Vol. VIII - Issue II (July- 2021)
ISSN - 2277-7067

राष्ट्रहिताय संस्कृतम्

Kavikulaguru Kalidas Sanskrit University
Ramtek, Dist. Nagpur, Maharashtra

Peer Reviewed

Journal of Fundamental & Comparative Research

UGC CARE Listed Journal

शोधसंहिता

New Research Frontiers

July 2021 Volume - VIII Issue II

Research Journal
ISSN No. 2277-7067

Journal of Fundamental & Comparative Research

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RAMTEK

Spatio - temporal variation of precipitation data in diverse zones of Sangli district

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Introduction:

Water is the significant source to every living thing, without water living things are does not endurance on the earth surface. More than 70% individuals in India are busy in farming area and this area was absolutely relying upon the water or water system rehearses. Precipitation is the best pointer to show the agronomic advancement of the well known fact is the place where higher the precipitation higher the agronomic creation. The issue of raising sufficient nourishment for millions is of critical significance. Indian economy is totally related with the rainstorm and its success is completely reliant on measure of precipitation get during storm season. The achievement or disappointment of yields at whatever year is methodicallly related with the conduct of the storm greatest conditions of India get 90 to 95 percent downpour from south-west rainstorm. Genuine usage of water assets is of prime significance to increment agronomic creation. The precipitation varieties are generally a result of alleviation varieties, contracted conditions, development of the storm through climatic condition and accessibility of plants. Precipitation in most of India is uncertain, lopsided and inconsistent circulated. Temperature and Rainfall is the tremendous boundaries which influencing farming movement of man.

The Irrigation Commission 1972 has familiar 67 drought prone districts approval of 326 Tahsils located in 8 states. Commission on Agriculture, 1976, documented a few more drought prone areas with slightly different norms. The Drought Area Study and Investigation Organization of C.W.C. set up in 1978 started with 99 districts after considering the list of districts identified by the Irrigation Commission and also by the National Commission on Agriculture for carrying out further studies. For the studies,

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C.W.C. adopted the same criteria as followed by the Irrigation commission 1972. The drought is occurring in an area: 1) when the annual rainfall is less than 75% of the normal in 20% of the years examined. 2) Less than 30% of the cultivated area is irrigated. CWC adopted a smaller unit viz. Tehsils for drought identification studies instead of districts and therefore, number of drought affected Tehsilswere identified as 315 out of a total of 725 Tehsils in 99 districts. Accordingly out of 108 M. ha. area of 99 districts, only 51.12 M.ha. Spread over 74 districts has been considered as drought districts. Thus, in contrast to over-all geographical area of the country (329 M.ha) about 1/6th area is drought prone. Irrigation is the most effective drought proofing mechanism. The total geographical area of the drought districts is 108 M.ha, out of which 81 M.ha. is culturable (75%), gross sown area is 61.9 M.ha. (57.4%) and the gross irrigated area is 4.3 M.ha. About 23.23% of the total cropped area is irrigated in the drought districts as against in all India average of 30.15%.

Rainfall is the ultimate significant natural hydrologic event and is a unique phenomenon varying both in space and time. The rainfall distribution is very uneven and it not only varied considerably from place to place but also fluctuates from year to year. The rainfall play vital role in planning and operation strategies of any agricultural programme for any area. Indian subcontinent gets around 75% of the annual rainfall during monsoon period, which lasts from June to September i.e. four months. The major water requirement of the country is fulfilled by rainfall, which occurs in the monsoon period. There is large variation in distribution of rainfall from year to year. In present study, the rainfall data since 1983 is used to investigate drought prone tehsils of Sangli district.

The purpose of this project is to illustrate the pretreatment process of weather-related data, demonstrate the application of different copulas to modeling of joint distributions of rainfall and temperature, select the most suitable copula function according to information criteria, and finally simulate rainfall and temperature simultaneously.

Geographical Information of Sangli District:

Sangli district falls partly in Krishna and Bhima basin. Consequently, Sangli district is divided into different drain systems. The whole district can be divided into three different parts depends on topography, climatology and rainfall viz.

1. **WesternZone** / hilly area of Shirala tehsil with heavy rainfall.
2. **Central Zone** / basin area of Krishna, Warna&Yerala rivers, comprising of Walwa, tehsil & western part of Tasgaon and Miraj tehsils with medium rainfall.

3. **Eastern Zone** / drought prone area which comprises of eastern part of Miraj, north-eastern part of Khanapurtehsil and Tasgaon tehsils, and whole of Atpadi, KavatheMahankal and Jath tehsils.

