ANALYSIS OF RAINFALL CHARACTERISTICS IN SEMI ARID REGION OF SANGLI DISTRICT, INDIA

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ABSTRACT

Water scarcity is a leading concern in both arid and semi arid regions. In this article the seasonal and annual rainfall and rainy days data is analysed for the years 1980 – 2012 to understand rainfall fluctuations in semi arid region of Sangli District of Yerla River basin, Maharashtra. The study area lies in the rain shadow zone of basaltic Deccan Traps region and receives 632.22 mm average annual rainfall. In the area the early rains are scanty and the late rains are capricious, so drought occurs repetitively. The monthly and annual rainfall and rainy days data of Vita and Tasgaon stations obtained from India Meteorological Department were analysed on the computer using Microsoft Excel. Correlation between average annual rainfall and average rainy days are calculated for each station. Temporal variations in rainfall are observed with wet and dry spells during the rainy season. September is the wettest month followed by June, October, July and August. There are little or no rainfall occurred in the pre monsoon period from February to May and sporadic showers occurred during the post monsoon period from mid October to January in the region. Nature and distribution of rainfall are essential for watersheds management and allied studies.

IndexTerms: Rainfall, Semiarid Region, Yerla River basin, Sangli District, Deccan Traps, India.

INTRODUCTION

Seasonal changes in rainfall pattern may alter the hydrological cycle and environmental processes as well as the vegetation and the entire ecosystem (Delitala et al., 2000; Lazaro et al., 2001). Lazaro et al. (2001) analysed thirty year rainfall data in semi – arid SE Spain for implications on vegetation and suggested that vegetation is not only adapted to the amount of precipitation but also its timing. Fu et al. (2012) were analysed Rainfall-Runoff Characteristics of Coastal Granite Catchment in Southern China. Sepaskhah and Moosavi-Fard (2010) determined the rainfall-runoff relationship based on soil physical properties for use in micro catchment water harvesting system design. Gadgil (2002) studied rainfall characteristics of Maharashtra and stated that semi-arid part of the state faces repetitive drought condition. CGWB studied long-term rainfall data between 1901 and 1990 to compute rainfall statistics and demarcated drought-prone area of the Maharashtra State and found that the area experiences drought in every five years.

Unde and Telore (2013) analysed critical drought prone Nidhal micro watershed of Satara District and found that watershed development programmes are essential for sustainable development. Shikalgar (2014) accessed and monitored droughts in the Yerla River basin and observed severe drought in the area in 2001, 2002 and 2012, using Modis Terra satellite data. GSDA (2009) observed that the northern part of the Yerla River is facing critical water scarcity problem and suggested a need of proper implementation for watershed management. Singh et al. (2003) and Simpson (2006) carried out rainfall analysis for understanding rainfall variations in a different part of India. Zende et al. (2012) analyzed rainfall trends and found that there was no significant climate change in the semi-arid region of Western Maharashtra. Telore and Unde (2018), Telore (2019) carried out hydrological charactieristics of the semi arid river basin of the Deccan Traps region and stated that watershed management is an ideal way to solve drinking and domestic water scarcity of the region. Therefore in this paper author find out the seasonal and annual trends of rainfall in the study region. Modarres and Silva (2007) showed that there is no significant climate variability in the arid and semi-arid environments of Iran. Machiwal et al. (2017) found that there are statistically significant increasing trends of annual rainfall over both hot and cold arid regions

of India. Authors identify significantly increasing trends of wet season rainfall over the hot arid region, and significantly increasing trends of dry season rainfall in the cold arid region.

Study area

The study area covers the southern part of the Yerla river basin, includes Vita and Tasgaon rain gauge stations of Sangli District. The administrative boundary of Satara and Sangli districts makes two parts of the Yerla River basin i.e. north and south. The southern part lies in Kadegaon, Khanapur, Tasgaon, and Palus Tahsil of Sangli district (Fig. 1 and Table 1). This zone receives 632.22 mm average annual rainfall. The rainfall is shown in Fig. 2 and Table 2. Annual variability of rainfall of various rain gauge stations is shown in Fig. 2 to 3 and the monthly variability of these stations is given in Fig. 4 and 5. The Yerla River basin receives above 85 % orographic type of rainfall from southwest monsoon winds from June to mid-October (rainy season). The study area lies in the rain shadow zone of the Deccan Trap region.

