*Biological Forum – An International Journal* **15(1): 737-742(2023)**

**ISSN No. (Print): 0975-1130**
**ISSN No. (Online): 2249-3239**

# Statical Analysis of Rainfall Data: A Case Study of Hamirpur District, Himachal Pradesh

***Prithi Pal Singh[1*] and M.R. Sharma[2]***
*[1]Research Scholar, Department of Civil Engineering,*
*Career Point University Hamirpur (Himachal Pradesh), India.*
*[2]Professor, Department of Civil Engineering,*
*Career Point University Hamirpur (Himachal Pradesh), India.*

*(Corresponding author: Prithi Pal Singh*)*
*(Received: 04 December 2022; Revised: 29 December 2022; Accepted: 15 January, 2023; Published: 18 January, 2023)*
*(Published by Research Trend)*

**ABSTRACT: Rainfall analysis is crucial for designing engineering projects and managing water resources. This paper focuses on the statistical study of rainfall in Hamirpur District, Himachal Pradesh, over a 30-year period, aiming to provide essential information for water resource planners, farmers and urban planners in the region. Mean, standard deviation, coefficient of variation, skewness, and kurtosis of monthly and annual rainfall were computed. Results revealed an unpredictable rainfall pattern, emphasizing the need for accurate input values in engineering design and crop planning. The study utilized various plotting position formulae and probability distribution functions to analyse the return period of yearly rainfall, identifying the Chegodayev technique as the most fitting distribution for this purpose. The projected rainfall for 5, 10, 50, 100, and 150 years return periods are 1279.57 mm, 1362.06 mm, 2021.97 mm, 2846.86 mm, and 3671.76 mm, respectively. This research contributes valuable insights into the specific rainfall dynamics of Hamirpur District, Himachal Pradesh, enhancing the relevance of the findings for local water management and infrastructure planning. The study faced challenges in dealing with the inherent unpredictability of rainfall patterns, particularly in months with lower variability. Additionally, ensuring the accuracy of input values for engineering structures and crop planning posed a significant challenge. This research makes significant contributions by providing in-depth statistical insights into the rainfall patterns of Hamirpur District. The identification of the Chegodayev technique as the optimal method for analysing return periods enhances the accuracy of rainfall projections for various planning horizons. The findings serve as a valuable resource for water resource planners, farmers and urban planners, facilitating informed decision-making in the development of engineering structures and crop planning strategies. The study underscores the importance of robust statistical analyses in understanding and managing the variability of rainfall, thereby contributing to the resilience and sustainability of water-related projects.**

**Keywords:** Statistical Analysis, Hamirpur (H.P.), Return Period, Rainfall Data.

## INTRODUCTION

Hamirpur (H.P.) is located in the south-western part of Himachal Pradesh. Geographically, this area falls under the Shivalik range of mountains. The land here is made up of conglomerate rock formation, produced by the solidification of loose rocks as well as other materials that have been eroded from the Lesser Himalayan areas. However, in many places the soil is poorly consolidated. Pine forests are regular features of this land in important hills traversing through Hamirpur.

The average elevation of Hamirpur ranges from four hundred meters to eleven hundred meters. Tracts of flat land are also seen here and there. As in the rest of Shivalik range, we can find many sub ranges traversing the region. Among them Jhak Dhar, Chabutra Hills and Sola Singhi Dhar need special mention.

The Hamirpur is watered by many big and small rivers. Among the big rivers we have Beas and Sutlej. River Beas runs through the northern edge of the district. Kunah Khad, Bakar Khad and Man Khad are some of the perennial streams that run northward to mingle into Beas. In the south we have, Sukkar Khad and Mundkhar Khad draining into Seer Khad, which in its turn drains into River Sutlej. (Source-https://www.hpsamb.org/hamirpur_home)

Hamirpur district falls in sub-humid sub-tropical zone. The winter prevails from November to March, spring in April and May, summer from June to September and transition season from October to November. The minimum temperature in the winter goes to 4°C and rises to maximum 38°C in summer. The average annual rainfall is about 1600 mm. There are two seasons of rainfall during the year one from December to March, associated with the passage of western disturbances and the other which is the main one, extending from middle of June till middle of September, caused by the south west monsoons. Some rain is also received in the post monsoon month of October. A major portion of precipitation (74%) is received during monsoon period from June to September. July and August are the wettest months. (Source- https://www.hamirpuronline.in/city-guide/geography-of-hamirpur)

