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Original Article

To Study Seasonal Rainfall Variability in Marathwada Division of Maharashtra

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ABSTRACT

Maharashtra, one of India's foremost states, is geographically divided into six regions: Konkan (Mumbai), North Maharashtra (Nashik), West Maharashtra (Pune), Vidarbha (Amravati and Nagpur) and Marathwada (Aurangabad). The climate in Marathwada is predominantly semi-arid, characterized by hot summers and mild winters. The Godavari River serves as the primary water source, flowing through the division's landscape, which is largely defined by valleys, plateaus and hills. A significant challenge facing Marathwada is drought and water scarcity. The average annual rainfall in drought-prone areas of the region is 882 mm. Rainfall data from 1990 to 2023 was analysed. The average annual rainfall of Marathwada division was calculated using the mean, standard deviation (SD), and coefficient of variation (CV) and the results are presented in a choropleth map.

Keywords: Marathwada, Rainfall Variability, Mean, Standard Deviation, Coefficient of variation, Choropleth map

INTRODUCTION

Maharashtra, a state in western India, showcases remarkable geographical and climatic diversity. From the inland Marathwada region to the coastal Konkan, its varied landscape contributes to a complex and fluctuating climate. The semi-arid region of Marathwada in Maharashtra depends heavily on the southwest monsoon, which delivers rainfall primarily from June to September. However, the monsoon's highly variable nature, both annually and geographically, creates obstacles for agriculture, water resource management and ensuring food security. According to IMD (India Meteorological Department) average annual rainfall in Marathwada is 882mm Marathwada comes under rain shadow area due to presence of western Ghats most of rainfall drains in the Konkan coastal plain (windward) and when it comes to Marathwada region it doesn't contain enough water vapour in the atmosphere. As a result, higher the mountains larger is the 'rain shadow zone'.

Definition and Objectives: - Seasonal rainfall variability refers to the fluctuations in rainfall patterns from year to year, or over shorter periods, such as within a season or between seasons. The primary purpose of this study is to achieve the following specific objectives.

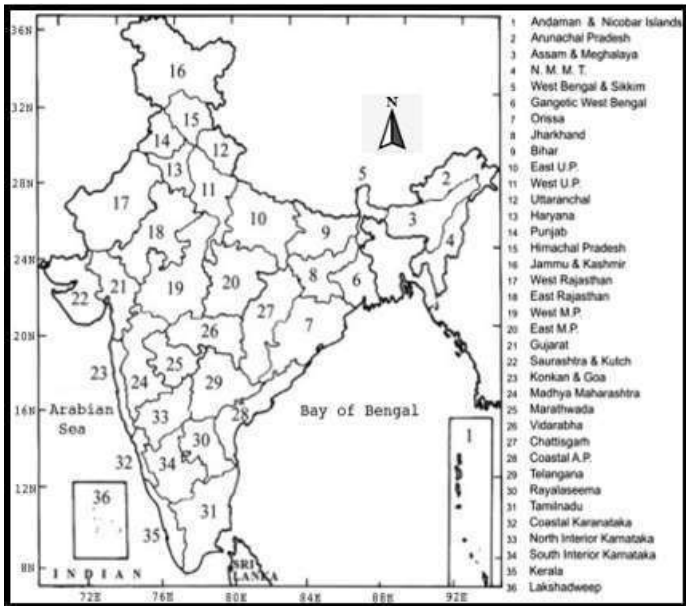
1. To study the seasonal annual rainfall of Marathwada Division during the year 1990 to 2023.

2. To Analyse seasonal rainfall variability in Marathwada division.

Study Area: - Chhatrapati Sambhajinagar (formerly Aurangabad) serves as the primary divisional headquarter for the Marathwada region. This region, located between 17.5°N and 20.5°N latitude and 74.5°E and 77.5°E longitude, encompasses 64,590 square kilometres, representing 21% of Maharashtra's total area. Marathwada is composed of eight districts: Chhatrapati Sambhajinagar (Aurangabad), Beed, Hingoli, Jalna, Latur, Nanded, Dharashiv (Osmanabad) and Parbhani. The India Meteorological Department (IMD) identifies Marathwada as meteorological division number 25.

