N_2 + 1)N_1 - 1}{2} - Z_{1-\alpha/2} \sqrt{\frac{1}{12} N_1 N_2 (N_1 + N_2 + 1)}$$

$$W_{\max} = (N_1 + N_2 + 1)N_1 - W_{\min}$$

$Z_{1-\alpha/2}$: Represents the value of the reduced centered variable of the normal distribution corresponding to α (at the 95% confidence level, we have $\alpha = 0.05$, so $Z_{1-\alpha/2} = 1.96$)

We will use the Wilcoxon test to verify the homogeneity of rainfall data from the four stations at the 5% significance level.

3.3.1.1. Application of the Wilcoxon method on the Marseille Marignane station

Table. 2 : Application of the Wilcoxon method on the Marseille Marignane station

x	y	Rank	(x)U(y)	origin	Rank	(x)U(y)	origin
630	645,6	1	276,8	X	11	530,1	Y
358	843,3	2	292,2	Y	12	542	Y
788,8	610,1	3	311,7	Y	13	610,1	Y
523,4	509,8	4	315,8	X	14	630	X
292,2	441,3	5	346,3	Y	15	645,6	Y
434,4	542	6	358	X	16	661,6	Y
315,8	661,6	7	434,4	X	17	788,8	X
276,8	530,1	8	441,3	Y	18	843,3	Y
	346,3	9	509,8	Y			
	311,7	10	523,4	X			

On a: N₁=8 , N₂=10

W_{min} = 53,45

W_{max}=98,55

W_x=59

we check the inequality: W_{min}<W_x<W_{max}

that is to say 53,45 < 59 < 98,55

➤ The inequality is therefore verified, the series is homogeneous

3.3.1.3. Application of the Wilcoxon method on the Oran Aerodrome Station.

Tab. 3: Application of the Wilcoxon method on the Oran Aerodrome Station.

X	Y	Rank	(X)U(Y)	Origin	Rank	(X)U(Y)	Origin
390	239	1	167	Y	11	496	Y
763	167	2	239	Y	12	547	Y
617	253	3	253	Y	13	617	X
691	299	4	267	X	14	678	Y
699	378	5	299	Y	15	691	X
451	326	6	325	X	16	699	X
325	547	7	326	Y	17	763	X
267	496	8	378	Y	18	790	Y
	678	9	390	X			
	790	10	451	X			

On a: $N_1=8$, $N_2=10$

$W_{min} = 53,45$

$W_{max}=98,55$

$W_x=90$

we check the inequality: $W_{min}<W_x<W_{max}$
that is to say $53,45<90<98,55$

➤ The inequality is therefore verified, the series is homogeneous

3.3.2. Adjustment by Normal law

The collected data can undergo several statistical treatments in order to check the reliability and the precision of the latter. Among its treatments we can cite the study of data homogeneity using the double mass method and linear regression among others [6].

This approach requires reference stations adjacent to our study stations. The lack of these leads us to set aside this aspect and to try to treat data series by employing an adjustment method that of the Normal law which alone can summarize the reliability of each series.

3.3.2.1. Theory of adjustment to the Normal law

The Normal law (the symmetrical bell curve around the mean) is a theoretical function commonly used in statistics as an approximation of sampling distributions, in general, the Normal law provides a good model for a random variable when:

- 1- There is a strong tendency for the variable to take a central value.
- 2- The positive and negative deviations from this central value are of equal probability.
- 3- The frequency of deviations decreases rapidly as the deviations increase.

