P-ISSN: 2618-0723
E-ISSN: 2618-0731

NAAS Rating: 5.04
www.extensionjournal.com

International Journal of Agriculture Extension and Social Development

Volume 7; SP-Issue 11; November 2024; Page No. 46-51

Received: 19-09-2024
Accepted: 24-10-2024

Indexed Journal
Peer Reviewed Journal

# Spatio-temporal analysis of rainfall patterns and their climatic implications in Mahanadi basin of Chhattisgarh, India

**[1]Anshu lata Xalxo, [2]N Manikandan and [3]Megha Sahu**

[1, 3]Department of Agrometeorology College of Agriculture, Raipur, Chhattisgarh, India

[2]ICAR-CRIDA, Hyderabad, Telangana, India

**DOI:** https://doi.org/10.33545/26180723.2024.v7.i11Sa.1313

**Corresponding Author:** Anshu lata Xalxo

**Abstract**

The present investigation entitled "Trend analysis of rainfall for different districts of Chhattisgarh state." was conducted at Institute Of Water Management, Bhubaneswar, Odisha, during 2019-2020. The district-wise long term weather data (1981-2018) was collected from Department of Agrometeorology, IGKV, Raipur. To fullfill the objectives of present investigation long term daily data (from 1981-2018) was used, which was averaged on monthly, annual and seasonal method of Ms-Excel. The 10 parental districts were selected for study i.e. Bilaspur, Korba, Mahasamund, Kabirdham, Dhamtari, Raigarh, Janjgir-Champa, Rajnandgaon, Raipur, Durg. Based on trend analysis it was reported that Dantewada and Mahasamund districts recorded significant increasing trend of rainfall at the rate of 8.3mm and 8.9mm per year respectively whereas, the districts Korba, Jashpur-Nagar and Kabirdham showed significant decreasing trend of rainfall at the rate of 8.3mm, 16.3mm and1.9mm per year.

**Keywords:** Rainfall, Mann-Kendall, significant, Chhattisgarh

## Introduction

Rainfall is a natural phenomenon that provides us with water that sustains life on the earth. According to one estimate, the amount of total water in the world is approximately 1.386 billion km3.Precipitation is the primary source of water for all living organisms, resulting in the maximum contribution of water. The world's average annual rainfall is around 1000mm, but it is dispersed across the globe. Southeast Asia's monsoon region is where the equatorial zone and the rainy season areas have the highest rainfall. To understand the spatial and temporal variations of rainfall, it is crucial to study the distribution of rainfall over time and space. It aids in comprehending the hydrological balance at a regional level and water management in agriculture. Activities profoundly depend on micro-level rainfall, variability analyses of rainfall in Indian context require urgent and systematic attention due to important promising suggestions on fresh agriculture, water availability etc. Planning and managing water resources are crucial. Modifications in rainfall trend, amount variability and its spatial and seasonal distribution critically modify the river runoff pattern and regimes (Gosain *et al*. 2006) [1] soil moisture, (Jain and Kumar, 2012) [2], frequency of rainfall extremes, ground water reservoirs, including droughts, floods and and agricultural productivity vegetation activity and cropping pattern Dore, 2005 [3] and Kumar *et al*. 2010 [4]. The most important and variable climatic parameter in the semi-arid tropics, according to interpretation, is rainfall. Trend and variability study of rainfall in Indian context require urgent and systematic attention due to important possible suggestions on agriculture, fresh water availability, food security and primary economic activities, etc. Jain and Kumar 2012 [2]. According to reports, India's most pressing issues are climate change and rainfall patterns. Due to number of factors that influenced directly or indirectly the rainfall pattern of any regions may change. It also becomes very important to know the distribution of rainfall over an area. This one factor not only helps in knowing the climatic condition but also helps in understanding natural vegetation, soil and also helps in selecting the crop. The quantity of rainfall an average, annual and seasonal or monthly scales is key elements affecting the water availability. The concentration of precipitation in time is also play a decisive role in agriculture production system. The analysis of changing rainfall distributions from the long term data helps to know the cycle of rainfall pattern across the particular area that also helps in knowing the future planning in agriculture and allied sectors.

