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(Research Article)

Juazeirinho Paraíba: Brazil and its rain oscillations

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Abstract

In the semi-arid region, where water resources are scarce and seriously extinct due to excessive exploitation, it is essential to estimate water needs with greater precision, In this view, the objective is to analyze and understand the variability of rainfall rates and the evaporative power of the municipality of Juazeirinho - Paraiba in the period 1962-2018, The monthly and annual precipitation data for the 57-year period were obtained by the Executive Agency for Water Management of the State of Paraiba, and the graphs of annual variations, Monthly and seasonal averages of precipitation to satisfactorily represent the region's pluviometry regime the software Estimated-T estimated the thermal data for the same period of the rainfall data, where the evaporative indices were calculated by the computation of the water balance, The analysis of the spatial and temporal variability of rainfall provides information on how rural and urban people should establish measures for capturing rainwater and storing it using the wettest period, The variations in rainfall over the years are linked to the phenomena of macromeso and microscales, being of great influence for the rainfall regimes of the municipality, Possibility of extreme climatic events due to the high spatial-temporal variability of precipitation will provide drought events as well as intense precipitation in a short time interval.

Keywords: Climatic variables; Local system; Regional system; Evaporative power

1. Introduction

The study of rainfall is of paramount importance for the design of projects in agriculture, irrigation and in various engineering such as: agronomy, civil, forestry, agricultural, agronomy, hydrology, among others, damming and drinking water supply, among the meteorological parameters that exert daily influence in the most varied human activities, precipitation stands out [12].

Water is an essential resource for the maintenance of life, especially with regard to "fresh water", this factor is linked to the multiple activities developed through this resource, among them, supply for human consumption, industrial and agricultural activities, , and importance to ecosystems [15].

Analyzing the climatology of precipitation in the municipality of Bananeiras - PB, in the period 1930-2011, as a contribution to Agroindustry and found that rainfall indices are essential to agro-industrial sustainability [13].

In the semi-arid region, even with the distributions and occurrences of irregular rains and with the actions of meteorological factors suffering blocks that prevent regularities, there are necessary and sufficient storage conditions, enough for this: not only good planning, but also adequate monitoring of the water quality [20].

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Analyzed the contribution to rainwater harvesting in relation to the number of days with rain and precipitation in the municipality of Teresina, which generated subsidies that served as an indication for the proper use of its capture. The average annual precipitation was 1,337.8 mm in 80 days. The months of February, March and April, 860.5 mm were recorded, spread over just 46 days over the three months. The quarter August, September and October with 60.6 mm in 12 days. In years with below-average precipitation, there was a better temporal distribution of rainfall, unlike when it rained above average, in which precipitation was more concentrated in time. There was a significant trend of increase in precipitation and in the number of days with rain in the 1st quarter of the year, while in the second and 4th quarter, this trend is reversed, that is, a reduction in both precipitation and the number of days of rain. Rainfall, when considering the period from 1913 to 2005, thus helping rainwater catchers to better plan their capture [14].

The Northeast region of Brazil, mainly in the semi-arid portion, is periodically affected by the occurrence of droughts with partial or total losses in the agricultural sector, which is practically subsistence [19], believe that there is increasing evidence between the distribution of meteorological variables and the modes of climate variability in different regions of the globe.

[3] stated that in Brazil and in the world, the biggest user of water is the production of food through irrigation, with 69% of the use destined for this purpose, to maintain a sustainable and environmental balance, irrigated agriculture needs to use water resources efficiently, where efficiency is achieved through irrigation management. The rational management of water in irrigated agriculture, which depends, among several factors, on the correct quantification of the water content lost by crop evapotranspiration [3].

In regions with a semi-arid climate, where water resources are scarce and seriously threatened by excessive exploitation, it is essential to estimate water needs with greater precision, according to the arguments to [5]. Low rainfall, high temperatures and evaporation can create problems for farmers in rural areas of the northeastern Brazilian semi-arid region, according to [2].

[4] evaluated the variation of evaporation in the class “A” tank in the city of Teresina-PI in three and a half decades and made a comparison with the changes in urbanization that occurred in that period, finding changes in evaporative indices in face of the occupation of man and their respective changes in space. Blocking the wind due to horizontal growth is contributing to the reduction of evaporation [EVR], the opposite occurs when it rains, there is no surface runoff and at the end of the precipitation the evaporative indices occur in greater proportions due to the exchange of heat. The series of daily evaporation data used in this work was separated between periods: 1986-1995, 1996-2005, 2006-2011 and compared with the complete series of 1976-2011, the oscillations of lower and higher values.