The climate gets warmer and drier towards the east and humidity goes on growing towards the west. The maximum temperature is 42º C while the minimum temperature is 14º C. The climate in the district is fairly tolerable throughout the year. The winter is pleasant from December to February. The summer season starts from mid-February to May. June to September is the months of normal rainy season. July and August are the months of heavy rainfall. The average rainfall of Sangli district is 400-450 mm per year.

The purpose of present study is to investigate the variations in the rainfall in different seasons of Sangli district by detecting the precipitation changes in the temporal and spatial structure for the period 1989to 2019. The present project consists of five sections. The first section introduces the paper and objects of the work. The second section deals with Reviewof literature with special reference to trends in rainfall data. The third section describes study area, methodology and statistical techniques used for analysis. The fourth section discusses results and its discussion while the fifth one outlines concluding remarks.

Review of Literature:

Climatic studies aim to identify and regulate the climatic changes in various perspectives. Here, we proceedtransient review of some of the research studies supplemented in the context of trend analysis of Indian monsoon rainfall information. Timeseries of annual rainfall, number of rainy-days per year and monthly rainfall of 10 stations were analyzed by Zende *et al.*[1] to evaluate climate variability in semiarid region of Western Maharashtra. They have reported that results showed mixed trends of increasing and decreasing rainfall, which were statistically significant only for Koregaon and Palus stations by the Mann–Kendall test. Also, with the exemption of Vita and Vaduj stations there was no statistically significant trend in the mean number of rainy-days per year. Accumulative and reducing monthly rainfall trends were found over large continuous areas in the study region. These trends were statistically noteworthy mostly during the winter and spring seasons, signifying a seasonal movement of rainfall concentration. Results also showed that there is no significant climate variability in the semi-arid environment of Western Maharashtra. Kumar and Jain[2] have piloted study to determine trends in annual and seasonal rainfall and rainy days over different river basins across India. Among 22 basins studied by them, 15 showed a decreasing trend in annual rainfall; only one basin showed a significant decreasing trend at 95% confidence level. Most of the basins have shown the same direction of trend in rainfall and rainy days at the annual and seasonal scale. Rainfall is subject to strong seasonality in tropical monsoonal climate. Kumar *et al.*[3] studied monthly, seasonal and annual trends of rainfall using monthly data series of 135 years (1871 to 2005) for 30 sub-divisions (sub-regions) in India. Half of the sub-divisions showed an increasing trend in annual rainfall, but for only three (Haryana, Punjab and Coastal Karnataka), this inclination was statistically significant. Similarly, only one sub-division (Chhattisgarh) designated a significant decreasing trend out of the 15 sub-divisions showing decreasing trend in annual rainfall. They have also reported that during June and July, the number of sub-divisions showing increasing rainfall is almost equal to those showing decreasing rainfall. There are spatial and temporal variations in various attributes of the rainy season such as starting date, ending date, durability, etc. Numerous notions of rainy season exist in the real world and the literature, e.g. green season, growing season, wet season, monsoonal rainy season and wet period. Krishnakumar *et al.*[4] have studied temporal variation in monthly, seasonal and annual rainfall over Kerala, during the period from 1871 to 2005. Their analysis discovered significant decrease in southwest monsoon rainfall while increase in post-monsoon season over the State of Kerala which is usually known as the ‗Gateway of summer monsoon'. According to Ranade *et al.*[5], a hydrological wet season by taking theconcernofimportant parameters such as initial and windup dates and duration, seasonal rainfall/rainwater and surplus rainfall/rainwater potential. They have performed analysis for the 11 major and 36 minor rivers basins as well as the West Coast Drainage System and the whole country using highly quality-controlled monthly rainfall from well spread network of 316 rain-gauge stations from earliest available year up to 2006 and observed declining tendency in the rainfall/rainwater and surplus rainfall over most of the minor basins. The state-wise analyses of rainfall have also been reported in the literature. As it can be seen from the above survey, previous studies have been conducted either river basin wise or state-wise. None of the study deals with month-wise and/or meteorological region-wise analysis of Indian rainfall data. Shesabhare and Kalange[6] have studied the trends in the time series of rainfall data for more than 100 years. They have reported the results of the trends monsoon month-wise as well as meteorological region-wise. As far as Indian economy is concerned, district is considered as smallest unit of the nation and accordingly policies are worked out. Thus, geographical location like district is playing a crucial role in the design of policy. This aspect along with others motivated us to undertake the study of rainfall with study area limited to Sangli district. Accordingto Pore *et al.*[7], Rainfall data is of great importance of any agricultural and non-agricultural programme. If appropriate and broad study of various rainfall data was assessed, the harshness and reoccurrence of drought can be forecast and various measures can be taken to cope up with the problems arising due to drought. In 2019, Wagmare and Wagmare study impacts of rainfall changeability of yields of main crops and investigate the benefits of rainwater harvesting as a livelihood policy.