## Materials and Methods

Study Area Chhattisgarh is located in the east-central part of India, between the latitude of 17º 46´N - 24º 5´ N and the longitudes of 80º 15´ E - 84º 20´ E. Its proximate position with the Tropic of Cancer has a major influence on its climate. The neighboring state of Chhattisgarh are Maharashtra and Madhya Pradesh on the west, Uttar Pradesh on the north, Jharkhand on the north-east, Orissa on the east, and Andhra Pradesh on the south, stretched in an area of 135,194 sq km. 2.2.

**Data**

The present work carried out in Bilaspur, Korba, Mahasamund, Kabirdham, Dhamtari, Raigarh, Janjgir-Champa, Rajnandgaon, Raipur, Durg from the period of 1981-2018. The district-wise monthly rainfall data from 1981-2000 has been collected from India Meteorological Department (https://mausam.imd.gov.in) and 2000-2018 collected from weather database of Agrometeorology department of Indira Gandhi Krishi Vishwavidalaya, Raipur Chhattisgarh.

**Description of software used**

The two software that are used in the current study are Weather cock software and Trend V1.0.2 software

**Table 1:** Geographical locations of selected plains districts of Chhattisgarh

| Station | Latitude | Longitude | Altitude |
|---|---|---|---|
| Bilaspur | 22.09°N | 82.15°E | 866 |
| Korba | 22.35°N | 82.68°E | 827 |
| Mahasamund | 21.1°N | 82.1°E | 1043 |
| Kabirdham | 21.32' to 22.28' N | 80.48' to 81.48E | 925 |
| Dhamtari | 20°42' N | 81°33' E | 317 |
| Raigarh | 21.9°N | 83.4°E | 215 |
| Janjgir-Champa | 21.6-22.4 N | 82.3-83.1 E | 294.4 |
| Rajnandgaon | 20°70'- 22°29' N | 80°23' to 81°29' E | 307 |
| Raipur | 21°13'N | 81°37'E | 290 |
| Durg | 20°54′ to 21°32′ N | 81°10′ to 81°36′E | 317 |

**2.4. To workout Precipitation Concentration Index (P.C.I) for different districts of Chhattisgarh state:**

The P.C.I refers to Precipitation Concentration Index given by Oliver (1980) and developed by De Luis et.al (1997) was used for the calculation of the annual P.C.I. Here the P.C.I was used to estimate the heterogeneity of rainfall". Through P.C.I the data related to the long term variability in the amount of rainfall received is obtained and was calculated using the formula given below eq (1).

**Table 2:** The different class limits of PCI (Precipitation Concentration Index) and representative of its rainfall concentration

| S. No. | P.C.I value | Concentration |
|---|---|---|
| 1 | P.C.I <10 | Uniform precipitation concentration (low precipitation concentration) |
| 2 | P.C.I >11 &<15 | Moderate precipitation concentration. |
| 3 | P.C.I >16 &<20 | Indicates irregular distribution. |
| 4 | P.C.I>20 | Indicates a strong irregular (high precipitation concentration) |

According to this classification, Oliver (1980) suggested that PCI values of less than 10 represent a uniform precipitation distribution (i.e., low precipitation concentration); PCI values from 11 to 15 denote a moderate precipitation concentration; values from 16 to 20 denoteir regular distribution and values above 20 represent a strong irregularity (i.e., high precipitation concentration) of precipitation distribution. The descriptions of concentration according to different values are given in table 2.

**Results and Discussion**

The rainfall variability, in terms of trend analysis, rainfall seasonality index and Precipitation concentration index was worked out for 10 parental districts they are Bilaspur, Korba, Mahasamund, Kabirdham, Dhamtari, Raigarh, Janjgir-Champa, Rajnandgaon, Raipur, Durg *viz*., monthly, seasonal and annual across the Chhattisgarh.

**Trend analysis of annual rain fall for Bilaspur district**

The outcome of trend analysis of rainfall workout for Bilaspur district is presented in (Table 3.1 and depicted in Fig.3.1). Indicates that district received a maximum rainfall of 1567.4 mm in the year 1994 and the lowest rainfall of 563.8mm in the year 2001, with the average annual rainfall of 1125.2 mm during the last 38 years. The district rainfall data subjected to trend analysis and outcome indicates non-significant stable trend of annual rainfall in linear trend graph. This result is in confirmatory with the finding of Meshram *et al*. (2016) that Bilaspur indicates nonsignificant stable trend for annual rainfall.

