



# Rainfall Trend Variations Over Ahmedabad Region Of Gujrat

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**Abstract-** The rainfall trend analysis study helps to assess the monsoon pattern of the Ahmedabad region so as to predict chances of occurrence of drought and flood. This study aims to analyse the rainfall trend in Ahmedabad of Gujrat state in India. Forty-one years (1981-2022) of monthly rainfall data has been analysed using Mann-Kendall test and Sen's slope estimation methods. In Mann-Kendall test, the test statistics ( $Z_c$ ) for January, March, June, July, August, September, October, November and December shows a rising trend while  $Z_c$  values corresponding to the months February, April, and May are showing negative trend during the study period.

**Keywords-** Trend analysis, Mann-Kendall test, Sen's Slope factor

## I. INTRODUCTION

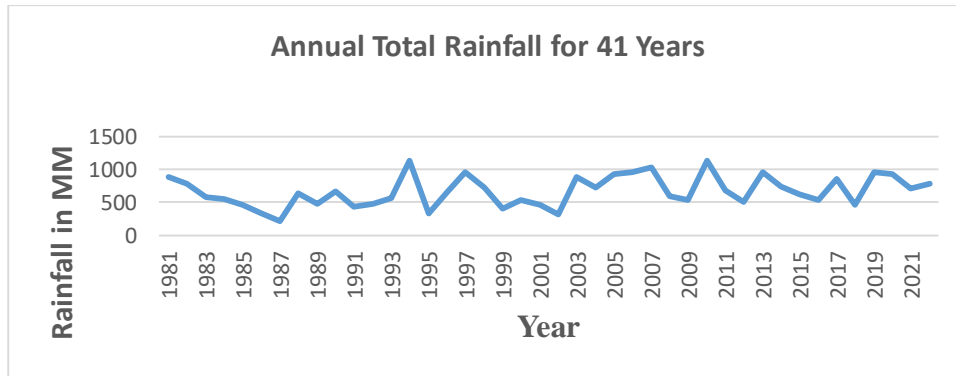
The Earth's climate has changed over the past century in terms of precipitation and temperature fluctuations. The biggest effect of climate change is changing precipitation. Changes in precipitation due to global warming will affect the hydrological cycle and stream flow structure and demands (especially in agriculture), which requires hydrological planning and management practices. Urbanization also causes climate change when land use changes due to agricultural and irrigation practices [1]. Changes in runoff and its distribution depend on likely future scenarios [2]. Since stream flow and precipitation are closely related, any modifications to precipitation patterns will affect it. The amount of water that is available to satisfy various demands, such as for agricultural, industrial, domestic water supply, and hydroelectric power generation, is significantly influenced by the amount of rainfall that an area receives. The agricultural production in many areas of the country is directly impacted by the South West monsoon's variations, which has an impact on the entire economy. Numerous studies have demonstrated that during the monsoon season, there is a lot of rain, whereas during the off-monsoon season, there is less rain. Floods are caused by excessive rain, and other seasons show a lack of water to meet needs, particularly those related to irrigation. The recent flooding in Kerala, particularly in the Vamanapuram River, put many lives and the surrounding agricultural area at danger. Numerous scientists investigated the national rainfall trend in various regions. In Himachal Pradesh, an investigation of rainfall trends from 1901 to 1984 at 11 sites found an increasing tendency in annual rainfall at 8 stations [4]. In their study of the relationship between the El Nio Southern Oscillation (ENSO) and monsoon rainfall across India, Kothawale et al. [5] found a significant correlation between El Nio episodes and insufficient monsoon rainfall. Annual severe rainfall over Kerala showed declining trends, especially for stations in mountainous terrain. [6].

In light of the problems mentioned earlier, the current study was conducted in an effort to determine the rainfall trend, the most significant climatic variable. For the selected 41 years (1981–2022) of the study, trend analysis of rainfall data from Ahmedabad region is utilized.

