ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 15, Issue, 08, pp.25519-25522, August, 2023
DOI: https://doi.org/10.24941/ijcr.45782.08.2023

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

ASSESSMENT OF TEMPORAL RAINFALL AND ITS CORRELATION WITH TEMPERATURE IN RANCHI, JHARKHAND

Chandan Kumar Pandit[1,*], Anamol Kumar Lal[2] and Uma Shanker Singh[3]

[1]Research Scholar, University Department of Mathematics, Ranchi University, Ranchi
[2]Assistant Professor, University Department of Mathematics, Ranchi University, Ranchi
[3]IFS(R), Lucknow

ARTICLE INFO

Article History:
Received 14th May, 2023
Received in revised form
18th June, 2023
Accepted 20th July, 2023
Published online 28th August, 2023

Key words:

Pearson's Correlation, Mann-Kendall test, Sen's slope method, Ranchi

**Corresponding Author:*
Chandan Kumar Pandit

ABSTRACT

This case report delves into the analysis of the effect of temperature change in rainfall pattern . Climate change is becoming a threat to the environment and livelihood of human. It is also affecting the economy of country as it is affecting agriculture process. Jharkhand being agriculture dominated state, also got affected by climate change. Correlation study of temperature and rainfall in India were positively correlated during January and May, but negatively correlated during July. In this paper, a correlation study of temperature and rainfall is done for the period 1973-2020. Pearson's correlation study for Ranchi signifies that the temperature and rainfall are negatively correlated for all the seasons and is significant for summer season whereas it is moderately correlated annually. The monthly correlation study signifies that the temperature and rainfall is negatively correlated for all month except November and January and is significant for month March, April, May, June, September and December. The month of November and January have positive correlation.

Citation: ***Chandan Kumar Pandit, Anamol Kumar Lal and Uma Shanker Singh.*** **2023.** "Assessment of Temporal Rainfall and its Correlation with Temperature in Ranchi, Jharkhand*". International Journal of Current Research*, 15, (08), 25519-25522.

INTRODUCTION

The variation in different atmospheric components over a very long period of time result in the climate change. The IPCC describes the climate change as the state of change in climatic conditions for a very long period of time typically decades or even more [IPCC, 2007]. IPCC also describes that climate change can be due to natural variability or as a result of human activities. Climate change is becoming a threat to the environment and livelihood of human. Researcher showed that the climate change has profound effect on rainfall variability and also on its intensity [Saleh, 2009]. The climate change leads to severe rainfall which results in floods in some areas whereas very less rainfall in some areas resulting in drought. Climate change also leads to extreme heat waves causing forest fires which results in destruction of various plants and animal species, melting of glaciers resulting in sea level rise. According to IPCC, the mean temperature has been increasing at a rate of 0.74C per century. According to Owusu-Sekyere [Owusu-Sekyere, 2011] the onset of rainfall is presently starting late than previously and that annual rainfall is decreasing and temperature increasing. The correlation between rainfall and temperature revealed that rainfall is not dependent on the variability of the temperature in Barishal region of Bangladesh [Tanarhte, 2012]. Rajeevan *et al.* [Rajeevan, 1998] found that temperature and rainfall in India were positively correlated during January and May, but negatively correlated during July. The rainfall variability has been affecting the national economy of India as India is agriculture dominated country. The climate change produce sometimes heavy rainfall is a region and very less rainfall in other region. This variability is affecting the agriculture pattern and crop yields in a negative way. Jharkhand being agriculture dominated state, also got affected by climate change. About 80% of the total population are dependent on agriculture and allied activities for their livelihood. Rainfall is the primary source of irrigation for the most parts of Jharkhand. Rainfall is also source of surface and ground water recharge. *Chandan et al.* showed that the decadal rainfall of Ranchi is increasing slowly but steadily [Chandan, 2023]. The global or continental scale studies of climate variables are not very useful for the planning and management at regional scale [Barsugli, 2009; Brekke , 2009]. Therefore, it is very important to study the climatic variables over a regional scale. The foremost aim of the present study is to analyze the correlation of rainfall and temperature for monthly, seasonally and yearly for Ranchi over a period of 48 years (1973-2020).

