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RAINFALL CHARACTERISTICS, PATTERN AND DISTRIBUTION OF NASHIK DISTRICT, MAHARASHTRA, INDIA

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ABSTRACT

An attempt has been made to examine the rainfall characteristics, pattern and distribution of Nashik district of Maharashtra state, India. The paper aims to analyze the spatio-temporal variation of Annual Average Rainfall (AAR) of 20 years (2000-2020) of Nashik district. For that monsoonal rainfall data of Nashik district for 15rainguage stations have been considered. From that data average rainfall data (for 20 years) of the study area have been calculated and presented by graphical method which shows that high rainfall experienced in 2006 within 20 years timespan and followed that 2019.Station wise AAR also depicted through graph which shows that the distribution of rainfall is mostly uneven and highly influenced by the physiography of the region, Igatpuri station recorded maximum rainfall (3118.11 mm) and Deola recorded minimum rainfall (497.44 mm.). From data Rainfall Trend Analysis (RTA) has been plotted which shows irregular trend of rainfall. Year-wise and station wise AAR shows highest rainfall record in 2006 (1745.3 mm) followed by 2019 (1648 mm.). Within 20 years period the lowest average annual rainfall was recorded in 2015 (592.2 mm.).From the calculated data tehsil wise AAR map also has been formed which reveals the western part of the study area receives the highest rainfall (>1000 mm), middle region receives moderate rainfall (600-1000 mm) and in eastern part it become erratic and low (< 600 mm).The result shows that study area has spatio-temporal variability of rainfall due to western ghat at western side. This significant knowledge about rainfall Characteristics are useful for water resource planning and management for Nashik district.

Keywords: Rainfall distribution, Average Annual Rainfall, Spatio-temporal variability, Nashik District

1. INTRODUCTION

Rainfall considered as a significant key factor in climatic changes. Rain water can be used for multiple purposes ranging from domestic, sanitation, industrial water supply and rainfed agriculture [10]. Changes in the rainfall patterns are one of the dimensions of climate change. Rainfall is one of the important climatic variables [3] which influence on the agriculture. In India about 85 % of the total rainfall is received through southwest monsoon .In India rainfall characteristics have been shown considerable variations from region to region [4] in that areas along coast and mountainous regions experiences highest rainfall whereas some areas declines due to rain shadow condition. The importance of The rainfall distribution is realised in agriculture and allied sectors. Agriculture plays an important role in Indian economyand the crop production and productivity depends on the amount of rainfall received [15]. An agricultureis of great importance in developing countries, where the rain-fed agriculture is still a dominant economic activity [6]. Physiography of any regions mostly affects on rainfall distribution [1].Maharashtra state is located in the western part of India and its rainfall pattern is mostly influenced by western ghat. Nashik district is situated in the northern part of Maharashtra and characterized by general dryness throughout the year except during monsoon season. The distribution of rainfall of Nashik district varies from west to east [13], it is high at west and becoming low at east and erratic at south and highly influenced by physiography. Agriculture is a major occupation of the study area so rainfall distribution plays important role in regional economy. Population Increment make shortage of water has become a severe problem globally [20] which proves gripes for water resource so there is great need of proper planning and management of local water resource. For that proper understanding of rainfall and its pattern is need of hour.

The rainfall characteristics are an important indicator for the study of the spatio-temporal distribution of precipitation and very useful for the assessment of seasonal precipitation changes. The main objectives of this study are to investigate and analyse the rainfall characteristics, pattern and distribution of Nashik district. This study is helpful for Management of Water Resource (MWR) concerning drought or flood, and proper planning and management of natural resources.

2. **Study Area-**Nashik district has been selected for the further study. Nashik district is situated in the northern part of Maharashtra and lies between 19^0 33’ to

20^0 53' North latitude and 73^0 15' to 75^0 16' East Longitude. It is situated partly in Tapi basin and partly in upper Godavari basin. Total geographical area of Nashik district is 15,530 sq.km. There are 15 Tehsils included in the Nashik district. The physiography of the region shows three distinct division of western low land, central plateau region and eastern hilly region. The elevation of the area is vary between 300 meter to 600 meter ASL. The distribution of rainfall varies from west to east, it is high at west and becoming low at east and erratic at south. The average annual rainfall in the district is 1034 mm. and mainly received from south-west monsoon. The district is drained by two main rivers the Godavari and the Girna. The entire study area exists basalt rock so the area is dominated by black cotton soil. The district is surrounded by Dhule district in the North, Jalgaon and Aurangabad district in the east, Ahmednagar district in the South, the Thane district in the south-west and Gujrat state in the north-west **(Figure 1)**. Total population of the study area is 61, 07,187 (2011census).