Methodology:

Material and Methods:

The data used for this study is secondary data. The data is obtained from the Indian Meteorological Department, Pune and Mahakrushi website. The data comprise the records of actual rainfall recorded at three tehsils in Sangli district. The rainfall records include observations spanning from 1983 to 2019 and cover a period over 37 years. For the said purpose the period of time series is long enough to carry out statistical analysis. As many hydrological time series data are not normally distributed, non-parametric tests were preferred over parametric tests. The methodology adopted for the study was designed as per the previous work in this area[6, 8].

Study area:

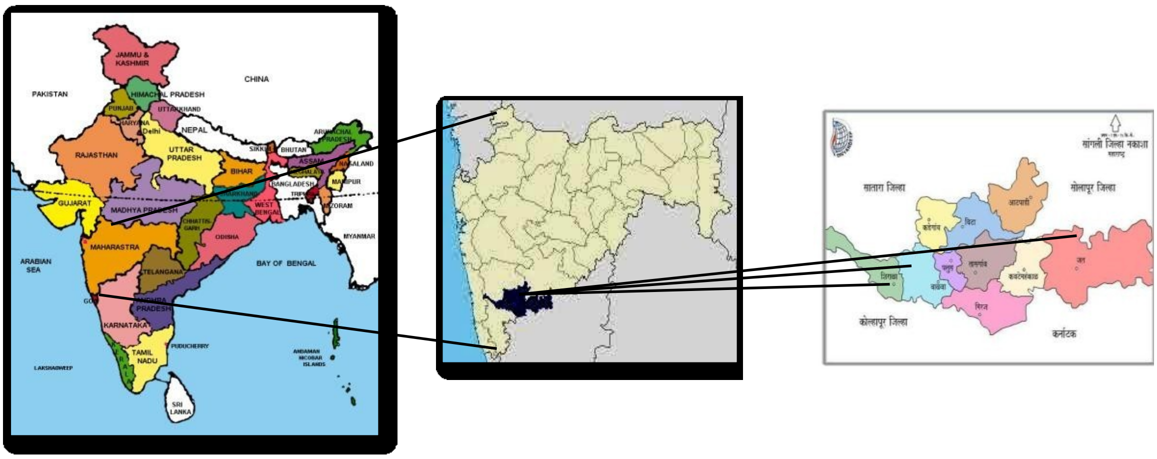

Figure 1: Location of Study Area

The present study is focused on Rainfall drifts in Sangli district of Maharashtra state. The Sangli district lies between 16^{0} 45‘and 70^{0}33‘north longitudes and 73^{0} 42‘ and 75^{0} 40‘ east latitudes. The district is divided in to 10 tehsils with an area of 8591.3 kilometers and a population near about 2825000. Geographically the district is divided into three zones, viz. western zone, central zone and eastern zone. The district lies in the Sothern part of Maharashtra state. This study is conducted considering three tehsils of Sangli district as a study area.

1. Shirala Tehsil **from Western Zone** with heavy rainfall.
2. Walawa – Islampur Tehsil from **Central Zone**with medium rainfall.
3. Jath Tehsil from **Eastern Zone**withdrought prone is selected as representative of three zones of Sangli District.

Note: Data used: All the tehsils of Sangli district collected monthly rainfall data from normal months from 1981 to 2019 (48) and use dry observation cells to inspect from Drought Monitoring Cell Bangalore and IITM-IMD Rainfall.