In the recent years, a number of studies have been carried out to interpret various trends across the globe focusing mainly on mean temperature and rainfall as they are the most important hydrological parameters due to climate change and global warming that have been affected (Shadmani *et al.* (2012); Sridhgar and Raviraj (2017); Alhaji *et al.* (2018); Nourani *et al.* (2018). Gocic and Trajkovic (2013) have studied annual and seasonal trends of seven meteorological variables for twelve weather stations in Serbia using Mann-Kendall test and Sen's slope estimator test during (1980-2010). Eastman & Khan (2022) conducted a study at Botanical Gardens rain-gauge in Georgetown and analyzed 30-year rainfall data for engineering projects, showing unpredictability, bi-modal pattern, and return period projections. Mondal *et al.* (2012) have carried out similar study with same statistical tests for the northeast part of Cuttack, India district by processing rainfall data from (1971-2010). Yadav *et al.* (2014) have studied the trends for precipitation and temperature for thirteen districts of Uttarakhand, India during (1971-2011). The results of their trend analysis suggested insignificant changes in the studied area. Chinchorkar *et al.,* (2015) analyzed the above-mentioned hydrological parameters for Anand district, India for the period 1(970-2011). They have found the increasing trend in mean maximum temperature, while decreasing trend in total monthly rainfall. Shaikh and Lodha (2020) have analyzed the aforesaid hydrological parameters for Hathmati river basin, India for the period (1966-2015). It was found that the trend for the hydrological parameters was positive, which showed a clear proof of climate change and that it will be causing severe effects on the hydrological parameters.

Some more studies relating to changing pattern of rainfall over India have observed that there is no clear trend of increase or decrease in average rainfall over the country (Mooley and Parthasarthy (1984); Thapliyal and Kulshrestha (1991); Lal (2001); Sinha Ray and De (2003); Kumar and Jain (2010). Though the all-India monsoon rainfall exhibited no significant trend over a long period of time, pockets of significant long-term rainfall changes on regional scale were identified in some studies (Jagannathan and Parthasarathy (1973); Raghavendra (1974); Chaudhary and Abhyankar (1979); Singh and Sen Roy 2002; Kumar *et al.* (2005); Goswami *et al.* (2006); Guhathakurta and Rajeevan (2006); Dash *et al.* (2007); Singh *et al*. (2008). Using high resolution gridded rainfall data (1951-2003), Goswami *et al.* (2006) have found increase in frequency and magnitude of extreme rainfall events during monsoon season over central India. Dash *et al.* (2007) have found decreasing trend in monsoon and an increasing trend in the pre-monsoon and post-monsoon rainfall during (1871-2002). Singh *et al.* (2008) have found an increasing trend in annual rainfall in nine river basins of northwest and central India. Based on high resolution daily gridded rainfall data of (1901-2004), Rajeevan *et al.* (2008) have concluded that the frequency of extreme rainfall events shows significant inter-annual and inter-decadal variations. Hari Pal Singh *et al.* (2010) conducted a study of potential rain water harvesting in H.P. Hem Chander and Gulsan Kumar (2018) highlighted the importance of rainwater harvesting to tackle the issue of water shortage. Gouda *et al.* (2022) conducted a study on extreme rainfall event analysis over the state of Himachal Pradesh. Lohani *et al.* (2015) conducted a study on rainfall data processing and trend analysis in H.P. Ashok Jaswal *et al.* (2015) conducted seasonal and Annual rainfall trends in H.P. during (1951-2005). Tirkey *et al.* (2020) conducted analysis of precipitation variability over Satluj basin, H.P. There is significant amount of research to be done in the selected study area in order to understand the rainfall pattern

**Study Area:** The main aim of the study is to conduct an analysis of rainfall of Hamirpur District using statistical techniques. It is situated between 76°18′ to 76°44′ East longitude and 31°25′ to 31°52′ North latitude (Fig. 1). In this study, 30 years (1994-2023) rainfall are used since they offer a constant time frame for analysis. Based on the observed data, findings from the analysis will provide extensive information on the estimated maximum rainfall to be predicted for the various return times. This analysis will be extremely important for irrigation engineers and water planners for selecting the best crops to produce in the area, designing irrigation schemes, building rainwater harvesting structures, and designing water infrastructures.


