



Rainfall Trends of Bhadradri District in the Past Three Decade

**Vindya Sabbineni ^{a*}, Srinivasarao R. ^a,
Lakshmi Narayanamma V. ^a, Umareddy R. ^a
and Sreenivas G. ^a**

^a *Krishi Vigyan Kendra, Professor Jaya Sankar Telangana State Agriculture University, Bhadradri Kothagudem, Telangana, India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Bhadradri district of the central Telangana zone is monsoon dependent as like our country in the past three decades many changes and shifts in the rainfall was experienced by the district farming community. Hence, the rainfall data of the past three decades (1991-2020) was analyzed by using non parametric statistical tests *i.e* Mann-Kendall (MK) test and Sen's slope estimator for determining the trend and magnitude. The Results of the study revealed that Z test value for annual rainfall was significantly increased with Positive linear trend of Sen's slope estimator with +12.79 mm increase per year. Among the seasons Southwest monsoon period reported significantly positive trend with Z value of 2.07 and Sen's slope estimator was +9.227 mm per season. Highest rainfall variability (116.3%) was found in the winter season with negative Z value (-1.559) and decreasing Sen's estimate of -0.397 mm per season was reported. Mann Kendall test values for monthly rainfall reported that significant increase in the march month with Z value of 2.030 and Sen's slope estimator was highest during the month of August +3.988 mm per month.

*Corresponding author: E-mail: vindya.s.vindya@gmail.com;

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1. INTRODUCTION

Bhadradi District was mostly agriculture dependent as like the Telangana state and country, with a gross cropped area of 1,39,036 ha under the cultivation of the Paddy, Maize, chilli and redgram in *Kharif* season and Greengram, Blackgram, Groundnut in the *rabi* season. The majority of area under cropping was rainfed, largely dependent on the monsoon rainfall, Hence, the rainfall in the region is a governing factor to determine crops, cropping pattern, individual crop area production & productivity of various crops and one of the important variable in determining the occurrence of floods and drought, the changes in the precipitation pattern was not uniform [1], In view of these the present study was aimed to analyse the variability and trend of the rainfall over Bhadradi district over past three decades (1991-2020).

2. MATERIALS AND METHODS

2.1 Study Area

Bhadradi district lies between 18° 13' and 17° 13' Northern latitude and 80° 12' and 81° 18' Eastern longitude in central zone of Telangana state and elevated at 109 m MSL with the decennial rainfall over the district was 1155 mm.

2.2 Data Sources

Monthly mean values of the rainfall data recorded at seventeen stations in the district was collected for past three decades (1991-2020) from O/o Chief Planning Officer, Bhadradi district and used for the present study.

2.3 Rainfall Seasons

According to the IMD classification monthly rainfall of the district was summed into seasonal rainfall *i.e.* Winter Season: January – February, Pre-Monsoon Season: March – May, Southwest Monsoon Season: June – September, Post Monsoon Season: October – December and analysis was done.

2.4 Standard Deviation of the Rainfall

An estimator for sigma sometimes used as the standard deviation of the sample, denoted by σ and define as follows. Standard deviation (SD).

$$\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n - 1}}$$

where (x_1, x_2, \dots, x_n) are the observed values of the sample items and \bar{x} is the mean value of these observations, while the denominator N stands size of the sample.