**Trend analysis of annual rainfall or Korba district**

The outcome of trend analysis of long term data of rainfall recorded for Korba district is presented in (Table 3.1 and depicted in the Fig. 3.1). It is quite clear from the table the 1920.2mm was maximum rainfall with the minimum rainfall of 751.5mm in the year 2000. The average annual rainfall of Korba district was 1281mm during last 38 years. A significant decreasing trend of rainfall was recorded in the district with decrease rate of 8.389mm per year.

**Trend analysis of annual rainfall for Mahasamund district**

The outcome of trend analysis of rainfall workout for Mahasamund district is presented in (Table 3.1and depicted in Fig.3.1) indicates that district received a maximum rainfall of 1582.1mm in the year 1985 and the lowest rainfall of 640.1mm in the year 1996, with the average annual rainfall of 1105.2 mm during the last 38 years. The district rainfall data is subjected to trend analysis and outcome indicates increasing significant trend at 5% level for annual rainfall in linear trend.

**Trend analysis of annual rainfall for Kabirdham district**

The results of trend analysis of rainfall of Kabirdham district carried out with the help of last 38 years data is presented in (Table3.1 and drawn in Fig.3.1). It is quite clear from the table that the highest rainfall was 1589.1mm in the year 1985, while in the year 2000 realized lowest amount of rainfall i.e. 687.4.mm with anaverage rainfall of 970.5mm. The result showed significant decreasing at 5% trend of rainfall on annual basis at the rate of 1.9mm per year. Contrast to the different findings Devendra showed that rainfall trend show large variability and reported nonsignificant stable trend and significant increasing trend at 10% significant level.

**Trend analysis of annual rainfall for Dhamtari district**

The rainfall data of Dhamtari district was shown in (Table 3.1 revealed that district received a maximum rainfall of 1320.4 mm in the year 2006 and the lowest rainfall of 770.5 mm in the year 1987, with the average annual rainfall of 1129.1 mm during last 38 years. The district rainfall data was subjected to trend analysis and outcome indicates non-significant increasing trend of annual rainfall in linear trend graph (Fig.3.1).

**Table 3.1:** Annual precipitation concentration index from (1981-2018) of Bilaspur, Korba, Mahasamund, Kabirdham, Dhamtari of Chhattisgarh state

| Year | Bilashpur | Korba | Mahasamund | Kabirdham | Dhamtari |
|---|---|---|---|---|---|
| 1981 | 24.4 | 23.6 | 23.7 | 21.1 | 38.6 |
| 1982 | 18.5 | 28.8 | 35.8 | 16.5 | 26.2 |
| 1983 | 23 | 25.6 | 25.2 | 22 | 28.8 |
| 1984 | 22.8 | 25.7 | 26.9 | 22.7 | 21.3 |
| 1985 | 24.4 | 28.8 | 26 | 19.6 | 24.3 |
| 1986 | 20.7 | 26.5 | 24.4 | 17 | 24.6 |
| 1987 | 23 | 24.7 | 23.1 | 20.9 | 29.2 |
| 1988 | 25.2 | 27.4 | 21.4 | 21.2 | 24 |
| 1989 | 25 | 34.6 | 27.3 | 24.4 | 26.6 |
| 1990 | 20.3 | 23.1 | 18.1 | 19.3 | 22.8 |
| 1991 | 32.3 | 29.4 | 30.1 | 32.7 | 33.8 |
| 1992 | 27.2 | 29.6 | 34.1 | 30 | 32.9 |
| 1993 | 24.6 | 30 | 23.3 | 22 | 28.2 |
| 1994 | 25.5 | 28.9 | 27.8 | 20.6 | 22.3 |
| 1995 | 23.3 | 30.4 | 34 | 32.3 | 35.3 |
| 1996 | 26 | 28.6 | 32.7 | 26.4 | 35.3 |
| 1997 | 17 | 21 | 30.6 | 25.3 | 29.2 |
| 1998 | 18.4 | 18.6 | 21.6 | 22.2 | 21.3 |
| 1999 | 22.6 | 25.1 | 29.1 | 27 | 21.2 |
| 2000 | 31.6 | 20.6 | 30 | 22 | 24 |
| 2001 | 29.4 | 24.6 | 24.4 | 23.3 | 22.1 |
| 2002 | 20.3 | 22.9 | 24 | 23.3 | 23.7 |
| 2003 | 18.3 | 26.2 | 28.6 | 18.8 | 21.8 |
| 2004 | 18.7 | 31.6 | 19.1 | 21.9 | 21.7 |
| 2005 | 19.4 | 24.4 | 19.6 | 22.1 | 20.4 |
| 2006 | 22.8 | 29 | 36.7 | 24.4 | 26.9 |
| 2007 | 21.1 | 24.3 | 21.9 | 20.6 | 22.2 |
| 2008 | 21.8 | 28 | 24.6 | 25.6 | 25.3 |
| 2009 | 27.6 | 41.8 | 59.5 | 26.6 | 38.5 |
| 2010 | 24.5 | 31.4 | 29.1 | 30.1 | 25 |
| 2011 | 23.2 | 27.6 | 29.9 | 23.4 | 24.9 |
| 2012 | 23 | 24.9 | 28.8 | 20.7 | 20.6 |
| 2013 | 18.6 | 25.3 | 22.6 | 18 | 22.9 |
| 2014 | 17.4 | 24.7 | 28.8 | 19.1 | 26.9 |
| 2015 | 21 | 27.1 | 23.2 | 21.7 | 19.4 |
| 2016 | 19.5 | 25.9 | 23.4 | 24 | 21.4 |
| 2017 | 23.4 | 26.9 | 24.1 | 14.9 | 21.8 |
| 2018 | 21.8 | 27.2 | 26.4 | 23.6 | 23.4 |
| Average | 22.8 | 27 | 27.6 | 22.8 | 25.8 |

