ASSESSMENT OF RAINFALL VARIABILITY USING COEFFICIENT OF VARIATION: A CASE STUDY OF NASHIK DISTRICT, MAHARASHTRA

*Sachin Subhash Sonawane

Assistant professor, Departement of Geography, Rayat Shikshan Santha's S.S.G.M College, Kopargaon (M.H), Savitribai Phule Pune University, Pune.

*Corresponding Author: Sachin Subhash Sonawane

Assistant professor, Departement of Geography, Rayat Shikshan Santha's S.S.G.M College, Kopargaon (M.H), Savitribai Phule Pune University, Pune.

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ABSTRACT

The present study analyses rainfall variability in Nashik district, Maharashtra, for a period of 21 years (2000–2020). The study is based on secondary annual rainfall data collected for fifteen tehsils. Statistical techniques such as mean annual rainfall, standard deviation, and coefficient of variation (CV) were applied to assess the rainfall variability. The coefficient of variation was used to classify tehsils into low, moderate, and high rainfall variability categories. The results show considerable spatial variation in rainfall across the district. High rainfall tehsil such as Igatpuri and Trimbakeshwar receive high rainfall but exhibit high inter-annual variability, indicating erratic monsoonal behaviour. Rain-shadow Tehsil including Malegaon, Nandgaon, and Yeola experience low mean rainfall along with high variability, reflecting high rainfall uncertainty. Moderate variability is observed in Tehsil such as Nashik, Niphad, Sinnar, and Chandwad, indicating relatively more stable rainfall conditions. Notably, no taluka falls under the low variability category, highlighting the overall instability of rainfall in the district. The study concludes that both high-rainfall and low-rainfall Tehsil in Nashik district are affected by moderate to high rainfall variability, which has significant implications for agricultural planning, water resource management, and drought preparedness. The findings provide a useful statistical basis for understanding rainfall behaviour at the tehsil level and for supporting local-level planning.

KEYWORDS: Rainfall variability, Coefficient of variation, Standard deviation.

INTRODUCTION

Rainfall is one of the most important climatic elements influencing agriculture, water resources, and socio-economic activities in India. The country largely depends on the southwest monsoon, and even small variations in rainfall amount and distribution can have significant impacts on crop production and water availability. Maharashtra, in particular, experiences wide spatial and temporal variability in rainfall due to its diverse physiography, ranging from the Western Ghats to the Deccan Plateau. This variability often results in floods in high-rainfall regions and droughts in rain-shadow areas.

Nashik district occupies a unique geographical position in northern Maharashtra, extending from the windward slopes of the Western Ghats to the semi-arid interior plateau. As a result, the district exhibits sharp contrasts in rainfall characteristics at the tehsil level. Tehsil such as Igatpuri and Trimbakeshwar receive heavy rainfall due to orographic effects, while eastern Tehsil like Malegaon, Nandgaon, and Yeola experience low and erratic rainfall conditions. This uneven distribution makes the district highly vulnerable to rainfall uncertainty, affecting agriculture, groundwater recharge, and surface water availability. Understanding rainfall variability is crucial because average rainfall alone does not adequately explain rainfall behaviour. Statistical measures such as mean rainfall, standard deviation, and coefficient of variation provide deeper insights into the consistency of rainfall over time. Tehsil wise analysis helps in identifying areas with stable and unstable rainfall, which is essential for agricultural planning, drought mitigation, and sustainable water resource management.

AIM AND OBJECTIVE OF STUDY

The aim of the present study is to analyse the tehsil wise rainfall variability in Nashik district, Maharashtra, using statistical measures for the period 2000–2020, in order to understand spatial differences in rainfall variability.