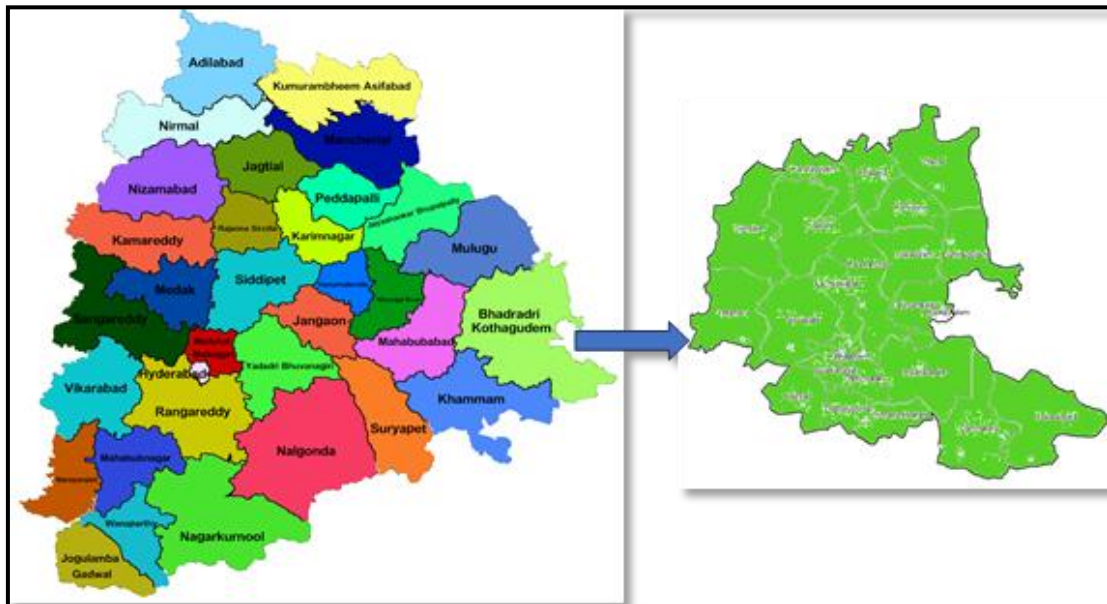


Fig. 1. Geographical Map of the Bhadradi district of the central Telangana zone

2.5 Co-efficient of variation (CV %)

Co-efficient of variation is the percentage variation between mean, standard deviation being considered as the total variation from the mean. High Co-efficient of variation indicates more variability and less stability.

$$CV = \frac{\sigma}{\mu}$$

In other words co-efficient of variation (CV) is defined as ratio of the standard deviation to the mean (μ).

2.6 Test Z

The widely accepted non-parametric test for rainfall working with time series trends was Mann-Kendall. Hence, changes in trends of monthly, seasonal and annual rainfall were detected in time series using Mann-Kendall (MK) test. Mann-Kendall test is used to test the null hypothesis H_0 of no trend, against the alternative hypothesis, H_1 of an increasing or decreasing monotonic trend. This is a rank correlation statistical test based on a comparison of the observed number of discordances and the value of the same quantity expected from a random series. In the computation of this statistical test MAKESENS exploits the normal approximation (Z) statistics (Salmi et al. 2002). The absolute

value of Z was compared with the standard normal cumulative distribution to detect if there is any trend at the selected level of significance (α) [2]. The trend is said to be increasing or decreasing if value of Z is positive or negative respectively.

2.7 Q value

If the linear trend is present in a time series, then the slope (change per unit time) can be estimated by using a simple non-parametric procedure, the Sen's slope estimator [3], These methods have become very useful in analyzing meteorological or atmospheric data, or where regular observations are to be analyzed over a long period.

3. RESULTS AND DISCUSSION

3.1 Annual Rainfall Trend

The results of past three-decade rainfall analysis implicated that mean annual rainfall was 1213.2 mm with standard deviation of 277.1 mm *i.e* 22.8% variation. Z test value for annual rainfall was positive (2.0) with significant increase. Positive linear trend was found by the Sen's slope estimator with +12.79 mm increase per year (Fig. 2), similar results were quoted by Yang et al. [4] for Wangmo and Xingren stations of Southwest Guizhou Autonomous Prefecture of China.

