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ANALYSIS OF RAINFALL PATTERN OVER AMBEDKAR NAGAR DISTRICT IN UTTAR PRADESH

Ankit[1*], Shivam[2], Ram Jeet Singh[2], Mo Akram[1], Sarvda Nand Tiwari[1], Sakshi Dixit[1], Vipin Kumar Roshan[1] and Shashank Verma[3]

[1]Department of Soil and Water Conservation Engineering, MCAET, ANDUAT, Kumarganj, Ayodhya, U.P., India
[2]Mahamaya College of Agricultural Engineering & Technology, ANDUAT, Kumarganj, Ayodhya, India
[3]Department of Processing and Food Engineering, MCAET, ANDUAT, Kumarganj, Ayodhya, U.P., India
*Corresponding Author E-mail: ankitv484@gmail.com

ABSTRACT

This study examines rainfall trends and anomalies over a 35-year period (1985-2019) in the Ambedkar Nagar district of Uttar Pradesh, India, to understand the region's hydrological dynamics and climatic patterns. Utilizing daily rainfall data from NASA's Prediction of Worldwide Energy Resources (POWER), the analysis focuses on four key precipitation indices: heavy precipitation days (R10), very heavy precipitation days (R20), consecutive wet days (CWD), and consecutive dry days (CDD). The Mann-Kendall test, a non-parametric method, was employed to identify statistically significant trends and turning points in the dataset, while Sen's slope estimated the trend magnitude. Results indicate substantial year-to-year variability in heavy and very heavy precipitation days, with notable peaks in 1998 and 2008 for R10, and in 1990 and 2008 for R20. The analysis of cumulative wet and dry days reveals significant fluctuations, highlighting periods of extreme wetness and dryness that have implications for agriculture, water management, and environmental sustainability. This comprehensive rainfall trend analysis provides valuable insights into the long-term climatic trends affecting Ambedkar Nagar, aiding in the development of adaptive strategies to cope with changing weather patterns. Understanding these trends is crucial for ensuring water availability, planning agricultural activities, and maintaining ecological balance in the region.

***Keywords*: Rainfall, Consecutive Wet Days (CWD), Consecutive Dry Days (CDD).

Introduction

Rainfall plays a major role in the earth's water cycle, which involves the continuous movement of water between the oceans, land, atmosphere, and living organisms. Rainfall analysis is necessary to determine the amount and volume of rainfall on a monthly and annual basis (Jain & Kumar, 2012). Rainfall analysis, a crucial component of the water cycle, involves analyzing the distribution, occurrence, intensity, and variability of precipitation over a specific area and time period. Rainfall study provides valuable insights into climatic trends, water availability, and potential impacts on human activities (Thomas *et al.*, 2007). Data on rainfall is essential for comprehending climate trends and how they affect different facets of life, such as water supplies, agriculture, and ecological systems.

An examination of rainfall trends from 1985 to 2019 in the Ambedkar Nagar district of Uttar Pradesh, India's northern state, offers important new information about the hydrological dynamics of the area. The purpose of this study is to investigate the trends, anomalies, and temporal changes in rainfall that have occurred in the Ambedkar Nagar district throughout the previous 35 years. We want to clarify the long-term trends in rainfall, seasonal variations, and possible effects on nearby populations, farming operations, and environmental sustainability by carefully examining this large dataset. In order to better understand the climatic regime of the Ambedkar Nagar district and to develop strategies for adaptation in the face of changing weather patterns, it is essential to analyze rainfall data from 1985 to 2019.

Rainfall trend analysis, according to Duhan and Pandey (2013), is the process of applying statistical methods to identify the pattern of changes in a long-term rainfall dataset over a certain period of time. The objective of trend analysis is to ascertain if patterns of rainfall are generally increasing or decreasing over time. The Mann-Kendall test is a non-parametric method for identifying patterns in data series. It may also be used to test for non-linear trends and turning points by utilizing statistic distribution (Mann, 1945; Basistha *et al.,* 2009; Oguntunde *et al.,* 2011). The trends of increase and reduction in the climate data series throughout time were statistically analyzed.