3. MATERIALS AND METHODS-

The study area is situated at SW part of India and receives rainfall by south-west The formula used to calculate Average Annual Rainfall (AAR) is as fallow:

monsoonal winds from June to October months. The distribution of rainfall is mostly uneven and highly influenced by Western Ghat so the present research is based on spatial rainfall distribution for that tehsil wise rainfall data of Nashik district has been considered. The temporal variability of the rainfall for 20 years (2000-2020) has been considered.

- **Rainfall Data-** Annual rainfall (AR) for 20 years (2000-2020) of Nashik district data were acquired from the Water Resource Department, North Maharashtra Region. The data was available for 15 rainguage stations which all are from Nashik District and Collected rainfall data is analysed as follow
- **Data Analysis**- To assess the spatial and temporal distribution of rainfall in Nashik district, annual rainfall for 20 years (2000-2020) were calculated and different statistical parameters e.g. Max., Min were calculated. Average Annual Rainfall (AAR) also calculated as well as standard Deviation (SD) and Cofficient Variation (CV) calculated with the help of Microsoft Excel **(Table 1)**.

$$\bar{p} = \frac{\Sigma p}{n}$$

Where,

Σp = Total rainfall ($P_1+P_2+P_3\ldots..P_n$)

n = Number of rainguage existing

AAR is depicted through line graph **(Figure 2)**

The formula used to calculate Standard Deviation (SD) of the rainfall data is as follows:

$$SD = \frac{\sqrt{\Sigma \chi^{-2}}}{n}$$

The Formula used to calculate Cofficient Variation (CV) as fallow

$$CV\ (\%) = \left[\frac{\text{Standard deviation}}{\text{Mean}}\right] * 100$$

- **Spatio-temporal Distribution of rainfall-** For better result of spatial rainfall variability of the study area all data summarized and tehsil- wise AAR were classified and depicted through the map **(Figure 5)**.

Table 1: Average Annual Rainfall (AAR) of Nashik District for the period 2000-2020 (20 years)

Year	Nahsik	Igatpuri	Dindori	Peth	Trimabakeshwar	Malegaon	Nandgaon	Chandwad	Kalwan	Baglan	Surgana	Deola	Niphad	Sinnar	Yeola	Study Area
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	760.04
2001	640.9	2890	488	1683.5	1799	383	382	558	490.8	380.9	1526.7	447	499	420.9	484	871.58
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	1047.513
2003	910.4	3569.2	859	2100	2310	384	400	438	772	577	1927	391	619.2	811.8	390	1097.24
2004	1059	3902	1094	2504	2467	671	517.4	828.3	1030.9	745	2474	464	1042.5	701.7	865.3	1357.74
2005	1220	4540	798	2840	3740	423.1	413	639	874	603	3066.8	491	884	676	508	1447.727
2006	1325.6	4770	1080	3330	3794	851	877.5	1161	1414	960	2992.2	864.3	879	951	930.6	1745.347
2007	834.1	3663	770	1957	2511.8	739	629.2	791.4	826	811.3	1947	675	780.9	688.9	678	1220.173
2008	1234	3869	1090	2227	2290.6	558	780	709	807	545	2013.5	454.5	733.1	684	725.8	1248.033
2009	534	2100	644	1580	1412	763.5	792	818.8	785	750.8	1339	597.5	568.6	722.5	500.9	927.24
2010	770	3084	740	1845	1634	871	790.8	879	589	520	1442.6	443	725	804.5	881	1067.927
2011	568	3032	565	1835	1642.9	396	571	551.5	480.4	553	1815	286.7	383	429	643	916.7667
2012	506	2789	645	1690	1523	509	309	640	533	463.4	1512	384	500.1	446.8	486	862.42
2013	774	2213	961	1950.6	2029.4	663.8	644	441	765.9	622.9	1853	530	567.6	478.4	465.7	997.3533
2014	621.4	1800	712	1299.9	1579	399.7	243	369	611	467.9	1088	390	486	399	342	720.5267
2015	594	1462	744	940.9	1120.7	281	260	344.9	620.7	392	650.1	284	484.1	414.2	290.8	592.2267
2016	1126	2099	1132	2001.8	2250.9	327.7	413.5	478.8	739.1	596	1122.9	562	648	656.3	507	977.4
2017	1050.8	2412	1819.9	2147.4	2730.5	321	473	583	687	568	1943.7	527	644	639	487	1135.553
2018	989.9	2989	887	1867	2021.2	547	568	639	732	583	1785	498.7	663	630.8	551	1063.44
2019	1337	5496	1283	3394.5	3895.7	677	682.5	740	750	745.2	2861.3	584.9	654.3	863	756.7	1648.073
2020	910	3870	760	1663	1426	889	863.4	779.2	739	1042.6	1553.6	786.7	676.2	922	805.6	1179.087
Max.	1337	5496	1819.9	3394.5	3895.7	889	877.5	1161	1414	1042.6	3066.8	864.3	1042.5	951	930.6	1745.347
Min	506	1462	488	940.9	1120.7	281	243	344.9	317.7	325.8	650.1	284	383	399	290.8	592.2267
Mean	927.9	3274	923.44	2093.33	2288.96	580.74	594.46	678.31	771.62	639.87	1903.54	522.31	683.79	668.08	612.09	1141.17
SD	264.1699	1045.2443	302.6788	615.01538	801.54151	193.31098	194.53679	196.82313	223.11675	180.66289	636.13422	146.6627	156.51284	173.4057	183.06864	288.6158897
CV %	28.46965	31.9256	32.77731	29.37976	35.01772	33.28701	32.72496	29.01669	28.91537	28.23431	33.41848	28.07963	22.88902	25.95583	29.90878	25.29122652

