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# Analysis of Normal Annual Rainfall of Kadapa District in Andhra Pradesh

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***Abstract:*** ***Rainfall is an important parameter in the assessment of water resources projects. The normal annual rainfall is the average value of annual rainfall of year over a specified 30 year period. The 30 year normal is recomputed every decade. Normal annual rainfall is important in planning and design of hydraulic structures. The annual rainfall of Kadapa District for the period of 1910 to 2019 is collected from Water Resources Information Systems portal. The change in normal annual rainfall for every decade is calculated by using MS-Excel spread sheet, starting from 1910. Statistical parameters such as mean, standard deviation and coefficient of variation are calculated. The trend of maximum rainfall and minimum rainfall for every 30 years period is analyzed. Index of wetness is also calculated.***
***Keywords: Normal Annual Rainfall, Index of wetness, Precipitation, Hydrology, Water Resources.***

## I. INTRODUCTION

Rainfall is one of the most important meteorological parameters in the recovery of groundwater systems. Rainfall is the liquid form of ' precipitation,' which acts as a primary source for recharging the groundwater system in an area. The records of rainfall show a wide range of variations in quantity and frequency from place to place. In India, precipitation occurs mostly during the south-west monsoon period (June-September). Analysis of rainfall data is important to understand the micro-level variability of the rainfall that is useful in the planning of agriculture, land and water development. Rainfall is therefore one of the climate variables that affect temporal patterns in the availability of water. Understanding rainfall fluctuations in this region is very important as most of the crops grown here are rain fed. Quantifying rainfall is important in water resources management. In this we discuss the long term variability of temporal rainfall in Kadapa district, Andhra Pradesh.

## II. STUDY AREA

Kadapa has a tropical wet and dry climate characterised by year round high temperatures. It has a record of reaching more than 50 degree Celsius. Summers are especially uncomfortable with hot and humid climate. During this time temperatures range from a minimum of 34 °C and can rise up to a maximum of 40 °C. Temperatures are range in the mid-thirties during the day. Humidity is around 75% during the summer months. Monsoon season brings substantial rain to the area. Kadapa gets rainfall from both the South west monsoon as well as the North East Monsoon. June to October is usually the monsoon. Winters are comparatively milder and the temperatures are lower after the onset of the monsoons. During this time the temperatures range from a maximum of 25 °C and can rise up to a maximum of 35 °C [1]. Humidity is much lower during the winter season. The District is situated within the Geographical Co-ordination of 13° 43' and 15° 14' of Northern latitude and 77° 55' and 79° 29' of the Eastern longitude.

Kadapa district is one of the chronically drought affected districts of Rayalaseema region of Andhra Pradesh. The district is also considered to be one of the districts endowed with rich history, ore minerals, flora & fauna. The altitude varies from 269 to 378.7 meters above sea level. South west monsoon season brings substantial rain to the area. Kadapa district gets rainfall from both the southwest monsoon as well as the northeast monsoon. The Kadapa district annual normal rainfall is 718.5 mm(Water Resources Information Systems portal). The Pennar River and its tributaries such as Cheyyair, Papaghni, Chitravati, Sagileru , Kunderu. Pincha and Mandavi are flowing in the District.

Janardhana Raju et.al, integrated geological, hydrological (surface and groundwater) and geochemical aspects have been studied for the development and management of water resources in drought prone Kadapa district. The main lithological units are crystallines, quartzites, shales and lime stones. About 91000 ha of land in the Kadapa district is irrigated by canal water. A registered ayacut of about 47000 ha is irrigated by 1368 minor irrigation tanks. A total of 503 spring channels are identified in the entire district originating from the rivers/streams, which has the capacity of irrigating about 8700 ha. The rainfall data for a period of 1910 to 2019 is taken from Water resources information system portal.

