Rainfall Variability in Satara District of Maharashtra: A Case Study

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Abstract— The study area is located in the Western ghats of the Maharashtra. The annual rainfall conditions differ from region to region. In spite of the technological developments in providing improved crop varieties and better management practices in Satara district, agriculture has been considered a gamble as the agricultural productivity is strongly influenced by the vagaries of the monsoon. The average annual rainfall is 1277 mm. The computation of eleven tahsilwise annual rainfall use help of mean, S.D. and coefficient of rainfall variability. This attempt has been made to 1998 to 2016 annual rainfall in Satara district. This article aims to studies related to trends in rainfall eastern part of Satara district in Maharashtra. There are changes in the results of the talukawise studies and a clear and rational picture of rainfall trend has variability in drought prone region. In a study on talukawise trend analysis seven tahsils had decreasing trend in annual rainfall. Among two tahsils showing increasing trend, Mahabaleshwar tahsil shows highest rainfall trend. Remaining two tahsil had the same direction of trend in annual rainfall and seasonal scale.

Key words: Annual Rainfall, Rainfall Variability, Drought Prone, Climate Change, Trend

I. INTRODUCTION

To meet the various water demands of agriculture, industry, irrigation, hydroelectric power generation, and other human activities in district water budget is important factor. More than 70 per cent of the population in India is engaged in agricultural activities [1]. The problem of raising ample food for millions is of crucial importance. Indian economy is completely associated with the monsoon and its prosperity is fully dependent on amount of rainfall receive during monsoon. The success or failure of crops in any year is closely related with the behaviour of the monsoon most of the states of India receive 90 to 95 per cent rain from south-west monsoon [2]. Effective utilization of water resources is of prime importance in order to increase agricultural production. The rainfall variations are largely because of relief variations, contracted conditions, movement of the monsoon through. Rainfall in the greater part of India is uncertain, irregular and unevenly distributed. Rainfall is the huge parameter affecting agriculture activity of man. Rainfall is the powerful single weather element influencing the intensity and location of farming system and the choice of enterprise [4]. Recent studies show that in some part of India the amount of rainfall is constant over last few decades but the duration of rainfall is reduced. Therefore it also becomes critical to store this water or most of its parts go waste in runoff. It also causes hazards like flood conditions arise [5]. Eastern part of Satara district is largely relied of natural rainfall. In Satara district an average annual rainfall is lot of closeness. The highest rainfall reported in western part of the Satara district in Mahabaleshwar tahsil. The rainfall generally decreases first rapidly and then slowly from the Western Ghats towards the eastern boundary of the Satara district. The government of Maharashtra and Central government of India declared total seven tahsil district drought prone areas. This attempt has been made 1998 to 2016 annual rainfall tabulation and use help of mean, rainfall trend calculation and variation of rainfall in Satara district. Eastern part of the drought prone region local people recognizes that the total rainfall had reduced over the past 40-45 years because of the loss of summer any rainy monsoon.

II. STUDY AREA

The Satara district is one of the important districts of the Maharashtra state well known for agricultural development. In addition, the agricultural and rural based cultural wisdom and closeness of the author, with all these motivated the researcher to undertake the present study.

The Satara district is situated in west part in Maharashtra state. This district consist eleven tahsil with 1,727 villages. The total area is covered with 10,480 sq.km and extending between 17^0 5' and 18^0 11' North latitudes and 73^0 33' to 74^0 54' East longitudes. According to the census of 2011 Satara district has a population of 3,003,741, nearly equal to the democracy of Albania or the US state of Mississippi. This gives it a positioning of 122nd in India (in association with a total of 640). The district has a population density of 287 occupants per square kilometre (740/sq.mi). The population growth rate of Satara district was 6.93% over the decade 2001-2011. The climate ranges from the rainiest in the Mahabaleshwar region, which has an average annual all of over 6000 mm to the driest in Man tahsil where the average annual rainfall is about 500 mm.

III. OBJECTIVES

The present study has following specific objectives.

- To study the average annual rainfall during the year 1998 to 2016.
- To find out trends of rainfall and coefficient of variations.