Occurred, with highlighting the decades 1976-1985 and 1986-1995, which presented the smallest variations. The decade of 2006-2011 in the month of October presented the biggest fluctuation of the studied periods. Annual fluctuations ranged from 1,852.7 to 2,409.4 mm. The evaporative indices had greater significance from the 1996s onwards, due to urban verticalization, alteration of the vegetation area, soil compaction with paving, backfilling of ponds and eutrophication of water bodies. The study complemented findings made in which they conclude that expanding urban development patterns have a negative impact on regional vegetation cover and increase the frequency of extreme heat events, due to the high rates of deforestation in the municipality.

Potential evaporation rates are stimulated by four meteorological variables, radiation, vapor pressure, wind speed and air temperature. Evaporation is a conceptual variable that cannot be measured directly according to [21],[22], Many different methods of estimating potential evaporation from one or more variables have been developed according to local climatic conditions and availability of adequate data in accordance with the authors [16]; [23]; [17]; [24], [21], [22] uses a single air temperature variable that is related to the potential evaporative indices through empirical relationships. Being required to be recalibrated and to maintain accuracy when applied outside the original spatial and temporal contexts according to [23].

[11] found in a study on climatic suitability for cowpea in the municipality of Barbalha - CE, through the water balance according to [21],[22] that evaporation behaved similarly to rainfall they emphasize when there was a higher rainfall an increase in evaporation was observed. The influence of precipitation generates as consequences lower evaporation rates lower relative humidity and consequently a drier climate.

The objective is to analyze and understand the variability of rainfall rates and the evaporative power of the municipality of Juazeirinho - Paraiba from 1962-2018.

2. Material and methods

Monthly and annual rainfall data for the 57-year period of observed data of 1962-2018. From the data graphs of annual variations monthly and seasonal averages of precipitation were obtained to satisfactorily represent the region's rainfall regime said data were provided by the Executive Agency for Water Management of the State of Paraiba [1] and by the Northeast Development Superintendence [18].

The data went through the gap filling process through the distance square model followed by the consistency and homogenization steps and generated in electronic spreadsheets followed by the realization of basic statistical calculations for the generation of graphs and tables and other parameters relevant to the development of the study.

Four types of climatic classifications were used by the method of [21], [22] for the periods: Normal; Rainy; Regular and Dry. In the Normal period the classification was of the type C1B'$_4$S2a'; in the rainy season there is a classification of type C$_2$D'a'; for the period of Regular rain the classification was of the type C$_2$E'R a' and in the dry period it was classified with C$_2$B'$_3$Ra'. In accordance with the classification of [6] and [7], its climate is of the type Bsh. This type of climate corroborates the result of the climate classification according to [12].

3. Results and discussion

Table 1 shows the descriptive statistics for rainfall in the municipality of Juazeirinho-PB from 1962 to 2018. The municipality has an annual average rainfall of 487.4 mm and its monthly fluctuations range from 4.4 mm (September) to 112. 7 mm (April). Standard errors flow from 1.1% (September) to 12.1% (April) with an annual error of 29%. The median is very far from the mean and its representativeness is unlikely to occur [8]. Fashion is only characterized in the months of April and May. Therefore, the fashion escapes from the central trend. The standard deviation was very dispersed from the mean and its possibility of occurrence was very small. The variance has very high values and is dispersed in relation to the mean. The kurtosis and asymmetry have a good relationship with the mean. The absolute minimum values detected in the series were 0.0 mm, that is. There was no minimum rainfall and that is, It did not rain,

Table 1 Descriptive statistics of rainfall data for Juazeirinho-PB from 1962 to 2018

Months	Mean	Standard error	Median	Mode	Standard deviation	Variance	Kurtosis	Asymmetry	Absolute minimum	Absolute maximum
Jan	45.6	7.6	27.5	0.0	57.2	3268.3	8.7	2.4	0.0	320.8
Feb	63.8	9.4	51.7	0.0	70.3	4937.5	9.2	2.5	0.0	403.3
Mar	108.5	10.9	110.6	0.0	81.2	6597.2	6.4	1.7	0.0	474.5
Apr	112.7	12.1	95.6	68.0	90.9	8259.2	4.3	1.6	0.0	490.9
May	43.8	5.5	32.3	35.2	41.3	1704.7	1.4	1.4	0.0	173.0
Jun	31.7	4.5	26.5	0.0	33.9	1150.8	13.2	3.1	0.0	205.9
Jul	33.0	3.4	27.9	0.0	25.3	640.6	-0.1	0.7	0.0	97.0
Aug	11.7	2.3	7.9	0.0	17.3	299.7	10.5	3.0	0.0	90.4
Set	4.4	1.1	0.3	0.0	8.0	64.1	11.2	3.1	0.0	41.0
Oct	6.4	2.8	0.0	0.0	20.7	427.3	22.1	4.5	0.0	126.0
Nov	4.8	1.8	0.0	0.0	13.2	173.6	18.6	4.0	0.0	78.6
Dec	20.9	4.9	0.7	0.0	36.8	1351.6	7.0	2.5	0.0	176.3
Yearly	487.4	29.0	494.3	#N/D	216.7	46972.8	2.4	1.0	126.9	1287.5