The function of the Normal law is determined by the following formula:

$$F(x) = \frac{1}{\sqrt{2\pi}} \int_{-a}^u t^{-u^2/2}$$

Where U is the reduced variable of GAUSS

$$U = \frac{x - \bar{x}}{\delta x}$$

$$\bar{x} = \frac{1}{N} \sum_{i=1}^n x_i, \quad \delta x = \sqrt{\frac{\sum (x_i - \bar{x})^2}{N}}$$

With :

x : random variable

\bar{x} : the mean of the random variable

δx : Standard deviation of the random variable

a) Marseille Marignane station:

Table .4: Table of annual rainfall frequency in Marseille Marignane.

observed value	effective n	cumulative effective	Frequency Fi= n /N+1 (%)
276,8	1	1	5,26
292,2	1	2	10,52
311,7	1	3	15,78
315,8	1	4	21,05
346,3	1	5	26,31
358	1	6	31,57
434,4	1	7	36,84
441,3	1	8	42,1
509,8	1	9	47,47
523,4	1	10	52,63
530,1	1	11	57,89
542	1	12	63,15
610,1	1	13	68,42
630	1	14	73,68
645,6	1	15	78,94
661,6	1	16	84,21
788,8	1	17	89,47
843,3	1	18	94,73

Citation: Mr. Dr BOUALEM ABDELKADER 2021, Comparative Study of Annual Precipitation between Oran Aerodrome (Algeria) and Marseille Marignane (France) Stations Located in the Mediterranean Basin; Journal of Basic and Applied Scientific Research, 11(5)10-18.

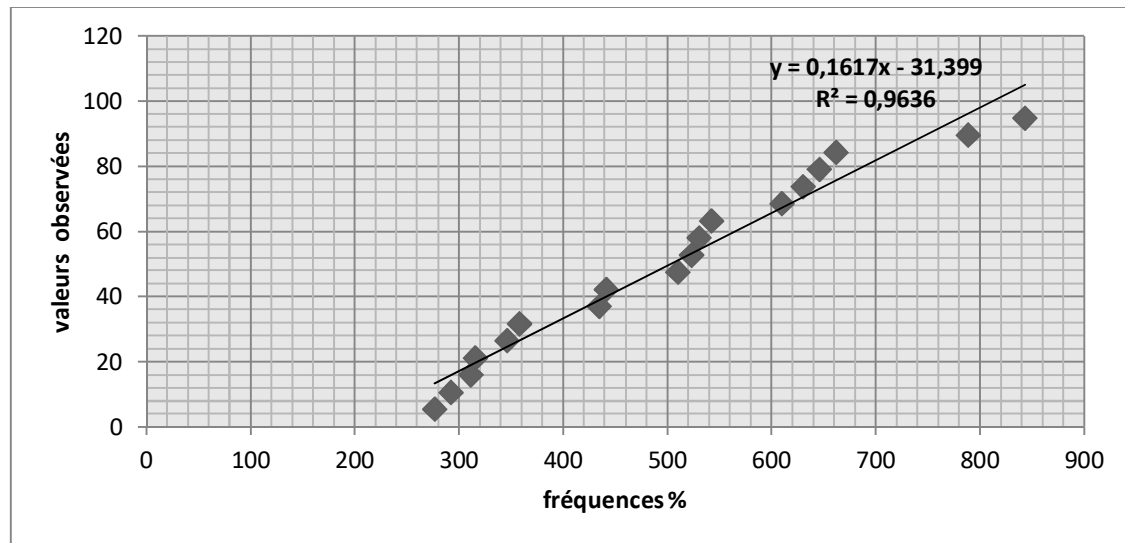


Figure 1: Plot of the Normal law of Marseille Marignane station

3.3.2.2. Analysis of normal law plots

The analysis of figure 1, shows us that the distributions observed in the station form a clear structure around different lines. We notice that the distribution aligns to the right while others deviate more or less. In order to confirm whether there is any normality of the different distributions we will submit them to the chi-square test.

b) Oran Aerodrome station:

Table. 5: Frequency table of annual rainfall at Oran Aerodrome.

observed value	effective n	cumulative effective	Frequency $F_i = n / N + 1$ (%)
167	1	1	5,26
239	1	2	10,52
253	1	3	15,78
267	1	4	21,05
299	1	5	26,31
325	1	6	31,57
326	1	7	36,84
378	1	8	42,1
390	1	9	47,47
451	1	10	52,63
496	1	11	57,89
547	1	12	63,15
617	1	13	68,42
678	1	14	73,68
691	1	15	78,94
699	1	16	84,21
763	1	17	89,47
790	1	18	94,73

