IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

Human Journals
Review Article
January 2022 Vol.:20, Issue:3

Ipojuca-Pernambuco Water Basin, Brazil and Its Pluviometric Analysis

IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

Raimundo Mainar de Medeiros*[1], Manoel Viera de França[1], Romildo Morant de Holanda[1], Luciano Marcelo Fallé Saboya[3], Moacy Cunha Filho[1], Fernando Cartaxo Rolim Neto[1], Wagner Rodolfo de Araújo[2]

1 Universidade Federal Rural de Pernambuco, Brasil

2 Universidade Estácio de Sá, Brasil

3 Universidade Federal de Campina Grande, Brasil

Submitted: 24 December 2021
Accepted: 30 December 2021
Published: 30 January 2022

www.ijsrm.humanjournals.com

Keywords: Predictability and Sustainability, Climate Variability, Precipitation Anomalies

ABSTRACT

Precipitation has the possibility of spreading heterogeneously across the globe, and the alterations between the radiation balance in the zonal bands and the association with atmospheric dynamics make it possible to distinguish globally widespread rainfall regimes. The objective is to statistically analyze the buoyancy of precipitation in the area of the Ipojuca river basin - PE as a feeder source of the hydrological systems of the State of Pernambuco. The simplified statistical parameters were used to calculate mean, standard deviation, coefficient of variance, maximum and minimum absolute rainfall, annual rainfall, and their anomalies for the period 1962-2017. Increasing variability of annual and monthly precipitation occurs. The variability is greatest during the spring and summer seasons and lowest in the winter and fall seasons. Positive and negative anomalies were recorded in 7 and 18 municipalities respectively. Knowledge of local weather conditions about extreme rain events enables seasonal forecasting to be improved and helps decision-makers in government agencies avoid or minimize natural disasters. In general, it is verified that the local rainfall pattern is influenced by several precipitating systems that contribute to the amount of local precipitation and that their contributions are interconnected with the local and regional meso and micro-scale systems with the interaction of land use and land cover.

INTRODUCTION

Simoni et al.(2014) show that the integration of rainfall regimes becomes the main artifice for carrying out socioeconomic planning and the conservation of the natural environment. According to Silva et al.(2011), the understanding of rainfall behavior in a given region is an indicator for the composition of the calendar and implementation of agricultural projects. The analysis of the distribution and its climatic variability of rainfall in hydrographic basins is of fundamental importance for the conception of the natural functioning of water systems, studies aimed at this purpose demonstrate an important role in human coverage, guiding measures for the rational use of water resources.

Precipitation tends to spread heterogeneously across the planet, the differences between the radiation balance in the zonal bands and the association with atmospheric dynamics allow for the differentiation of globally distributed rainfall regimes.

Medeiros et al.(2013) showed that the rainfall rates resulting from La Niña are due to being above average, compared to El Niño periods, which can show a reduction of between 60 to 65% in the rainfall index.

Oliveira et al. (2015) demonstrated that the reduction in rainfall under the effect of El Niño in the Northeast region is a natural climatological phenomenon that is attributed to the increase in rainfall in the southern region of Brazil.

According to the authors, Fitzjarrald et al. (2008) and Cohen et al. (2014) clarify that the precipitation induced by the river breeze towards the interior of the continent is not being counted in the measurements of the pluviometers of the automatic and conventional stations.

Medeiros (2016) studied the hydrographic basin of the Uruçuí Preto River – PI, specifically, in the content modeling of flow, precipitation, temperature and relative humidity of the air, and its climatic variability, providing technical support to decision-makers, civil society, companies, and state and municipal governments, more specifically suggest to farmers and riverside population how the information contained in meteorological data should be used, as well as advice to improve access to drinking water.

Silva et al. (2012) show that the oceans are of fundamental importance in rainfall buoyancy, as the deviations around the average rainfall are intrinsically related to phenomena that occur on the surface of the oceans, thus variations in Sea Surface Temperature (SST) and the correlation with rainfall distribution across the globe.