4. RESULTS AND DISCUSSION-

4.1. Average Annual Rainfall (AAR) of Nashik District -

Rainfall data records were analysed for 2000-2020 (20 years), in which the annual and average rainfall were calculated for each year. The year wise average rainfall depicted through line graph which clearly shows high variability of rainfall in the study area. Climatic change is one of the major impacts in the rainfall variation [19] and rainfall pattern. From the calculated data highest rainfall record was found in 2006 (1745.3 mm) and lowest rainfall record was in 2015 (592.2 mm.) which clearly shows that local physiography influences on spatial distribution of the rainfall and local climatic variation [1] affects on temporal distribution of rainfall **(Figure 1)**.

Western Ghat plays an important role in spatio-temporal variability of rainfall. **Figure 2** shows the fluctuations of the AAR of the study area. It has been found in 2004, 2005, 2006 and 2019 highest rainfall and lowest rainfall recorded in year 2014 and 2015.

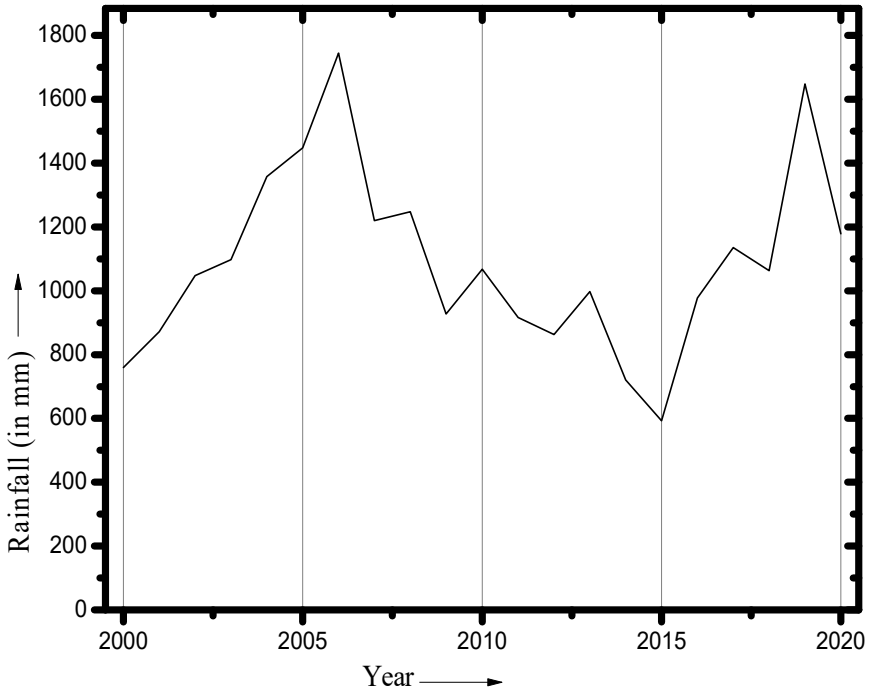

Figure 1: Average Annual Rainfall (AAR) of Nashik District for the period 2000-2020 (20 years)