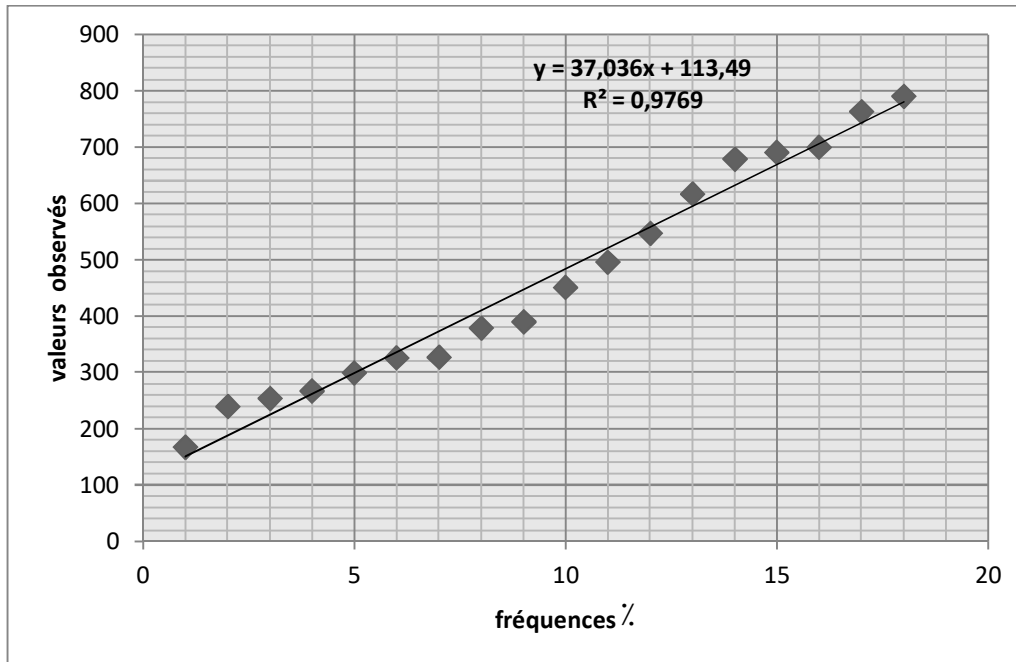


Figure .2: Plot of the Normal law of the Oran Aéroport station

3.3.2.2. Analysis of normal law plots

Figure analysis. 2, shows us that the distributions observed in each of the stations form a clear structure around different lines. We notice that some distributions are aligned on the lines while others deviate more or less.

In order to confirm whether there is any normality of the different distributions we will submit them to the chi-square test.

3.3.3. Chi-square test

Before performing the chi-square test we will first try to determine the coefficient of variation (Cv) which will tell us if all the conditions are met to perform the chi-square test, i.e. the coefficient of variation must be less than 0.5 for each station

a) Calculation of the coefficient of variation (Cv)

It is the ratio of the standard deviation to the mean. The coefficient of variation numerically indicates the importance of the degree of variability of rainfall averages in the series [1] as well as the dispersion in number of values around the mean, the larger this number, the greater the dispersion, it also allows us to better understand the variability of rainfall and the irregularity of rainfall.

As the coefficient of variation is less than 0.5 for the four stations, we can calculate the chi-square.

Table. 6: Calculation of the coefficient of variation

Station	Average p(mm)	Standard deviation δ	$Cv = \delta / P$
Marseille Marignane	503,4	170,57	0,33
Oran Aéroport	465,33	200,04	0,42

b) Chi-square test theory

If n_i represents the number of samples observed and n_{pi} the number of theoretical samples, calculated as a function of a certain distribution hypothesis, the tables of the chi-square distribution law allowing for various adequacy thresholds to obtain the value of the chi-square test not to be exceeded as a function of the number of degrees of freedom in the sample.

$ddl = K - 1$

With ddl : number of degrees of freedom

K: number of class

This is a test that checks whether the differences between the distribution of the sample series and the distribution of the theoretical law are due to mere chance or if the sample follows a law other than the one used.