Souza et al. (2012) showed that excessive rainfall, added to other factors in the biophysical environment, can cause floods, floods, floods, floods, bring down barriers, roads and when there is no excess or rainfall below the climatological, result in droughts, silting of rivers, affecting the productive, socioeconomic and environmental sectors.

Monteiro et al. (2014) showed that rainfall impacts are generated by the intensity of rainfall occurring in a short period of time in most Brazilian cities causing floods and landslides and gaining media attention given the high number of homeless people, in addition to the proliferation of diseases, losses economic, environmental damage, deaths, among others.

Bertoni et al. (2001) showed that precipitation admits to being of great importance in the hydrological process since the annual distribution of precipitation in a hydrographic basin is the basis for decision-making, planning, and prevention related to irrigation, agriculture, industrial, and domestic water supply, in addition to soil erosion control and flooding, flooding, among other factors.

Medeiros et al. (2015) showed that the analysis and diagnosis of rainfall fluctuations in the Northeast region of Brazil, and especially in the State of Paraíba, is of great importance, mainly due to its irregularity, since climate variables are important under the climate approach. The results showed trends towards reductions in rainfall, with fluctuations in rainfall throughout the sample series, evidencing the recurrence of maximum annual rainfall values within a range of 15, 12, and 7 years.

Coscarelli et al. (2012) analyzed the daily rainfall distribution in southern Italy, and the importance of understanding the variability of rainy days in the annual distribution of precipitation, as well as the possible risks of flooding and soil instability in terms of erosive power.

Medeiros et al. (2013) performed an analysis of the climate and availability of surface and underground water resources in the Uruçuí Preto river basin area - PI. In the Köppen classification, two climatic types are distinguished Aw (tropical climate with a dry winter season) and BSh (Climate of warm steppes at low latitudes and altitudes). The maximum annual temperature is 32.1 °C, the minimum annual 20.0 °C, with an annual temperature range of 12.1 °C and the average annual temperature of 26.1 °C; the annual mean relative humidity is 64.2%, the mean annual evaporation is 2098.7 mm and the annual evapotranspiration is 1,470.7 mm. The total annual sunshine is 2,701.8 hours per year. The fluviometric stations located in the municipalities of Jerumenha and Cristino Castro record average flows of 6.9 m³/s to 6.1 m³/s in the driest quarter and average flows ranging between 90 and 54 m³/s in the rainiest quarter.

The distribution of precipitation is quite irregular in time and space, and the rainy seasons occur differently, in terms of quantity, duration, and distribution. The aim is to statistically analyze the buoyancy of rainfall in the hydrographic basin area of the Ipojuca River - PE as a feeding source for the hydrological systems of the State of Pernambuco.

MATERIAL AND METHODS

The Ipojuca River basin (IRHB), is located in its entirety in the State of Pernambuco, between 08º09'50" and 08º40'20" of south latitude, and 34º57'52" and 37º02'48" of west longitude. Due to its elongated conformation in the west-east direction, this basin has a strategic position in the state space, serving as a great water channel connecting the Metropolitan Region of Recife and the Sertão region of the State. The upper, middle, and sub-middle sections of the basin are located in the Sertão (small portion) and Agreste regions of the State, while the lower section has most of its area located in the Mata Pernambucana zone, including the coastal strip of the State. to the north, with the Capibaribe river basin, a group of small coastal river basins and with the State of Paraíba; to the south, with the basin of the River Sirinhaém; to the east, with the Atlantic Ocean; and, to the west, with the basins of the Ipanema and Moxotó Rivers and the State of Paraíba (Figure 1).

Figure 1. The hydrographic basin of the Ipojuca river and surrounding municipalities.

Source: Medeiros, (2022).