The Mann-Kendall test has been a useful tool in many research to determine if trends in hydrologic climatic variables like precipitation are statistically significant or not within the context of climate change (Shivam *et al.,* 2019). Non-parametric tests are those that don't make any assumptions about the population under study. Understanding any specific parametric category of probability distributions is irrelevant. Because non-parametric techniques don't rely on an underlying population, they are also known as distribution-free tests. Sen's slope is used to assess a trend's magnitude, such as its growing or decreasing magnitude, but whether.

Materials and Methods

Study Area Description

India's Uttar Pradesh state is located in the northern region, between latitudes 23°52'N and 31°28'N and longitudes 77°3'E and 84°39'E. This study is focused on the district of Ambedkar Nagar in Uttar Pradesh. Data on rainfall in that district served as the basis for the study.

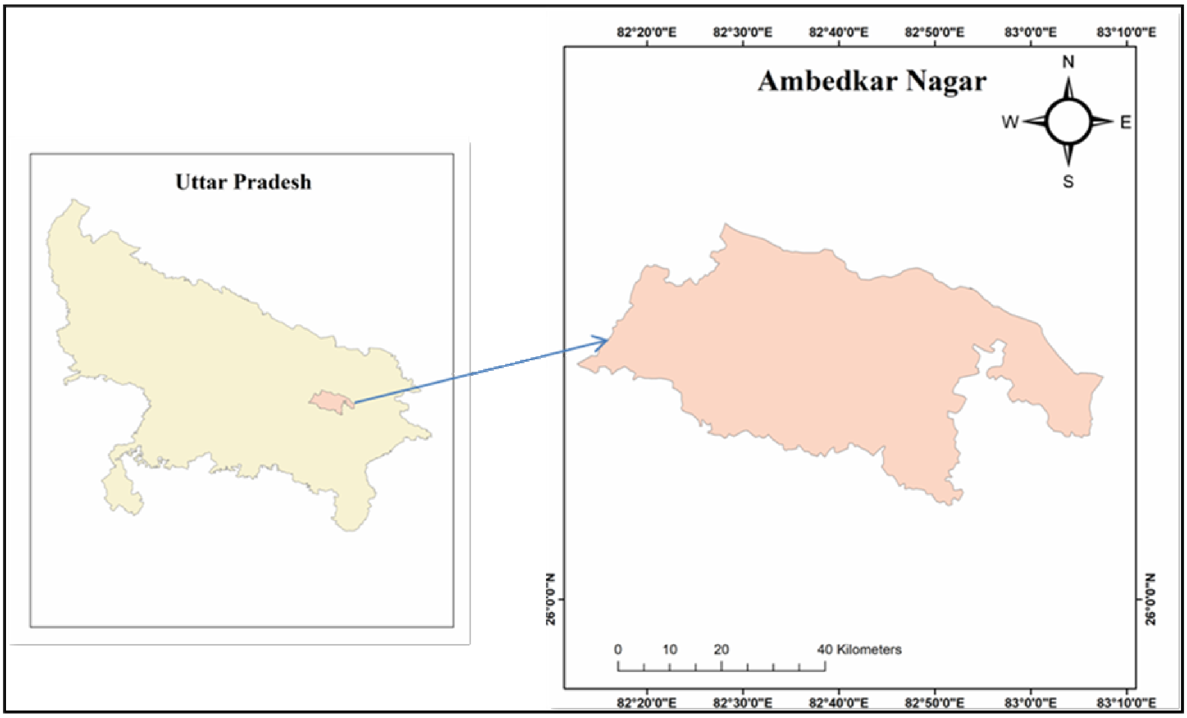

Fig. 1: Description of study area

Data Collection

The historical daily rainfall data used in this study was obtained from NASA Prediction of Worldwide Energy Resources (POWER) for a 35-year period, from 1985 to 2019. During the pre-whitening procedure, auto-correlation was eliminated from the calculation.

Precipitation Indices

Four precipitation indices were determined: heavy precipitation days (R10mm), very heavy precipitation days (R20), and consecutive wet days (CWD), Consecutive dry days (CDD).