1. To examine the mean annual rainfall pattern of different Tehsil in Nashik district.

2. To assess and classify rainfall variability across tehsils of Nashik district.

## SELECTION OF STUDY AREA

1. **To study**

2. **Key Statistics**

Key Statistics

The Nashik district is located in the northern part of the state of Maharashtra, India. Nashik district lies between approximately 19°33′ N to 20°53′ N latitudes and 73°16′ E to 75°06′ E longitudes. The district covers a geographical area of about 15,530 sq. km and forms an important part of the Deccan Plateau, with its western boundary marked by the Western Ghats. The district is bounded by Palghar district and Thane district to the west, Ahmednagar district to the south and southeast, Jalgaon district to the east, and Dhule district to the north. The physiography of the district varies from rugged hilly terrain in the west to gently sloping plains in the east. Administratively, Nashik district is divided into 15 Tehsil, namely Nashik, Igatpuri, Dindori, Peth, Trimbakeshwar, Malegaon, Nandgaon, Chandwad, Kalwan, Baglan, Surgana, Deola, Niphad, Sinnar, and Yeola.

The western Tehsil fall under the high-rainfall zone due to the orographic influence of the Western Ghats, while the eastern Tehsil lie in the rain-shadow region and receive comparatively low and irregular rainfall. The diverse topography and climatic conditions of Nashik district make it an ideal region for studying spatial and temporal rainfall variability at the taluka level.

Map No. 1

Location of Study area
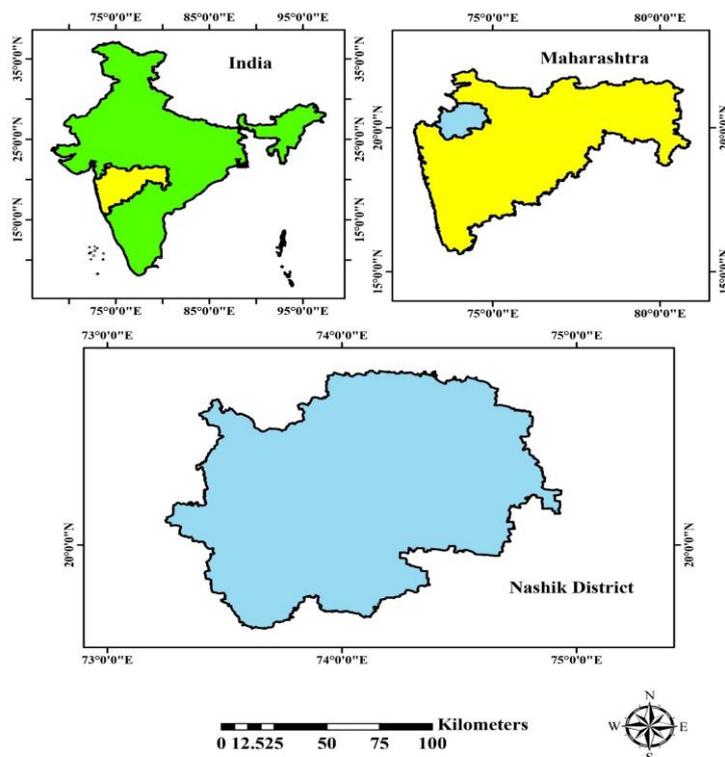
DATABASE AND METHODOLOGY

The present study is based on secondary rainfall data collected for Nashik district, Maharashtra. Tehsil wise annual rainfall data for a period of 21 years (2000–2020) were used to analyse rainfall variability. The dataset covers fifteen Tehsil, namely Nashik, Igatpuri, Dindori, Peth, Trimbakeshwar, Malegaon, Nandgaon, Chandwad, Kalwan, Baglan, Surgana, Deola, Niphad, Sinnar, and Yeola. The rainfall data were obtained from government and institutional sources such as the District Statistical Office, India Meteorological Department (IMD), and published records. The data were checked for consistency before analysis. Annual rainfall values were compiled in tabular form and used for statistical analysis of rainfall variability.

The study employs statistical methods to examine the spatial and temporal variability of rainfall at the tehsil level. The methodology consists of the following steps: Year-wise annual rainfall data for each tehsil were arranged systematically. Mean annual rainfall was calculated to understand the average rainfall conditions of each taluka during the study period. To assess rainfall variability, the following statistical measures were computed for each tehsil Mean Annual Rainfall (mm), Standard Deviation (SD) to measure absolute variability and Coefficient of Variation (CV %) to assess rainfall reliability

Table No. 1

Statistical Measures Used for Rainfall Variability calculation.

