Journal of Natural Resource Conservation and Management
Vol. 2, No. 2, pp 146-150, 2021
doi: 10.51396/ANRCM.2.2.2021.146-150

Short Communication

Rainfall trends in the Satara district of Maharashtra over the last two decades

K.A. Ahire*, R.C. Kothawale, P.D. Hange, Bhagyashri R. Jalgaonkar, A.D. Patil, J.P. Shewale

Department of Irrigation and Drainage Engineering, SCAE, Karad, Satara (MS), India
Corresponding author E-mail: ahirekunal17@gmail.com

Received : September 07, 2021
Revised : November 30, 2021
Accepted : December 2, 2021
Published : December 31, 2021

ABSTRACT

This study analyzed rainfall trends over the last two decades in 11 tehsils of Maharashtra's Satara district, including Satara, Jawali, Patan, Karad, Koregaon, Khatav, Man, Phaltan, Khandala, Wai, and Mahabaleshwar. Rainfall data from the Satara district was analyzed for monthly and annual rainfall trends for 21 years (2000-2020). The monthly and annual rainfall data was obtained from the Mahaagri website (www.mahaagri.gov.in). Rainfall data was analyzed using a variety of methods. To investigate rainfall variability, the mean, standard deviation, and coefficient of variation of monthly and annual rainfall data were determined. For 11 tehsils, the yearly rainfall was divided into three categories: low rainfall (291-1455 mm), moderate rainfall (5432024 mm), and high rainfall (650-2894 mm). Monthly and annual rainfall in all tehsils in the Satara district showed variations in rainfall every two or three years. The study revealed that tehsils in the east, such as Man, Khatav, and Phaltan are prone to drought, but the districts in the west receive excess rain.

Keywords: Rainfall variability, Annual, Monthly, Decades, Trend analysis, Drought

INTRODUCTION

Rainfall is one of the most powerful meteorological factors impacting the intensity and location of farming systems, as well as the enterprise decision. According to recent studies, the amount of rainfall in some parts of India has remained consistent over the previous several decades, but the length of rainfall has decreased across the country. As a result, it is necessary to preserve the available water; otherwise, it will be lost as runoff, posing flood-related risks. Natural rainfall is a major source of water in the Satara district's eastern region. The western region of the Satara district (Mahabaleshwar tehsil) received the most rainfall. As it goes from the western ghats to the Satara district's eastern limit, rainfall drops swiftly at first, then gradually increases. The Maharashtra and Indian governments have designated four tehsils in the district as drought-prone zones. The total annual rainfall in the drought-prone region has decreased during the previous 40-45 years, according to the local people in the eastern part of the region.

The Satara district is one of the important districts of the Maharashtra state in India and is well known for its agricultural activity. The district has a largely rural setup and the changes in rainfall have an impact on everything including the agricultural productivity of the region. Precise estimation of the rainfall trends in the district would provide important information for planning and development. The area is characterized by a low level of productivity and natural resources, especially water, are limited and pose a major constraint for crop production. Crops and cropping patterns are dependent on rainfall characteristics. Therefore, an attempt was made to analyze rainfall for the period 2000 to 2020 to examine the rainfall patterns and trends in the Satara district to obtain precise and long-term impacts.