Mann Kendall test

The Mann-Kendall test was proposed by Mann (1945) and Kendall (1975) for the analysis of rainfall climatic time series data. Trend analysis statistically checks the increasing and decreasing trend in rainfall climatic time series data (Shivam *et al.,* 2019). That analysis checked the null hypothesis versus the alternate hypothesis. The formula of Mann-Kendall is listed below-

$$(sign(x_i - x_j))^{\cdot} = \begin{cases} -1 \text{ for } (x_i - x_j) < 0 \\ 0 \text{ for } (x_i - x_j) = 0 \\ 1 \text{ for } (X_i - x_j) > 0 \end{cases} \quad \ldots 1$$

X= data set

i= 1,2,3………n term

j=i+1

For calculating the sum of all signs formula will be used-

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \text{sign}(x_i - X_j) \quad \ldots 2$$

S= Sum of all Sign

N= number

The following formula is used to calculate the variance-

$$Var(S) = \frac{n(n-1)(2n+5) - \sum_{p-1}^{q} tp(tp-1)(2tp+5)}{18} \quad \ldots 3$$

Var (S) = Variance of sum

n = Total number

tp = Number of terms whose equal value

For calculating Z value will be calculated by following the formula-

$$Z = \begin{cases} \frac{s-1}{\sqrt{var(s)}} & \text{if } S > 0 \\ 0 & \text{if } S = 0 \\ \frac{s+1}{\sqrt{var(S)}} & \text{if } S < 0 \end{cases} \quad \ldots 4$$

Z= Trend Value

Z is an indicator for trend significance. It frequently follows the standard normal distribution. If Z is greater than 0, the series is showing an upward trend, and vice versa. An upward or downward monotonous trend is tested using a significance level (two-tailed test). The 5% level of significance used in this study. The Modified Mann-Kendall (MMK) test is used to determine whether there is a trend in the Rainfall series if it is serially auto- correlated (Rahman *et al.,* 2017).

Correlation between various variable:

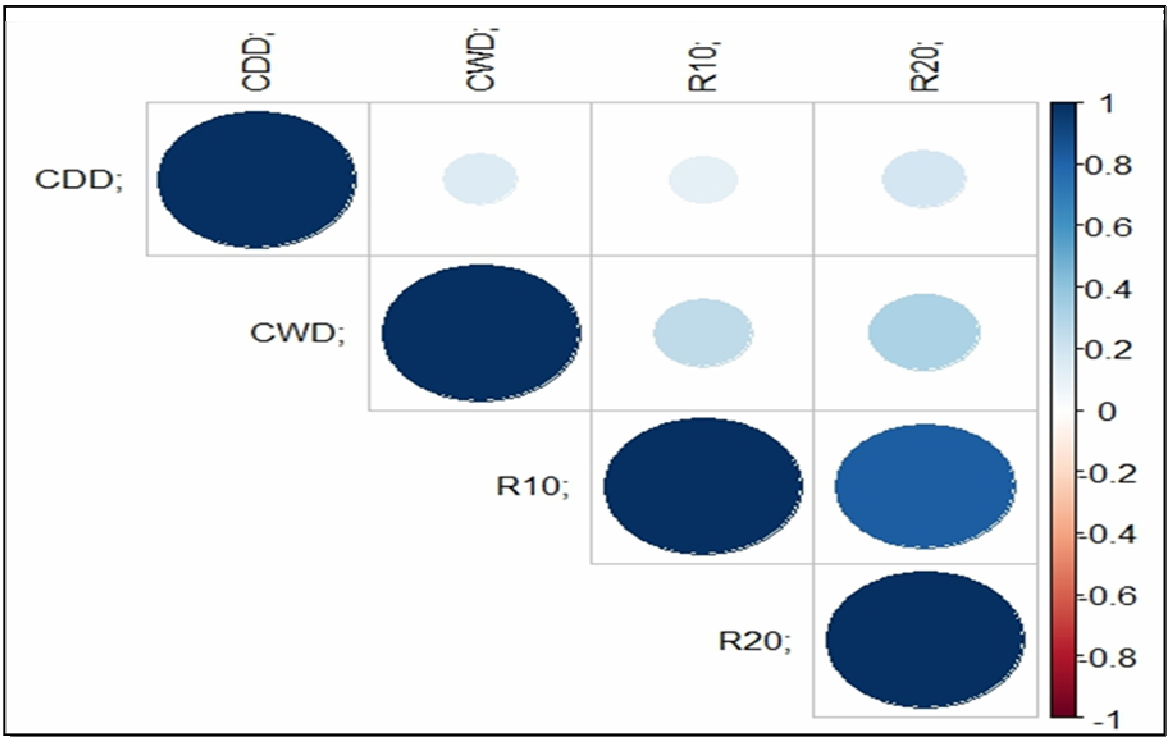

Fig. 2 : Correlation between CDD, CWD, R10 and R20

This figure 2 provides an overview of the relationships between four variables: CDD, CWD, R10, and R20. The size of the circles represents the relative magnitude or value of each variable, with larger circles indicating higher values and smaller circles indicating lower values. Looking at the grid, we can see that CDD has the largest circle, suggesting it has the highest value among the variables. CWD has the second-largest circle, indicating it has a relatively high value as well. In contrast, R10 and R20 have smaller circles, implying they have lower values compared to CDD and CWD. The legend on the right provides a scale that ranges from -1 to 1, which could represent the possible range of values for the variables. However, without additional context or information about the specific variables and their meanings, it's challenging to draw any concrete conclusions about the relationships or significance of the values depicted. Nevertheless, this visualization offers a concise and visually compelling way to compare the relative magnitudes of the four variables. It could be useful for quickly identifying patterns, trends, or anomalies in the data, or for facilitating further analysis and exploration. To gain a deeper understanding of the significance and implications of this data, it would be helpful to have more information about the variables, the context in which they are being measured, and the overall purpose of the analysis. With this additional context, the insights derived from this visualization could be more meaningful and actionable.

Result and Discussions

Analysis of R10 and R20 from 1985-2001

The Fig 3 provides detailed information on the number of heavy precipitation days (R10) and very heavy precipitation days (R20) that occurred each year from 1985 to 2001. The "R10" metric represents the number of days in a given year where the total precipitation was 10mm or more. These are considered "heavy precipitation days." The data shows significant variability in the R10 values from year to year. 1998 had the highest number with 36 heavy precipitation days, while 1989 had the lowest with only 19 such days. The "R20" metric represents the number of days in a year where the total precipitation was 20mm or more. These are considered "very heavy precipitation days." Again, there was substantial fluctuation in the R20 values over the 17-year period. 1990 had the most very heavy precipitation days at 18, while 1995 had the lowest at just 5 days. The R10 and R20 metrics provide insight into the frequency and intensity of heavy rainfall events, which is important for understanding potential impacts on things like flooding, agriculture, and overall climate trends.

By examining the year-over-year variability in both the heavy and very heavy precipitation days, gain a deeper appreciation for the changing weather conditions experienced in this region from 1985 through 2001.