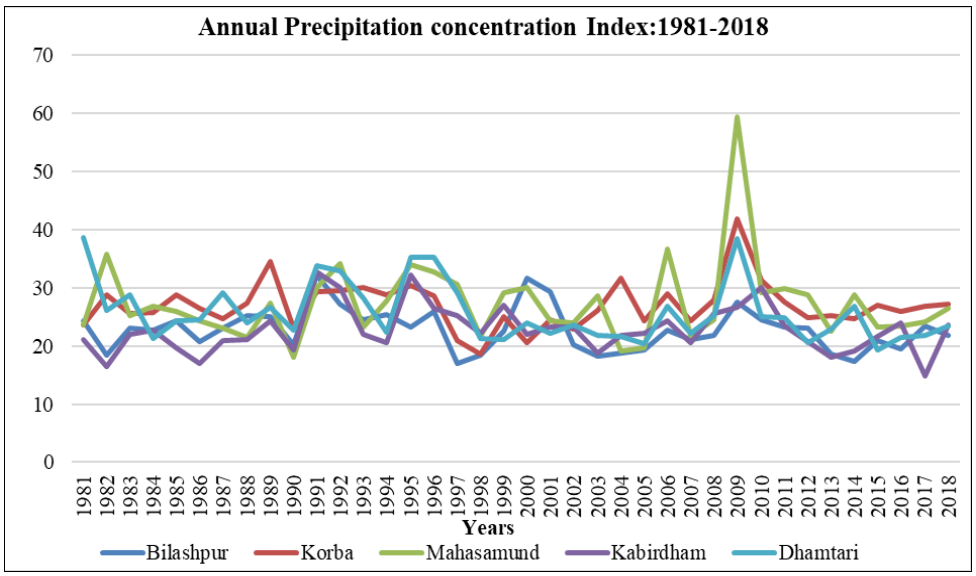


**Fig 3.1:** Annual precipitation concentration index from (1981-2018) of Bilaspur, Korba, Mahasamund, Kabirdham, Dhamtari of Chhattisgarh state

**Trend analysis of annual rainfall or Raigarh district**

The outcome of trend analysis of long term data of rainfall recorded for Raigarh district is presented in Table 3.2 (b) and depicted in the Fig. 3.2. It is quite clear from the table the 2244.4mm was maximum rainfall with the minimum rainfall of 778.2mm in the year 2014 and 2000 respectively. The average annual rainfall of Raigarh district was 1266.4mm during last 38 years. A significant decreasing trend of rainfall was recorded in the district with decrease rate of 2.42 mm per year. Similar result revealed by Devendra *et al.* (2018), Nema *et al.* (2018) [7] that Raigarh district showing significant decreasing trend of rainfall.