Results and Discussion:

Average rainfall fluctuation of three selected tehsil of Sangli district are represented in Fig.2

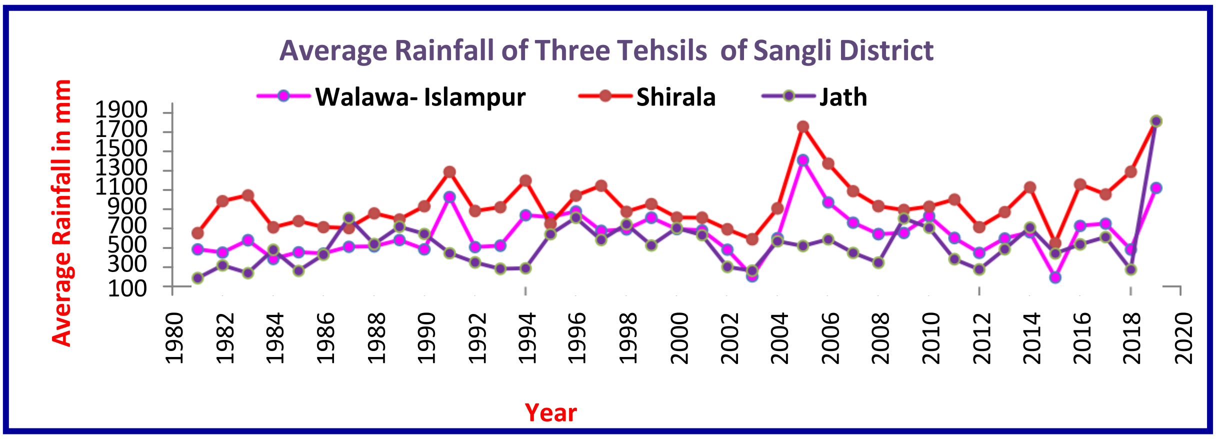

Figure 2: Variability of rainfall for three tehsils of Sangli district (1981-2019)

It is marked that the annual rainfall among the zones under consideration could best be described as oscillatory. The trend is not regular but irregular. However comparing the three tehsils, it can be observed that the Walawa - Islampur tehsil trend is more regular than the other. Additionally, the Shirala tehsil has the highest oscillatory trend of rainfall. The higher precipitation recorded in the Shiralatehsilgenerally could be credited to the mountainous nature of the area, coupled with thick forests and also the Warana River and VasantSagar Dam which supply the bulk of the atmospheric moisture for precipitation. The low rainfall at Jath tehsil could be attributed to the vegetationless nature of the area. The loss of vegetation in these areas, compared to that of forest and mountainous areas, reduces natural cooling provided by evapotranspiration, the process through which intercepted radiation is utilized by plants, soils, and water bodies to convert water to water vapour[9]. This water vaporincreases to the upper atmosphere, condenses, and eventually falls as rain. However other studies averred that since rainfall in the tropics is extremely variable in both space and time, identifying the precise cause of fluctuations remains problematic[10, 11].

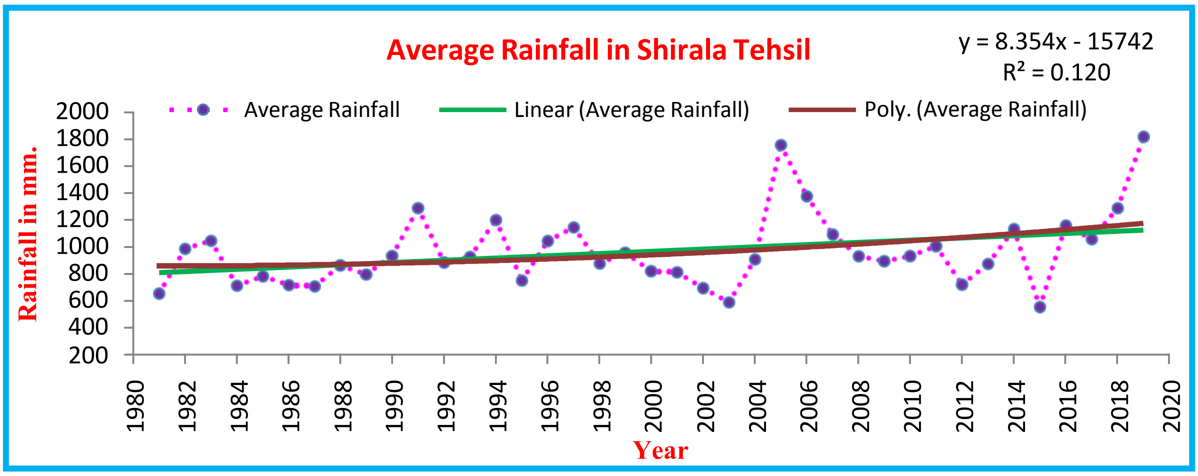

Figure 3: Average and polynomial multi-curve of annual rainfall for Shirala Tehsil

Western Zone / hilly area of Sangli district represented by Shirala tehsil with heavy rainfall. Shirala Tehsil (Fig. 3) shows a decline in general migration at a rate of -26.20 mm per year. Multiple bend patterns decreased from 1981 to 1991, and bend patterns increased from1990. The redirection pattern declined slightly between 1998 and 2003, indicating that low rainfall could last for up to four years. In 2005 and 2018 it shows the highest rainfall and it is upto 1750-1800mm.The years 1981, 1984- 1988, 2000 to 2004, 2008 to 2013, 2015 and 2017 this region suffers from drought conditions while year 1987, 1989, 1992 to 1994, 2007, 2014 and 2015 show average rainfall.