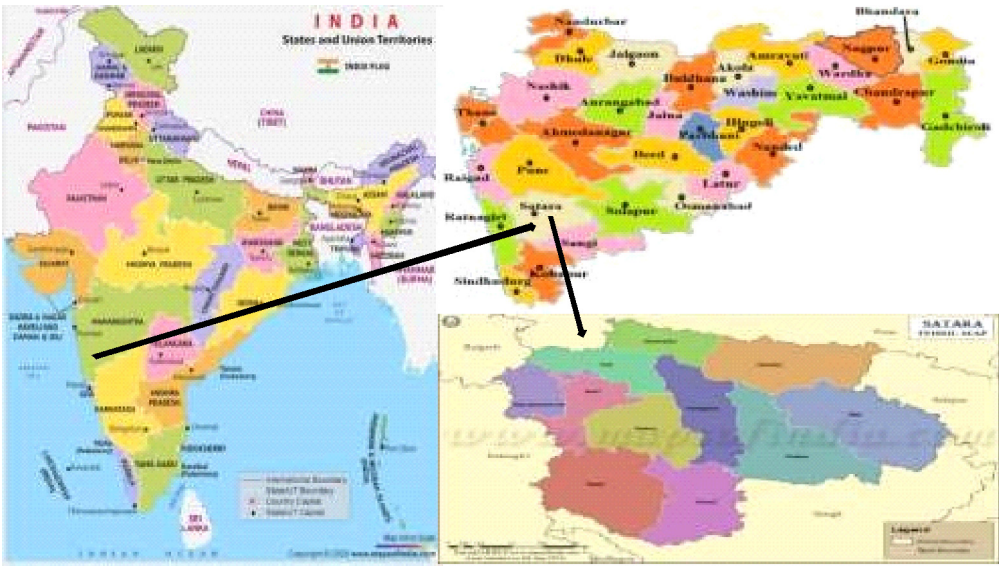


Fig. 1. Location map of the study area

MATERIAL AND METHODS

Study area

The Satara district is situated in the west part of Maharashtra state in India. This district consists of eleven tehsils with 1,727 villages.

Rainfall data

The Rainfall data for the period of 21 years (2000-2020) was extracted from the website: www.mahaagri.gov.in. Data were used to calculate the mean, standard deviation, coefficient of variation (CV), probability distribution, and trend analysis of rainfall. The uniformity of rainfall distribution can be assessed by using common measures of dispersion i.e., mean, standard deviation, and coefficient of variation (CV), and the same is explained in the following equations:

1. Arithmetic mean

The sum of the values divided by the number of values is called the mean of the sample. The mean, also referred to by statisticians as the average, is the most common statistic used to measure the center of a numerical data set. The mean is the sum of all the values in the data set divided by the number of values in the data set.

$$Xavg = \sum_{i=0}^{n} \frac{Xi}{n}$$

Where,
Xavg = Arithmetic mean
X = The rainfall magnitude in mm
i = 1,2, to n
n = Number of the sample

2. Standard deviation

Standard deviation is the measure of the amount of variation or dispersion of a set of values, from its mean values. A standard deviation is a number used to tell how measurements for a group are spread out from the average (mean or expected value). A low standard deviation means that most of the numbers are close to the average, while a high standard deviation means that the numbers are more spread out. (Anonymous, 2021)

$$\sigma = \sqrt{\left[\sum \frac{(Xi - Xavg)^2}{n-1}\right]}$$

Where,
σ = Standard deviation
X = The rainfall magnitude in mm
i = 1,2, to n
Xavg = Arithmetic mean
n = Number of the sample

3. Coefficient of variation (CV)

It is the ratio of the standard deviation to the mean. It is generally expressed in percentage (%).