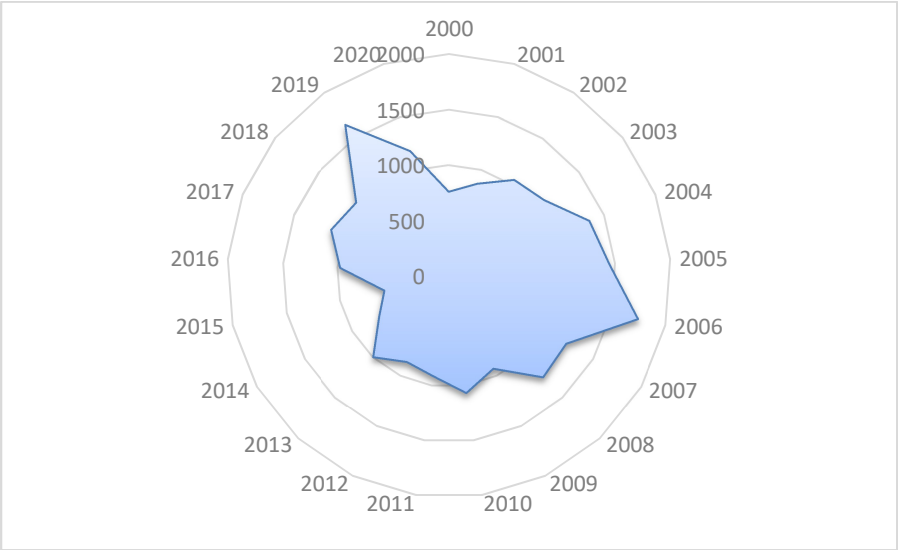

Figure 2: Radar diagram of year wise distribution of AAR of the study area

4.2. Rainfall trend Analysis (RTA) -

Rainfall data records were analysed for 2000-2020 (20 years), in which the annual and average rainfall were calculated for each year. The year wise average rainfall plotted through **Figure 3** which shows irregular trend of rainfall. Year-wise and station wise AAR shows highest rainfall record in 2006 (1745.3mm) followed by 2019 (1648 mm.). Within 20 years period the lowest average annual rainfall was recorded in 2015 (592.2 mm.) which shows temporal irregularity of rainfall within study area. RTA shows irregularity of distribution of rainfall.

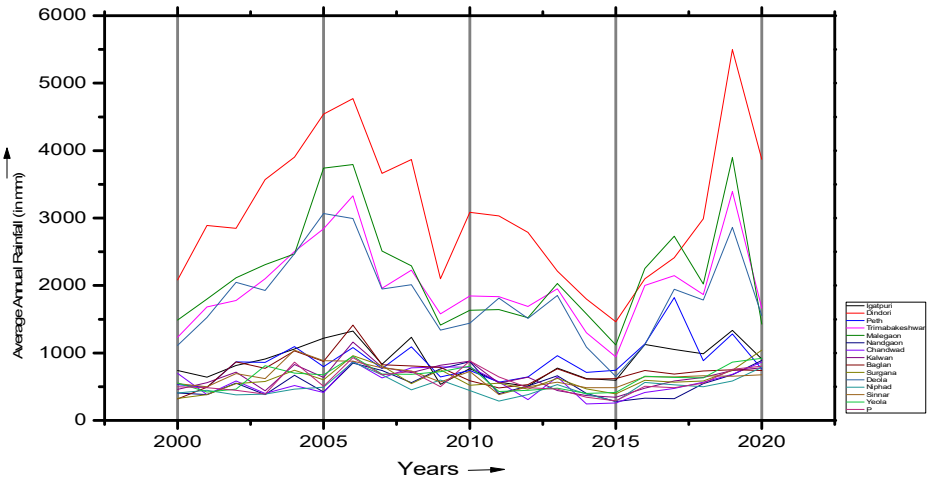

Figure 3: Rainfall Trend Analysis of Nashik District

4.3. Station wise distribution of AAR in the study area-

Station wise distribution of AAR of Nashik district is plotted through bar graph **(Figure 4)** which reveals that Tehsils which are situated on the western side of the study area receives highest rainfall e.g. Igatpuri, Trimbakeshwar, Peth etc. It due to impact of western ghaton south-west monsoonal wind, which effective at western side and become erractic at east. From the analysis it has been clear that Deola and Sinnar tehsil records lowest rainfall.