The hydrographic basin of the Ipojuca River (IRHB) covers an area of 3,435.34 km^2, corresponding to 3.49% of the state's area. 25 municipalities are included in this basin, 14 of which have their headquarters in the basin. The route of the Ipojuca River, with about 320 km, is predominantly oriented in the west-east direction, with its intermittent fluvial regime, becoming perennial to from its medium course, near the city of Caruaru. Its main tributaries, on the right bank, are the streams: Liberal, Taquara, and do Mel, and, on the left bank, the streams of Coutinho, Mocós, Muxoxo, and Pata Choca. Liberal creek, its most important tributary, has its sources in the municipality of Alagoinha. It drains, along its 47 km of extension, areas in the municipalities of Alagoinha, Pesqueira, and Sanharó, and flows into the Ipojuca River. Its estuary has been significantly altered in recent years, as a result of the installation of the Suape Port Complex.

The rainy season starts in February with pre-season rains (rainfalls that precede the start of the rainy season) and ends at the end of August and may last until the first half of September. The rainy quarter is centered on May, June, and July and its driest months occur between October, November, and December. The factors causing rainfall in the municipality are the contribution of the Intertropical Convergence Zone (ITCZ), formation of high-level Cyclonic vortices (SAVC), the influence of the contribution of northeast trade winds in the transport of steam and moisture, formation of instability lines, the orography and its local contributions forming clouds and causing moderate to heavy rain in accordance with Medeiros (2016).

According to the Köppen climate classification, the BHRI area is mostly climate type “As” (climatic with summer dry season), followed by types Am (monsoon climate) and BSh (warm steppe climate of low latitudes and altitudes). This is in accordance with the studies by Medeiros et al. (2018) and Alvares et al. (2014).

Precipitation data provided by the Agência das Aguas e Clima in the State of Pernambuco (APAC) were used, corresponding to the 25 rainfall stations that surround the hydrographic basin of the Ipojuca River (IRHB), with a historical series of 53 years between the period 1962 and 2015. Data analysis was performed using the basic statistics under study. The calculations of means, standard deviation, coefficient of variation, maximum and minimum absolute precipitation, and their variability, anomaly, and normalized standard deviations were performed. Galvani (2011) shows that it is important to have a notion of the degree of dispersion of values in relation to the average value. The Coefficient of Variation (VC), according to the author, is used to make comparisons in relative terms and expresses the variability of each data set normalized in relation to the mean, in percentage.

RESULTS AND DISCUSSION

The hydrographic basin of the Ipojuca River (BHRI) has an average rainfall of 882.6 mm, corresponding to the period 1962-2017. The wettest city is Ipojuca with an annual total of 1,946.3 mm with a percentage of 220.51 mm above its normal and the least rainy city is Caruaru with an annual total of 565.5 mm which represents 64% of the basin average.

Table 1 shows the fluctuations in the mean, standard deviation, coefficient of variance, absolute maximum and minimum rainfall, and its representative range of the 25 municipalities surrounding BHRI in the period 1962-2017.

Table 1. Average values for the period 1962-2017 in the area of the Ipojuca river basin.

Período	Average	DP	CV	maximum	Minimum	amplitude
1962-2015	(mm)	(mm)	(%)	(mm)	(mm)	(mm)
	882,6	387,5	43,9	1946,3	565,5	1380,8

Caption: Average= Climatological average; SD=Standard deviation; CV= Coefficient of variance; Maximum = absolute maximum precipitation; Minimum = absolute minimum precipitation; Amplitude = pluvial amplitude (difference between the maximum and the minimum).

Source: Medeiros, (2022).

Precipitation with higher rates are recorded in the spring and summer seasons and intermediate values in the winter and autumn seasons, the deviations and the median are well above normal, the coefficient of variance is higher than that observed annually in the summer and autumn season and between the normality in the summer and spring seasons, as can be seen in table 2, this is because during the spring and summer there are influences of the factors causing rainfall in activities, directly affecting the rainfall volume. The winter and autumn seasons as the ones with the lowest registered rainfall.

Table 2. Variability of mean seasonal precipitation for the Ipojuca river basin

Station	Precipitation média (mm)	Standard deviation (mm)	Median (mm)	coefficient of variation	precipitation maximum (mm)	precipitation minimum(mm)	Amplitude (mm)
Winter	47,1	12,7	83,2	0,284	83,2	32,5	50,7
Spring	119,9	39,1	230,9	0,330	230,9	85,3	145,6
Summer	101,3	66,5	265,9	0,684	265,9	39,4	226,4
autumn	77,8	47,2	206,5	1,758	206,5	29,6	176,9

Source: Medeiros, (2022).