Source: https://www.mapsofindia.com/maps/himachalpradesh/districts/ hamirpur.htm

**Fig. 1.** Location map of Hamirpur.

## MATERIAL AND METHOD

Monthly and annual precipitation data of 30 years (1994-2023), were collected from the Jal Shakti Vibhag Hamirpur and Met Centre Shimla for the rain gauge stations located in the district. The long-term variability and trend of the area's rainfall pattern were evaluated using statistical techniques such as mean, standard deviation, skewness, kurtosis and coefficient of variation on these data. The return period of yearly rainfall was also evaluated using plotting position formulas such as California, Hazen, Weibull, Chegodayev, Blom and Gringorten. It is commonly recommended that a return period of 5 to 100 years be used for soil and water conservation measures, dam building, irrigation and drainage works, therefore estimated rainfall is calculated for 5, 10, 50, 100 and 150 years.

**Plotting Position Methods.** Table 1 shows the plotting position methods used in this research. These are the most commonly used empirical equations for determining P, according to Subramanya (2013). The results from these methods are usually good for small extrapolations as errors increases with the number of extrapolations.

**Table 1: Plotting Position Methods.**

| Plotting Position Method | Equation for P |
|---|---|
| California | $\frac{m}{N}$ |
| Weibull | $\frac{m}{(N+1)}$ |
| Hazen | $\frac{(m-0.5)}{(N)}$ |
| Chegodayev | $\frac{m-0.3}{(N+0.4)}$ |
| Blom | $\frac{(m-3/8)}{(N+1/4)}$ |
| Gringorten | $\frac{(m-0.44)}{(N+0.12)}$ |

Where, m is rank of the data, and N = number of the sample (no. of years). (Source-Subramanya (2013).

To determine the return period, the rainfall data were ranked in descending order and several plotting positions and probabilistic methods were used. The rainfall-return period equation acquired from the graphs for the different plotting position methods were used to determine the rainfall magnitudes for various return periods

## RESULTS AND DISCUSSION

**Yearly Rainfall Analysis.** The yearly rainfall distribution of Hamirpur district has been analyzed for 30 years (1994-2023). The annual rainfall and average are depicted in Fig. 2. The maximum rainfall (1728.20mm) occurred in 1997, followed by 1569.90 mm occurring in 2006. The minimum rainfall (817.20 mm) occurred in 2017, and the second-lowest year (843.2 mm) occurred in 2018. It is shown that the average annual rainfall for the 30-year period is 1274.45 mm.

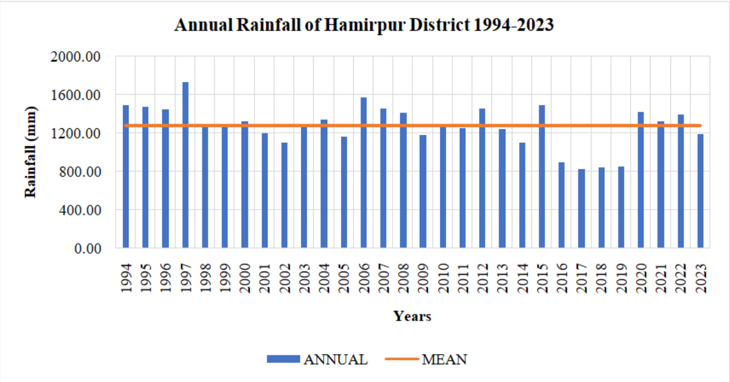


**Fig. 2.** Annual Rainfall of Hamirpur District.

For the year 1997, July received the highest rainfall of 560.50 mm out of 1728.20 mm.

Table 2 displays the descriptive parameters for annual rainfall from 1994-2023. The fairly high standard deviation value of 220.35 indicates that there is a significant variance in the annual rainfall values. The rainfall is erratic, as evidenced by the coefficient of variation, which measures how far data points in a data series are from the mean and is determined to be 17.29 %. With an average value of (-) 0.49, skewness which is a measure of asymmetry around the mean in frequency distributions indicates that the annual precipitation is asymmetric and skewed to the right of the mean. Kurtosis, a measure of how peaky or flat a frequency distribution is, has a value of 0.17 which is near to zero and suggests that it has a mesokurtic distribution.