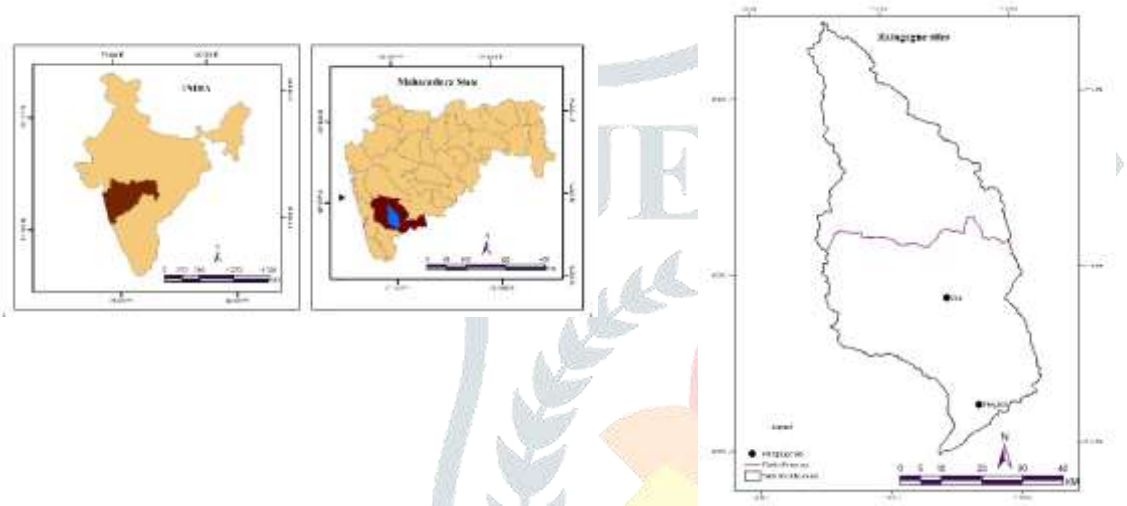

Fig. 1 Location map of the study area and raingauge sites

Rainfall Database

The monthly and annual rainfall and rainy day data during the period 1980 to 2012 (33 years) obtained from India Meteorological Department, Pune were analysed on the computer using MS Office Excel software. Four rain gauge stations are located in the Yerla River basin, in which Vita and Tasgaon are located in the southern part lies in the Sangli District (Fig. 1). The description of rain gauge stations and rainfall data used in the study is shown in Table 1 and Fig. 1.

Table 1 Description of raingauge stations and rainfall data

Sr. No.	Station Name	Duration for which data is obtained
1	Vita	1980-1996, 1998-2012
2	Tasgaon	1980-1982, 1984-1985, 1987-1988, 1990-2012

RAINFALL MAGNITUDE AND VARIABILITY

A) Spatial Distribution

The Spatial distribution of rainfall is observed in this rain shadow area from west to east and north to south. The greatest fall was 1211.8 mm at Vita in 1981 and least 186.6 mm at Tasgaon in 2003 (Table 2). Average annual rainfall in the area ranges between 186.6 and 1211.80 mm. The maximum annual rainfall ranges from 1004 mm at Tasgaon to 1211.8 mm at Vita. Minimum annual rainfall ranges from 186.6 mm at Tasgaon to 306.9 mm at Vita. In the study area annual mean maximum and mean minimum rainfall is 1043.35 mm and 240.45 mm respectively. If individual stations are

considered Vita records the highest average annual rainfall of 651.34 mm, followed by Tasgaon, 613.10 mm (Table 2, Fig. 1). This area receives 632.22 mm of average annual rainfall. The northern part i.e Vita receives higher mean rainfall (651.34 mm) than the southern part i.e. Tasgaon (613.1 mm). On the basis of rainfall data it is found that the northern part of the semi arid basin receives higher rainfall than the southern part.