The months with the highest rainfall recorded for the BHRI area are April (128.6 mm), June (120 mm), and July (124.3). The months with the highest coefficients of variation are from May to November. The maximum absolute precipitations occurred from April to July, and the minimum absolute precipitations were registered in October and November. Amplitude fluctuations range from 37.7 mm in November to 263.9 mm in July. (Table 3).

Galvani (2011) showed that the calculation of the standard deviation is essential to get the notion of the “degree of dispersion of values in relation to the mean value”. According to the author, the coefficient of variation is used to make comparisons in relative terms and expresses "the variability of each set of data normalized in relation to the mean, in percentage."

Table 3. Variability of mean seasonal precipitation for the Ipojuca river basin, corresponding to the 25 surrounding municipalities.

Meses	Average (mm)	Standard deviation (mm)	Median (mm)	coefficient of variation	precipitation maximum (mm)	precipitation minimum (mm)	Amplitude (mm)
Jan	44,1	11,9	83,0	0,269	83,0	30,7	52,3
Feb	62,6	13,4	103,8	0,214	103,8	46,6	57,2
Mar	116,9	23,8	176,8	0,204	176,8	88,2	88,7
Abp	128,6	32,1	225,5	0,250	225,5	100,7	124,8
May	114,1	61,2	290,3	0,536	290,3	66,9	223,4
Jun	120,0	74,5	320,2	0,621	320,2	56,3	263,9
Jul	124,3	76,1	286,8	0,612	286,8	46,7	240,0
Aug	59,7	49,0	190,6	0,820	190,6	15,3	175,3
Sep	39,0	26,0	111,5	0,668	111,5	14,3	97,2
Out	19,1	11,0	51,5	0,578	51,5	9,5	41,9
Nov	19,8	10,1	43,5	0,512	43,5	5,8	37,7
De	34,5	12,7	62,8	0,367	62,8	20,3	42,5
Annual	882,6	387,5	1946,3	0,439	1946,3	565,5	1380,8

Source: Medeiros, (2022).

In a scenario of future climate change, mainly due to increased concentrations of the greenhouse effect, it is often assumed that only the mean can change, with the standard deviation remaining unchanged in accordance with Bem-Gai et al. (1998).

The months of March to July have 69% of monthly rainfall contribution, while in the months of August to February their contributions are 31% of the annual value. In agreement with Medeiros (2016). (Figure 2).

The months of April, June, and July have high rainfall contributions and those with low contributions occur between October and November, respectively.

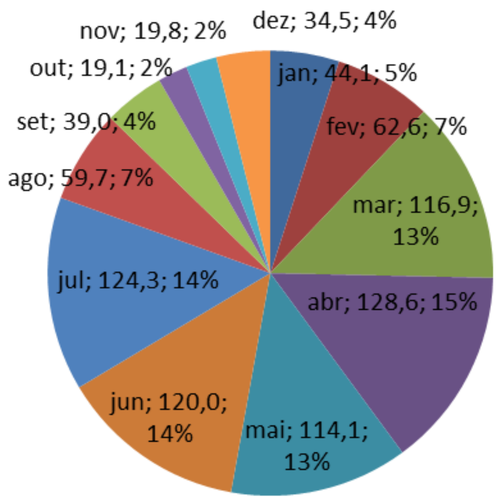

Figure 2 shows the percentage of monthly rainfall in the BHRI area between the period 1962 to 2017.

Source: Medeiros, (2022).

Figure 3 shows the annual and historical precipitation by municipal of the entire historical series, around the basin under study, there is an irregularity in the distribution of precipitation over the months in the 55 years observed. In the municipalities of Amarají, Escada, Ipojuca, Primavera and Vitória de Santo Antão, rainfall above 900 mm is recorded, for the other municipalities in the study area, rainfall is below 900 mm. These irregularities are due to the inhibiting and/or causing factors of rain in BHRI, being part of the rainfall regimes in the coastal, forest, and rural areas, respectively.