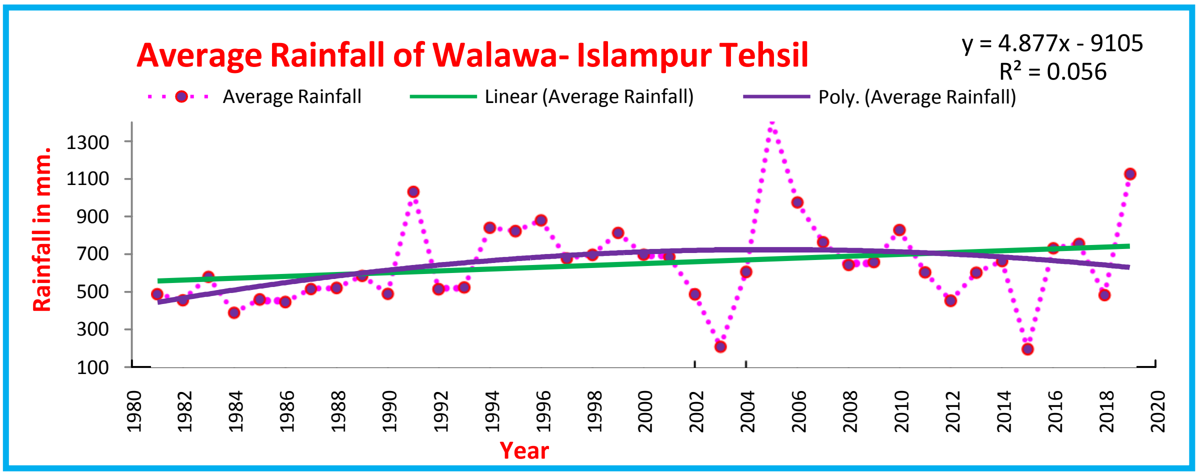

Figure 4: Average and polynomial multi-curve of annual rainfall for Walawa-IslampurTehsil

Walawa – Islampur Tehsil represents Central Zone with medium rainfall in Sangli District. It shows minimum rainfall from 1981to1990 as well as from 2000 to 2004 and from 2008 to 2016 than the average rainfall. It shows same pattern as like Shirala Tehsil. In year 1991, 2005and 2019 it shows heavy rainfall. The highest rainfall occurs in year 2005 causes flood situation. In this region drought condition was observed during the years from 1981, 1982, 1984 to 1990,2002to 2004,2008 to 2015 and 2018. While in year 1983, 1989,1997,1998,2000,2001,2007, 2016 and 2017average rainfall was observed