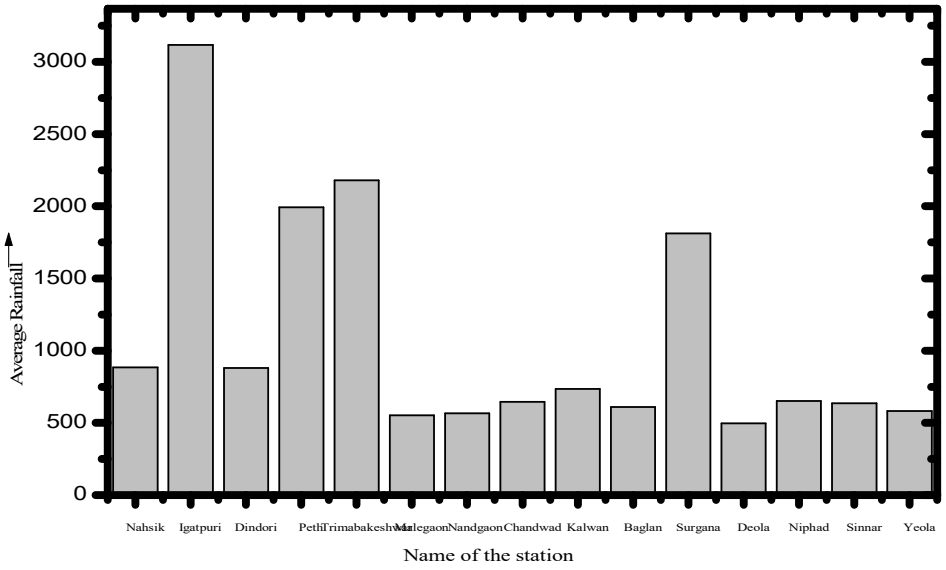

Figure 4: Stationwise AAR in the study area

4.4. Tehsil wise distribution of average annual rainfall in the study area-

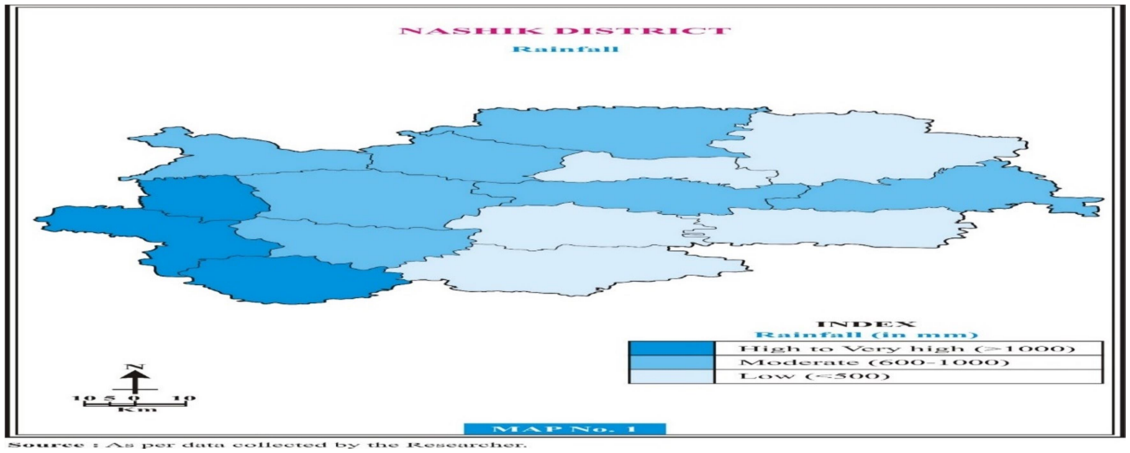

Figure 5: Distribution of average annual rainfall in the study area

Rainfall data records for 2000-2020 (20 years)were analysed and depicted through the Map **(Figure 5)** which represents spatial rainfall variation of Nashik district. Map shows tehsils which are at western part receives highest rainfall (>1000 mm.) it is due to western ghat and physiographic setting of the region followed that it becomes moderate at middle region (600-1000 mm) and it became low (<500 mm.)due to orographic effect.

CONCLUSION-

In this study AAR and RTA was analysed to identify the spatio-temporal variability of rainfall which revealed that the western part of Nashik district experiences higher rainfall than the eastern part. The rainfall of the study area is largely influenced by the Western Ghat and its physical setting. Rainfall trend shows high spatial variation from west to east. The result from this study also shows the risk of dry spell during rainy season. Results also shows the risk of water scarcity is more at eastern part of the study area than the western part. All this spatial variation in rainfall in Nashik district could be due to elevated hills of western Ghat at west and river plains at east which created orographic condition in the Study area. Temporal variations in rainfall may due to the local atmospheric condition. The analysed outcomes also shows that the western part of the study area receives more rainfall therefore it is suitable for water conservation projects as well as irrigation programme. The outcomes are also useful for predicting the variability of rainfall in the study. The study would helpful in Planning of water resource (PWR). It is also useful in PWR during dry spell. The result shows that study area has spatio-temporal variability of rainfall due to western ghat at western side. This significant knowledge about rainfall Characteristics are useful for water resource management for Nashik district. The study could also helpful for farmers and local government for decision making during climatic change and draught.

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