Fonte: Medeiros, [2022]

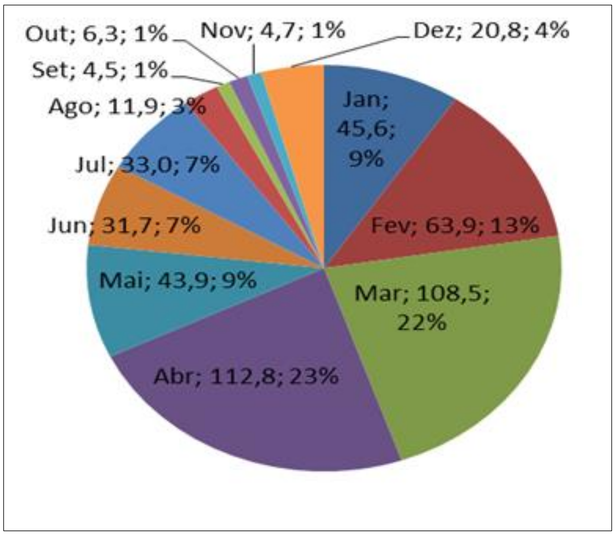
Table 2 shows the variability of absolute maximum rainfall values and their respective years of occurrence. Between the months of May and December, there was no record of absolute maximum rainfall, these variabilities are linked to local and regional effects, in the months of January and February, the values provided in Table 1 for the years 2004 and 1985 were recorded, [10]; [9] and [12] corroborate the results discussed.

Table 2 Maximum rainfall values recorded in the series 1962 to 2018 in Juazeirinho – Paraíba.

Parameters/months	Absolute maximums	Years
Jan	501.1	2004
Feb	48.8	1985
Sea	0.0	1981
Apr	0.0	1985
May	0.0	2011
June	0.0	2006
july	0.0	1977
Aug	0.0	2000
set	0.0	2000
Oct	0.0	1976
Nov	0.0	1997
Den	0.0	1963
Yearly	0.0	1985

Fonte: Medeiros, [2022],

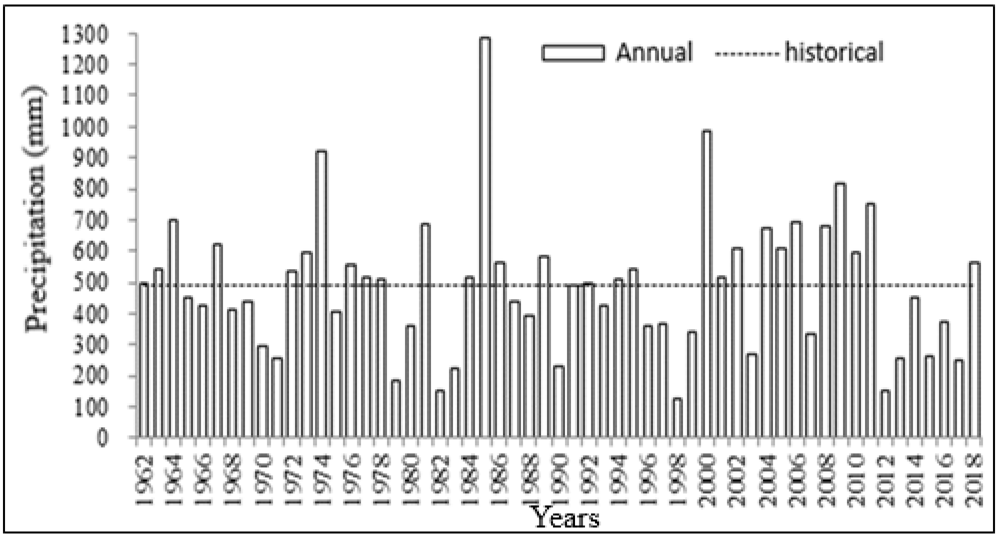
The rainfall variability and its percentage can be seen in Figure 1, with a historical average rainfall of 487.6 mm. The months with the highest rainfall correspond to the months from January to July and from August to December the lowest rainfall rates. These variabilities are in accordance with the study by [12] and the results corroborate those [10].