TABLE 1
Annual Rainfall Data Of Kadapa District, Andhra Pradesh Taken From Wris Portal

| Year | Rainfall (mm) | Year | Rainfall (mm) | Year | Rainfall (mm) | Year | Rainfall (mm) | Year | Rainfall (mm) |
|---|---|---|---|---|---|---|---|---|---|
| 1910 | 985.62 | 1935 | 736.67 | 1960 | 834.68 | 1985 | 683.94 | 2010 | 1060.7 |
| 1911 | 579.26 | 1936 | 668.52 | 1961 | 730.5 | 1986 | 671.72 | 2011 | 771.31 |
| 1912 | 744.27 | 1937 | 778.21 | 1962 | 1176.29 | 1987 | 798.4 | 2012 | 659.47 |
| 1913 | 649.71 | 1938 | 637.58 | 1963 | 666.28 | 1988 | 896.89 | 2013 | 700.53 |
| 1914 | 632.85 | 1939 | 798.24 | 1964 | 755.85 | 1989 | 705.13 | 2014 | 475.78 |
| 1915 | 915.6 | 1940 | 1016.47 | 1965 | 647.99 | 1990 | 1022.66 | 2015 | 1174.03 |
| 1916 | 1000.46 | 1941 | 710.89 | 1966 | 942.2 | 1991 | 1073.49 | 2016 | 561.82 |
| 1917 | 1043.83 | 1942 | 588.24 | 1967 | 809.83 | 1992 | 599.04 | 2017 | 869.08 |
| 1918 | 690.28 | 1943 | 1126.19 | 1968 | 627.03 | 1993 | 871.65 | 2018 | 412.74 |
| 1919 | 880.12 | 1944 | 871.02 | 1969 | 905.1 | 1994 | 741.39 | 2019 | 761.2 |
| 1920 | 715.52 | 1945 | 567.48 | 1970 | 739.33 | 1995 | 833.75 | | |
| 1921 | 774.55 | 1946 | 1055.41 | 1971 | 575.86 | 1996 | 1347.63 | | |
| 1922 | 813.4 | 1947 | 661.57 | 1972 | 879.02 | 1997 | 809.87 | | |
| 1923 | 497.66 | 1948 | 588.24 | 1973 | 704.75 | 1998 | 835.87 | | |
| 1924 | 728.8 | 1949 | 806.49 | 1974 | 746.53 | 1999 | 454.73 | | |
| 1925 | 973.05 | 1950 | 482.34 | 1975 | 1047.23 | 2000 | 823.69 | | |
| 1926 | 665.41 | 1951 | 499.72 | 1976 | 928.74 | 2001 | 1010.57 | | |
| 1927 | 698.48 | 1952 | 754.93 | 1977 | 808.05 | 2002 | 557.24 | | |
| 1928 | 694.18 | 1953 | 754.1 | 1978 | 855.59 | 2003 | 721.59 | | |
| 1929 | 719.39 | 1954 | 871.98 | 1979 | 860.26 | 2004 | 686.98 | | |
| 1930 | 1022.9 | 1955 | 794.91 | 1980 | 623.64 | 2005 | 1065.41 | | |
| 1931 | 676.93 | 1956 | 1074.78 | 1981 | 810.12 | 2006 | 572.26 | | |
| 1932 | 587.74 | 1957 | 616.33 | 1982 | 591.26 | 2007 | 1209.92 | | |
| 1933 | 610.04 | 1958 | 872.86 | 1983 | 1007.41 | 2008 | 885.06 | | |
| 1934 | 586.56 | 1959 | 656.95 | 1984 | 825.17 | 2009 | 816.01 | | |

*A. Methodology*

The objective of the analysis is to:

*1)* Identify the variation in normal annual rainfall.
*2)* Understand rainfall trend and variability in index wetness.
*3)* Statistical parameters for annual rainfall analysis are such as mean, standard deviation and coefficient of variation are calculated for 30 years duration for every decade starting from 1910 to 1990.

Index of wetness is defined as the ratio of actual annual rainfall to normal annual rainfall.

## III.RESULTS AND DISCUSSION

The annual rainfall data for the duration 1910-2019 is taken from WRIS portal and analysed to evaluate the change in normal annual rainfall. The normal annual rain fall was calculated for every decade starting from 1910 to 1990. The duration for calculating annual rainfall has taken as 30 years. The preliminary analysis of rainfall data revealed that the annual average rainfall for the entire study duration (1910-2019) is 782.88 mm. While the maximum being 1347.63 mm in year 1996 and minimum being 412.74mm in year 2018. The statistical parameters such as Mean, Standard Deviation and Coefficient of Variation are calculated for every 30 years duration starting from year 1910 and are shown in the Table. 2.