Sr. No.	Statistical Measure	Formula	Where
1	Mean Annual Rainfall	$\bar{X} = \frac{\sum X}{N}$	$\bar{X}$ = Mean annual rainfall (mm); X = Annual rainfall of a given year (mm); $\sum X$ = Sum of annual rainfall values; N = Total number of years
2	Standard Deviation (SD)	$\sigma = \sqrt{\frac{\sum(X-\bar{X})^2}{N}}$	σ = Standard deviation of annual rainfall (mm); X = Annual rainfall of a given year (mm); $\bar{X}$ = Mean annual rainfall (mm); $(X - \bar{X})$ = Deviation from mean; N = Total number of years
3	Coefficient of Variation (CV %)	$CV = \frac{\sigma}{\bar{X}} \times 100$	CV = Coefficient of Variation (%); σ = Standard deviation (mm); $\bar{X}$ = Mean annual rainfall (mm); 100 = Constant to express CV in percentage

Table No. 2

Average Annual Rainfall of Nashik District (2000–2020).

Sr.No	Year	Nashik	Igatpuri	Dindori	Peth	Trimbakeshwar	Malegaon	Nandgaon	Chandwad	Kalwan	Baglan	Surgana	Deola	Niphad	Sinnar	Yeola
1	2000	740.8	2083.8	530	1233	1487	408	696	461.2	317.7	325.8	1110.4	406.7	545.4	556.8	498
2	2001	640.9	2890	488	1683.5	1799	383	382	558	490.8	380.9	1526.7	447	499	420.9	484
3	2002	813.2	2847.3	867	1777	2114.6	552	584	716.2	868	544.7	2047	378.3	692.9	465.1	445.4
4	2003	910.4	3569.2	859	2100	2310	384	400	438	772	577	1927	391	619.2	811.8	390
5	2004	1059	3902	1094	2504	2467	671	517.4	828.3	1030.9	745	2474	464	1042.5	701.7	865.3
6	2005	1220	4540	798	2840	3740	423.1	413	639	874	603	3066.8	491	884	676	508
7	2006	1325.6	4770	1080	3330	3794	851	877.5	1161	1414	960	2992.2	864.3	879	951	930.6
8	2007	834.1	3663	770	1957	2511.8	739	629.2	791.4	826	811.3	1947	675	780.9	688.9	678
9	2008	1234	3869	1090	2227	2290.6	558	780	709	807	545	2013.5	454.5	733.1	684	725.8
10	2009	534	2100	644	1580	1412	763.5	792	818.8	785	750.8	1339	597.5	568.6	722.5	500.9
11	2010	770	3084	740	1845	1634	871	790.8	879	589	520	1442.6	443	725	804.5	881
12	2011	568	3032	565	1835	1642.9	396	571	551.5	480.4	553	1815	286.7	383	429	643
13	2012	506	2789	645	1690	1523	509	309	640	533	463.4	1512	384	500.1	446.8	486
14	2013	774	2213	961	1950.6	2029.4	663.8	644	441	765.9	622.9	1853	530	567.6	478.4	465.7
15	2014	621.4	1800	712	1299.9	1579	399.7	243	369	611	467.9	1088	390	486	399	342
16	2015	594	1462	744	940.9	1120.7	281	260	344.9	620.7	392	650.1	284	484.1	414.2	290.8
17	2016	1126	2099	1132	2001.8	2250.9	327.7	413.5	478.8	739.1	596	1122.9	562	648	656.3	507
18	2017	1050.8	2412	1819.9	2147.4	2730.5	321	473	583	687	568	1943.7	527	644	639	487
19	2018	989.9	2989	887	1867	2021.2	547	568	639	732	583	1785	498.7	663	630.8	551
20	2019	1337	5496	1283	3394.5	3895.7	677	682.5	740	750	745.2	2861.3	584.9	654.3	863	756.7
21	2020	910	3870	760	1663	1426	889	863.4	779.2	739	1042.6	1553.6	786.7	676.2	922	805.6