Marathwada is indeed assigned the number 25 by IMD

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.



Source- India Meteorological Department (IMD)

Winter (November to January) is characterized by:

- Cool and dry weather with clear skies.
- Temperatures ranging from 10°C to 20°C (50°F to 68°F).
- Minimal rainfall, averaging only 10-20 mm (0.4-0.8 inches).
- Low humidity levels, typically around 30-40%.

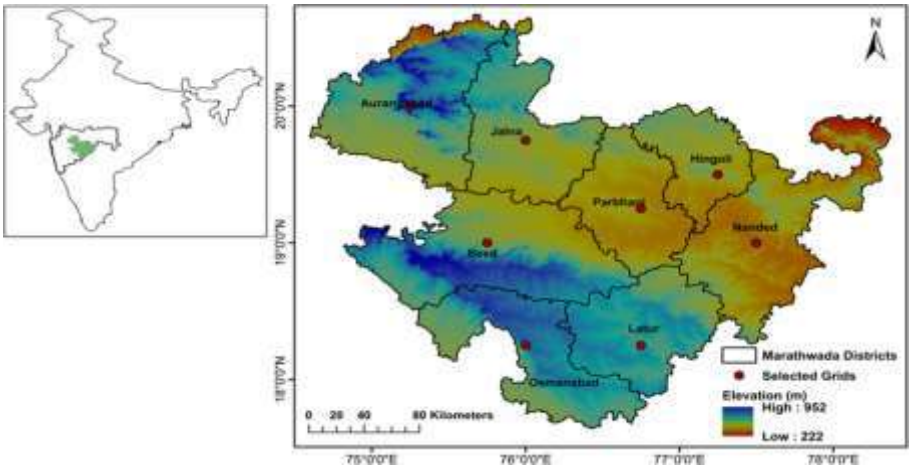
Summer (February to May) is defined by:

- Hot and dry weather, with occasional heatwaves.
- High temperatures, fluctuating between 30°C and 45°C (86°F and 113°F).
- Minimal rainfall, averaging 10-20 mm (0.4-0.8 inches).
- Low humidity, generally around 20-30%.

The Monsoon season (June to September) brings:

- Warm and humid weather, with frequent rainfall and thunderstorms.
- Temperatures between 20°C and 30°C (68°F and 86°F).
- Significant rainfall, averaging 700-800 mm (27-31 inches).
- High humidity, typically between 60-80%.

October Heat- marks the transition from the Monsoon to the Winter season. During this period, the Marathwada region experiences elevated temperatures, often reaching up to 40 degrees Celsius.



Marathwada districts Map by using Digitally Elevated Model (DEM)

Source: - India Meteorological Department (IMD)

Research Methodology: - The present research relies on secondary data obtained from the India Meteorological Department (IMD). The dataset comprises 33 years of records, covering the period from 1990 to 2023. The study investigates rainfall trends within the Marathwada division. Mean rainfall, standard deviation, and coefficient of variation were calculated to represent these trends, and the findings are presented. The follow in formulas were employed for data analysis:

- Mean Rainfall = (Σ Rainfall) / Number of Years = mm
- Standard Deviation = √[(Σ (Rainfall - Mean Rainfall)^2) / (Number of Years - 1)] = mm
- Coefficient of variation (CV) = (Standard Deviation / Mean Rainfall) × 100 = %"