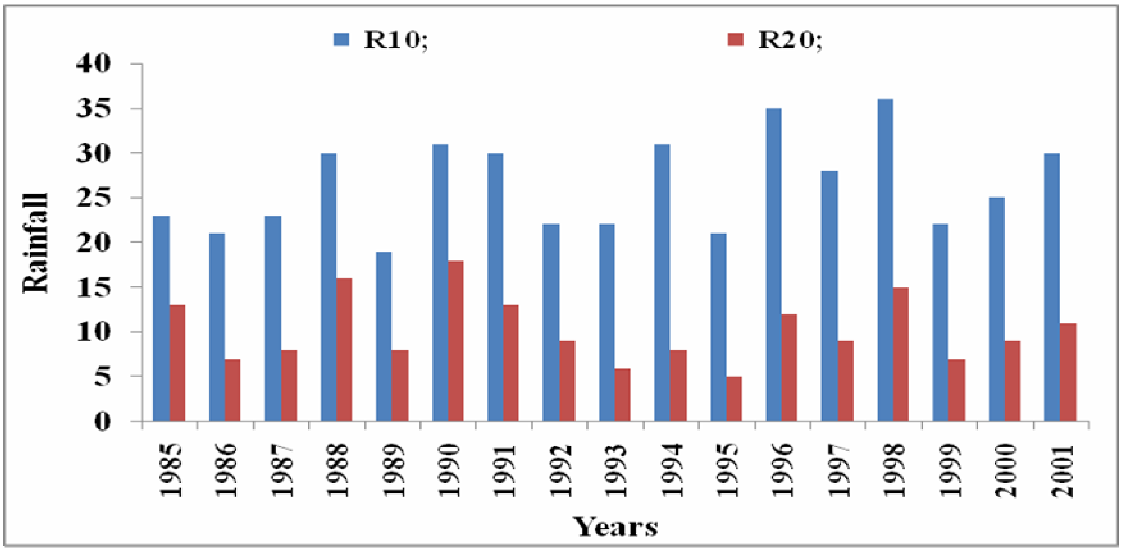

Fig. 3 : R10 and R20 from 1985-2001

The values for R10 and R20 vary from year to year, indicating some form of change or fluctuation. It is important to note that without additional context or information, it is challenging to determine the exact nature of the variables or the reasons behind these variations.

Analysis of R10 and R20 from 2002-2019:

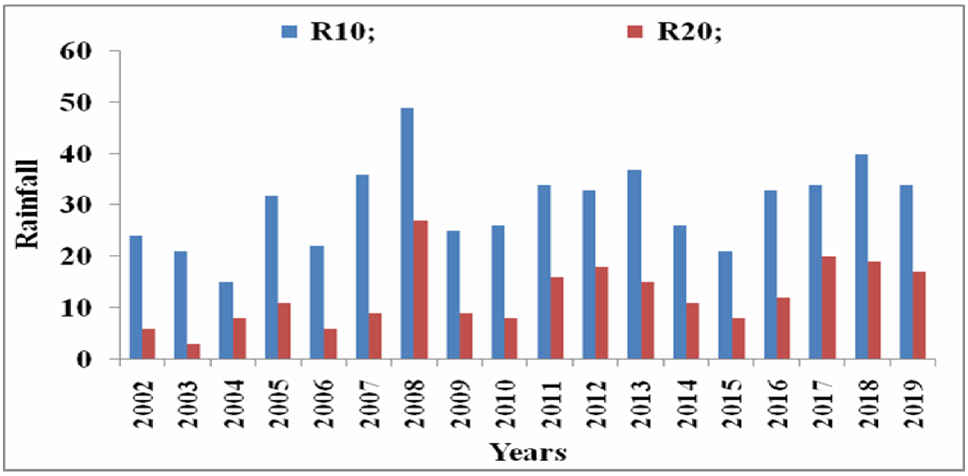

Fig 4: R10 and R20 from 2002 -2019

The Figure 4 provides information on the number of heavy precipitation days (R10) and very heavy precipitation days (R20) from 2002 to 2019. The R10 metric, representing days with 10 mm or more of precipitation, continued to show substantial year-to-year variability over this later time period. 2008 had the highest R10 value at 49 heavy precipitation days, while 2004 had the lowest at just 15 days. The R20 metric, tracking days with 20 mm or more of precipitation, also fluctuated considerably. 2008 had the maximum number of very heavy precipitation days at 27, more than double the 2003 low of 3 such days. The R10 and R20 metrics provide valuable insights into the frequency and intensity of heavy rainfall events, which is crucial for assessing impacts related to flooding, agriculture, and broader climate trends. Examining the year-over-year variability continues to demonstrate the dynamic nature of the local precipitation regime. Certain years experienced a high frequency of both heavy and very heavy precipitation days, while other years saw relatively fewer of these impactful rainfall events. Integrating this expanded data set with the previously provided information allows for a more complete analysis of the changing precipitation characteristics in this location over the 35-year period from 1985 to 2019.

Analysis of Commutative Wet and Dry Days from 1985-2001:

This Figure 5 provides data on the Cumulative Wet Days (CWD) and Cumulative Dry Days (CDD) for each year from 1985 to 2001.