Study Area: Ranchi, the capitol of Jharkhand, is situated on the Chotanagpur plateau of eastern India. Ranchi have an area of 5097 km^2 with population density of 572/km^2. It lies in 22 52'-23 45' North latitude and 84 45'-85 50' East longitude. Ranchi is situated at average mean sea level ranging from 500 to 700. The annual average rainfall is 1300 mm of which 80% rainfall is received in south-west monsoon. The agriculture is heavily dependent on the rainfall as only 8.30% of agricultural use has irrigation facilities.

Data Collection: The daily rainfall and average temperature data of Ranchi is obtained from the website of National Centre For Environmental Information (https://www.ncdc.noaa.gov/cdo-web/) for the period 1973-2020.The data were then averaged into monthly, seasonal, yearly and decadal data series. For the trend analysis non-parametric test like Mann-Kendall test and Sen's slope method were applied. Also, to check the correlation between rainfall and temperature, Pearson's correlation test is applied.

METHODOLOGY

The daily rainfall and daily average temperature data were first analyzed and then monthly, seasonal and annual rainfall and average temperature were calculated. The data were then divided by decades. The Pearson's correlation test was applied on these data set to find the correlation between temperature and rainfall. Mann-Kendall test and Sen's slope method were applied on these data sets to find out possible linear trend in the data series.

Pearson's Correlation Coefficient: It is a bivariate correlation which measures the linear correlation between two sets of data. It is the ratio between the covariance of two variables and the product of their standard deviation. Hence it is essentially a normalized measurement of the covariance, such that the result always has a value between −1 and 1.Since correlation is a measure of linear relationship, a zero value does not mean there is no relationship. It just means that there is no linear relationship, but there may be a quadratic or any other higher degree relationship between the data points. Also, the correlation between one data point and another will now be explored. This is quite different from correlation between variables. Pearson correlation between two data points X and Y is given by:

Correlation (X,Y) $=\frac{Cov(X,Y)}{\sigma_X \times \sigma_Y}$

Where Cov(X,Y) is covariance of X and Y and is given by

Cov(X,Y) $=\frac{1}{n-1}\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})$

Where $\bar{x}$ and $\bar{y}$are mean of data set X and Y respectively and n is the sample size.

And σ_X and σ_Y are standard deviation of X and Y respectively.

The Pearson Correlation is the actual correlation value that denotes magnitude and direction, the Sig. (2-tailed) is the *p*-value that is interpreted to check the significance of correlation. If the *p*-value is less than 0.05, then correlation is statistically significant between the two data set and the *p*-value is more than 0.05, then the correlation is not statistically significant association between the two data set.

Mann-Kendall Test: The Mann-Kendall test is non-parametric trend test which is used to determine whether or not there is a linear monotonic trend in a given time series data. The null hypothesis states that there is no monotonic trend, and this is tested against one of three possible alternative hypotheses: (i) there is an upward monotonic trend, (ii) there is a downward monotonic trend, or (iii) there is either an upward monotonic trend or a downward monotonic trend. It is very useful as it does not require the data to be normally distributed.

The first step in the Mann-Kendall test for a time series $x_1,x_2,x_3,\ldots,x_n$ of length n is to compute the indicator function Sg n (x_i-x_j) as follows:

$$\text{Sgn}(x_i-x_j)=\begin{cases}1, & x_i-x_j>0\\ 0, & x_i-x_j=0\\ -1, & x_i-x_j<0\end{cases}$$

Next we compute mean S and variance Var(S) of Sgn(x_i-x_j) as follows:

$$S=\sum_{i=1}^{n-1}\sum_{j=i+1}^{n} sgn(x_i-x_j)$$

And Var(S) $=\frac{[n(n-1)(2n+5)-\sum_t t(t-1)(2t+5)]}{18}$

Where t is the extent of any given tie.