Table 2 Rainfall statistics of the study area (1980 - 2012)

Sr. No.	Station Name	Mean	Maxi-mum	Year	Mini-mum	Year	Standard Deviation	CV %	Skew-ness
1	Vita	651.34	1211.8	1981	306.9	2003	71.16	60.69	- 0.14
2	Tasgaon	613.1	1004.0	1991	186.6	2003	56.82	49.20	0.35
	Average	632.22	1107.9		246.75				

All Rainfall values in mm; CV % : Coefficient of Variation in %

ANNUAL VARIABILITY IN RAINFALL

The rainfall is shown in Fig. 1 and Table 2. Annual variability of rainfall of various raingauge stations are shown in Fig. 2 to 5 and monthly variability of these stations is given in Fig. 6 and 7.

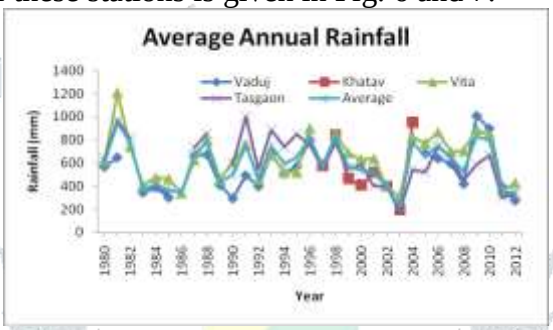

Fig. 2 Average annual rainfall in the study area

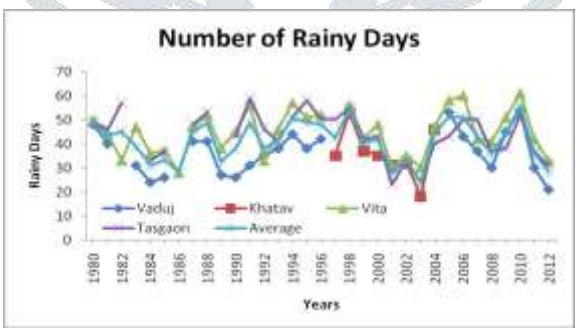

Fig. 3 Number of average rainy days in the study area

STATION WISE RAINFALL CHARACTERISTICS

1) Vita (Khanapur) Station

Vita station receives an average annual rainfall of 651.34 mm for the period of 32 years from 1980 to 2012 (Fig. 4). Maximum annual rainfall of the station is 1211.8 mm in 1981 and minimum rainfall is 306.9 mm in 2003. During the record period of rainfall, 17 years rainfall is above average and 15 years below average. The distribution of rainfall at this

station is multimodal. The gap between maximum peaks is 6, 2, 2, 2, 5 and 2 years and minimum peak is 3, 2, 2, 2, 1, 6, 4 and 3 years above and below the average line. In the year 2003 severe drought condition occurred in the Vita area (Fig. 4). Rainfall data show that the repetitive drought situation occurred in this region.

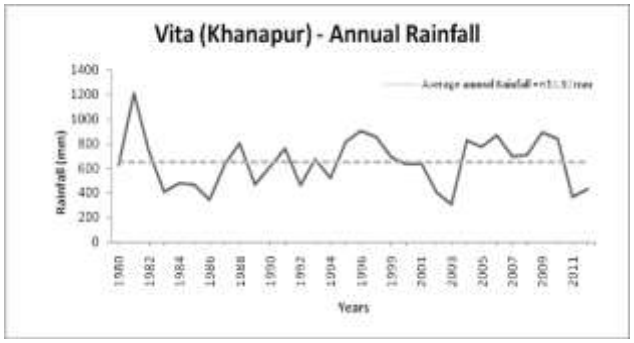

Fig. 4 Annual rainfall of Vita (Khanapur) Station (1980 - 2012)