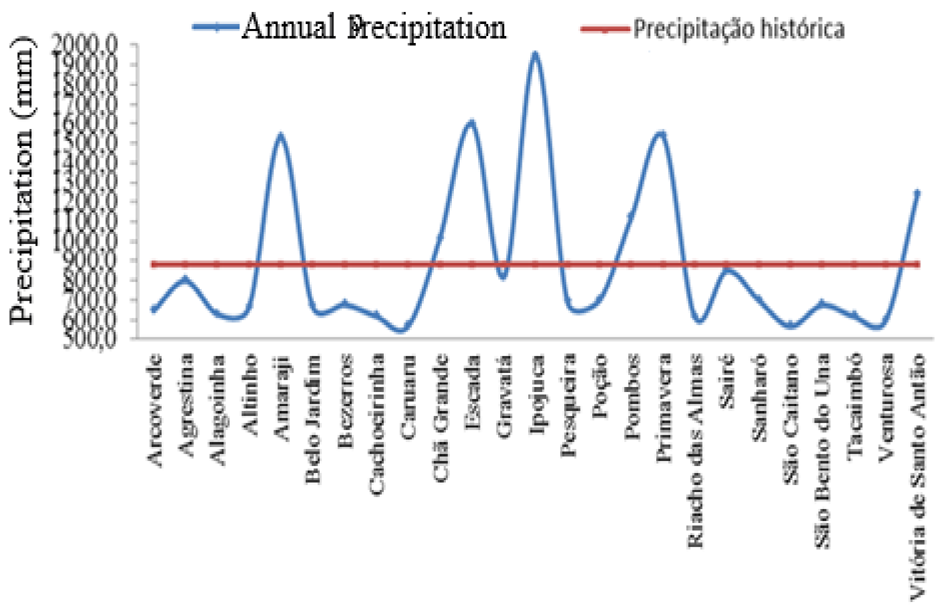

Figure 3. Average annual and climatological precipitation for the area of the Ipojuca river basin in the period 1962-2017.

Source: Medeiros, (2022).

Analyzing the rainfall anomalies shown in Figure 4, it is observed that from the total of 25 municipalities, only 7 municipalities had positive anomalies, with two municipalities with anomalies below 200 mm, one with anomalies close to 400 mm and the others with anomalies exceeding the 600mm.

The variability of negative anomalies stands out in the municipalities Agrestina, Gravata, and Sairé, which have the smallest anomalies recorded in the period 1962-2017.

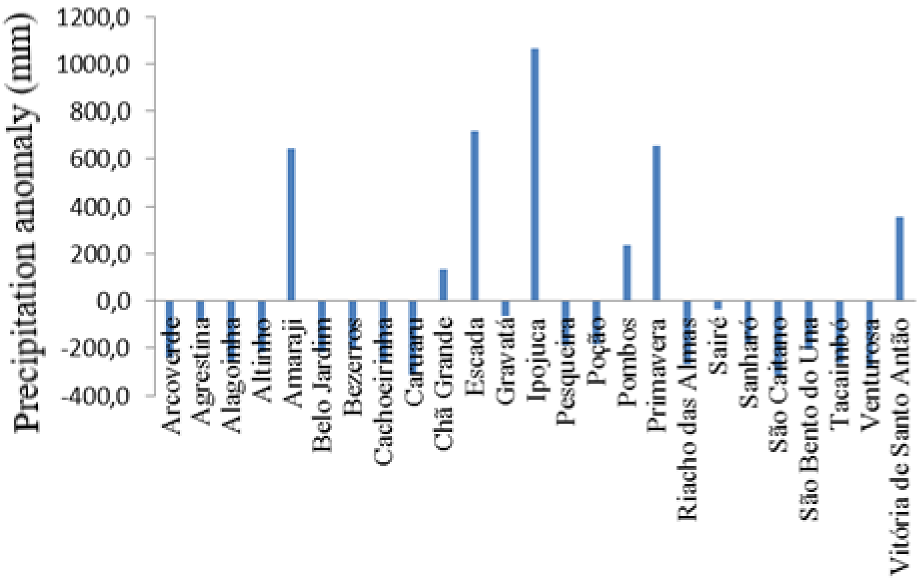

Figure 4. Monthly average precipitation anomaly for the Ipojuca river basin area in the period 1962-2017.