**Trend analysis of annual rainfall for Janjgir-champa district**

The effect of trend analysis of long term rainfall data of Janjgir-Champa district is presented in Table 3.2 and depicted in Fig. 3.2). The maximum amount of rainfall was obtained in the year 1983 *i.e.* 1773.1mm and the lowest rainfall was 782.4 mm in the year 2000, with the average annual rainfall of 1193.5 mm during the 38 years. The district rainfall data is subjected to trend analysis and outcome indicates non-significant stable trend of annual rainfall in linear trend graph.

**Table 3.2:** Annual preeipitation concentration index from (1981-2018) of Raigarh, Janjgir-Champa, Rajnandgaon, Raipur, Durg of chhattisgarh state.

| Year | Raigarh | Janjgir-champa | Rajnandgon | Raipur | Durg |
|---|---|---|---|---|---|
| 1981 | 24.7 | 27.5 | 27.4 | 24.9 | 34.,2 |
| 1982 | 28.5 | 27 | 21.1 | 29.6 | 26.2 |
| 1983 | 20.6 | 23.5 | 22.8 | 22.8 | 24.8 |
| 1984 | 23.3 | 26.7 | 20.1 | 24.8 | 21.8 |
| 1985 | 23 | 25.7 | 22 | 24.8 | 24.4 |
| 1986 | 18.5 | 27.6 | 22.9 | 25.5 | 25 |
| 1987 | 26.1 | 39.4 | 16.9 | 24.8 | 31 |
| 1988 | 22.5 | 24.1 | 23 | 21.7 | 23 |
| 1989 | 24.1 | 28.6 | 23.4 | 23.8 | 2.32 |
| 1990 | 19.8 | 23.8 | 19.4 | 16.9 | 20.6 |
| 1991 | 25.6 | 31.6 | 32.1 | 28 | 31.9 |
| 1992 | 26.1 | 27.3 | 33.5 | 28.3 | 34.5 |
| 1993 | 21.2 | 31.3 | 64 | 24.3 | 22.8 |
| 1994 | 26 | 29.4 | 22.7 | 23.4 | 25.8 |
| 1995 | 25.4 | 27.1 | 29.1 | 24.8 | 30.7 |
| 1996 | 26.3 | 28.3 | 26.4 | 32.6 | 34,2 |
| 1997 | 20.2 | 20.3 | 23.5 | 23.8 | 26,3 |
| 1998 | 17.2 | 17.6 | 27.2 | 18.3 | 17,6 |
| 1999 | 22.5 | 30.3 | 24 | 25.2 | 21.4 |
| 2000 | 23.7 | 30.5 | 28.1 | 29.3 | 283 |
| 2001 | 27.9 | 25.6 | 21.7 | 23.1 | 19.9 |
| 2002 | 26.9 | 24.5 | 23.8 | 23.2 | 21.1 |
| 2003 | 19.8 | 22.1 | 24.2 | 24 | 23.4 |
| 2004 | 31.1 | 27.2 | 24.9 | 22.2 | 27.8 |
| 2005 | 24.2 | 20.2 | 19.5 | 22 | 23.7 |
| 2006 | 26.6 | 27.2 | 32.7 | 25.8 | 30 |
| 2007 | 20.1 | 23.9 | 24.5 | 25.2 | 25.4 |
| 2008 | 24.9 | 26.3 | 22.9 | 23 | 26 |
| 2009 | 39.2 | 37.3 | 40.3 | 43.7 | 35.2 |
| 2010 | 24.9 | 28.4 | 25.7 | 28.1 | 24.9 |
| 2011 | 32.1 | 25.2 | 26.2 | 21.9 | 23.4 |
| 2012 | 24.3 | 228 | 26.7 | 24.3 | 24.7 |
| 2013 | 27.4 | 20.3 | 25.8 | 21.5 | 23.8 |
| 2014 | 26 | 24.3 | 26.6 | 23.3 | 22.1 |
| 2015 | 25.6 | 27.2 | 20.1 | 20.7 | 20.2 |
| 2016 | 26.5 | 28 | 19.8 | 22.2 | 21.6 |
| 2017 | 23.8 | 25.2 | 22.7 | 21.9 | 22.1 |
| 2018 | 25.5 | 26.3 | 25.7 | 26.2 | 21.4 |
| Average | 25 | 26.6 | 25.6 | 24.7 | 32.1 |

