Statistical Analysis of 30 Years Rainfall Data of YSR Kadapa District, Andhra Pradesh, India

VishnuvardhanVarada

Department of Humanities and Sciences, Annamacharya Institute of Technology and Sciences (Autonomous), Rajampet, Andhra Pradesh, India
vishnuvardhan36369@gmail.com

Venkatesh Merugu

Global Enviro Labs, 2-2-1075/14/A/1, First Floor, Thilaknagar X Roads, BaghAmberpet, Hyderabad, Telangana, India
meruguvenkatesh.rv@gmail.com

Rakesh Podaralla

Department of Computer Science and Technology, DRK Institute of Science and Technology, Bowrampet Village, GandimaisammaMandal, Telangana, India
rakeshpodaralla@gmail.com

Sagar Varada

Virtusaconsulting services private limited, Sy No. 115, Nanakramguda Village, SerilingampallyMandal, Hyderabad, Telangana, India.
Varadasagar34u@gmail.com

Swaroop Varada

D.No:12-2-152, Bellary Road, Rayadurg, Andhra Pradesh, India
swaroopvarada@gmail.com

Abstract: Water is a vital natural resource for the existence of life on earth. Water is used for domestic consumption, is also a source of power and serves many useful purposes for agriculture and related sectors, food security, energy security and industries. The main important source of water in any area is rain and it has a dramatic effect on agriculture and other sectors. So, we need to analyze the rainfall data across the country to get the status, so that future rainfall criteria and its effects on various places can be determined. Rainfall distribution of YSR Kadapa district has been assessed for 30 years (1990-2019) precipitation data and results indicated that the annual rainfall is erratic and the maximum rainfall of 1154.1 mm occurred in 1996 followed by 2007 (1006.1 mm) and minimum rainfall occurred in 2018 of 350.4 mm and that in 2014 (401.3 mm) being the second lowest. The year 1996 is referred as 'wet year' and 2018 as 'dry year' among the study period.It is also shown that the average rainfall for the selected study period of 30 years is 678.0 mm. The mean monthly rainfall analysis of study period shows that the October month observed maximum average rainfall of 138.5 mm and the lowest average rainfall observed in the month of January which is 1.1 mm. Statistical features of annual and monthly rainfall series of YSR Kadapa district was studied and then variability and trends of the rainfall were analyzed. A variability analysis of rainfall is of great importance for researchers and policy makers in their decision making as rainfall plays dominant role in deciding the use of the water availability in the areas.

Keywords: Annual rainfall, Monthly rainfall, Rainfall trend, Statistical parameters, YSR Kadapa district

I. INTRODUCTION

Climate change is the most crucial and everyone's talk around the world and these changes bring a drastic change in nature. Climate change resulted drought, flood, cyclones, hurricanes and rise in temperatures [1]. Humans are unable to bear these changes and their effects, which occur due to changes of precipitation and temperature. However, atmospheric temperature and precipitation are the two most sensible factors to the people. Between these two, changes in precipitation are one of the most important factors, which impact the society and then determine the overall impact of climate change. Water is a vital natural resource for the existence of life on earth. Water is used for domestic consumption, is also a source of power and serves many

useful purposes for agriculture and related sectors, food security, energy security and industries [2-6]. The main important source of water in any area is rain and it has a dramatic effect on agriculture and other sectors.

In view of the above, a number of studies have been conducted to analyze long term trends of rainfall in India. During the last 4 to 5 decades, the rainfall series have been tabulated and the interannual variability of monsoon rainfall has been rigorously examined byseveral researchers, notably by Parthasarathy and Dhar [7], Parthasarathy and Mooley [8], Alvi and Koteswarm [9], Thapliyal and Kulshresta [10], Srivastava et al [11]. Recently Guhathakurtha and Rajeevan [12] constructed monthly, seasonal and annual rainfall time series of 36 meteorological subdivisions of India and India as one unit using the monthly rainfall data for the period 1901-2003 and later updated by Guhathakurtha et al [13]. These studies indicate that to know rainfall trend patterns are essential for economic development and hydrological planning of the country and adapting to extreme events. Therefore, this paper attempts to assess the long-term variability of rainfall pattern over YSR Kadapa district (YSR Kadapa district taken as one unit) of Andhra Pradesh.