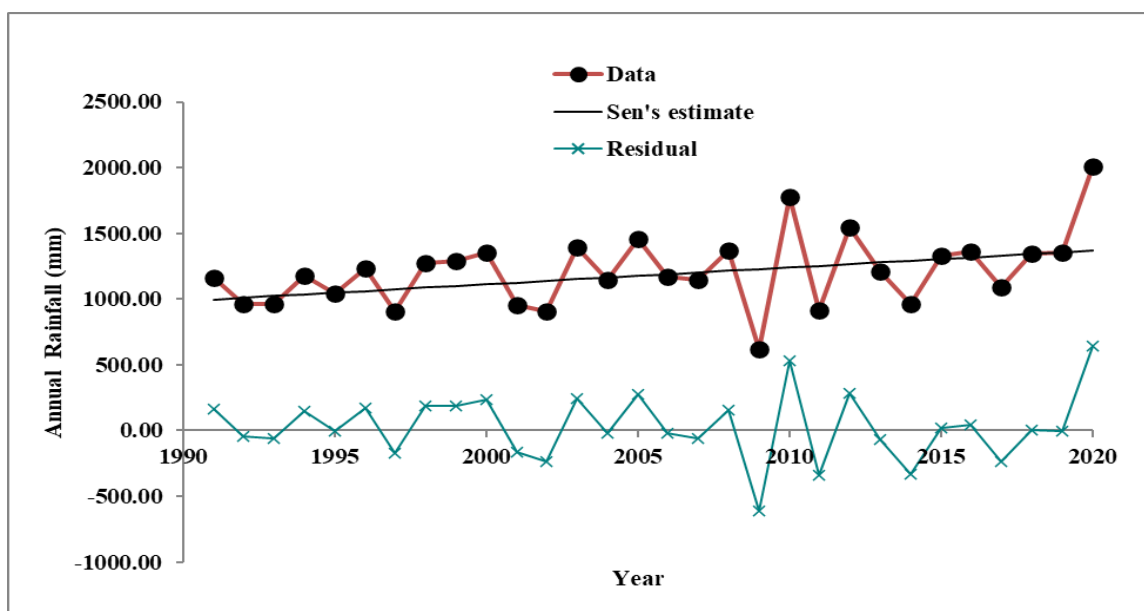


Fig. 2. Annual Sen'S Estimate Trend lines for Bhadradi District of Central Telangana