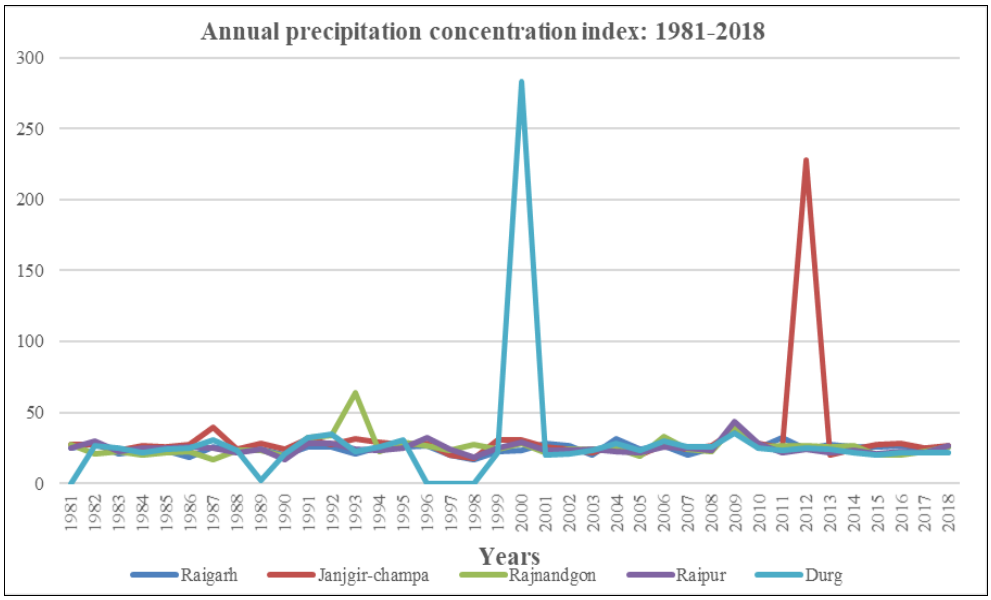


**Fig. 3.2:** Annual precipitation concentration index from (1981-2018) of Raigarh, Janjgir-Champa, Rajnandgaon, Raipur, Drug of Chhattisgarh state.

**Trend analysis of annual rainfall for Rajnandhgaon district**

The rainfall data of Rajnandhgaon district was shown in Table 3.2 revealed that district received a maximum rainfall of 2506.6mm in the year 1993 and the lowest rainfall of 769.8mm in the year 2009, with the average annual rainfall of 1179.2 mm during the 38 years. The district rainfall data was subjected to trend analysis and outcome indicates non-significant decreasing trend of annual rainfall in linear trend graph (Fig.3.2).

**Trend analysis of annual rainfall for Raipur district**

The effect of trend analysis of long term rainfall data of Raipur district is presented in Table 4.1(c) and depicted in Fig. 4.15. The maximum amount of rainfall was obtained in the year 1994 *i.e.* 1654.9mm and the lowest rainfall was 707.8mm in the year 2009, with the average 1136.7mm annual rainfall during the last38 years. The district rainfall data was subjected to trend analysis and outcome indicates non-significant stable trend of annual rainfall in linear trend graph (Fig. 4.15). Contrast to one finding Swain *et al.* 2015 reported that there is a decreasing significant trend in Raipur.

**Trend analysis of annual rainfall for Durg district**

The outcome of trend analysis of long term data of rainfall recorded for Durg district is presented in (Table 3.2 and depicted in the Fig. 3.2). It is quite clear from the table the 1552.3mm was maximum rainfall with the minimum rainfall of 650.0mm in the year 2011 and 1988 respectively. The average annual rainfall of Raigarh district was 1080mm during the last 38 years. A significant decreasing trend of rainfall was recorded in the district with decrease rate of 5.2 mm per year.