1) Data Base and Methodology

The current study is based on the rainfall data collected from Indian Metrological Department for 19 years. Agricultural Statistical Information State, Socio Economic Review Satara District and Agricultural District Office, The data has been collected from 1998 to 2016. The trend of rainfall is calculated and represent by mean, Standard Deviation, and Coefficient of Variation in percentage of rainfall in Satara District shows the presentation of result chart, graph method is used. For the data analysis following formula has been used.

$$C.V. = \frac{S.D.}{Mean} \times 100$$

Where,

C.V. = Coefficient of variability of Rainfall

S.D. = Standard Deviation of Rainfall
Mean = Mean of Rainfall

2) Annual Rainfall Distribution

Rainfall is a key factor, studied by influences the agricultural economy of the locality. It also determines the cropping pattern, performance of various agricultural and cultural habits. The analysis of rainfall for the period 1998 – 2016 tells that the normal annual rainfall over the district varies from 489.68 to about 5389.86 mm. In the eastern part of the district around Dahiwadi, Khatav, Phaltan, Khandala taluka it is minimum and increases towards the west and reaches ultimate around Mahabaleshwar. The study also discovers that entire eastern, north eastern and south eastern parts of the district comprising almost entire Dahiwadi, Khatav, Phaltan, Khandala tahsils and parts of Koregaon and Karad tahsils in the plains which experienced droughts for more than 20% of the years can be categorized as "Drought Area". The average rainfall data for the period (1998-2016) are presented in Table1.

The average annual rainfall for Satara district is 1277 mm. It is found that high rainfall recorded in Mahabaleshwar tahsil 5389.86 mm, Patan 1631.16mm, and Jawali 1595.70 mm. Medium rainfall in central and middle part of the Satara 1030.32 mm, Wai 932.06 mm, Karad 736.07 mm and Koregaon 743.64 mm and decreasing rapidly towards eastern part of the Khandala 556.87 mm, Khatav 539.14 mm, Phaltan 540.71 mm and Man tahsil 489.68 mm, The Coefficient of variation is 37.76 per cent Patan, 27.72 per cent Jawali tahsil. While western Ghats of the Mahabaleshwar tahsil 27.9 per cent comes variability of rainfall the Satara tahsil 31.78 per cent, Phaltan tahsil 53.31 per cent and results comes to Man, Khatav, Khandala Karad, and Wai tahsils respectively 43.67, 39.48, 32.36, 32.42, 32.79 per cent.

It can be easily found that very high rainfall two decade in mean annual rainfall Mahabaleshwar tahsil, Standard deviation come result 1503.49, Medium rainfall recorded in two decade Patan tahsil 1631.16, Jawali tahsil 1567.92 and Satara tahsil 1033.13 in western part of the Satara district. Normal rainfall is studied during the year 1998 to 2015 Standard Deviation comes Satara tahsil 328.3, Wai tahsil 305.5, Koregaon tahsil 314.73 and Karad tahsil 238.6. In eastern part of drought prone region result comes of Phaltan 288.26, Khatav 288.63, Dahiwadi 213.825 and Khandala tahsil 180.21. It is very clear that drought prone tahsils recorded low rainfall.

Table No 1 shows that the western part of the Satara district Mahabaleshwar tahsil highest recorded average rainfall during the 1998 to 2016 years. Jawali, Patan, Wai and Satara tahsil normal rainfall recorded in during the year. Then Karad, Koregaon recorded medium rainfall. Easter part of the Satara district Khandala, Phaltan, Khatav and Dahiwadi tahsils shows the clear picture less amount of rainfall during the 19 years. The observed some of the results are thus mainly dependent on local scale climatic controls, physiographical condition, rather than large scale climatic forcing.

3) Rainfall Trend in Satara District of the Drought Prone Region

The data obtained on the average annual rainfall of Satara district for the period in two decade viz. 1998 to 2016 were analysed by simple tabular method. The proportion were estimated for each of the below years to know the variation in the rainfall of the Satara district for period under the study. As the result of the rainfall variability in the Satara district. During the period 1998-2016, the difference of the actual average rainfall and trend of the rainfall in Satara district of eastern part of the drought prone region. The above Table No 1 show that the actual line and trend line of increasing is negative. This means that the trend is negative. The deficit of the drinking water, reducing level of water, shortage of grain for cattle, food shortage, effects on agriculture, population emigrated searching of water another district [3]. The study also suggests that the variability of rainfall of the Satara district is decreasing in drought prone area. The data of the trend of rainfall variability is indicated curve trend line and actual line is variation then, it is clear that balanced rainfall in this study region. These results also indicated that for the analysed time period, there was no climate in the region of western Satara district. The tahsils with significant annual rainfall trends are evenly distributed to the eastern region showed negative trends.

IV. CONCLUSION

The study has represented a detailed breakdown of rainfall variability and trend of rainfall in the drought prone area in the eastern part of the Satara district. By using 19 years recoded of rainfall in all eleven tahsils, the study scrutinized the temporal and spatial variation of rainfall on a western, central and eastern part of the Satara district. The main recordings of the study are summarized below.