The application of the test consists in comparing the observed size (ni) with the theoretical size (npi) obtained for each class, by applying the law we then have:

$$\chi^2 = \sum_{i=1}^p \frac{(ni - npi)^2}{npi}$$

Or the theoretical class size:

$$npi = \frac{n}{k}$$

With k: the number of classes

n: observed number of class k = 4

Table .7 Chi-square test for the Marseille Marignane station

Class K	Class limits	Observed effective (ni)	Theoretical effective (npi)	$\frac{(ni - npi)^2}{npi}$
1	276,8-315,8	4	4,5	0,05
2	346,3-441,3	4	4,5	0,05
3	509,8-542	4	4,5	0,05
4	610,1-843,3	6	4,5	0,5
Total		N=18	Npi=18	$\chi^2=0,65$

Table 8: Chi-square test for the Oran Aerodrome station

Class K	Class limits	Observed effective (ni)	Theoretical effective (npi)	$\frac{(ni - npi)^2}{npi}$
1	167-267	4	4,5	0,05
2	299-378	4	4,5	0,05
3	390-547	4	4,5	0,05
4	617-790	6	4,5	0,5
Totals		N=18	Npi=18	$\chi^2=0,65$

Table 9: Result of the test of χ^2 of the annual precipitation of the four stations.

	Oran A�rodrome	Marseille Marignane
χ^2 calculated	0,65	0,65
Ddl	3	3
χ^2 tabulated	7,815	
Observation	Good fit	

c. Chi-square test result

χ^2 calculated = 0.65

The number of degrees of freedom dof = k - 1 = 4 - 1 = 3

For a risk $\alpha = 5\%$ χ^2 tabulated = 7.815 > χ^2 calculated = 0.65; therefore the fit to the normal distribution is acceptable.

4. CONCLUSION

The analysis of the different graphs of the plot of the normal law showed us that the series can be distributed normally. In order to confirm this possibility of normal distribution we proceeded to the chi-square test which revealed to us that the adequacy to a normal distribution is possible.

So we can use our data in perceptual terms by determining the different parameters a namely the rainfall periods for a given recurrence period more precisely the calculation of the dry and wet modulus for the periods of ten, fifty and a hundred years then a study of the annual variations and monthly rainfall amounts for the various stations in the study region.

Acknowledgments: I would like to thank all of my colleagues in the laboratory for the management of water, soil and the environment from the faculty of nature and life sciences as well as my Master II students and not forgetting the staff of the national meteorological office (Oran).

REFERENCES

Journal

1. Boualem, A ;(2014 : Analysis and study of rainfall in the region Mascara (ALGERIA) .University of Mostaganem Faculty of Natural Sciences and Life Department of Agronomy; Asian Academic Research Journal of Multidisciplinary; 2014

Conferences

2. Boualem, A and Mederbal, K; 2009: Potentialities and problems of water resources in Algeria, article of communication at the international conference of Geosciences, Fez (Morocco) May 2009.

Documents

3. Llamas, J; 1993: General hydrology. Gaétan Morin, ed

4. Lachance, M; 1996. Basic statistics, course notes I.N.R.S.-Eau.

5. Gaussen, H and Bagnouls. M. F; 1948: Maps of rainfall for Algeria (average 1913-1947) . 1: 500000, IGN, Paris

Briefs

6 .Boualem, A and Yourid, K; 2017 : Analysis and contribution to the rainfall study in the coastal region of Western Algeria, Master II thesis, Conservatory management option of water, soil and the environment, Mostaganem University.

7 . Boualem, A and Abedelwahab, A ; 2017 : Rainfall approach and study of the Saïda region, Master II thesis, Conservatory management option of water, soil and Environment, Mostaganem University.

8 .Boualem, A, Habouchi, R; 2018: Study and Analysis of Annual and Monthly Precipitation in the Oran region. Conservatory management option for water, soil and the environment, Mostaganem University.

Data bank

Data source: International Climatology Agency (www.infoclimat.fr/climatologie) and National Meteorological Office (Algeria).