(Source: Water Resource Department: Nashik District**)**

CONCLUSION

The tehsil wise rainfall variability analysis for the period 2000–2020 reveals significant spatial variation in rainfall across Nashik district. The highest mean annual rainfall is recorded in Igatpuri (3118.11 mm), followed by Trimbakeshwar (2179.97 mm) and Peth (1993.65 mm), which are located in the Western Ghats and receive heavy orographic rainfall. However, these high-rainfall Tehsil also exhibit high standard deviation and coefficient of variation values (CV > 30%), indicating considerable year-to-year fluctuations of rainfall. Other hand, rain-shadow Tehsil such as Malegaon, Nandgaon, Yeola, and Deola receive comparatively low mean rainfall, yet most of them also show high variability, reflecting erratic monsoonal behavior.

Tehsil such as Nashik, Chandwad, Kalwan, Baglan, Deola, Niphad, and Sinnar fall under the moderate variability category (CV between 20–30%), suggesting relatively more stable rainfall conditions compared to other parts of the district. Notably, no taluka exhibits low rainfall variability (CV < 20%), highlighting the overall instability of rainfall across the district. The combined analysis of mean rainfall, standard deviation, and coefficient of variation indicates that both high-rainfall and low-rainfall Tehsil experience significant rainfall variability.

Table No. 3

TEHSIL-WISE RAINFALL VARIABILITY OF NASHIK DISTRICT (2000–2020).

Sr. No	Tehsil	Mean (mm)	SD (mm)	CV (%)	Variability
1	Nashik	883.77	257.8	**29.17**	Moderate
2	Igatpuri	3118.11	1020.05	**32.71**	High
3	Dindori	879.47	295.38	**33.59**	High
4	Peth	1993.65	600.19	**30.11**	High
5	Trimbakeshwar	2179.97	782.22	**35.88**	High
6	Malegaon	553.09	188.65	**34.11**	High
7	Nandgaon	566.16	189.85	**33.53**	High
8	Chandwad	646.01	192.08	**29.73**	Moderate
9	Kalwan	734.88	217.74	**29.63**	Moderate
10	Baglan	609.4	176.31	**28.93**	Moderate
11	Surgana	1812.9	620.8	**34.24**	High
12	Deola	497.44	143.13	**28.77**	Moderate
13	Niphad	651.23	152.74	**23.45**	Moderate
14	Sinnar	636.27	169.23	**26.6**	Moderate
15	Yeola	582.94	178.66	**30.65**	High

(**Source:** Compile by Researcher)

Table No. 4

Tehsil-wise Rainfall Variability Groups of Nashik District. (2000–2020)

Sr. No	Variability	CV Range	Tehsil
1	☐ Low Variability	< 20%	*None*
2	☐ Moderate Variability	20–30%	Niphad, Sinnar, Deola, Baglan, Nashik, Kalwan, Chandwad
3	☐ High Variability	> 30%	Igatpuri, Dindori, Peth, Trimbakeshwar, Malegaon, Nandgaon, Surgana, Yeola

(**Source:** Compile by Researcher)