**Table 2: Descriptive Parameters for Annual Rainfall from 1994-2023.**

| Description | Descriptive Statistics |
|---|---|
| Mean Rainfall (mm) | 1274.45 |
| Standard Deviation | 220.35 |
| Co-efficient of Variation | 17.29% |
| Skewness | (-)0.49 |
| Kurtosis | 0.17 |

**Analysis of Plotting Position Methods.** Table 3 shows the annual rainfall for different return periods for the different plotting positions. The California method yields the highest value for rainfall for various return periods, whereas the Hazen method yields the lowest value and is hence unsuitable for the analysis. Unlike other methods of distribution, the Chegodayev approach offers a maximum rainfall that is roughly 99.7% of the average maximum rainfall and offers the best fit distribution for yearly rainfall data. The Chi-square test was also used to assess the fit of these distributions. Chegodayev method provides the lowest Chi-square and was determined to be the best match for the distribution.

The rainfall for any return period can be projected, using the equation of the line, as shown in Fig. 3. Using Chegodayev plotting position method, the exceedance probability of the greatest rainfall of 1718.20 mm (1997) recurring is 2.3% and the second highest rainfall of 1569.90 mm which resulted in the 2006 is 5.6 %.

**Monthly Rainfall Analysis.** Month wise rainfall distribution of Hamirpur district has been analyzed for 30 years (1994-2023). A plot of the mean monthly rainfall data for the period (1994–2023) is depicted in Fig. 4 which shows rainfall pattern of Hamirpur District. The maximum mean rainfall occurred in the month of August (374.19mm), followed by July (325.58mm). The minimum mean rainfall (15.31mm) occurred in November, and the second-lowest month (18.93mm) occurred in the month of December.

**Table 3: Maximum Annual Rainfall (mm) - Based on Different Plotting Position Methods.**

| Method/Return Period | 5 | 10 | 50 | 100 | 150 |
|---|---|---|---|---|---|
| Weibull | 1295.46 | 1415.96 | 2379.97 | 3584.99 | 4790.01 |
| Califonia | 1299.48 | 1424.00 | 2420.14 | 3665.33 | 4910.51 |
| Hazen | 1270.30 | 1327.12 | 1781.66 | 2349.83 | 2918.01 |
| Chegodayev | 1279.57 | 1362.06 | 2021.97 | 2846.86 | 3671.76 |
| Blom | 1276.56 | 1349.44 | 1932.48 | 2661.28 | 3390.07 |
| Gringorten | 1272.92 | 1337.43 | 1853.50 | 2498.58 | 3143.67 |
| **Average** | **1282.38** | **1369.33** | **2064.95** | **2934.48** | **3804.00** |