II. Study area

YSR Kadapa district is one of the chronically drought affected districts of Rayalaseema region of Andhra Pradesh (Figure 1). The district is also considered to be one of the districts endowed with rich history, ore minerals, flora & fauna. It has a total geographical area of 15,379 sq.km lies between the 13° 43' and 15° 14' Northern latitudes and 77° 55' and 79° 29' of the Eastern longitude. The altitude varies from 269 to 3787 meters above sea level. Monsoon season brings substantial rain to the area. YSR Kadapa district gets rainfall from both the southwest monsoon as well as the northeast monsoon. The YSR kadapa district annual normal rainfall is 699.6 mm. Southwest and northeast monsoon contributes 55% and 30% and winter and summer contributes 15% of rainfall. The YSR Kadapa district is drained by Pennarriver and its chief tributaries are Cheyyair, Papaghni, Chitravati, Sagileru and Kunderu. Pincha and Mandavi are minor streams. About 21,758 ha area is irrigated by canals while 4,168 ha and 1,29,983 ha are irrigated through dug wells and bore wells respectively. It has ground water resources of 1.05 lakh ham. Out of the total geographical area, 5,00,961 ha (32.57%) of the area is covered by forests. Similarly, barren and uncultivable land is 14.4% and cultivable waste and current fallows put together is 9.1%. The net area sown is 8.6% to the total geographical area.

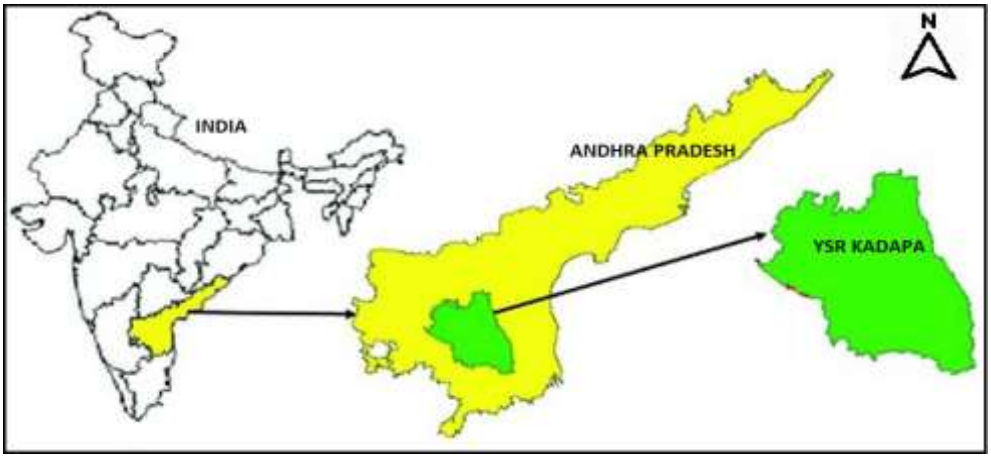

Figure 1. Location map of the YSR Kadapa district

III. Materials and Methods

Annual and monthly precipitation data of 30 years (1990-2019), were collected from Chief planning office, Kadapa, Andhra Pradesh. These data were analysed using statistical procedures such as mean, standard deviation, skewness, kurtosis, and coefficient of variation to assess the long-term variability and trend of rainfall pattern over the area.

IV. Results and Discussion

The results got from the present investigation have been described under following heads. The detailed characteristics of rainfall of YSR kadapa district is represented in Table 1.

