EXPLORATORY ANALYSIS OF RAINFALL SEASONALITY IN NATAL, NORTHEAST BRAZIL, FROM 1991 TO 2020

Conference Paper · July 2023

CITATIONS
0

READS
27

3 authors:

Dayvid Carlos Medeiros
Universidade Federal do Rio Grande do Norte
5 PUBLICATIONS **0** CITATIONS
SEE PROFILE

Júlio César Freire de Farias
Universidade Federal do Rio Grande do Norte
4 PUBLICATIONS **0** CITATIONS
SEE PROFILE

Francisco Castelhano
Universidade Federal do Rio Grande do Norte
52 PUBLICATIONS **120** CITATIONS
SEE PROFILE

EXPLORATORY ANALYSIS OF RAINFALL SEASONALITY IN NATAL, NORTHEAST BRAZIL, FROM 1991 TO 2020

Dayvid Carlos de MEDEIROS, Julio Cesar FARIAS, Francisco Jablinski CASTELHANO

Federal University of Rio Grande do Norte, Natal, Rio Grande do Norte, Brazil, dayvidcarlos.14@gmail.com, julio.freire.118@ufrn.edu.br, francisco.castelhano@ufrn.br

Abstract: *This work aims to analyze the seasonality of precipitation in the city of Natal, Rio Grande do Norte, northeastern Brazil. The methodology consisted of collecting rainfall data for Natal from the National Institute of Meteorology (INMET) for 1991 – 2020. Data organization and calculations were performed using the R software and according to their totals: extreme dry (< 15th percentile), dry (15th - 35th percentile), usual (35th - 65th percentile), wet (65th - 85th percentile) and extreme wet (>85th percentile). The Mann-Kendall trend test was also applied for each station and for the annual data, revealing an absence of significant trends in the city.*

Keywords: *Seasonality, trends; Rio Grande do Norte, precipitation.*

Résumé : ***Analyse exploratoire de la saisonnalité des precipitation à Natal, nord-est du Brésil, de 1991 à 2020****. Ce travail vise à analyser la saisonnalité des précipitations dans la ville de Natal, Rio Grande do Norte, nord-est du Brésil. La méthodologie a consisté à collecter les données pluviométriques du Natal auprès de l'Institut National de la Météorologie (INMET) pour la période 1991 – 2020. L'organisation des données et les calculs ont été effectués à l'aide du logiciel R et selon leurs totaux : extrême sec (< 15e centile), sec (15e - 35e centile), habituelle (35e - 65e centile), humide (65e - 85e centile) et extrêmement humide (>85e centile). Le test de tendance Mann-Kendall a également été appliqué pour chaque station et pour les données annuelles, révélant une absence de tendances significatives dans la ville.*

Mots clés : *Saisonnalité, tendances, Rio Grande do Norte, précipitation.*

Introduction

The urban climate is the result of the co-participation between society and nature in the atmospheric field, being responsible for the creation of specific climates in urban areas (Castelhano, 2020; Monteiro, 1976). Monteiro (1976) recognizes the urbanized space as the core of the urban climate and the way they are planned and organized can bring direct repercussions to their climates. The author purposes a division of the urban climate into three minor fields, namely: thermodynamic (thermal comfort); hydrodynamic (precipitation), and physical-chemical (air quality). In this work, the analysis of the second subsystem will be focused on, specifically the seasonality of rainfall, which allows us to guide the analyses, and it is worth emphasizing the inseparability of these elements. Thus, the objective of this work is to analyze the variability and seasonality of precipitation in the city of Natal, Rio Grande do Norte, northeastern Brazil. Therefore, seeking to contain fallacious speeches that use climate change as the only explanation for the intensification of socio-environmental problems, such as flooding, mass movements, and others. Thus, understanding the behavior of rainfall is essential for the development of urban planning measures that help to face these challenges. The city is the most populated in the Rio Grande Norte state with 890,480 inhabitants (IBGE,2020), and is located in the rainy tropical climate domain (classified as As' by Koppen-Geiger), with hot summers (December, January, and February) and concentrated rainfall during the winter (June, July, and August). According to Alves (2009), the atmospheric systems responsible for precipitation in the study area are Intertropical Convergence Zone (ITCZ), East Wave Disturbance, and Mesoscale Convective Complexes (MCC).