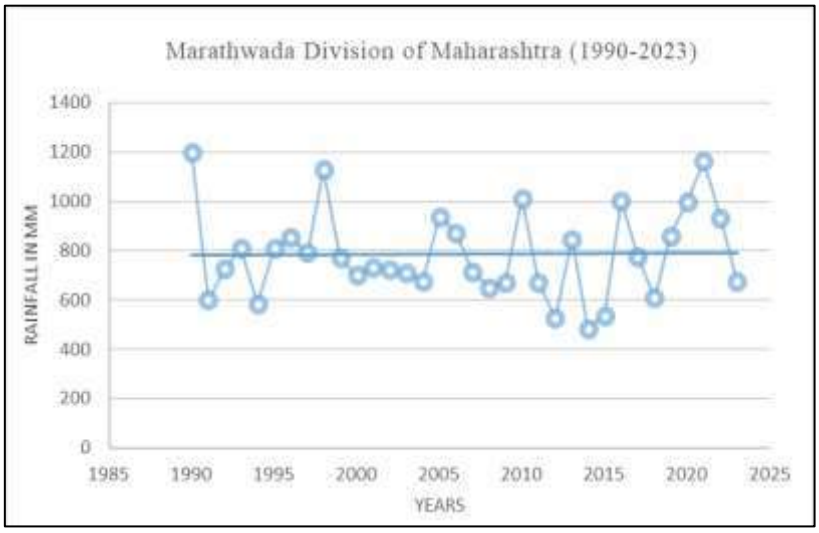
Table 1- Monthly Rainfall Data of Marathwada Division (1990-2023)

Year	Column1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
	NORM	4	2.4	6.8	5.3	13.4	135	170.4	176.9	160.9	74	17.8	5	771.6
1990	ACTL	2.9	0	0	0	142	221	129.9	369.9	103	223.1	5	2.9	1199.6
1991	ACTL	0.3	0.4	0.4	9.8	9.4	250	222.4	49.8	38.5	9.1	10.9	0	600.9
1992	ACTL	0	0	0	3.5	6.5	220	79.1	202.6	139.3	51.9	23.5	0	726
1993	ACTL	0	1.1	5.8	1.7	9	89.2	219	166.2	121.7	135.6	5.6	55.1	810
1994	ACTL	3.2	0.1	0	15	14.3	108	119.4	162.6	62.6	65.4	32.6	0	583.7
1995	ACTL	48.1	0.2	23.3	10.8	18	137	185.1	95.4	137.5	152.8	1.2	0	809.5
1996	ACTL	0.1	0	0.3	10.9	1.5	55.5	187.5	246.4	227.9	117.8	4.5	0.5	852.9
1997	ACTL	7.7	1.1	8.3	14.3	8	75.8	131	122.6	163.4	106.8	98.3	54.3	791.7
1998	ACTL	0.1	0.3	3.4	1.6	8.7	190	255.1	251.5	236.3	150.3	31.7	0	1128.9
1999	ACTL	0	5.8	0.1	0	18	145	133.1	133	215.9	118.2	0	0	769.5
2000	ACTL	0.5	4.1	0.5	0.4	17.1	191	161.3	246.5	45.5	30.9	0.7	1.7	700.5
2001	ACTL	4.7	0.5	0.5	10	0.7	150	56.7	255.8	83.8	170.5	1	0	733.8
2002	ACTL	5.5	3.9	0.6	5.9	9.1	242	58.5	223.8	122.8	44.5	4.7	0	721.2
2003	ACTL	1.7	1.3	2.1	5.1	23.9	116	251.9	184.4	96.3	21.8	4.5	0.8	709.7
2004	ACTL	1.3	0.4	5.5	1.9	29.5	101	200	76.5	176.7	58.1	24.2	0	675.2
2005	ACTL	12.5	0.6	11.4	1.6	2.2	58.8	412.3	124.6	213.5	100.5	0	0	937.9
2006	ACTL	0	0	30.7	1.6	26.7	135	116.2	301.3	209.4	47.7	4.6	0	872.9
2007	ACTL	0	0	0.1	0.7	9.1	186	123.1	146.2	240.7	0.9	7.5	0	713.8
2008	ACTL	0.1	0.1	14.6	3.7	1.8	66.7	106.4	150.3	270.6	33.1	1.7	0.3	649.3
2009	ACTL	0	0	0.5	0.8	7.4	64.3	140.2	167.3	159.8	59.3	63.2	8.4	671.2
2010	ACTL	4.4	5.8	3.9	0.7	4.7	120	329.5	291.4	157.3	58.1	36.7	0.2	1012.3
2011	ACTL	0	4	0.6	4.2	3.5	80.3	231.4	230.3	89.9	24.7	0	0	669
2012	ACTL	0	0	0	0.6	2.3	72.2	161.1	101.7	120.5	68.3	0.4	0	527
2013	ACTL	0.3	0.7	0.5	2	2.1	158	295.2	137.3	153.4	94	2.2	1.6	847.3
2014	ACTL	0.2	6.7	36.6	2.4	1.3	30.9	103.9	178.2	86.9	13.2	20.4	3.7	484.4
2015	ACTL	12.3	2.2	33.6	38	11.2	121	28.2	111.6	154.3	20.9	4.5	0	537.4
2016	ACTL	0	3.8	11.4	3.6	6.6	168	283.5	88.6	329.7	108.5	0	0.2	1003.8
2017	ACTL	0	0	5.7	0	3.7	191	83	244	141.3	99.4	2.8	3.1	773.6
2018	ACTL	0	8	1.6	10.5	5.6	202	120.8	207.9	31.4	10.6	10	0	608.6
2019	ACTL	0	0.4	0.3	5.4	0.7	90.6	142.8	139.1	215.1	236.3	27.4	1.5	859.6
2020	ACTL	2.8	0.8	9.5	11.8	10.7	209	225.9	158	258.2	112.9	0	0	999.3
2021	ACTL	0.4	9.8	7.1	6.4	22.8	191	257.2	170.8	378.5	93.8	16.5	7.9	1161.8
2022	ACTL	0.3	0	1	0.5	2.7	144	351.8	86.7	217.6	132.1	0	2.1	932.9
2023	ACTL	0.6	0	6	28.3	11.1	41.6	287.5	47	193.7	7.7	44.5	6.2	674.2
													Standard Deviation	**179.827**
													Mean	**786.747**
													CV	**22.857**