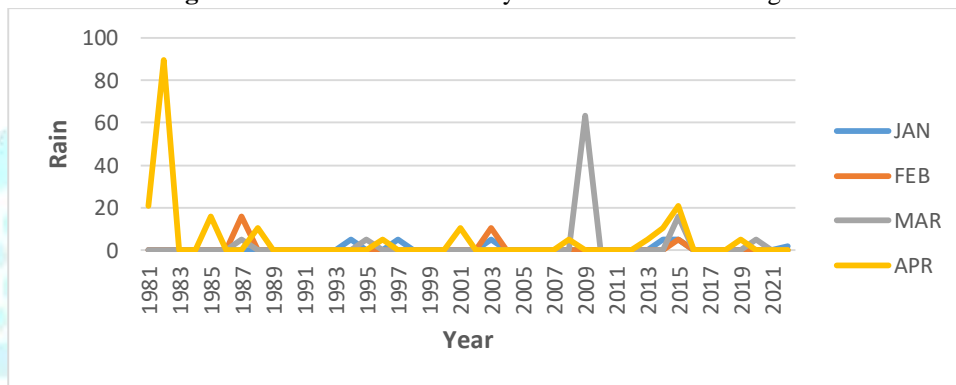


### III. RESULTS AND DISCUSSION

Figure 2 shows the annual variation of total rainfall and shows that the highest rainfall was 1139.10 mm in 2010 and the lowest was 210.94 mm in 1987. The year 2010 is called "wet year" and the year 1987 is "dry year" between the study periods.



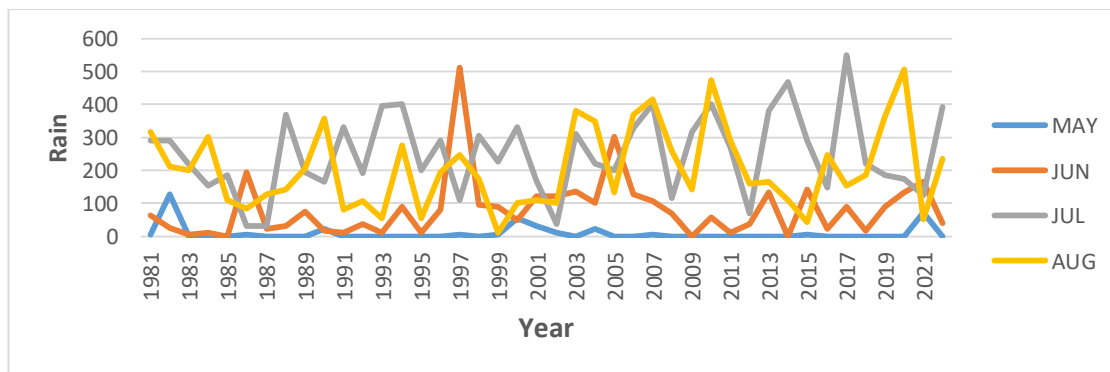
**Figure.2** Annual Rainfall of 41 years for Ahmedabad Region



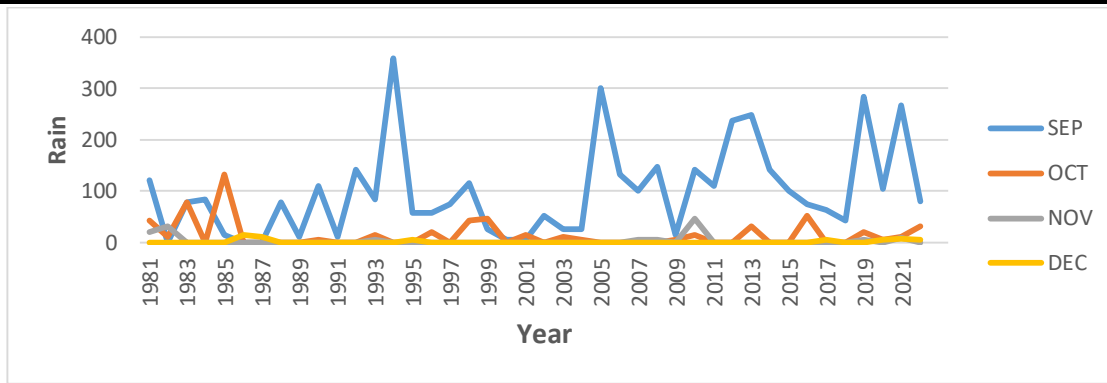
**Figure 3** Rainfall variation of 41 years -January, February, March and April months

It is also shown that the average rainfall for the selected 41-year study period is 670.25 mm. The average precipitation observed in September and July is the second highest during the 41-year study period. It rains the least in March, 0.13 mm. Figures 3, 4 and 5 show the annual variation of precipitation in the selected 41-year study period according to individual months.