The "CWD" column represents the total number of wet days that occurred in each year. For example, in 1985 there were 21 cumulative wet days, meaning there were 21 days with precipitation that year. The "CDD" column represents the total number of dry days that occurred in each year. So in 1985 there were 73 cumulative dry days, indicating that for the rest of the year after the 21 wet days, there were 73 days without precipitation.

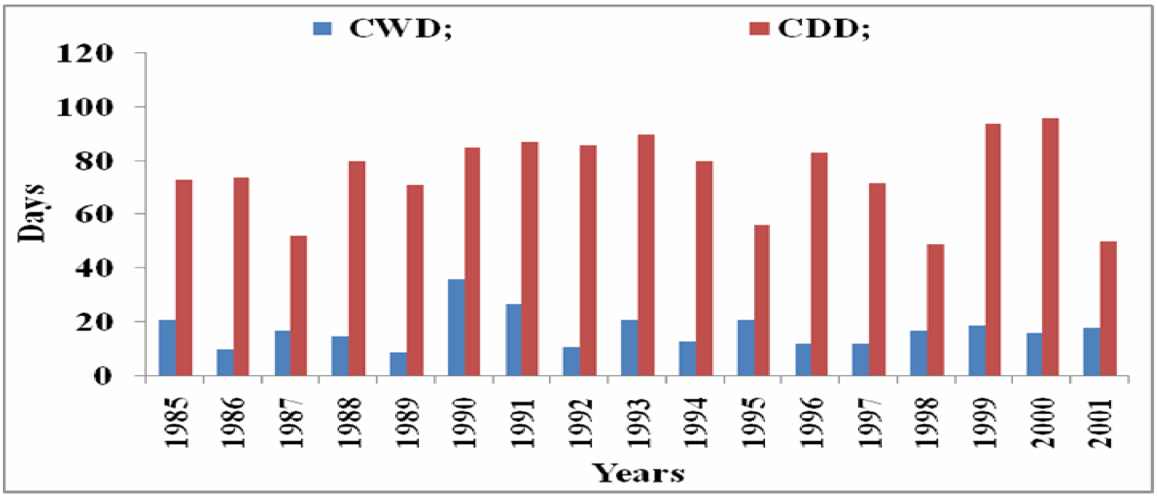

Fig. 5 : Commutative Wet and Dry Days from 1985-2001

The data shows some variability in the number of wet and dry days from year to year. For instance, 1990 had the highest number of cumulative wet days at 36, while 1989 had the lowest at only 9 cumulative wet days. Similarly, 1999 and 2000 had the highest number of cumulative dry days at 94 and 96 respectively, while 1998 had the lowest at 49 cumulative dry days. Overall, this data provides insight into the precipitation patterns and weather conditions experienced in this location over the 17-year period from 1985 to 2001.

Analysis of Commutative Wet and Dry Days from 2002-2019:

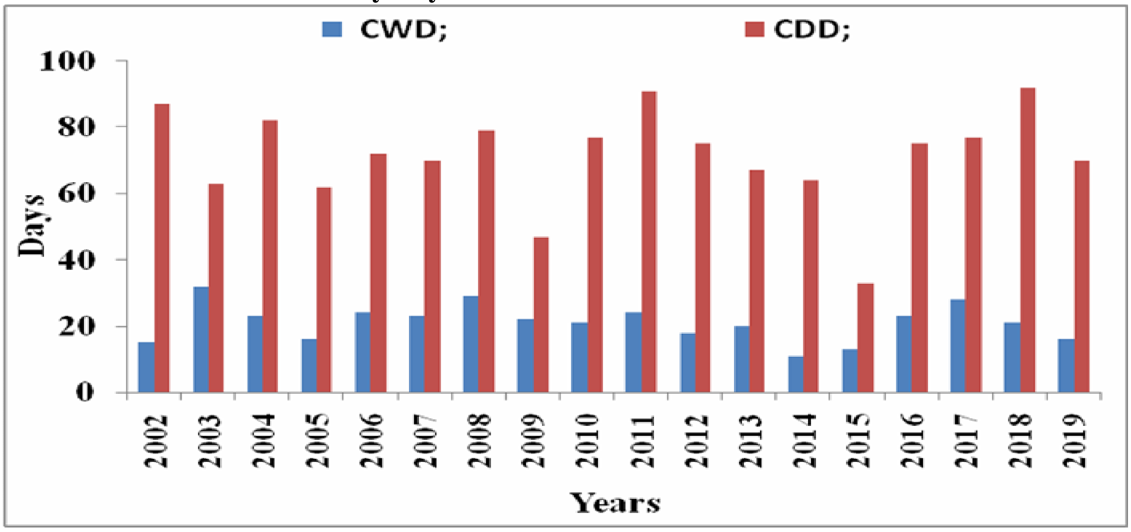

Fig. 6 : Commutative Wet and Dry Days from 2002-2019

The Figure 6 shows commutative wet and dry days in different year from 2002 to 2019. The CWD represents the Cumulative Wet Days for that year. For example, in 2002 there were 15 cumulative wet days, meaning there were 15 days with precipitation that year. The CDD represents the Cumulative Dry Days for that year. So, in 2002 there were 87 cumulative dry days, indicating that for the rest of the year after the 15 wet days, there were 87 days without precipitation. Looking at the data, we can see continued variability in the precipitation patterns year-over-year. Some years had higher numbers of wet days, like 2003 with 32 CWD, while other years had fewer, like 2014 with only 11 CWD. The dry day counts also fluctuated, with 2015 having the lowest number at 33 CDD, and 2018 having one of the highest at 92 CDD. Overall, this expanded dataset provides a more comprehensive view of the weather conditions in this location from 2002 through 2019, complementing the earlier data from 1985 to 2001. The CWD and CDD metrics allow us to analyze the precipitation trends over this 35-year period.

Conclusions

The Ambedkar Nagar district in Uttar Pradesh's research on rainfall trends from 1985 to 2019 shows considerable variability and noteworthy trends in precipitation patterns during the 35-year period. The study used the Mann-Kendall test to find trends in cumulative wet and dry days (CWD) and heavy (R10) and extremely heavy (R20) precipitation days (CDD). The findings demonstrate significant annual variations, with certain years seeing noticeably more rainfall events that have an effect on agriculture, water supply, and environmental sustainability. The information emphasizes how crucial it is to comprehend regional climate variations for efficient planning of agricultural operations and management of water resources. Overall, the study emphasizes how dynamic the rainfall patterns in the area are, underscoring the necessity of ongoing observation and adaptable tactics to lessen the effects of climatic unpredictability on nearby communities.

References

Basistha, A., Arya, D.S. and Goel, N.K. (2009). Analysis of historical changes in rainfall in the Indian Himalayas. *Int. J. Climatol*., 29, 555–572.

Duhan, D. and Pandey, A. (2013). Statistical analysis of long term spatial and temporal trends of precipitation during 1901–2002 at Madhya Pradesh, India. *Atmospheric Research*, *122*, 136-149.

Jain, S.K. and Kumar, V. (2012). Trend analysis of rainfall and temperature data for India. *Current Science*, 37-49.

Kendall, M.G. (1975). Rank Correlation Methods, 4th edition. Charles Griffin, London, U.K.

Mann, H. B. (1945). Nonparametric tests against trend. *Econometrical*, 13: 245-259.

Oguntunde, P.G., Abiodun, B.J., Olukunle, O.J. and Olufayoa, A.A. (2011). Trends and variability in pan evaporation and other climatic variables at Ibadan, Nigeria, 1973–2008, Meteorol. Appl., doi: 10.1002/ met.281, in press.

Rahman, M.A., Yunsheng, L. and Sultana, N. (2017). Analysis and prediction of rainfall trends over Bangladesh using Mann–Kendall, Spearman's rho tests and ARIMA model. *Meteorology and Atmospheric Physics*, 129(4), 409-424.

Shivam, G., Goyal, M.K. and Sarma, A.K. (2019). Index-based study of future precipitation changes over subansiri river catchment under changing climate. *Journal of Environmental Informatics*, 34(1), 1-14.

Thomas, D.S., Twyman, C., Osbahr, H. and Hewitson, B. (2007). Adaptation to climate change and variability: farmer responses to intra-seasonal precipitation trends in South Africa. *Climatic Change*, 83(3), 301-322.