1) Annual rainfall in the Satara district varies from about 5389.86 mm in Mahabaleshwar (western part) to 489.68 mm in eastern part of the Dahiwadi tahsil.
2) Trend analysis of annual average rainfall indicators shows fluctuations in 18years. During the period of 1998, 1999, 2002, 2003, 2006, 2007, 2010, 2011, 2015, 2016 shows decreasing trends in drought prone region. In 2000, 2001, 2003, 2004, 2005, 2008, 2009, 2012, 2013and 2014 shows pattern of increasing trends in heavy rainfall in western part of the study region.

Year	M'shwar	Jawali	Dahiwadi	Koregaon	Phaltan	Khatav	Khandala	Karad	Patan	Wai	Satara
1998	4997.9	1664.9	764	841.7	864.3	839.9	699.8	705.7	1560.1	1123.4	928.9
1999	5506.6	1608.4	577.9	887.4	532.8	461.1	481.8	790.2	1671.8	1101	1059.7
2000	4158.4	942.5	311	621.8	385.3	406	442.8	535.9	1165	662	959.6
2001	4519.8	1092.4	357.6	519.8	478.4	518.6	349.7	654.9	1203.4	678	1031.6
2002	5094.3	1320.1	353	586.2	344.3	398.1	266.6	467.2	1244.7	561.6	741.6
2003	4441.4	1191.9	149.4	393.6	96.2	192.9	218.1	419.4	987.7	547.2	583.7
2004	6506.9	1103.6	534.2	987.6	764.5	951.5	760.4	777.9	1612.1	1129.7	1092.7
2005	8824.3	2272.9	572.8	1435.5	471.1	684.2	785.6	1230.8	3250.9	1574.3	1849.1
2006	8599.1	2746.6	570.6	1365.9	703.2	639.6	789.7	1098.5	2905.6	1483.6	1678.9

2007	6265	1679.1	595.3	895.2	725	593.4	685.9	1025.1	2220.6	1033.4	1231.7
2008	5604.8	1520.6	455.1	568.2	342.4	419.7	440.6	880.7	1239	836.3	764.1
2009	4531.2	1719.2	977.1	950.3	1132.4	1006.1	722.1	894	1298.7	1118	1113.1
2010	4351.1	1617.9	827.5	938.9	1120.4	896.9	752.4	957.1	1599.8	1128.4	1093.4
2011	6555.3	1721	242.2	514.9	311.9	393.9	443.8	617.3	1909.6	903.6	851.9
2012	3882.5	1236.7	269.6	360.5	278	275.4	469.9	546.2	1497.3	683	685.4
2013	3820.4	1788.5	392.6	595.9	486.5	602	633.7	570.1	1498.4	885.4	1182.3
2014	5660.4	1654.7	483.1	479.8	301.6	601.6	523.2	668.3	1571.8	799.7	1090.6
2015	3697.9	1341.5	381.3	442.3	394.4	543.7	557.6	410	924.3	522.4	658
2016	4352.6	1423.1	397.2	492.5	403.4	596.4	565.1	512.3	1229.6	612.7	789.1
Total	101369.9	29645.6	9211.5	13878	10136.1	11021	10588.8	13761.6	30590.4	17383.7	19385.4
Mean	5335.2579	1567.917	489.6833	743.6389	540.7056	579.14	556.87	736.07	1631.15	931.72	1033.12
S.D.	1503.49	434.78	213.825	314.73	288.26	228.63	180.21	238.6	615.84	305.5	328.3
C.V. (%)	27.9	27.73	43.67	42.32	53.31	39.48	32.36	32.42	37.76	32.79	31.78

Table 1: Average Annual Rainfall 1998 to 2016

The main focus in this study has been to understand rainfall variability as a basis for improving the understanding of crop to climate relationships in this drought prone region. In a follow up paper, I analyze impacts of rainfall variability of yields of staple crops and investigate the benefits of rainwater harvesting as a livelihood strategy. In conclusion, this study has shown that there are significant intra-regional differences in rainfall amount, variability and trend. In general, rainfall amount is higher and its variability lower, in the western part of the region than in the eastern part. The observed trends in some of the results are thus mainly dependent on local scale climatic controls, rather than large scale climatic forcing. The results also suggest the need for further investigation local anthropogenic intervention in the environment, which could be one of the major causes of climate change in drought prone regions.

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