Mann-Kendall test statistic Z is then computed as follows:

$$Z=\begin{cases}\frac{S-1}{\sqrt{Var(S)}} & if\ S>0\\ 0 & if\ S=0\\ \frac{S+1}{\sqrt{Var(S)}} & if\ S<0\end{cases}$$

The value of Z>0 represents monotonic upward trend in data series whereas Z<0 represents monotonic downward trend.

Sen's Slope Method: It is a non-parametric test which is highly efficient to find out linear trend in univariate data series. This can be applied to a data set having missing value and outliers in the data series.

The Sen's estimator β of slope is calculated as follows:

$$\beta = \text{Median}\left(\frac{x_j-x_i}{j-i}\right)$$

Where x_j and x_i are the data values at time j and i (j>i) respectively. β>0 indicates an upward trend whereas β<0 indicates downward trend in the data series.

RESULTS

The data sets were first analyzed for the mean rainfall and mean temperature for the period 1973-2020. The annual mean rainfall for the period 1973-2020 is 765.5 mm and annual mean temperature is 24ºC for the same period (Table 3). The South-west monsoon contributes maximum rainfall (80.7 %) to the annual rainfall. The monthly mean rainfall and temperature is also calculated which shows that the maximum rainfall is received in the month of July (198.8 mm) and August (198.6 mm) and the least rainfall is received in the month of December (7.4 mm) for period 1973-2020. The maximum mean temperature is observed in the month of May (30.16ºC) and is minimum for the month January (16.73ºC).

Trend analysis: The data were further analyzed to find out possible trend. Mann-Kendall test and Sen's slope method signifies positive trend in rainfall for the month May, June, July, August, September and is significant only for July (Table 1). It also signifies that monsoon and annual rainfall are increasing significantly (Figure 1). Trend analysis on temperature data set signifies non-significantly positive trend only for August and no trend for other months and seasons (Table 2).

Table 1. **MK statistic and Sen's estimator of Rainfall**

Rainfall	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Z	0.38	0.73	0.37	0.81	2.36	3.12	2.64	2.95	2.68	1.89	-0.19	-0.73
β	0	0.014	0	0.057	0.525	3.73	5.96	4.63	3.38	0.625	0	0

Table 2: MK statistic and Sen's estimator for Temperature

Temperature	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Z	-1.61	-0.31	-0.8	-1.45	-0.28	-0.19	1.9	2.69	1.61	-1.51	-0.57	-0.76
β	-0.016	-0.003	-0.01	-0.26	-0.004	-0.003	0.014	0.016	0.013	-0.018	-0.006	-0.007

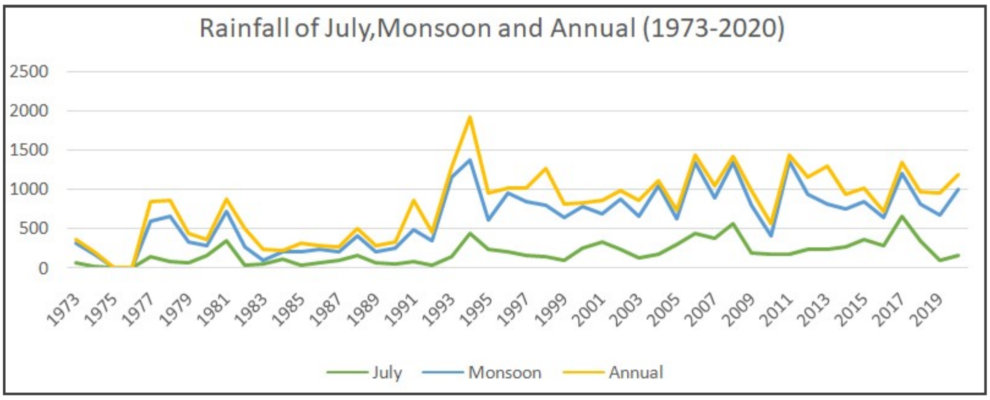

Figure 1. Rainfall of July, Monsoon and annual

Correlation analysis: The data were then analyzed to find out the correlation between temperature and rainfall for the period 1973-2020. Pearson's correlation coefficient signifies that the temperature and rainfall are negatively correlated for all the seasons and is significant for the summer season having the correlation coefficient (-0.473) whereas it is moderately correlated annually (-0.331). The linear regression curve of rainfall against temperature is plotted for summer season (Figure 2).