1. Data and Methods

The methodology consisted of collecting, organizing, and categorization of rainfall data by season for the city of Natal. Daily data provided by the National Institute of Meteorology (INMETt) from 1991 to 2020 were used, considering the most recent climatological normal for the city. Data were organized and distributed by the season of the year and later categorized according to the total values for each season. When analyzing a time series of rainfall data, it is possible to classify rainfall to observe its usual, recurring or extreme characteristics. Therefore, it was observed the importance of applying the technique of

percentiles, for the classification of seasons, in extreme dry, dry, usual, wet and extreme wet. The categorization of station types was based on the quantile methodology (Xavier, 1998). Thus, for each season we distributed precipitation into five categories concerning their totals: Extreme dry season (< 15th percentile), dry season (15th - 35th percentile), usual season (35th - 65th percentile), wet season (65th percentile - 85) and extreme wet season (>85th percentile). The data organization and calculations were performed using R software. After the categorization, we performed the Mann-Kendall trend test analysis in each station and for annual values. Table 1, reveals the ranges of rainfall values for each category and season, respectively.

Table 1. Categories of precipitation (mm) for each season in Natal, Rio Grande do Norte, Brazil

Seasons	EXTREME DRY	DRY	USUAL	WET	EXTREME WET
DJF - SUMMER	< 90.5	90.5 to 147.6	147.6 to 214.3	214.3 to 335.8	> 335.8
MAM - AUTUMN	< 480.8	480.8 to 549.1	549.1 to 729.4	729.4 to 890.6	> 890.6
JJA - WINTER	< 421.1	421.1 to 575.7	575.7 to 850.7	850.7 to 1103.8	> 1103.8
SON - SPRING	< 46.8	46.8 to 70.3	70.3 to 85.2	85.2 to 152.5	> 152.5

2. Results and Discussion

Table 2 presents the precipitation in each season of the year categorized according to the values presented in table 1 for the period 1991 - 2020.

Table 2. Totals of precipitation (mm) and categories in Natal, Rio Grande do Norte, Brazil - 1991-2020

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
DJF	43.5	240	91.5	181.6	85.7	123.6	146.3	132.8	220.7	157
MAM	715.3	730	349.3	797.4	901.2	726.2	754.8	341.5	604.5	514.7
JJA	531.3	512.2	319.6	1111.9	689.6	526.2	278.3	1139.5	209.1	1348.5
SON	74.1	45.1	88.6	80.9	67.1	208.7	14	41.2	70.7	225.9

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
DJF	88.1	215.6	246.5	665.3	48.8	141.3	168.3	92	417	207
MAM	509.1	744.4	643.2	585.4	878.6	653.4	633.6	897.1	957.2	523.5
JJA	623.6	929.7	497.8	1127.4	984.3	599.4	848.1	1416.9	881.8	402
SON	45.8	128.4	76.3	68.9	76.7	142.1	111.7	79.1	84.4	50.9

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
DJF	424.5	188.8	90.1	155	175.2	290.7	192.5	360.1	222.3	387.1
MAM	931.3	391.3	465.6	535	542.7	526.9	670.7	787.9	917.2	322.7
JJA	734.6	600.4	1071.7	861.5	660.8	263.5	636.3	586.9	530.8	N/A
SON	98.1	60.7	249.7	204.5	33.4	83.9	155.1	68.7	82.3	N/A

Category
EXTREME DRY
DRY
USUAL
WET
EXTREME WET

Seasons
DJF - SUMMER
MAM - AUTUMN
JJA - WINTER
SON - SPRING

During Summer season (December, January and February) it is possible to notice a concentration of Extreme Wet and Wet years during the last decade, meanwhile, during the first decade, the Dry years are more recurrent.