**Table 3.3:** South-west monsoon Seasonality Index values for Rajnandhgaon, Raipur, Durg, Narayanpur and Bijapur from 1981-2018

| YEAR | Bilaspur | korba | Mahasamund | Kabirdham | Dhamtari | Raigarh | Janjgir-Champa | Rajnandhgaon | Raipur | Durg |
|---|---|---|---|---|---|---|---|---|---|---|
| 1981 | 1.2 | 1.1 | 1.3 | 1.1 | 1.4 | 1.2 | 1.3 | 1.1 | 1.2 | 1.4 |
| 1982 | 0.8 | 1 | 1.2 | 0.9 | 1.3 | 1 | 0.9 | 0.9 | 0.9 | 1.1 |
| 1983 | 1.1 | 1.1 | 1.3 | 1.1 | 1.3 | 1 | 1.2 | 1.1 | 1.1 | 1.1 |
| 1984 | 1.1 | 1.2 | 1.3 | 1 | 1.1 | 1.1 | 1.2 | 1 | 1.2 | 1.1 |
| 1985 | 1.1 | 1.2 | 1.3 | 0.9 | 1.2 | 1.1 | 1.2 | 1.1 | 1.2 | 1.2 |
| 1986 | 0.9 | 1.2 | 1.1 | 0.9 | 1.2 | 0.9 | 1.3 | 1.1 | 1.2 | 1.2 |
| 1987 | 1 | 1.2 | 1.1 | 0.9 | 1.1 | 1.2 | 1.2 | 0.8 | 1 | 1.1 |
| 1988 | 1.2 | 1.3 | 1.1 | 1.1 | 1.2 | 1.1 | 1.1 | 1.2 | 1.2 | 1.3 |
| 1989 | 1.2 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.3 | 1.2 | 1.2 | 1.2 |
| 1990 | 1.1 | 1.2 | 1 | 1 | 1.2 | 1 | 1.2 | 1 | 0.9 | 1.1 |
| 1991 | 1.3 | 1.3 | 1.3 | 1.2 | 1.4 | 1.1 | 1.3 | 1.3 | 1.1 | 1.3 |
| 1992 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.5 | 1.3 |
| 1993 | 1.3 | 1.3 | 1.2 | 1.1 | 1.3 | 1.1 | 1.4 | 1.4 | 1.3 | 1.1 |
| 1994 | 1.2 | 1.3 | 1.3 | 1.1 | 1.1 | 1.3 | 1.3 | 1.1 | 1.6 | 1.2 |
| 1995 | 1.1 | 1.2 | 1.4 | 1.2 | 1.3 | 1.1 | 1.1 | 1.2 | 1 | 1.1 |
| 1996 | 1.1 | 1.3 | 1.3 | 1.2 | 1.4 | 1.3 | 1.2 | 1.2 | 1 | 1.3 |
| 1997 | 0.9 | 1 | 1.2 | 1 | 1.2 | 1.1 | 1 | 1 | 1.2 | 1.1 |
| 1998 | 0.8 | 1 | 1.1 | 1.1 | 1.1 | 0.9 | 0.9 | 0.9 | 1.1 | 0.9 |
| 1999 | 1.1 | 1.2 | 1.3 | 1.3 | 1 | 1.1 | 1.2 | 1.2 | 1.1 | 1.1 |
| 2000 | 1.2 | 1 | 1.3 | 1.1 | 1.1 | 1.2 | 1.2 | 1.2 | 0.8 | 1.3 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1 | 1.1 | 1 |
| 2002 | 1 | 1 | 1 | 1.1 | 1.1 | 1.1 | 1 | 1.1 | 1.1 | 1 |
| 2003 | 1 | 1.2 | 1.1 | 1 | 1 | 1.1 | 1.1 | 1.2 | 1.4 | 1.1 |
| 2004 | 0.9 | 1.2 | 1 | 1 | 1.1 | 1.3 | 1.2 | 1.2 | 0.9 | 1.3 |
| 2005 | 1 | 1.1 | 0.9 | 1.2 | 1 | 1.2 | 1 | 1 | 1.2 | 1.1 |
| 2006 | 1 | 1.2 | 1.3 | 1.1 | 1.1 | 1.1 | 1.1 | 1.3 | 1.1 | 1.2 |
| 2007 | 1.1 | 1.2 | 1.2 | 1 | 1.2 | 1.1 | 1.2 | 1.1 | 1.8 | 1.3 |
| 2008 | 1.2 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.3 | 1.1 | 1.7 | 1.3 |
| 2009 | 1.1 | 1.4 | 1.5 | 1.2 | 1.2 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 |
| 2010 | 1.2 | 1.3 | 1.2 | 1.3 | 1.1 | 1.2 | 1.3 | 1.2 | 1 | 1.2 |
| 2011 | 1.1 | 1.3 | 1.3 | 1 | 1.2 | 1.3 | 1.2 | 1.3 | 1.3 | 1.2 |
| 2012 | 1 | 1.2 | 1.2 | 1 | 1.1 | 1.2 | 1.1 | 1.2 | 1.4 | 1.2 |
| 2013 | 1 | 1.1 | 1.1 | 1 | 1.1 | 1.3 | 1.1 | 1.2 | 1.5 | 1.1 |
| 2014 | 0.9 | 1.1 | 1.3 | 0.9 | 1.2 | 1.2 | 1.1 | 1.1 | 1.2 | 1 |
| 2015 | 1.1 | 1.2 | 1.2 | 1.2 | 1 | 1.3 | 1.3 | 1.1 | 1 | 1.1 |
| 2016 | 1 | 1.3 | 1.1 | 1.2 | 1.1 | 1.2 | 1.3 | 1 | 1.1 | 1.2 |
| 2017 | 1.2 | 1.3 | 1.2 | 0.7 | 1.1 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 |
| 2018 | 1.1 | 1.3 | 1.2 | 1.1 | 1 | 1.1 | 1.1 | 1.2 | 1.7 | 1.1 |