2) Tasgaon Station

The average annual rainfall of Tasgaon station is 613.10 mm for the period of 30 years from 1980 to 2012. Maximum annual rainfall of the station is 1004 mm in 1991 and minimum rainfall is 186.6 mm in 2003. Out of 30 years of rainfall, 14 years rainfall is above average and 16 years it is below average. The distribution of rainfall at this station is multimodal. The gap between maximum peaks is 4, 1, 1, 1, 2, 2, 5 and 4 years and minimum peak is 2, 2, 1, 4, 5, 5 and 2 years above and below the average line. Like Khatav and Vita this station also faced critical drought condition in the year 2003 (Fig. 5).

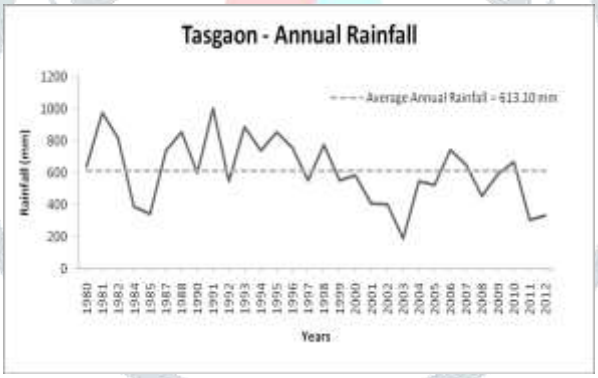

Fig. 5 Annual rainfall of Tasgaon Station (1980 - 2012)

SEASONAL VARIABILITY

1) Vita (Khanapur)

Analysis of monthly rainfall data shows that the mean rainfall of Vita (Khanapur) station for the record period is 114.8 mm (Fig. 6). The seasonal mean rainfall for the record period varies between 50.92 mm in 2003 and 233.60 mm in 1981. The coefficient of variation for the monsoon season for different years of record ranges between 22.55 % in 2010 and 129.80 % in 1981. During the period of record in 1981 more than 100 %, indicating the operation of some extreme events due to heavy rainfall. Similarly, if we look towards the direction of variation of rainfall in a particular monsoon season on the study area the coefficient of skewness varies between - 1.37 in 1980 and + 2.11 in 1981. Analysis of monthly rainfall data reveals that the skewness coefficient for the year 1980, 1983, 1989, 1990, 1996, 2000, 2005, 2006, 2008, 2009 and 2010 are negative suggesting much of the rainfall was received during mid August to mid October. The skewness coefficient values for the year 1981, 1982, 1984, 1985, 1986, 1988, 1991, 1992, 2001, 2002 and 2012 is greater than + 1.00 suggesting the most amount of rainfall received during the mid June to mid August months. The remaining years

have positively skewed closer to zero, which exhibits normal distribution of rainfall. During the period of record maximum mean rainfall received in September i.e. 160.5 mm, followed by June (123 mm), October (102.3 mm), July (97.26 mm) and August (91.01 mm) (Fig. 6).