Table-1 Annual and monthly rainfall of YSR Kadapa district during 1990-2019

Years	January	February	March	April	May	June	July	August	September	Octobar	November	December	Annual rainfall
1990	0.0	0.0	20.1	1.0	28.4	46.2	52.4	61.1	169.3	170.1	144.0	6.3	698.8
1991	1.3	0.0	1.1	11.9	15.9	187.0	42.3	76.3	71.0	165.9	194.5	0.8	767.9
1992	0.2	0.1	0.0	2.8	15.1	25.8	85.8	82.4	49.0	62.0	118.7	0.2	442.1
1993	0.0	0.0	4.3	0.2	52.4	21.9	108.1	95.7	79.4	138.2	108.8	93.5	702.4
1994	0.3	3.1	0.0	27.0	30.0	21.3	82.9	65.2	28.6	196.1	70.7	7.0	532.2
1995	4.3	0.0	5.4	0.5	122.6	51.3	170.0	140.4	109.7	117.2	33.1	0.0	754.5
1996	0.0	0.0	0.0	16.8	15.4	270.7	46.7	204.0	169.6	315.3	23.8	91.9	1154.1
1997	2.0	0.0	4.6	18.5	18.2	57.1	24.7	75.3	238.3	81.1	93.8	43.2	656.9
1998	0.0	0.0	0.4	36.5	27.7	33.3	96.8	132.7	172.1	137.3	127.6	10.6	774.9
1999	0.0	2.0	0.3	0.5	42.9	56.7	53.5	119.5	35.6	88.9	54.4	1.1	455.3
2000	0.0	16.6	0.0	27.2	82.0	76.8	95.0	249.8	59.0	111.8	22.0	35.0	775.1
2001	0.1	0.0	1.3	65.9	13.7	14.9	60.1	94.0	185.8	404.4	25.2	16.6	882.0
2002	5.0	0.6	0.3	9.0	49.6	68.4	31.1	43.8	57.1	174.9	26.9	0.9	467.6
2003	0.0	0.0	9.5	3.9	0.0	20.9	175.0	89.8	123.0	236.1	3.4	3.1	664.7
2004	0.0	0.0	10.3	24.6	136.1	20.9	138.2	10.4	169.2	64.4	30.1	0.0	604.2
2005	0.0	2.7	3.4	19.1	36.2	39.1	116.1	99.4	76.0	302.1	100.7	60.7	855.5
2006	0.0	0.0	31.8	2.8	45.3	55.0	45.1	59.4	138.4	55.3	67.8	16.8	517.7
2007	0.0	0.0	0.0	12.4	64.8	197.6	64.1	180.6	202.5	221.4	34.4	28.3	1006.1
2008	0.0	31.9	47.4	1.5	22.3	14.3	49.5	105.5	115.4	109.6	199.0	3.2	699.6
2009	0.3	0.0	6.4	7.9	43.3	46.5	28.9	144.9	136.9	22.6	141.2	28.1	607.0
2010	2.5	1.3	0.0	12.3	48.5	119.4	165.1	136.6	101.2	76.9	198.8	45.4	907.9
2011	0.3	3.6	0.0	20.0	30.6	37.6	117.3	167.7	52.0	113.8	92.0	23.8	658.6
2012	1.6	0.0	0.1	31.6	27.6	41.8	125.0	88.2	37.1	76.5	75.4	57.7	562.6
2013	0.0	29.4	7.8	8.9	22.7	60.9	85.2	122.7	174.8	208.4	27.5	1.5	749.8
2014	0.0	0.0	3.8	4.5	16.4	46.7	40.1	79.8	85.2	73.7	37.2	13.8	401.3
2015	2.1	0.0	8.8	71.5	23.8	62.3	31.5	128.3	124.5	78.1	323.5	27.0	881.4
2016	11.9	0.1	0.7	0.1	33.6	116.8	122.8	46.7	94.3	11.2	7.2	57.6	491.1
2017	1.3	0.0	8.5	8.6	10.4	87.1	46.4	188.9	163.1	177.6	28.3	0.6	720.8
2018	0.0	1.7	39.4	5.9	37.4	31.2	21.5	58.1	90.2	31.4	29.5	4.1	350.4
2019	10.1	0.6	0.2	16.0	14.9	33.6	63.2	92.9	172.6	133.9	27.9	32.1	598.0
Mean	1.1	3.1	7.2	15.6	37.6	65.4	79.5	108.0	116.0	138.5	82.3	23.7	678.0

4.1 Annual rainfall analysis-

Rainfall distribution of YSR Kadapa district has been studied for 30 years (1990-2019) precipitation data. Figure 2 shows the annual rainfall variation and it is shown that the maximum rainfall of 1154.1 mm occurred in 1996 followed by 2007 (1006.1 mm) and minimum rainfall occurred in 2018 of 350.4 mm and that in 2014 (401.3 mm) being the second lowest. The year 1996 is referred as ‘wet year’ and 2018 as ‘dry year’ among the study period. It is also shown that the average rainfall for the selected study period of 30 years is 678.0 mm.