TABLE 2
MEAN, MAXIMUM AND MINIMUM, SD AND COVARIANCE OF ANNUAL RAINFALL

| Duration | Annual Rainfall (mm) | | | Standard Deviation (mm) | Coefficient of Variation % |
|---|---|---|---|---|---|
| | Minimum | Maximum | Mean | | |
| 1910-1939 | 497.66 | 1043.83 | 750.19 | 145.5123364 | 19.39 |
| 1920-1949 | 497.66 | 1126.19 | 745.861 | 158.2980883 | 21.22 |
| 1930-1959 | 482.34 | 1126.19 | 749.143 | 175.3768245 | 23.41 |
| 1940-1969 | 482.34 | 1176.29 | 782.2217 | 183.0987249 | 23.407 |
| 1950-1979 | 482.34 | 1176.29 | 787.337 | 159.6378947 | 20.275 |
| 1960-1989 | 575.86 | 1176.29 | 795.1597 | 140.7453439 | 17.7 |
| 1970-1999 | 454.73 | 1347.63 | 811.6373 | 177.5526132 | 21.87 |
| 1980-2009 | 454.73 | 1347.63 | 818.4163 | 201.0422456 | 24.56 |
| 1990-2019 | 412.74 | 1347.63 | 812.849 | 232.4548373 | 28.597 |

The variation of Minimum rainfall and Maximum rainfall and mean for the duration of 30 years over every decade are shown in Fig.1. It is observed that minimum rainfall occurred is decreasing by 17% and maximum rainfall occurred is increasing by 29% whereas, the mean is increasing by 8.35%.

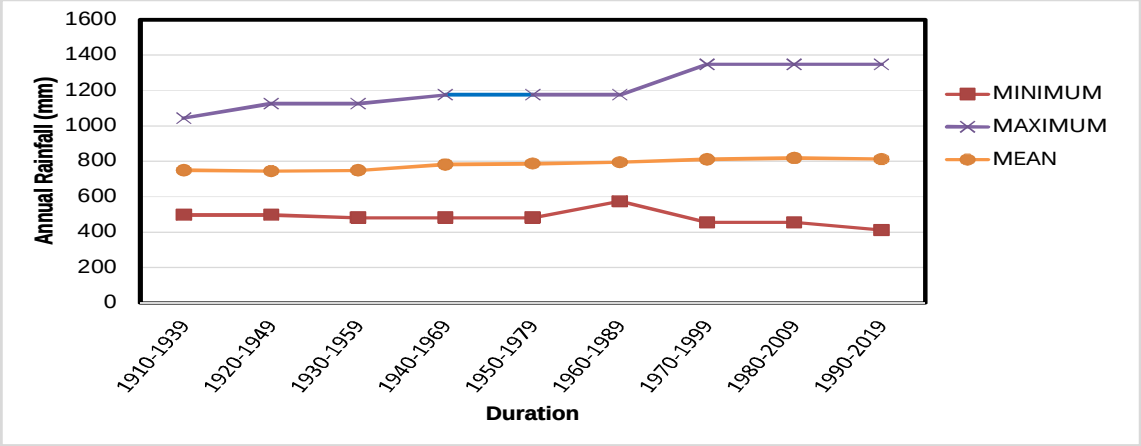


Fig. 1 Mean, Maximum and Minimum Annual Rainfall for 30 years duration over every decade.

The index of wetness is calculated for every year in the entire said duration and tabulated in Table.3. It shows that, the number of years greater than the normal rainfall are increasing. For entire length of rainfall data, the average rainfall is 782.88 mm . The number of individual years with annual rainfall more than average annual rainfall are 50.

TABLE.3
Number Of Years Greater Than Normal Annual Rainfall And Number Of Years Lesser Than Normal Annual Rainfall.

| Duration | No of years greater than Normal rainfall | No of years less than Normal rainfall |
|---|---|---|
| 1910-1939 | 11 | 19 |
| 1920-1949 | 11 | 19 |
| 1930-1959 | 14 | 16 |
| 1940-1969 | 14 | 16 |
| 1950-1979 | 15 | 15 |
| 1960-1989 | 16 | 14 |
| 1970-1999 | 14 | 16 |
| 1980-2009 | 14 | 16 |
| 1990-2019 | 15 | 15 |

## IV. CONCLUSIONS

The rainfall data from 1910 to 2019 is selected for the study and the average annual rainfall calculated is 782.88 mm. Maximum annual rainfall is observed in the year 1996 with 1347.63 mm and minimum annual rainfall observed is 412.74 mm in the year 2018. Standard deviation and Coefficient of variation are calculated for the duration of 30 years over every decade. The maximum annual rainfall is progressively increasing, whereas, the minimum rainfall is decreasing every decade. In water resources point of view, both the changes will negatively impact the environment and humans as the maximum rainfall will cause flooding due to excess water and minimum rainfall will result in drought. The statistical parameters such as Standard deviation and Coefficient of variation corroborate the trend shown in Fig.1. As majority of the farmers in Kadapa depends on rain fed crops, uniform distribution of annual rainfall is extremely important.