$$CV = \frac{\sigma}{Xavg} \times 100$$

Where,

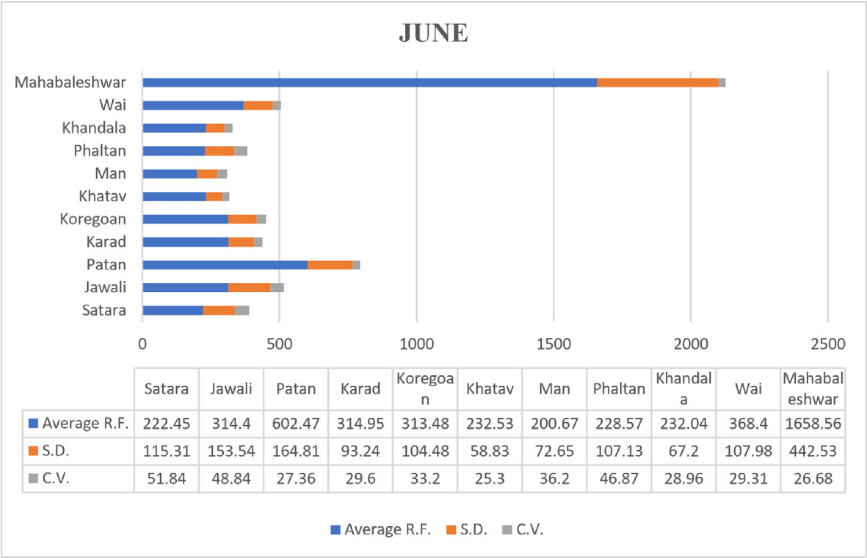
CV = Coefficient of variation

Xavg = Arithmetic mean

σ = Standard deviation

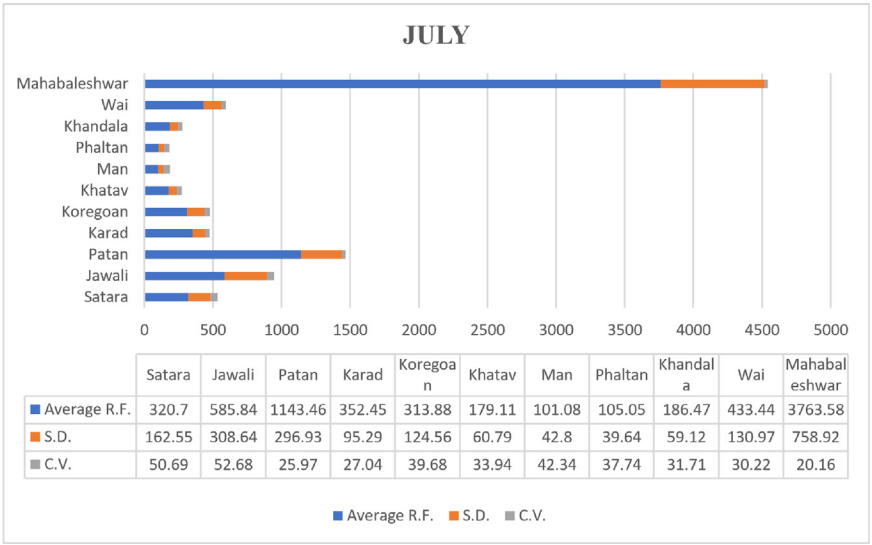
RESULTS AND DISCUSSION

According to a 20-year analysis, tehsils on the west side of Satara district, such as Mahabaleshwar, Wai, Patan, and Jawali, receive the most rainfall (>1600 mm), while tehsils on the east side, such as Man, Khatav, Phaltan, and Khandala, receive the least rainfall (650 mm), and the remaining three tehsils, Satara, Karad, and Korego As a result, the tehsils on the west side have a positive trend while the tehsils on the east side have a negative trend. Fig. 2, Fig. 3, Fig. 4 and Fig. 5 show the monthly average rainfall for June (min-200.67 mm, max-1658.56 mm), July (min-101.08 mm, max-3763.58 mm), August (min-140.46 mm, max-3192.78 mm) and September (min-158.53 mm, max-1146.28 mm), respectively, months of last 21 years. These figures show annual average rainfall (min-505.93 mm, max-5307.42 mm), standard deviation (min-190.97, max-1484.77), and coefficient of variation (min-27.98%, max-50.24%) for June, July, August and September months.