Similar pattern can be recognized when we look at the Spring season (September, October and November) with most of their Extreme Wets and Wet years during the last decade. Autumn season (March, April and May), in the other hand, concentrated their Dry and Extreme Dry seasons in the last decade, and their Wet and Extreme Wet years during the decade 2001-2010.

The years of 1993, 1997, 1998, 2001, 2010, 2013 and 2015 were the ones with more seasons classified as Extreme Dry or Dry. This can be explained by the occurrence of strong El Niño, except for 2010, which causes droughts over the Northeast Brazil. Wet seasons, however, were concentrated in the years 2009 and 2011, years with strong La Niñas, causing the opposite effect in the brazilian region where Natal is located.

Even so, the Mann-Kendall trend test did not reveled any significant trend (positive or negative) for Natal (Table 3). The absence of trends for precipitation in Natal is in accordance with recent literature that revealed the same fact for the costal zone of northeast Brazil (Dubreuil et al, 2018; Castelhano an Pinto, 2022).

Table 3. Trend Values (tau and p-value) for precipitation in each season and yearly in Natal, Rio Grande do Norte, Brazil - 1991-2020.

	TAU	P-VALUE
DJF	0.329	0.011
MAM	-0.039	0.775
JJA	-0.004	0.985
SON	0.143	0.284
TOTAL	0.021	0.886

Conclusions

It was found that regarding the seasonality of rainfall in Natal, Rio Grande Norte, despite the various synoptic systems present, when observing in detail and using statistics to aid the analysis, it was possible to verify the absence of trends in the climate of the region. Thus, it is possible to state that rainfall in the area under analysis has not shown significant trends however, revealed a significant variability during the study period.

Despite the fact that Natal is close to the Equatorial, and seasonality effects in the city are quite smooth compare to cities from higher latitudes, this paper revealed several differences in both trends and frequencies of precipitation categories across the seasons, justifying the application of a seasonal approach. However, the authors strongly suggest that further studies in monthly scale would be carry out in order to define the trends and categories in a more detailed scale and verify the effects of the seasonality.

Understanding the behavior of rainfall is essential for the development of urban planning measures that help to face socioenvironmental problems. linked to precipitations such as floods, mass movements, and other disasters Those events are usually referred to as a consequence of climate change, however, we were able to suggest that they are more connected to a local sociopolitical situation than a global issue.

Acknowledgement: The authors would like to acknowledge the Federal University of Rio Grande do Norte and the National Institute for Meteorology for the data and structure to develop this research.

Bibliography

Alves A.E.L., 2009: *Monitoramento da qualidade das águas de chuvas conforme a atuação dos sistemas sinóticos na cidade de Natal/RN.* Universidade Federal do Rio Grande do Norte, 200 pages.

Castelhano F.J., 2020: *O Clima e as Cidades.* Intersaberes, 258 pages.

Castelhano F.J., Pinto, J.E..S.S,2022: Tendências e alterações climáticas no Estado de Sergipe, nordeste do Brasil, *Revista do Departamento de Geografia*, **42**, e185565.

Dubreuil V.; Fante K.P., Planchon O., Sant'anna Neto J.L., 2018: Climate Change Evidence in Brazil from Koppen's Climate Annual Types Frequency, *International Journal of Climatology*, **1**, 1-14.

Monteiro, C.A.F., 1976: *Teoria e Clima Urbano*, IG USP, 270 pages.

Xavier T. M. B. S, Xavier A. F. S. 1999: Caracterização de períodos secos e ou excessivamente chuvosos no estado do Ceará através da técnica dos quantis: 1964-1998. *Revista Brasileira de Meteorologia*, **14**, 63-78.