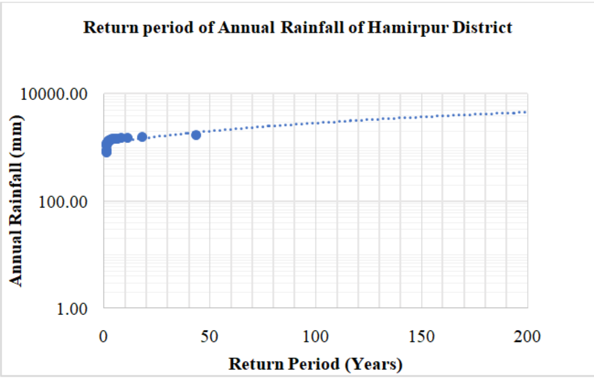


**Fig. 3.** Return Period of Annual Rainfall of Hamirpur District.

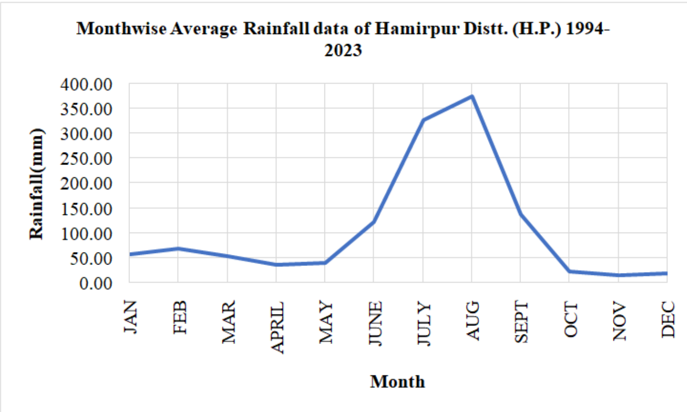


**Fig. 4.** Mean Monthly Rainfall of Hamirpur District.

**Descriptive Parameters**. From Table 4, it is observed that higher average rainfall values are received in the months of July, August and September (325.58 mm, 374.19 mm and 137.42 mm respectively) The standard deviation values are less than the corresponding mean values with the exception of October, November and December out of which November indicating the largest variation in the distribution of rainfall. A high variability is noted in rainfall data for October, November, and December (137.24%, 186.46% and 133.70%) respectively and lower variability in rainfall for July, August and September (36.04%, 30.61% and 39.58%) respectively.

**Table 4: Descriptive Parameters for Monthly Rainfall Analysis.**

| Descriptive Parameters for Monthly Rainfall Analysis Hamirpur 1994-2023 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Month** | **Mean Rainfall (mm)** | **Standard deviation (mm)** | **Coefficient of Variation (%)** | **Skewness** | **Kurtosis** | **Minimum(mm)** | **Maximum (mm)** |
| JAN | 57.87 | 41.58 | 71.84 | 1.27 | 2.03 | 0.00 | 181.00 |
| FEB | 68.82 | 50.53 | 73.42 | 0.63 | -0.33 | 1.80 | 170.20 |
| MAR | 53.53 | 43.40 | 81.08 | 1.30 | 2.85 | 0.00 | 195.25 |
| APR | 36.12 | 28.28 | 78.30 | 0.61 | -0.71 | 0.00 | 96.90 |
| MAY | 40.62 | 29.35 | 72.27 | 0.85 | 0.34 | 0.00 | 114.00 |
| JUN | 122.19 | 68.65 | 56.19 | 0.67 | -0.30 | 17.10 | 273.30 |
| JUL | 325.58 | 117.33 | 36.04 | -0.40 | -0.17 | 88.40 | 560.50 |
| AUG | 374.19 | 114.53 | 30.61 | 0.38 | -0.70 | 185.00 | 602.30 |
| SEP | 137.42 | 54.38 | 39.58 | 0.22 | -0.67 | 39.50 | 250.51 |
| OCT | 23.88 | 32.77 | 137.24 | 2.98 | 12.77 | 0.00 | 167.80 |
| NOV | 15.31 | 28.55 | 186.46 | 3.24 | 13.12 | 0.00 | 140.00 |
| DEC | 18.93 | 25.31 | 133.70 | 1.51 | 1.90 | 0.00 | 91.20 |

From the above table it is clear that the data series are generally positively skewed, with the exception of July which is slightly negatively skewed. The range of kurtosis for all the data series is from (-) 0.71 to 13.12. Negative kurtosis, which denotes flat distributions, and is seen in the months of February, April, June, July, August and September whereas positive kurtosis, which denotes peaked distributions, is visible in all other months.

## CONCLUSIONS

Statistical analysis of rainfall data of Hamirpur District (H.P.) for (1994–2023) was done to understand the rainfall pattern of the Hamirpur District. The mean, standard deviation and coefficient of variation of yearly and monthly rainfall were determined to check the rainfall variability. From the calculated results, the rainfall pattern is found to be erratic. The greatest rainfall of 1728.20 mm occurred in 1997, followed by 1569.90 mm in 2006 while the minimum rainfall of 817.20 mm occurred in 2017, and average annual rainfall for the 30-year period is 1274.45 mm. The highest mean rainfall value is in August (374.19 mm) and the least is in November (15.31 mm). Generally, A high variability is noted in rainfall data for October, November and December (137.74%, 186.46% and 133.70%) respectively and lower variability in rainfall for July, August and September (36.04%, 30.61% and 39.58%) respectively.

Agriculture engineers, farmers, and planners of water resources will all benefit from this analysis. It will provide assistance to them in determining the availability of water and design the appropriate storage. For instance, given the very unpredictable rainfall pattern, good drainage systems in areas where they do not already exist can be properly designed which will avoid flooding, in agricultural stabilization and also offer farmers security when making long-term investments. It will also aid in a better understanding of climate and rainfall patterns on a regional and global scale.