## Conclusion

On the basis of our study the following important outcome can be drawn:

There was significant increasing trend of rainfall in Dantewada and Mahasamund districts at the 8.918mm per year respectively. While the districts Korba and Jashpur-Nagar reported significant decreasing trend of rainfall at the rate 8.3mm, 16.3mm and 1.9mm per year.

The Seasonality Index for mean annual rainfall indicates that Mahasamund, and Raipur showed extreme seasonality which indicates that the rainfall in a year is in between 1-2 months and the values for these districts ranges from 1.2 to 1.3. The Seasonality Index for south-west monsoon showed that Korba, Janjgir-champa having the maximum value with more than 0.40 which indicates that there was short-drier period in the season.

The Precipitation Concentration Index for the annual rainfall value indicates that the Chhattisgarh state comes under high precipitation concentration area with a strong irregular distribution of rainfall whereas, Drug district observed the maximum value of Precipitation Concentration Index i.e in between 28-30. The Precipitation Concentration Index for the south-west monsoon indicates that Korba, Mahasamund, Janjgir-Champa, and Rajnandhgaon show the maximum values of Precipitation Concentration Index that was between 10.2- 10.8 which means that the precipitation concentration was of moderate over this period. Whereas, the rest of the districts having uniform rainfall distribution with low precipitation concentration throughout the south-west monsoon.

## Suggestions for future research work

Based on the present study the following suggestion can be taken up for future research. This study can be drawn sized up to block and village level for better output.

## References


1. Gosain AK, Rao S, Basuray D. Climate change impact assessment on hydrology of Indian River basins. Curr Sci. 2006;90:346-353.
2. Jain SK, Kumar V. Trend analysis of rainfall and temperature data for India. Curr Sci J. 2012;102(1):37-49.
3. Dore MHI. Climate change and changes in global precipitation patterns: What do we know? Environ Int. 2005;31:1167-1181.
4. Kumar V, Jain SK, Singh Y. Analysis of long-term rainfall trends in India. Hydrol Sci J. 2010;55(4):484-496.
5. Chandniha SK, Meshram SG, Adamowski JF, Meshram C. Trend analysis of precipitation in Jharkhand State, India. Theor Appl Climatol. 2017;130(1-2):261-274.
6. Panda A, Sahu N. Trend analysis of seasonal rainfall and temperature pattern in Kalahandi, Bolangir and Koraput districts of Odisha, India. Atmos Sci Lett. 2019;20(10):932.
7. Nema MK, Khare D, Adamowski J, Chandniha SK. Spatio-temporal analysis of rainfall trends in Chhattisgarh State, Central India over the last 115 years. J Water Land Dev. 2018;36(1):117-128.
8. Nikhil Raj PP, Azeez PA. Trend analysis of rainfall in Bharathapuzha River basin, Kerala, India. Int J Climatol. 2012;32(4):533-539.
9. Valli M, Sree KS, Krishna IV. Analysis of precipitation concentration index and rainfall prediction in various agro-climatic zones of Andhra Pradesh, India. Int Res J Environ Sci. 2013;2(5):53-61.
10. Zhang Q, Xu CY, Gemmer M, Chen YD, Liu C. Changing properties of precipitation concentration in the Pearl River basin, China. Stoch Environ Res Risk Assess. 2009;23(3):377-385.