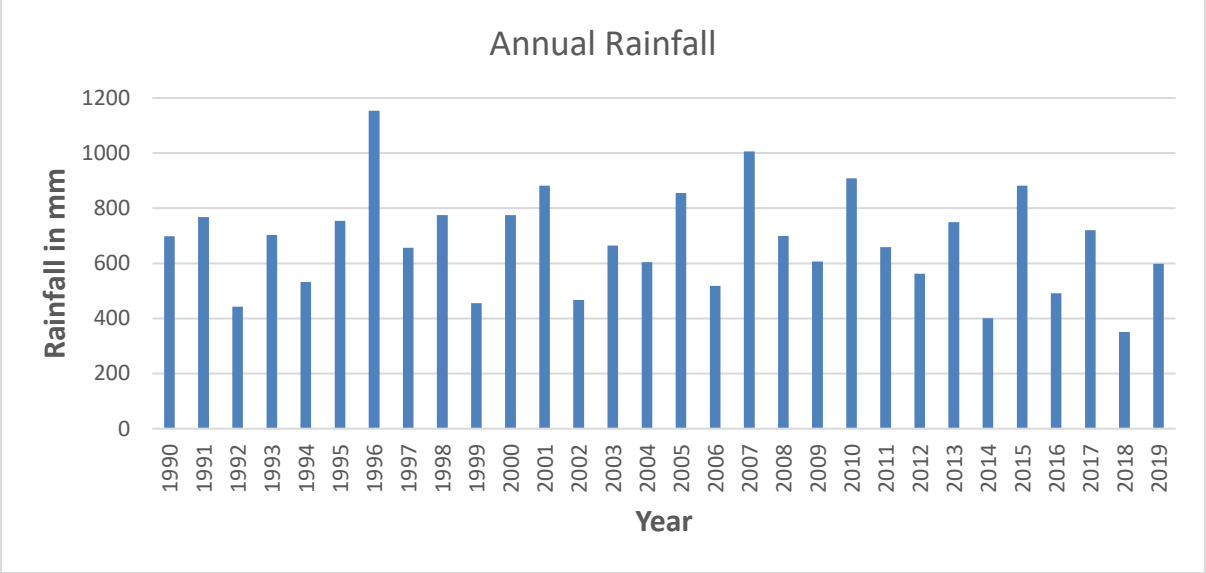

Figure 2. Annual rainfall distribution of YSR Kadapa district during 1990-2019

The below Table 2 shows that the standard deviation value is 184.71 which is considerably large this indicates there is larger variation in rainfall pattern. Skewness is the measure of asymmetry in frequency distribution about the mean predominantly positive skewness of average value 0.44 indicating annual precipitation in the region is asymmetric and it lies to the right of mean that is right skewed. Kurtosis is the measure of peakedness or flatness of frequency distribution having value of 0.23, indicating slightly leptokurtic in nature. Coefficient of variation is the measure of spread data points in data series around the mean which is found 30.89 which shows erratic nature of rainfall.

Table-2 Statistical parameters for annual rainfall pattern of YSR Kadapa district during 1990-2019

Description	Normal series
Mean Rainfall (mm)	678.0
Standard deviation	184.71
Co-efficient of variation	30.89
Skewness	0.44
Kurtosis	0.23

4.2 Monthly rainfall analysis-

The mean monthly rainfall analysis of YSR Kadapa district (Table 3) shows that the October month observed maximum average rainfall of 138.5 mm and September month shows the second highest of 116.0 mm for the study period of 30 years. While the lowest mean rainfall occurred in the month of January (1.1 mm), followed by February, March and April (3.1, 7.2 and 15.6 mm). The standard deviation values are lower than their corresponding mean values in the months of May, June, July, August, September, October and November. For the remaining months such as January, February, March, April and December, however, the standard deviation values are higher than their corresponding mean values, showing greater variation in the distribution of rainfall over the months. The rainfall was stable in the month of September with coefficient of variation of 48.52% followed by August with 48.78%. A high variability of rainfall was found in the month of February with coefficient of variation of 259.77% followed by January with 200.44% respectively.

Table-3 Statistical parameters for monthly rainfall pattern of YSR Kadapa district during 1990-2019

Month	Mean	Standard Deviation	Skewness	Kurtosis	Co-efficient of variation
January	1.1	2.7	3.02	10.47	200.44
February	3.1	8.11	3.04	8.44	259.77
March	7.2	12.04	2.33	4.96	167.32
April	15.6	17.59	1.95	4.09	112.49
May	37.6	30.42	2.00	4.36	80.93
June	65.4	59.27	2.16	4.74	90.58
July	79.5	45.22	0.69	-0.53	56.89
August	108.0	52.68	0.76	0.64	48.78
September	116.0	56.29	0.22	-0.91	48.52
October	138.5	91.19	1.13	1.34	65.83
November	82.3	73.68	1.52	2.60	89.58
December	23.7	26.74	1.29	1.08	112.85

The skewness of all the data series was found between 0.22 to 3.04. From the Table 3 it is clear that normal series data is positive in all months that showed a positively skewed distribution. The kurtosis of all the data series varies between -0.91 to 10.47. The months of July and September showed a negative kurtosis which indicated a flat distributions during the months and in all the remaining months it showed a positive kurtosis which indicated a peaked distribution.

V. Conclusion

The present study is an attempt to make a preliminary analysis of the rainfall pattern in YSR Kadapa district over the period between 1990 and 2019. The study throws some light over the annual and monthly rainfall of this area that is influenced by the southwest monsoon as well as the northeast monsoon rains. The rainfall in YSR Kadapa district is highly variable, uneven and heterogenous. The annual average rainfall of 678.0 mm varies from a maximum of 1154.1 mm in 1996 to the minimum of 350.4 mm in 2018. The month of October received maximum average rainfall for all years on an average and January received lowest average rainfall. In this study, we used descriptive statistics to display information about the distribution of the annual and monthly rainfall. While more detailed and extensive data need to be analyzed for making more definitive assessments and predictions over this area.

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