Once adequate data becomes available, it is recommended that similar studies be performed for other districts of Himachal Pradesh. Short duration storms which higher intensities, as opposed to longer storms with higher constant loading, can have different effects on drainage systems.

The findings of this study lay the groundwork for future research endeavors in the field of rainfall analysis and water resource management. Subsequent studies could explore the integration of advanced meteorological models and climate change projections to enhance the accuracy of long-term rainfall predictions. Additionally, investigations into the impact of unpredictable rainfall patterns on specific agricultural practices and urban infrastructure development could provide valuable insights for adaptive planning. The incorporation of emerging technologies, such as remote sensing and machine learning, could further refine our understanding of regional rainfall variations and contribute to the development of more robust engineering solutions and sustainable water management strategies.

It is important to declare that there is no conflict of interest associated with the research presented in this paper. The authors have conducted this study with a commitment to scientific integrity and objectivity, free from any external influences that could compromise the validity or impartiality of the findings. The research is solely aimed at contributing to the scientific community's understanding of rainfall patterns in Hamirpur District, Himachal Pradesh, and providing practical insights for water resource planning and infrastructure development.

**Acknowledgement**. The authors would like to express their gratitude to Jal Shakti Vibhag Hamirpur and Meteorological centre Shimla for providing the necessary resources and support for conducting this research.

## REFERENCES


Alhaji, U. U., Yusuf, A. S., Edet, C. O, Oche, C. O., Agbo, E. P. (2018). Trend analysis of temperature in Gombe state using Mann Kendall trend test. *Journal of Scientific Research and Reports*, *20*(3), 1–9.

Chander Hem & Kumar Gulshan (2018). Rain-Water Harvesting Structures as an Alternative Water Resource under Rain-Fed Conditions of District Hamirpur, Himachal Pradesh, India, *3*, 226-233.

Chaudhary, A. and Abhyankar, V. P. (1979). Does precipitation pattern foretell Gujarat climate becoming arid. *Mausam*, *30*(1), 85-90.

Chinchorkar, S. S., Sayyad, F. G., Vaidya, V. B. and Vyas, P. (2015). Trend detection in annual maximum temperature and precipitation using the Mann Kendall test – A case study to assess climate change on Anand of central Gujarat. *MAUSAM*, *66*, 1–6.

Dash, S. K., Jenamani, R. K., Kalsi, S. R., & Panda, S. K. (2007). Some evidence of climate change in twentieth-century India. *Climatic change*, *85*(3-4), 299-321.

Eastman, S. O., & Khan, B. (2022). Statistical Analysis of Rainfall Data: A Case Study of Georgetown, Guyana. *10*(6), 1-12.

Gouda, K. C., Rath Sudhansu, Singh Nidhi, Ghosh Sayanta and Lata Renu (2022). Extreme rainfall event analysis over the state of Himachal Pradesh in India. *Theoretical and Applied Climatology*, *151*.

Gocic, M. and Trajkovic, S. (2013) Analysis of changes in meteorological variables using Mann-Kendall and Sen's slope estimator statistical tests in Serbia. *Global and Planetary Change, 100,* 172–182.

Goswami, B. N., Venugopal, V., Sengupta, D., Madhusoodanam, M. S. and Xavier, P. K. (2006). Increasing trends of extreme rain eventsover India in a warming environment. *Science*, *314,* 1442-1445.

Guhathakurta, P. and Rajeevan, M. (2006). Trends in the rainfall pattern over India. *India Meteorological Department Research Report No.* 2/2006, p23.

Jagannathan, P. and Parthasarathy, B. (1973). Trends and periodicitiesof rainfall over India. *Monthly Weather Rev.*, *101,* 371-375.

Jaswal Ashok, Bhan, S., Karandikar, A. and Gujar, M. (2015). Seasonal and annual rainfall trends in Himachal Pradesh during 1951-2005. *Mausam, 66,* 247-264.

Kumar, V., Singh, P. and Jain, S. K. (2005). Rainfall trends over Himachal Pradesh, Western Himalaya, India", Conference on Development of Hydro Power Projects - *A Prospective Challenge, Shimla,* 20-22 April, 2005.

Kumar, V. and Jain, S. K. (2010). Trends in seasonal and annual rainfall and rainy days in Kashmir valley in the last century. *Quaternary Intl., 212,* 64-69.