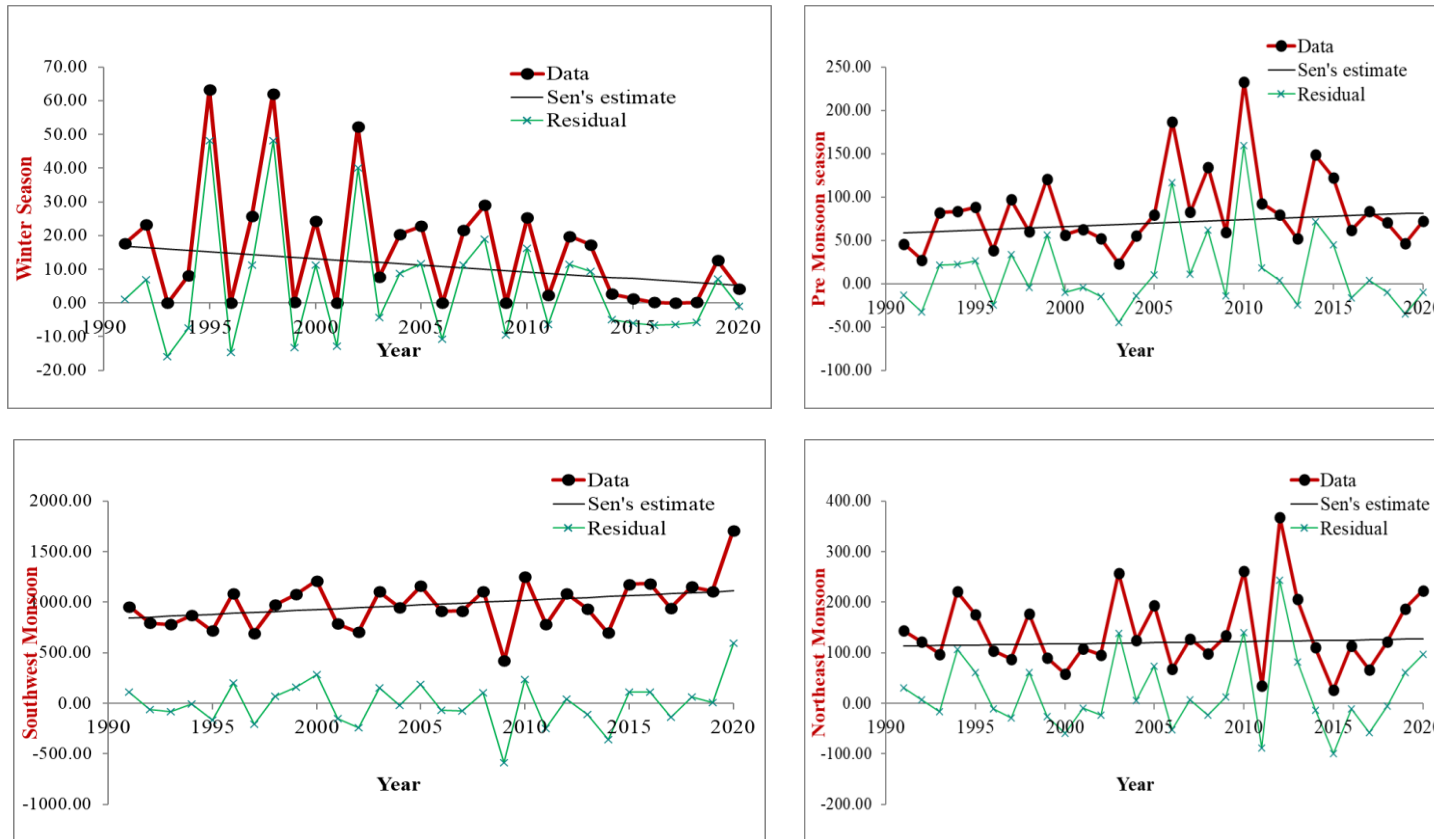


Fig. 3. Seasonally Sen'S Estimate Trend lines for Bhadradi District of Central

Table 1. Monthly, Seasonal, and annual rainfall characteristics and trends for Bhadradi District

Month	Mean	SD	CV	Test Z	Q
January	8.7	15.8	180.6	-0.933	0.000
February	6.8	12.9	190.9	-0.739	0.000
March	11.0	23.0	209.4	2.030*	0.207
April	24.8	20.3	82.0	0.464	0.223
May	47.6	44.0	92.5	0.607	0.354
June	171.6	111.4	64.9	1.213	2.456
July	291.9	92.0	31.5	-0.143	-0.338
August	315.7	144.4	45.7	1.035	3.988
September	195.3	102.1	52.3	1.463	3.178
October	103.6	55.2	53.3	-0.036	-0.080
November	26.7	45.7	170.8	-0.089	-0.017
December	9.6	22.8	236.2	0.991	0.000
Season	Mean	SD	CV	Test Z	Q
Winter	15.5	18.0	116.3	-1.559	-0.397
Pre Monsoon	83.3	45.7	54.8	0.999	0.780
SWM	974.5	240.5	24.7	2.070*	9.227
Post Monsoon/ NEM	139.9	74.9	53.5	0.357	0.469
Annual	1213.2	277.1	22.8	2.0*	12.79

Z=Mann Kendall test Q=Sen's Slope (mm/year) *=0.05 level of significance

3.2 Seasonal Rainfall Trend

Bhadradi district receives chief amount of rainfall during the Southwest Monsoon season (June-September) followed by Post Monsoon period (October-December) due to the impact of Northeast Monsoon. In the Southwest monsoon period 974.5±240.5 mm with 24.7% variation receives and significantly positive trend was reported with Z value of 2.07 and Sen's slope estimator was +9.227 mm per season. Highest rainfall variability (116.3%) was found in the winter season with negative Z value (-1.559) and decreasing Sen's estimate of -0.397 mm per season was reported. Pre monsoon and post monsoon positive Z value and positive Q values but there is no significance in these seasons (Table 1, Fig. 3).

3.3 Monthly Rainfall Trend

Monthly rainfall pattern of past three decades (1991-2020) showed that August month received highest amount of rainfall 315.7±144.4mm followed by July month with 291.9±92.0 mm and lowest rainfall received February 6.8±12.9. the rainfall variability was highest during the December (236.2%) followed by march (209.4%) and February (190.9%).

Mann Kendall test values for monthly rainfall reported that significant increase in the march

month with Z value of 2.030 and non-significant positive values were reported in April-June, August and September months and non-significant negative values were reported in January, February, July, October and November months.

Sen's slope estimator was highest during the month of August +3.988 mm per month followed by September and June with +3.178 mm and +2.456 mm respectively. Increasing trend slope was reported from March-May and decreasing trend slope was reported in July, October and November months. Trend line was linear in December, January and February months [5-9].

4. SUMMARY AND CONCLUSION

Rainfall trend analysis study results summarized that in the past three decades rainfall of Bhadradi district shows 22.8% variation annual rainfall associated with highest variability during winter season followed by monsoon periods. Mann Kendall test values and Sens's estimator values shows the similar trend. The higher positive test Z and Q values are reported in the South West monsoon period followed by pre monsoon and North East monsoon, where as negative values were reported during the winters. It can be concluded that the district annual rainfall is in increasing trend annually.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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