Source- India Meteorological Department (IMD)

This analysis examines the standard deviation, mean, and coefficient of variation (CV) of rainfall in the

Marathwada region of Maharashtra. The mean rainfall is a critical statistic for analysing rainfall variability as it represents the average rainfall conditions, providing a foundational understanding of typical precipitation levels for the region. The mean serves as a reference point for understanding deviations in rainfall patterns, allowing for the identification of periods of drought, excess rainfall or floods. Mean rainfall facilitates comparisons of rainfall patterns across different geographic locations, seasons, and years. Mean rainfall data is essential input for informed decision-making in sectors such as agriculture, water resource management, and infrastructure development. Analysing long-term trends in mean rainfall is crucial for identifying potential impacts of climate change on regional precipitation patterns. Understanding both the mean rainfall and its deviation allows for better assessment and management of risks associated with extreme weather events related to rainfall. Over the period of 1990-2023, the mean rainfall in the Marathwada division was calculated to be 786.747 mm.



Source- Rainfall data were obtained from the India Meteorological Department (IMD).

The region of Marathwada in Maharashtra exhibits a standard deviation of 179.827mm. The Coefficient of Variation (CV) of rainfall variability is a dimensionless measure that expresses the standard deviation of rainfall as a percentage of the mean rainfall. The coefficient of variation for the Marathwada region from 1990 to 2023 is 22.857%.

CONCLUSION: -

Analysis of rainfall patterns in Marathwada reveals key insights into the region's precipitation characteristics. The average rainfall serves as a crucial reference point. However, a standard deviation of 179.827 mm highlights considerable yearly fluctuations. The coefficient of variation (CV) of 22.857% confirms this moderate variability, suggesting a degree of stability despite the fluctuations. In summary, Marathwada's rainfall exhibits moderate variability with notable year-to-year changes. This understanding is crucial for effective agricultural planning, water resource management, and disaster mitigation strategies. Therefore, by leveraging insights into rainfall patterns and variability, policymakers and stakeholders can implement strategies to manage these variations, lessen the impact of extreme weather, and foster sustainable development.

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