Source: Medeiros, (2022).

Table 4 shows the variability of the average rainfall anomaly for the Ipojuca river basin, corresponding to the 25 surrounding municipalities for the study period between the years 1962-2017.

The municipalities that presented negative anomalies every month were: Altinho, Belo Jardim, Cachoeirinha, Caruaru, Riacho das Almas, São Caitano and Tacaimbó. While the municipalities of Amaraji, Chã Grande, Escada, Ipojuca, Primavera and Vitoria de Santo Antão registered positive anomalies every month, the other municipalities presented alternating months, ie, negative anomalies fluctuations and positive.

Table 4. Variability of the average rainfall anomaly for the Ipojuca river basin, corresponding to the 25 surrounding municipalities.

Counties	Jan	Feb	mar	abp	may	jun	Jul	aug	sep	out	nov	dec	annual
Arcoverde	3,9	11,2	5,4	-19,2	-45,3	-53,1	-66,5	-30,6	-24,7	-9,0	1,2	-11,3	-237,9
Argentina	-9,0	-15,0	-25,7	-15,5	-10,9	-2,2	5,8	5,5	1,6	-4,1	-4,4	-10,8	-84,7
Alagoinha	-1,6	6,8	-3,5	-16,2	-40,0	-57,3	-68,7	-42,3	-19,9	-4,9	-4,9	-1,0	-253,3
Altinho	-10,7	-16,0	-28,8	-21,8	-30,5	-32,2	-31,7	-17,2	-8,2	-6,0	-7,0	-10,2	-220,2
Amaraji	12,4	10,4	27,6	41,4	88,0	130,0	157,2	84,0	34,4	16,3	21,2	23,3	646,2
Belo Jardim	-4,8	-2,1	-2,0	-14,4	-38,2	-47,7	-44,1	-26,4	-21,7	-8,7	-3,1	-2,1	-215,2
Bezerros	-10,5	-12,9	-20,2	-16,7	-24,6	-35,5	-32,0	-21,3	-6,0	-5,3	-10,0	-10,1	-205,1
Cachoeirinha	-7,3	-11,2	-22,1	-21,5	-39,3	-45,4	-49,3	-30,1	-14,7	-5,8	-5,8	-12,8	-265,3
Caruaru	-13,4	-14,0	-26,2	-27,9	-43,9	-50,1	-55,9	-30,5	-17,2	-9,6	-14,0	-14,2	-316,8
Chã Grande	1,5	-1,2	8,1	14,1	25,7	23,4	32,6	5,1	12,4	4,6	3,9	1,2	131,5
Escada	21,9	24,0	46,2	70,7	122,9	126,0	112,9	91,7	49,2	19,5	15,3	15,6	715,8
Gravatá	-3,4	-6,5	-3,7	1,9	3,4	-15,6	-17,0	-17,9	4,9	0,5	-2,5	-8,4	-64,2
Ipojuca	38,9	41,2	59,9	97,0	176,2	200,2	162,5	130,9	72,6	32,4	23,7	28,3	1063,7
Pesqueira	-0,1	6,6	5,8	-14,1	-37,6	-42,0	-50,2	-28,8	-20,2	-6,6	-2,1	-2,7	-192,0
Poção	0,9	5,6	19,5	-11,8	-43,6	-39,9	-41,6	-27,1	-23,5	-9,2	-3,8	-10,6	-185,2
Pombos	2,8	-1,4	10,4	12,5	33,5	46,2	66,3	25,0	16,7	6,8	5,2	11,6	235,7
Primavera	12,8	11,5	30,0	40,7	85,9	134,4	155,4	90,1	34,8	15,8	18,7	23,5	653,7
Riacho Almas	-13,4	-15,0	-24,5	-26,4	-35,9	-37,4	-40,6	-30,1	-13,7	-7,3	-13,0	-10,0	-267,5
Sairé	-3,1	-6,4	-8,0	1,2	2,8	-12,7	-0,5	-8,3	7,0	0,7	-2,8	-3,8	-33,9
Sanharó	-0,3	1,9	4,8	-12,0	-37,4	-46,6	-42,4	-26,4	-19,8	-7,0	-5,1	9,1	-181,2
São Caitano	-11,8	-12,9	-27,0	-26,1	-47,1	-56,0	-54,1	-33,2	-17,5	-9,0	-9,7	-12,5	-317,1
S Bento do Una	-3,0	-4,1	-14,6	-17,4	-36,3	-43,8	-46,6	-27,1	-15,2	-3,2	-0,6	3,1	-208,7
Tacaimbó	-7,6	-8,2	-18,0	-20,4	-43,3	-51,1	-47,4	-32,7	-17,9	-7,8	-3,6	-8,2	-266,2
Venturosa	-3,2	4,5	-13,2	-21,5	-42,5	-63,8	-77,5	-44,4	-20,7	-3,8	-3,6	1,6	-288,1
Vitória S Antão	8,0	3,3	19,6	23,4	58,0	72,2	73,2	42,3	27,2	10,7	6,8	11,5	356,1