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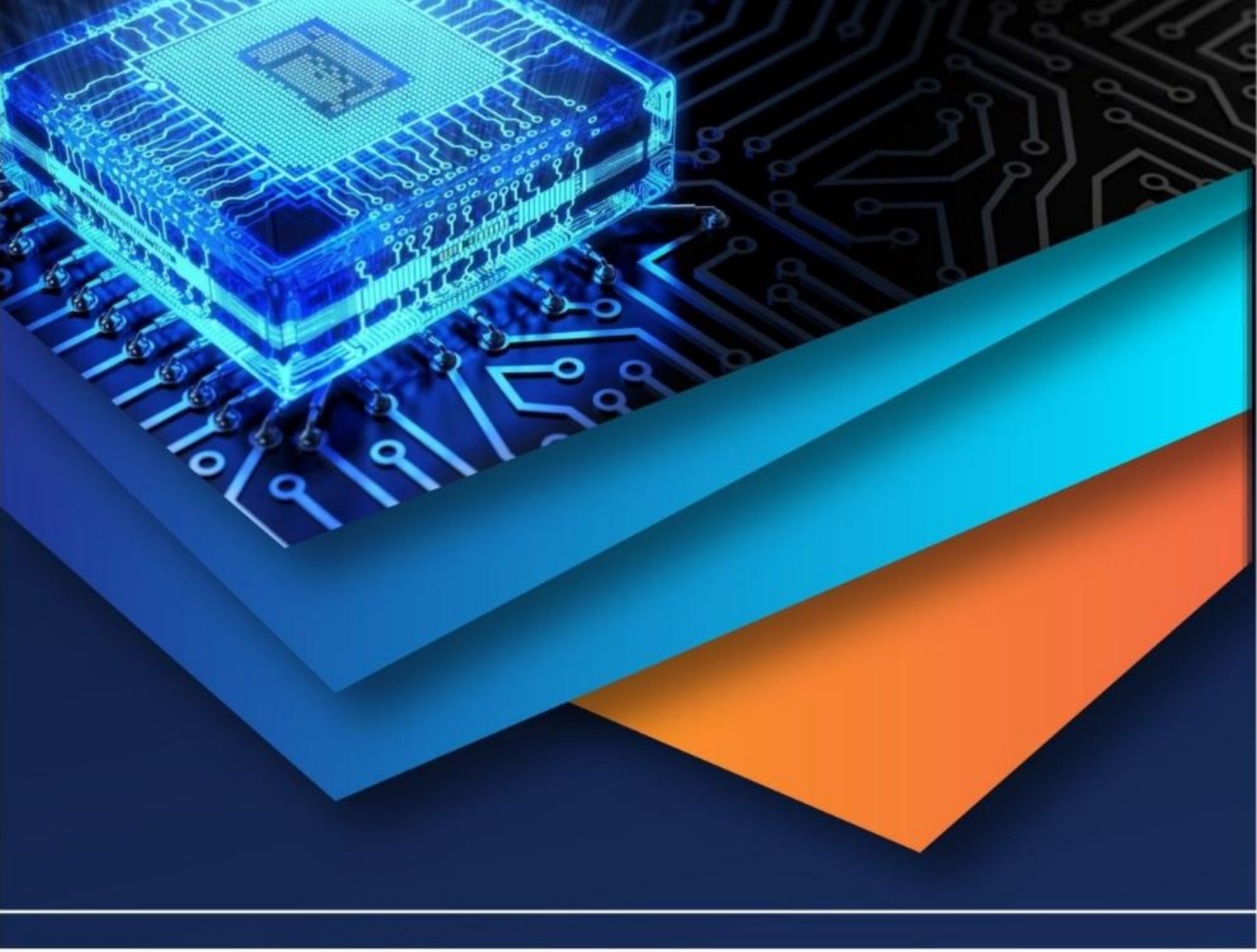

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