Map No. 1

TEHSIL-WISE RAINFALL VARIABILITY OF NASHIK DISTRICT (2000–2020)
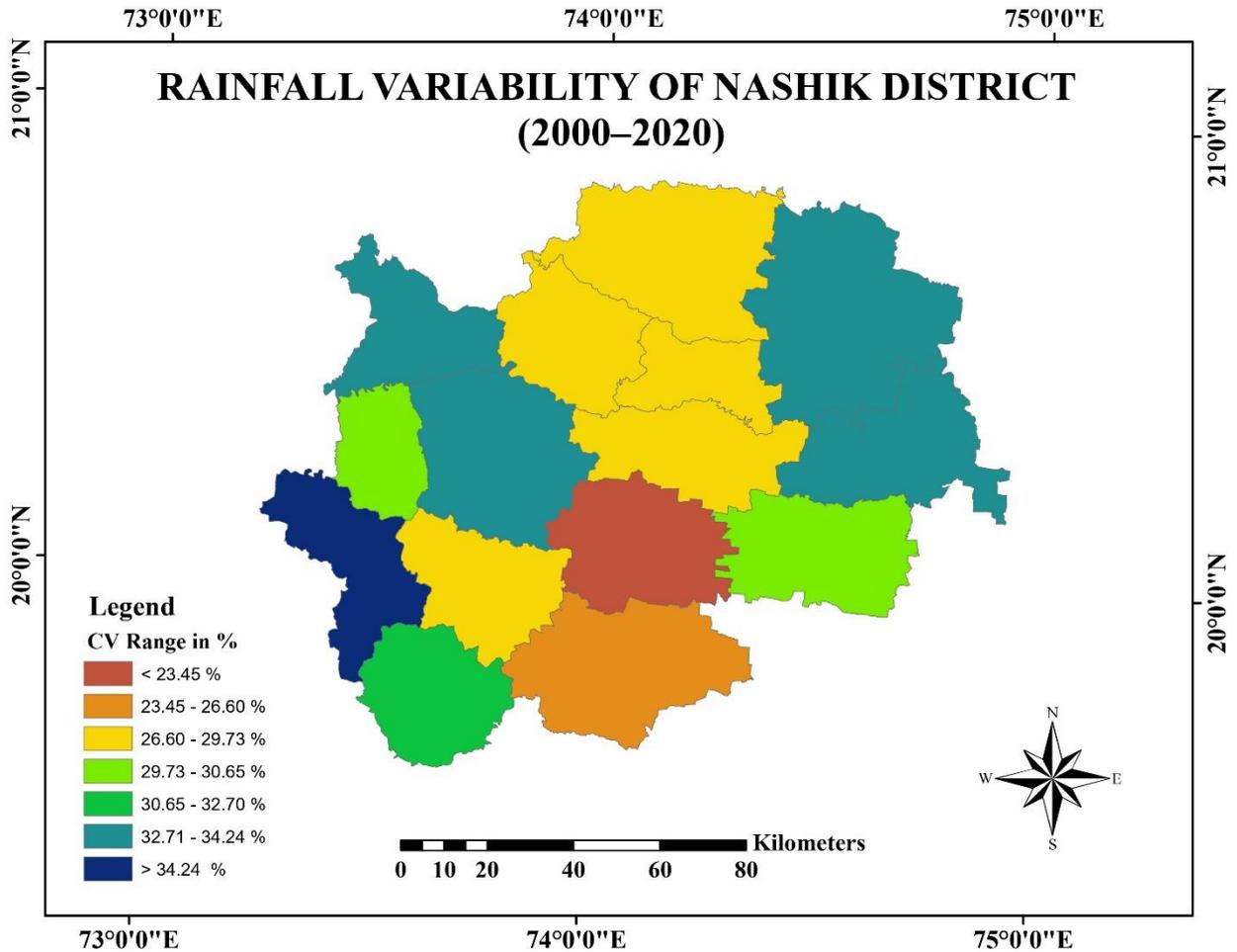
The classification of Tehsil based on the coefficient of variation (CV) clearly shows the pattern of rainfall reliability across the district. The table no. 4 shows that no tehsil falls under the low variability category (CV < 20%), indicating that rainfall is generally unstable throughout the region. Tehsil such as Niphad, Sinnar, Deola, Baglan, Nashik, Kalwan, and Chandwad fall in the moderate variability group (CV 20–30%), suggesting comparatively more dependable rainfall conditions, though still subject to inter-annual fluctuations. other hand, a larger number of Tehsil Igatpuri, Dindori, Peth, Trimbakeshwar, Malegaon, Nandgaon, Surgana, and Yeola exhibit high rainfall variability (CV > 30%), reflecting erratic and unreliable rainfall patterns.

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