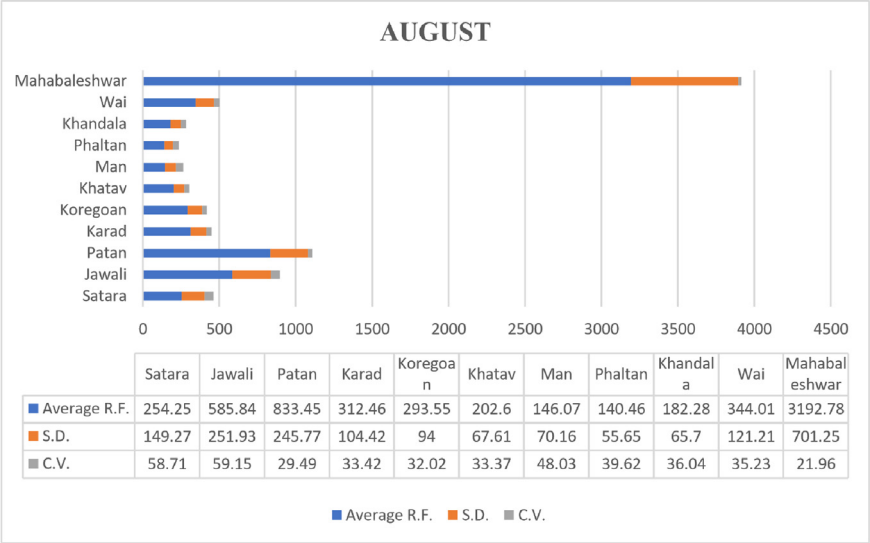
	Satara	Jawali	Patan	Karad	Koregoan	Khatav	Man	Phaltan	Khandala	Wai	Mahabaleshwar
Average R.F.	222.45	314.4	602.47	314.95	313.48	232.53	200.67	228.57	232.04	368.4	1658.56
S.D.	115.31	153.54	164.81	93.24	104.48	58.83	72.65	107.13	67.2	107.98	442.53
C.V.	51.84	48.84	27.36	29.6	33.2	25.3	36.2	46.87	28.96	29.31	26.68

Fig. 2. Average rainfall, standard deviation, and coefficient of variation for June month



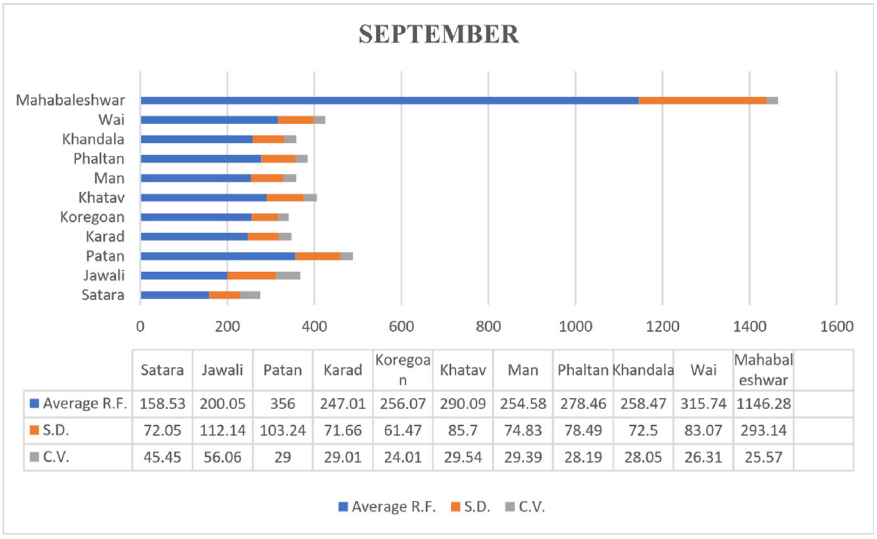
	Satara	Jawali	Patan	Karad	Koregoan	Khatav	Man	Phaltan	Khandala	Wai	Mahabaleshwar
Average R.F.	320.7	585.84	1143.46	352.45	313.88	179.11	101.08	105.05	186.47	433.44	3763.58
S.D.	162.55	308.64	296.93	95.29	124.56	60.79	42.8	39.64	59.12	130.97	758.92
C.V.	50.69	52.68	25.97	27.04	39.68	33.94	42.34	37.74	31.71	30.22	20.16

