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Trends in Rainfall over Anakapalle, Vishakhapatnam, Andhra Pradesh, India

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ABSTRACT
The current study looks at long-term trends as well as short-term variability in rainfall across the country. Anakapalle is in neighborhood of Vishakhapatnam, Andhra Pradesh, India. Data on rainfall from 1952 to 2016. The long mean, standard deviation, and value of tk are calculated using Cramer's test. Cramer's test was used to examine the rainfall results over a 31-year period. The years with the highest average rainfall, such as 1977, 1983, 1986, 1990, 2006, and 2016, was either non-important or marginally significant at the 5% mark, with the year 1990 recording the highest rainfall of 1630.5 mm in the time series.
Keywords: *Trend, statistical tests, temperature, rainfall*

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INTRODUCTION

Annual precipitation is around 80 cm (30 inches) across the globe, although it is scattered unevenly (Lal, 2014). Climate is an essential part of the earth's structure. Climate and climate are made up of several factors such as temperature, rainfall, albedo, air pressure, and humidity. The average temperature is often used to describe climate. In a general context, it is the mathematical description of related quantities in terms of their mean and variability over a time span extending from months to thousands or millions of years [2].. The equatorial regions and Southeast Asia's monsoon areas get the most rainfall. On the other hand, temperate areas produce a modest volume of precipitation. Little snow falls in the desert areas of the subtropical high-pressure belt and the Polar Regions. During the north east monsoon season, the heating center of Asia's summer monsoon moved south eastward from its initial or so-called normal position in south Asia to the maritime continent and the equatorial western pacific.

The Indian summer monsoon time series was devised by Parthasarathy *et al.* [6]. The most prominent or significant difference on an inter-annual basis is between the so-called strong monsoon seasons with moderate or above-average rainfall and the so-called weak monsoon seasons with minimal or deficit rainfall.

Rainfall variability happens over a wide variety of time scales. Understanding certain forms of uncertainty will often lead to better risk control in both industrial and agricultural settings. In comparison to other atmospheric variables, rainfall, which is the most significant climate parameter in tropical countries, has a high degree of spatial and temporal variability. There are also short-term fluctuations, such as day-to-day variations or weeks-to-month variations, and longer-term fluctuations, which can last anywhere from a few years to decades. The domains of temporal and spatial scales influence inter-annual variability. The intensity of mean atmospheric circulation processes, which can play a major role in inter-annual fluctuations if they change. According to meteorologist Shang-Ping Xie, trends of ocean temperature in the tropics and subtropics will change, causing changes in rainfall patterns.

In research on climate change detection, analyzing long-term shifts in rainfall factors is a critical role. Improvements and extensions to various datasets, as well as increasingly advanced data analyses, have all contributed to a better understanding of historical and current climate change around the world. Several researchers looked at rainfall patterns and anomalies all over the world [3, 4].

Since 1947, India's annual rainfall has shown no discernible pattern, and the annual average decline rate of the 7-year normalized moving average of annual rainfall was found to be 0.11 percent. During this time, the highest annual rainfall (1401.4 mm) was recorded in 1990, and the lowest annual rainfall (935.9 mm)

was recorded in 2002. Since 1947, there has been no discernible pattern in monsoon rainfall (July-September), and the annual average declining rate of the 7-year normalized moving average of monsoon rainfall has been found to be 0.07 percent. During this time, the highest monsoon rainfall (887.8 mm) was recorded in 1988, and the lowest monsoon rainfall (527.8 mm) was recorded in 2002. Summer rainfall (April-June) has shown no discernible pattern from 1947 to 2012, with an annual average decrease rate of 0.12 percent for the 7-year adjusted moving average. During this time, the highest summer rainfall (357.7 mm) was recorded in 1971, and the lowest summer rainfall (166.8 mm) was recorded in 2009. Winter rainfall (December-March) has been decreasing since 1947, with an annual average decline rate of 0.23 percent for the 7-year normalized moving average of winter rainfall. During this time, the highest winter rainfall (145.2 mm) was recorded in 1990, and the lowest winter rainfall (37.4 mm) was recorded in 1999 [1].

It is to note that there have been alternating periods extending to 3-4 decades with less and more frequent weak monsoons over India. For example, the 44-year period 1921-64 witnessed just three drought years; during such epochs, the monsoon was found to be less correlated with the ENSO. During the other periods like that of 1965-87 which had as many as 10 drought years out of 23, the monsoon was found to be strongly linked to the ENSO [6]. Climate change studies do not exclude local trends small scale area. In fact, local and regional scale analysis is more relevant to devise specific development and adaptation plans to mitigate negative effects of climate change. Keeping in view the importance the present work was to understand the variations in rainfall, in Anakapalle, Vishakhapatnam, Andhra Pradesh, India by Cramer's test.

MATERIAL AND METHODS

The purpose of study Rainfall data's of Anakapalle were collected from the Regional Agricultural Research Station (RARS), Anakapalle (17.6896^0 N, 82.9977^0 E), Vishakhapatnam, Andhra Pradesh, annual rainfall data for 65 years from 1952 to 2016 were collected.