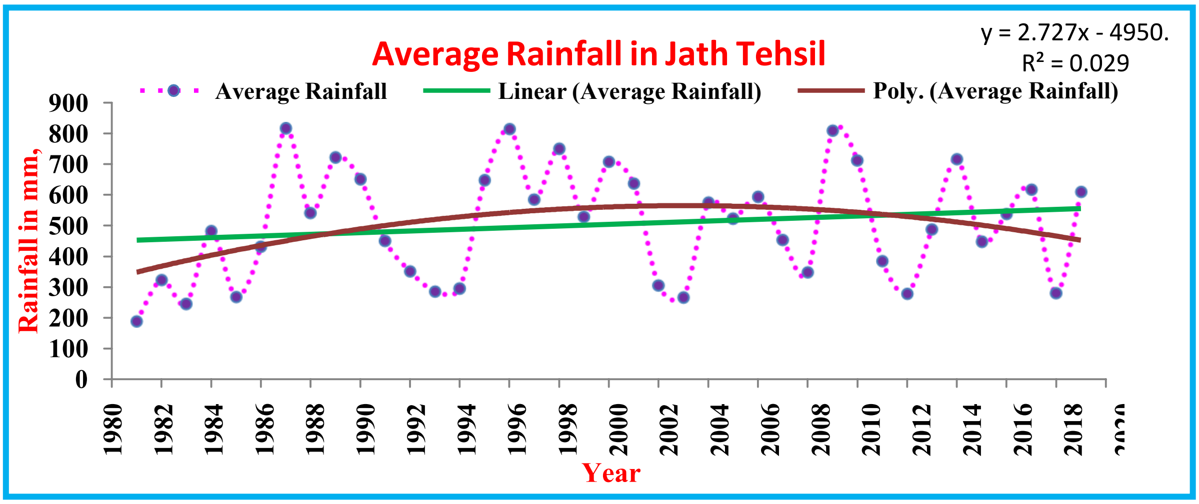

Figure 5: Average and polynomial multi-curve of annual rainfall for JathTehsil

Jath Tehsil from Eastern Zoneis with drought prone region. The average rainfall of this region is observed in 1984, 1991, 1999, 2005 and 2016 years. During 1981 to 1983, 1985, 1986, 1991 to 1994, 2002, 2003, 2005, 2007, 2008, 2011 to 2013, 2015 and 2018 rainfall decreases than average rainfall hence that region suffers from drought conditions. While years from 1987 to1990, 1995 to 1998, 2000, 2001, 2004, 2006, 2009, 2010, 2014, 2017 and 2019 show maximum rainfall than average rainfall. The highest rainfall occurs in year 1887 and 2009. It was about 809 to 815 mm.

Table 1: Linear Regression statistic results for annual rainfall for three tehsils of Sangli District.

Sr. No.	Tehsil	Regression equationy	□-square	Statistically significant
1	Shirala	8.3544x - 15742	0.1209	No
2	Walawa- Islampur	4.8773x - 9105	0.0565	No
3	Jath	2.7272x - 4950.1	0.0295	No

Linear regression is one of the simplest methods to calculate the trend of data in time series. The equation of linear regression line is given byY = a + bX, where X is the independent variable and Yis the dependent variable. The slope line is b and a is the intercept (value of Y when X=0). The slope of regression describes the trend whether positive or negative. In this study dependent variable Y is rainfall and independent variable X is year. Linear regression requires the assumption of normal distribution. In this study, the null hypothesis is that the slope of the line is zero or there is no trend in the data. The value of R-square (R^2) or the square of the correlation from the regression analysis was used to show how strong the correlation and relationship between the variables X and Y are. The value is a fraction between 0.0 and 1.0. The R^2 value of 1.0 means that the correlation becomes strong and all points lie on a straight line. On the other hand, an R^2 value of 0.0 means that there is no correlation and no linear relationship between X and Y

The results of the linear regression trend analysis are presented in Table 1, respectively, covering Shirala, Walawa- Islampur and Jath tehsils respectively, of the Sangli District. In these trend tests, trend of annual rainfall for 40 years has been computed for each independently. The linear trend lines of the annual rainfall indicated a downward trend and annual rainfall data for the Shirala Tehsil. That means there is no statistically significant trend in the annual and monthly rainfall data for northern zone. Additionally, the R-square statistic also indicated a very weak relationship between the variables, rainfall, and year.

Conclusion:

The study has represented a comprehensive breakdown of rainfallvariability and trend of rainfall in Sangli and Satara districts. The area inthe eastern part of the Sanglireceiving very lessrainfall compare to the other parts of the district. By using 35 years recodedof rainfall in both the district, the study scrutinized the temporal and spatialvariation of rainfall on a western, central and eastern part of the study area.These results also indicated that for the analyzed time-period, there was no significant climate change in the study area. The results also suggest the need for further investigation on local environmental issues, which could be one of the major causes of climate change. The main recordings of the study are summarized below.

1. Annual rainfall in the Sangli district varies from year to year.

2. Trend analysis of annual average rainfall indicators shows fluctuations in 35 years.During the period of, 1982, 1983, 1986, 1987, 1995, 2000,2001showsdecreasing trends in Sangli district.

3. Coefficient of variation in Sangli district was 17.37.

The key focus in this study has been to understand rainfallvariability as a basis for improving the understanding of crop to climateinteractions in study region. We analyze impacts of rainfall variability ofyields of staple crops and investigate the benefits of rainwater harvestingas a livelihood approach. In conclusion, this study has shown thatthere are significant intra-regional alterations in rainfall amount,irregularity and trend. In general, rainfall amount is higher and itsvariability 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 making. Theresults also suggest the need for further investigation local anthropogenicintervention in the environment, which could be one of the major causesof climate change in study regions.

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