Fig. 3. Average rainfall, standard deviation, and coefficient of variation for July month



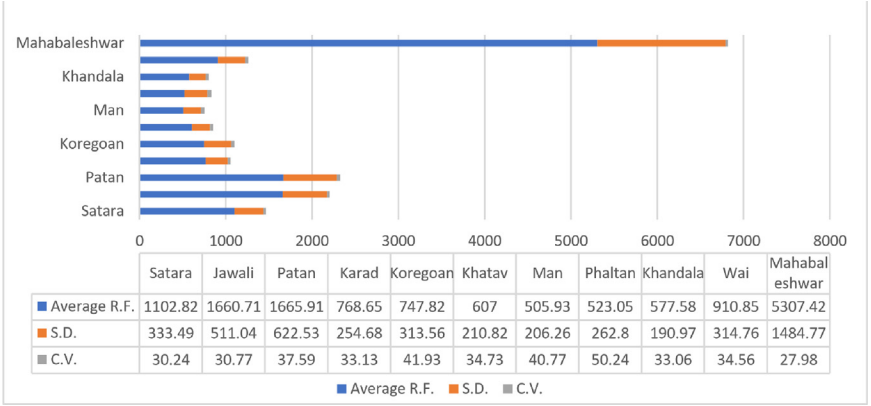
	Satara	Jawali	Patan	Karad	Koregoan	Khatav	Man	Phaltan	Khandala	Wai	Mahabaleshwar
Average R.F.	254.25	585.84	833.45	312.46	293.55	202.6	146.07	140.46	182.28	344.01	3192.78
S.D.	149.27	251.93	245.77	104.42	94	67.61	70.16	55.65	65.7	121.21	701.25
C.V.	58.71	59.15	29.49	33.42	32.02	33.37	48.03	39.62	36.04	35.23	21.96

Fig. 4. Average rainfall, standard deviation, and coefficient of variation for August month



	Satara	Jawali	Patan	Karad	Koregoan	Khatav	Man	Phaltan	Khandala	Wai	Mahabaleshwar
Average R.F.	158.53	200.05	356	247.01	256.07	290.09	254.58	278.46	258.47	315.74	1146.28
S.D.	72.05	112.14	103.24	71.66	61.47	85.7	74.83	78.49	72.5	83.07	293.14
C.V.	45.45	56.06	29	29.01	24.01	29.54	29.39	28.19	28.05	26.31	25.57

Fig. 5. Average rainfall, standard deviation, and coefficient of variation for September month



	Satara	Jawali	Patan	Karad	Koregoan	Khatav	Man	Phaltan	Khandala	Wai	Mahabaleshwar
Average R.F.	1102.82	1660.71	1665.91	768.65	747.82	607	505.93	523.05	577.58	910.85	5307.42
S.D.	333.49	511.04	622.53	254.68	313.56	210.82	206.26	262.8	190.97	314.76	1484.77
C.V.	30.24	30.77	37.59	33.13	41.93	34.73	40.77	50.24	33.06	34.56	27.98

Fig. 6. Annual variation of rainfall for Satara district

Fig. 6 shows yearly average rainfall, standard deviation, and coefficient of variation for 20 years of 11 tehsils present in the Satara district. Based on the annual variation, the tehsils present in the west received high rainfall (>1600 mm) while the tehsils located in the east received low rainfall (<650 mm) during the period of study. In a similar study for the Maharashtra state (Singh et al., 2021), a decreasing magnitude of the rainfall trends was reported for the whole Satara district. The innovative trend analysis (ITA) proposed by Sen (2012) showed a positive trend for the Satara district, at a 1% level.

CONCLUSIONS

The study revealed that the eastern side of the district has negative trends in rainfall, and therefore can be considered a drought-prone zone. The tehsils in the east, such as Man, Khatav, and Phaltan are prone to drought, but the districts in the west receive excess rain.

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