Cramer's Tau (Cramer's T) or Cramer's V calculates the moving mean; a smoothing mean is utilized to smooth out many of the short-term fluctuations [9].

$t_k = l_k\sqrt{[n(N-2)/\{N-n(1+\text{tk}*\text{tk}\}]}$

Cramer's T corrects for the problem that measures of association for tables of different dimension may be difficult to compare directly.

If t_k=0, The variables are not associated.

If t_k=1, They are perfectly associated.

If t_k<0.25, The association is weak.

If t_k>0.75, The association is strong.

If 0.25<t_k<0.75, The association is moderate.

Stability of long term records in terms of comparison between the overall mean of an entire record and the mean of a certain part of the record [9]. Cramer's T equals to 0 when there is no relationship between the two variables and generally has a maximum value of 1, regardless of the dimension of the table or the sample size. This makes it possible to use Cramer's T to compare the strength of association between any two cross classification tables. Tables which have a strong relationship between the variables with a smaller value of t_k. The Cramer's test is carried out excel spreadsheet from calculating the long mean, standard deviation to the value of t_k. If there is increasing trends in the climatic series, the slope coefficient should be possible and satisfactorily significant.

RESULTS AND DISCUSSION

The rainfall data's were studied by applying Cramer's test for 31 years running means. The study on the stability of long term records in terms of a comparison between overall mean of entire datasets and theme an of a certain part of the dataset [9]. t_k is considered as Student's t. this Student's t test repeated for any number of sub-periods; here the sub-period was 31 years with N-2 degrees of freedom. Time plot of t value placed at centre of the sub periods shows the variability. The Cramer's test shows results described below (Figure.1). For annual rainfall of Anakapalle, the moving average from 1968 shows fluctuating results up to 1988 after which the trend actual rises over the mean value up to year 2006 after which it decreases significantly. The t_k value is significant when its value is 1 or closer to 1 which implies that years like 1970 and 1973 although having rainfall rate much lesser than all-time average (1117.347 mm), i.e., 953 mm and 586.2 mm respectively in which 1976 had the lowest in the group. In addition to this highest average years like 1977, 1983, 1986, 1990, 2006 and 2016 are non-significant or moderately significant at 5% level in which the year 1990 having 1630.5 mm of rainfall which is highest in the time series. The shorter fluctuations were studied by applying Cramer's t test for the years running means. The

striking features are the varied epochs of the above and below normal ISM rainfall at different spatial scales in various region [5-8].

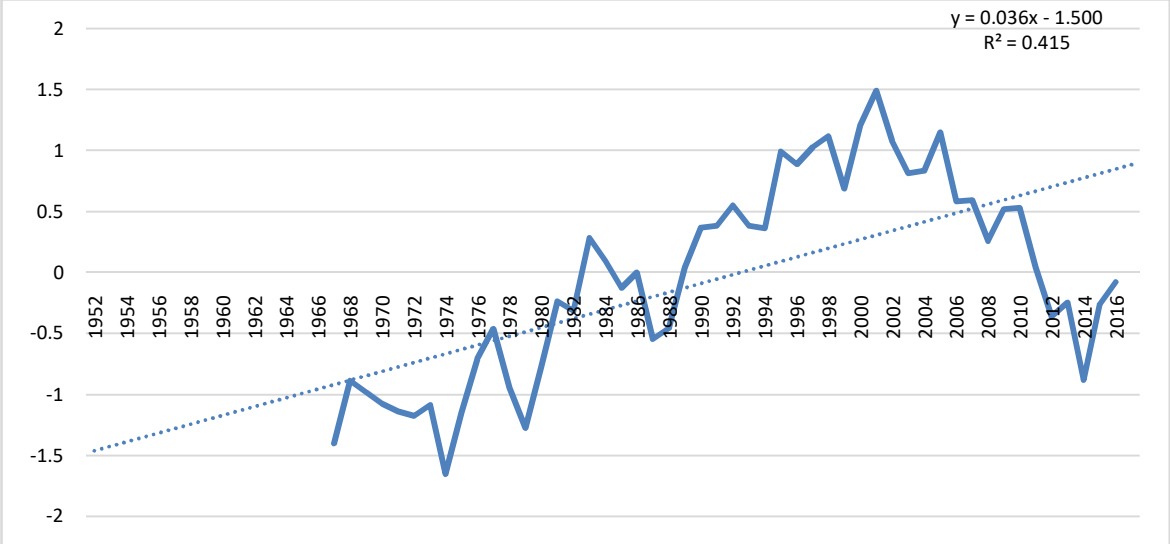

Fig 1. Cramer's test for the rainfall for the period 1952–2016 of Anakapalle.

CONCLUSION

The time series of the rainfall from Cramer's test shows that after only 1988 the rainfall rate increases frequently over the all-time average value (sub mean) which supports the increase of rainfall during this decade.

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