Source: Medeiros, [2022],

Figure 1 Distribution of historical average rainfall and percentage's for the municipality of Juazeirinho - PB, in the period 1962-2018.

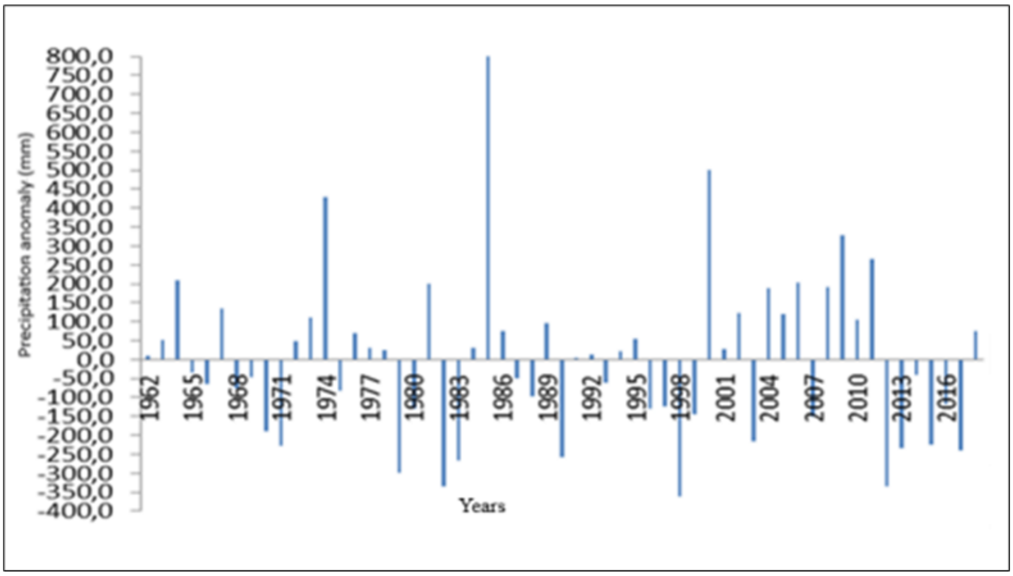
Figure 2 shows the annual and historical rainfall fluctuations of Juazeirinho - Paraíba, from 1962 to 2018 the municipality has a historical rainfall of 487.6 mm. The highest rainfall rates were recorded in 1974 with 915.2 mm; 1985 [1300 mm] and the year 200 with 1000 mm. The lowest rainfall rates were recorded in 1982 with 185 mm; 1998 rained 170 mm and in 2012 it rained 182.2 mm. It also highlights the interannual irregularities in the rainfall rates that are a result of the synoptic systems acting both regionally and locally. These fluctuations corroborate the results of [8]; [12].



Source: Medeiros, [2022],

Figure 2 Annual and historical rainfall in Juazeirinho - PB, in the period 1962-2018.