Source: Medeiros, (2022).

CONCLUSIONS

There is an increasing variability of annual and monthly precipitation. Variability is greater during the spring and summer seasons and less variability in the winter and autumn seasons.

Positive anomalies are registered in seven municipalities whereas negative anomalies occur in eighteen municipalities.

The result of the annual analysis made it possible to identify the climatic extreme municipalities with high total annual rainfall in Ipojuca, Escada, Primavera, and Amaraji and the extreme climatic municipalities with reduced total annual rainfall were Sairé, Gravata, and Agrestina.

Improved knowledge of local weather conditions on the occurrence of extreme rain events allows for the improvement of seasonal forecasts and helps decision-makers from government agencies to avoid or minimize natural disasters.

In general, it appears that local precipitation patterns are influenced by several precipitation systems that contribute to the amount of local precipitation and that their contributions are interconnected to meso and micro-scale and local scale systems with the interaction of land use and land cover.

REFERENCES

1.Alvares, C.A.; Stape, J.L.; Sentles, P.C.; Gonçalves, J.L.M.; Sparovek, G. Köppen's climate classification map for Brazil. Meteorologische Zeitschrift. 22, 2014. p.711–728.

2.APAC. Water and climate agency of the State of Pernambuco. 2017. ttp://apac.gov.br

3.Bem-Gai, T.; Bitan, A.; Manes, A.; Alpert, P.; Rubin, S. Spatial and temporal changer in Rainfall frequency distribution patterns in Israel. Theor. Appl. Climatol. v.61. 1998. p.177-190.

4.Bertoni, J.C.; Tucci, C.E.M.; Precipitation. In: Tucci, C.E.M. Hydrology: Science and application. Porto Alegre: University Ed. – UFRGS, ABRH, 2001. p.230

5. Cohen, J.C.P.; Fitzjarrald, D.R.; Oliveira, F.A.F.; Saraiva, I.; BARBOSA, I.R.S.; Gandu, AW Radar observed spatial and temporal rainfall variability near the Tapajos Amazon confluence. Brazilian Journal of Meteorology. v.29, 2014. p.23 30.

6. Coscarelli, R.; Caloiero, T. Analysis of daily and monthly rainfall concentration in Southern Italy (Calabria region). Journal of Hydrology. v. 416-417, 2012. p.145-156,

7.Fitzjarrald, D.R.; Sakai, R.K.; Moraes, O.L.L.; Oliveira, R.C.; Azevedo, O.C.; Matthew, J. Spatial and temporal rainfall variability near the Amazon Tapajós confluence. JGR: Biogeosciences. 2008. p.113, 1 17.