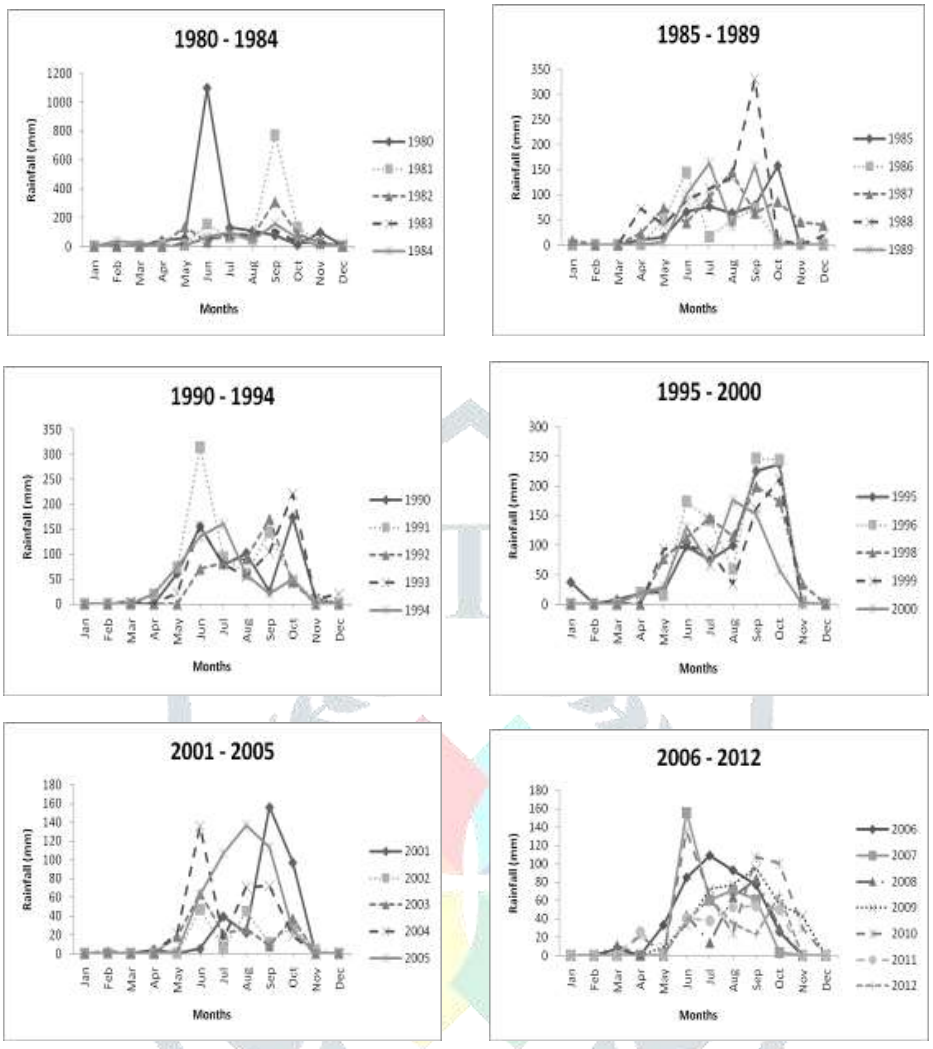

Fig. 6 Monthly rainfall of Vita (Khanapur) Station (1980-2012)

2) Tasgaon

Analysis of monthly rainfall data of Tasgaon station shows that the mean rainfall for the record period is 105.18 mm (Fig. 7). The seasonal mean rainfall for the record period varies from 58.6 mm in 1985 to 180.06 mm in 1981. The coefficient of variation for the monsoon season for different years of record ranges between 0.62 % in 1993 and 95.44 % in 2008. Other characteristics of this station in comparison to others is, during the record period more than 100 % variation in rainfall is not observed. If we look towards the direction of variation of rainfall in a particular monsoon season on the study area the coefficient of skewness varies between -1.57 in 1987 and +1.97 in 2009. Analysis of monthly rainfall data reveals that the skewness coefficient for the year 1980, 1985, 1987, 1992, 1999, 2000, 2002, 2005, 2006 and 2011 are negative suggesting much of the rainfall was received during mid August to mid October. The skewness coefficient values for the year 1981, 1988, 1991, 1993, 2008, 2009 and 2012 is greater than + 1.00, shows the most amount of rainfall received in the early monsoon months. The remaining years have positively skewed closer to zero exhibits normal distribution of rainfall. During the period of record maximum mean rainfall received in September (128.54 mm), followed by June (117.99 mm), October (97.79 mm), July (96.59 mm) and August (84.99 mm) (Fig. 7).