Lal, M. (2001). Climatic change – Implications for India's water resources. *J. Ind. Water Resour. Soc*., *21,* 101-119.

Lohani Anil Kumar, Krishan Gopal, Chhabra Ajeet and Singh Nidhi (2015). Rainfall data processing and trend analysis in Himachal Pradesh, India.

Mann, H. B. (1945) Nonparametric tests against trend. *Econometrica, 13,* 245–259.

Mondal, A., Kundu, S. and Mukhopadhyay, A. (2012) Rainfall Trend Analysis by Mann-Kendall Test: A Case Study of North-Eastern part of Cuttack district, Orissa. *International Journal of Geology, Earth and Environmental Sciences, 2*(1), 70-78.

Mooley, D. A. and Parthasarthy, B. (1984). Fluctuations of all India summer monsoon rainfall during 1871-1978. *Climatic Change*, *6*, 287-301.

Nourani, V., Danandeh Mehr, A. and Azad, N. (2018). Trend analysis of hydroclimatological variables in Urmia Lake basin using hybrid wavelet Mann–Kendall and Sen tests. *Environmental Earth Sciences, 77,* 207(1-18).

Raghavendra, V. K. (1974). Trends and periodicities of rainfall in sub-divisions of Maharashtra state. *Indian J. Met. Geophys*, *25*, 197-210.

Rajeevan, M., Bhate, J. and Jaswal, A. K. (2008). Analysis of variability and trends of extreme rainfall events over India using 104 years of gridded daily rainfall data. *Geophys*. *Res. Lett., 35,* L18707.

Singh, H. P., Sharma, M. R., Hassan Quamrul and Ahsan Naved (2010). *Potential of rainwater harvesting in Himachal Pradesh*, *9,* 837-842.

Singh Pratap, Kumar Vijay, Thomas, T. and Arora Manohar (2008). Changes in rainfall and relative humidity in river basins in northwest and central India. *Hydrological Processes - Hydrol Process*, *22*, 2982-2992.

Singh, R. B. and Sen Roy, S. (2002). Climate variability and hydrological extremes in a Himalayan catchment", *ERB and Northern European FRIEND Project 5* Conference, Slovakia.

Sinha, K. C. and De, U. S. (2003). Climate change in India as evidenced from instrumental records. *WMO Bulletin, No. 52*, 53-58, World Meteorological Organization, Geneva, Switzerland.

Shadmani, M., Marofi, S. and Roknian, M. (2012). Trend Analysis in Reference Evapotranspiration Using Mann-Kendall and Spearman's Rho Tests in Arid Regions of Iran. *Water Resources Management, 26,* 211–224.

Shaikh, M. M. and Lodha, P. P. (2020) A framework for climate change impact on hydrological parameter of Hathmati river through simulation modelling. Ph.D. Thesis, Gujarat Technological University.

Sridhar, S. I. and Raviraj, A. (2017). Statistical Trend Analysis of Rainfall in Amaravathi River Basin Using Mann-Kendall Test. *Current World Environment*, *12*(1), 89-96.

Subramanya, K. (2013). *Engineering Hydrology*. (4$^{th}$ ed.). McGraw-Hill Publishing, New Delhi.

Thapliyal, V. and Kulshreshtha, S. M. (1991). Climate changes and trends over India. *Mausam, 42,* 333-338.

Tirkey, N., Parhi, P. K., Lohani, A. K. & Chandniha, S. K. (2021). Analysis of precipitation variability over Satluj Basin, Himachal Pradesh, India: 1901–2013. *Journal of Water and Climate Change*, *12*(1), 127-135.

Yadav, R., Tripathi, S. K., Pranuthi, G. and Dubey, S. K. (2014). Trend analysis by Mann- Kendall test for precipitation and temperature for thirteen districts of Uttarakhand. *Journal of Agrometeorology, 16*(2), 164–171.

Hamirpur Home. (*https://www.hpsamb.org/hamirpur_home*)

Geography of Hamirpur. (*https://www.hamirpuronline.in/city-guide/geography-of-hamirpur*).


**How to cite this article:** Prithi Pal Singh and M.R. Sharma (2023). Statical Analysis of Rainfall Data: A Case Study of Hamirpur District, Himachal Pradesh. *Biological Forum – An International Journal, 15*(1): 737-742.