8.Galvani, E. Descriptive statistics in the classroom. In: VEnturi, LA Geography: Field, laboratory, and classroom practices. São Paulo: Editora Sarandi, 2011.

9.Medeiros, R.M.; Holanda, R.M.; Viana, M.A.; Silva, V. P. Climate classification in köppen model for the state of Pernambuco - Brazil. Journal of Geography (Recife). v.35, 2018. p.219 - 234.

10.Medeiros, R. M. Climatological study of the hydrographic basin of the Uruçuí Preto-PI. Publisher of the Federal University of Campina Grande – EDUFCG. Federal University of Campina Grande – UFCG editora@ufcg.edu.br. 2016. p.287.

11. Medeiros, R. M. Provocative and/or inhibiting factors for rain in the state of Pernambuco. 2016. Single distributions.

12. Medeiros, R.M.; Matos, R.M.; Saboya, LM F. Diagnosis of rainfall fluctuations in the state of Paraíba. Brazilian journal of physical geography. V.8, n.4, 2015. p.1017-1027.

13.Medeiros, R.M.; Santos, DC; Correia, D.S.; Oliveira, V.G.; RafaeL, A. R. Study of rainfall in the city of Campinas do Piauí. In: International Congress of Biological Sciences, 1, Recife, Annals. UCP, 2013. p.1-11.

14.Medeiros, R.M.; Silva, V.P.R.; Gomes Filho, M. F. Hydroclimatic analysis of the hydrographic basin of the Uruçuí Preto River – Piaui. Journal of Engineering and Technology. v.5. n.4. 2013. p.151-163.

15. Monteiro, J.B.; Zanella, M. E. Extreme rainfall events and associated impacts in Fortaleza - CE: an analysis using the quantile technique, in Silva, C. A. F. E. S.; Steinke, E.T. (Orgs.). UFGD, Dourados, 2014. p.165-186.

16. Oliveira, NL; Marcuzzo, F.F.N.; Barros, R. G. Influence of El Niño and La Niña on the number of days of rainfall in the State of Mato Grosso. Science and Nature, Santa Maria, v.37 n.4. p.284-297. 2015. DOI: http://dx.doi.org/105902/2179460X12717.

17. Silva, M.E.S.; Silva, C.B. Climatic variability - Physical and dynamic processes in the oceans and atmosphere. Journal of the Department of Geography (USP), v. 2. 2012. p.121-135.

18, Silva, V.P.R.; Pereira, E.R.R.; Azevedo, PV; Sousa, F.A.S.; Sousa, I. F. Analysis of rainfall and rainy days in the Northeast region of Brazil. Brazilian Journal of Agricultural and Environmental Engineering. v.15, n.2, 2011. p.131–138.

19. Simioni, J.P.D.; Rovani, F.F.M.; Iensse, AC; Wollmann, C. A. Characterization of Rainfall in the Ibicuí River Microbasin, RS. Journal of the Department of Geography – USP, v.28, 2014. p.112-133, Available at < http://www.revistas.usp.br/rdg/article/view/90008/92798>. Accessed on 4/13/2017.

20. Souza, W.M.; Azevedo, PV; Araújo, L. E. Classification of Daily Precipitation and Impacts Resulting from Disasters Associated with Rainfall in the City of Recife-PE. Brazilian Journal of Physical Geography. v.02, 2012. p.250-268.

Image *Author -1*	***Author Name – Corresponding Author*** *Raimundo Mainar de Medeiros* *Rural Federal University of Pernambuco*
Image *Author -2*	***Manoel Vieira de França*** *Rural Federal University of Pernambuco*
Image *Author -3*	**Luciano Marcelo Fallé Saboya3** *Federal University of Campina Grande*
Image *Author -4*	***Romildo Morant de Holanda*** *Rural Federal University of Pernambuco*
Image *Author -5*	*Wagner Rodolfo de Araújo* *Rural Federal University of Pernambuco*
Image *Author -5*	***Moacyr Cunha Filho*** *Rural Federal University of Pernambuco*