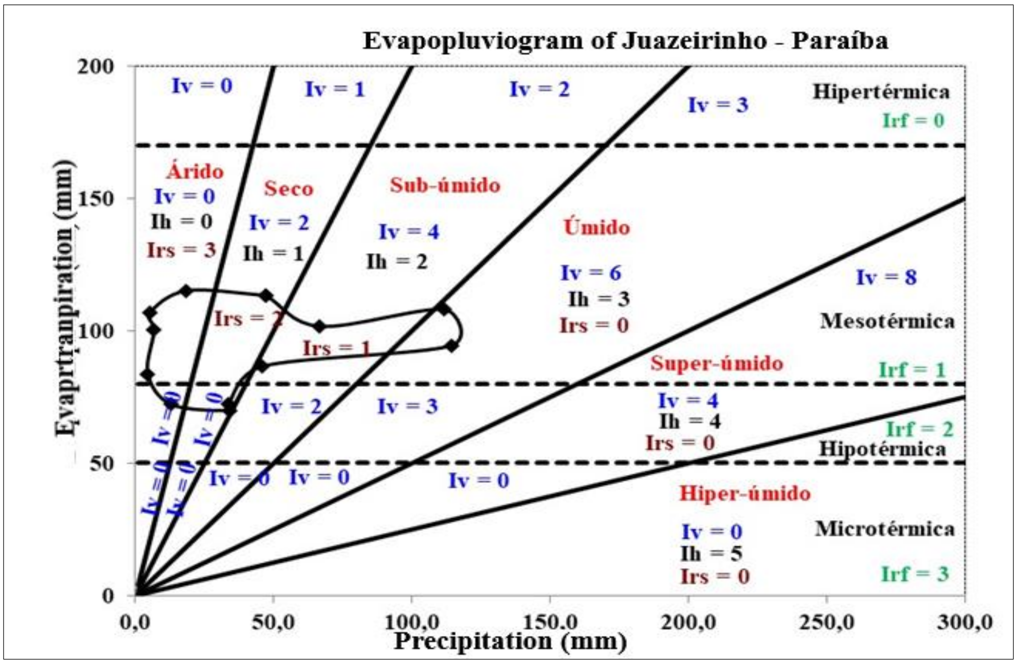
The fluctuations of the annual precipitation anomalies of Juazeirinho - Paraíba from 1962-2018 can be observed in Figure 3, with twenty-eight years of positive anomalies, twenty-seven years of negative anomalies and two years with anomalies close to zero or neutral, these fluctuations demonstrate the variability and irregularities recorded between years in the study area, these discussions corroborate the results exposed by [8].



Source: Medeiros, [2022]

Figure 3 Annual rainfall anomaly in Juazeirinho - PB, in the period 1962-2018

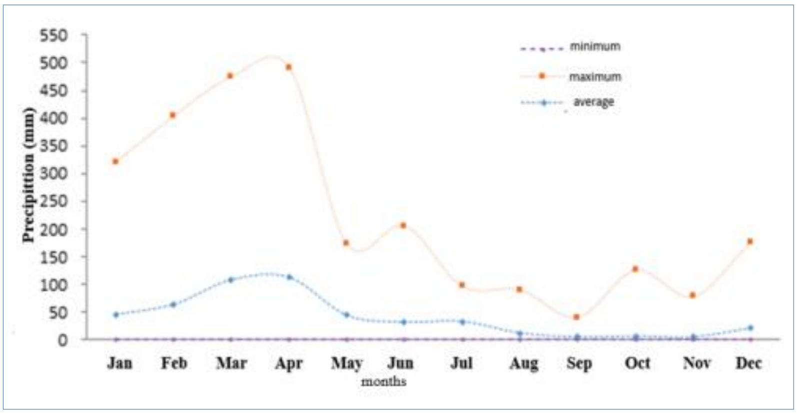
The evapopluviogram [Figure 5] provides us with the variability of the types of climate recorded during the 57 rainfall observations that took place in the municipality. Five months of arid climate stand out; two months of dry climate; two months of sub-humid climate and two months of humid climate. These variability in climates provide subsidies for decision makers in the areas of agriculture, agribusiness, water resources, irrigation, energy generation, and storage and water impoundment, in addition to facilitating the aforementioned information in real time for designers.



Source: Medeiros, [2022]

Figure 4 Evapopluviogram of Juazeirinho - Paraíba from 1962-2018

In Figure 5, it is possible to observe the fluctuations of the maximum and absolute minimum rainfall, and the monthly average of Juazeirinho - Paraíba from 1962-2018. The minimum rainfall fluctuated close to 0,0 mm, meaning that it rained almost nothing during the study series. The absolute maximum precipitation begins to increase significantly in the month of November and continues until April with its maximum peak between May and April and its minimum peak in September, From May to May, irregularities are registered due to local and regional effects that have little performance in the study area. The average rainfall ranges from 0 mm (September) to 110 mm (March, April). The main element causing the rainfall indices is the Intertropical Convergence Zone, The studies by [8]; [12] corroborate the results discussed.



Source: Medeiros, [2022]

Figure 5 Absolute monthly maximum, minimum rainfall and monthly average for Juazeirinho - Paraíba, from 1962-2018.

4. Conclusion

The analysis of the spatial and temporal variability of rainfall provides information on how rural and urban people should establish measures for capturing rainwater and storing it using the wettest period.

The variations in rainfall over the years are linked to the phenomena of macro, meso and microscales, being of great influence for the rainfall regimes of the municipality.

Possibility of extreme climatic events due to the high spatio-temporal variability of precipitation will provide drought events as well as intense precipitation in a short time interval.

Compliance with ethical standards

Disclosure of conflict of interest

All authors contributed equally to the development of the article.

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