In the non-parametric Mann-Kendall test, the 41-year precipitation trend from January to December is calculated for each month separately with the magnitude of the slope of Sen (Q). The results show that the Mann-Kendall test showed a serial trend of Zc statistics for 41 years for an individual in the 12 months from January to December, which is 2.36, -0.06, 2.41, -0.32, -1.67, 3.40, 3.11, 1.75, 6.30, 0.08, 0.49, and 1.81.

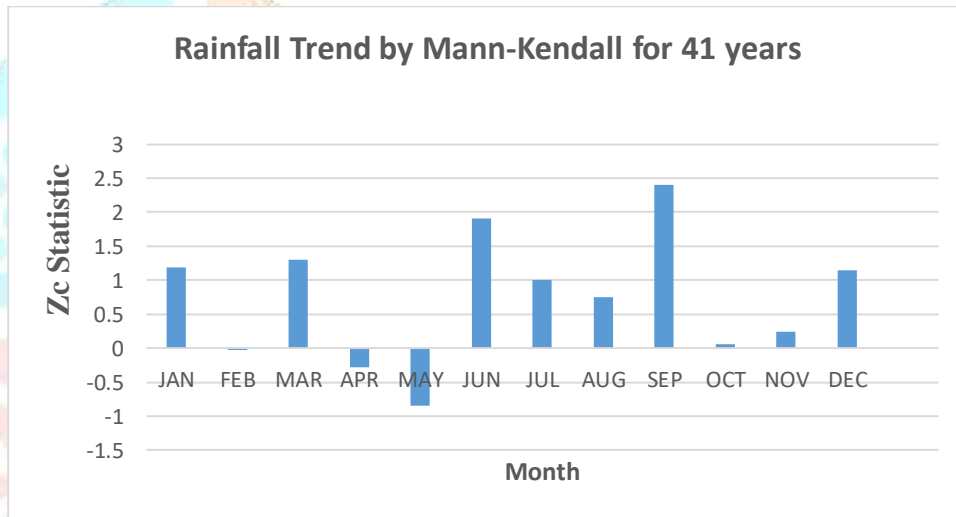


**Figure 4** Rainfall variation of 41 years -May, June, July and August months.



**Figure 5** Rainfall variation of 41 years September, October, November and December months.

Fig. 6 shows the variation in Zc values for different months. Highest positive trend is observed during the month of September which is 2.40. The highest negative trend (-0.85) is shown in the month of May. These are the implications of the effect of South West monsoon. Table 2 showed the Sen’s slope estimation factor and Kendall test statistics (Zc) for the study period for individual months. There is negative trend in the month of February, April and May and the other months showed the positive trend.



**Figure 6** Trend of Zc for Individual Months for 41 Years (1981-2022).

Months	Corrected Zc	Mann-Kendall test original (z)	Tau	Sen's Slope estimator
Jan	2.363	1.183	0.077	0.000
Feb	-0.0651	-0.024	-0.002	0.000
Mar	2.417	1.306	0.085	0.000
Apr	-0.323	-0.286	-0.025	0.000
May	-1.672	-0.851	-0.075	0.000
June	3.403	1.911	0.205	1.387
Jul	3.114	0.998	0.108	1.419
Aug	1.753	0.748	0.081	1.375
Sept	6.307	2.408	0.259	2.051
Oct	0.081	0.058	0.006	0.00
Nov	0.493	0.238	0.018	0.000
Dec	1.817	1.140	0.080	0.000

**Table 2** Estimated Sen's Slope and Kendall's test statistics (Zc) values from 1981 to 2022.

#### IV CONCLUSION

In the non-parametric Mann-Kendall test, the Zc statistic shows that the trend for the 41-year series (1981-2022) in the 12 individual months from January to December 2.36, -0.06, 2.41, -0.32, -1.67, 3.40, 3.11, 1.75, 6.30, 0.08, 0.49, and 1.81. respectively. For January, March, June, July, August September, October, November and December, precipitation tends to gradually increase, while the Zc value shows a negative trend in February, April, and May. Therefore, the Zc values for nine months show a positive trend and for the remaining three months they show a negative trend, representing an almost negligible situation. Analysis of rainfall trends has helped in understanding the monsoon pattern of Ahmedabad region and thereby predicting drought conditions during monsoon and non-monsoon periods.

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