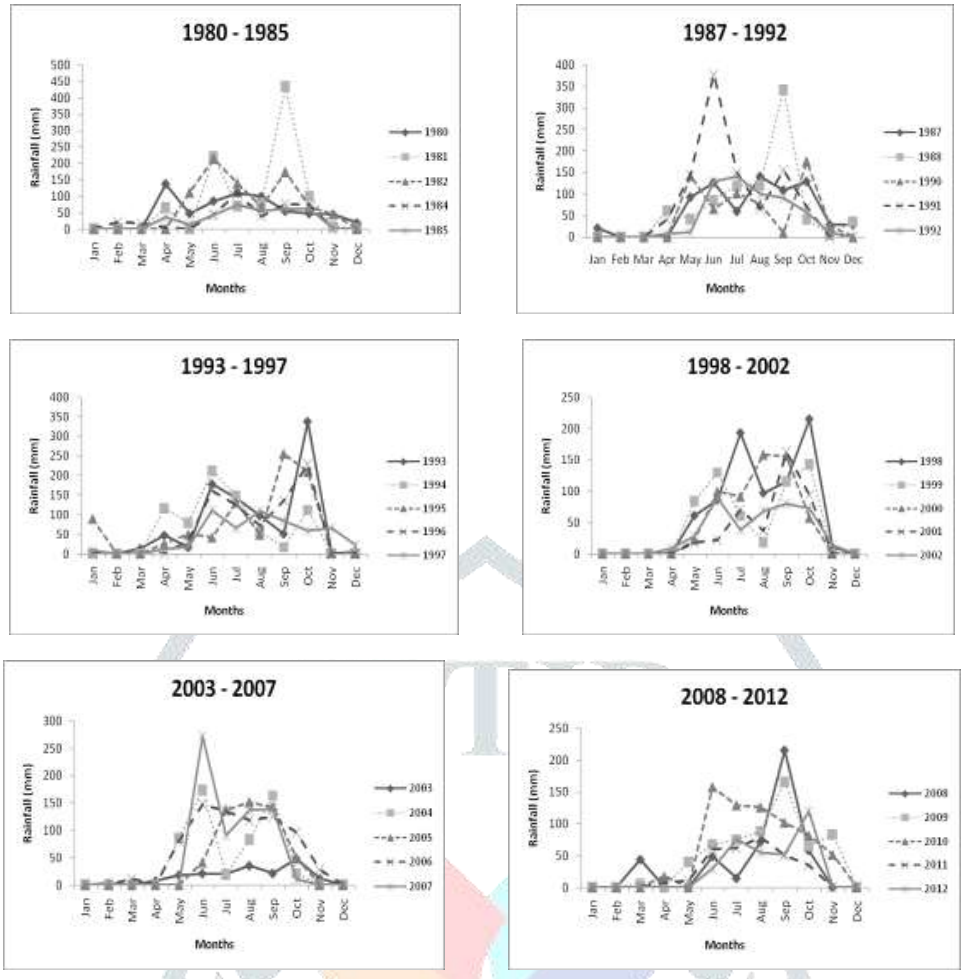

Fig. 7 Monthly rainfall of Tasgaon Station (1980-2012)

Correlation between Annual Rainfall and Number of Rainy Days

The correlation between average annual rainfall and average rainy days are calculated of each station. Correlation values of Tasgaon is 0.8215 indicates strong positive correlation between these two parameters. The correlation value of Vita is 0.5668 indicates a positive correlation between these two values. In the study area highest positive correlation observed at Tasgaon and least positive correlation observed at Vita. In the Yerla River basin correlation between annual rainfall and rainy days is found strong positive to positive relationship between these two parameters indicates annual rainfall increases when rainy days increased.

CONCLUSION

In this article observation and analysis of seasonal and annual rainfall is carried out in this semi arid region of the Deccan Traps, India. The study area receives average annual rainfall of 632.25 mm. In the area correlation between annual rainfall and rainy days is found strong positive (0.82) to positive relationship (0.57) between these two parameters indicates annual rainfall increases when rainy days increased. The present study is useful for sustainable watershed development and allied studies.

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