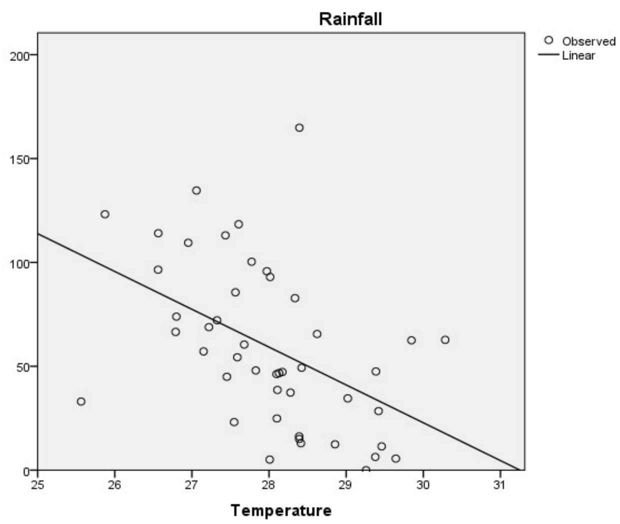

Figure 1. Linear regression curve for summer season

Table 3. Correlation coefficient and linear regression value

1973-2020	Mean Rainfall (mm)	Mean Temperature (ºC)	Correlation coefficient (Temperature=1)	R^2 value	P value
Annual	765.475	24.009	-0.331	0.110	0.025
Summer	54.21	28.04	-0.473	0.224	0.001
Monsoon	617.692	26.40	-0.275	0.076	0.064
Post Monsoon	65.87	20.50	-0.225	0.050	0.133
Winter	27.69	18.43	-0.160	0.026	0.287

Monthly correlation analysis: The correlation study for monthly data set signifies that the temperature and rainfall is negatively correlated for all month except November and January. The correlation is positively correlated for the month of November and January. The correlation is significantly negative for month March, April, May, June, September and December (Table 4).The correlation is positive for November and January.

Table 4. Monthly correlation coefficient with p value

Month	Correlation coefficient (Temperature=1)	P value	Result
January	0.047	0.749	Non-significant
February	-0.140	0.341	Non-significant
March	-0.541	0	Significant
April	-0.354	0.014	Significant
May	-0.471	0.001	Significant
June	-0.500	0	Significant
July	-0.261	0.073	Non-significant
August	-0.047	0.749	Non-significant
September	-0.325	0.024	Significant
October	-0.248	0.089	Non-significant
November	0.115	0.435	Non-significant
December	-0.290	0.046	Significant

CONCLUSION

This paper presents a correlation study of rainfall and temperature over Ranchi district of Jharkhand. The study of interdependence of rainfall and temperature can be very useful for the agriculture production in the region. This study of correlation is based on the meteorological data for the Ranchi district over a period of 48 years. From the analysis of data from 1973-2020,it is observed that the 80.7% of annual rainfall is received in Monsoon season (June- September) and July and August months are months of maximum rainfall. The hottest month is May and the coolest month is December. Rainfall is increasing significantly for July month, monsoon season and annually. Temperature has no significant trend. Pearson's correlation coefficient study shows that the rainfall and temperature is significantly negative correlated for summer season and for month March, April, May, June, September and December. The correlation is positive for the month of January and November.

REFERENCES

IPCC. 2007. Climate change- impacts, adaptation and vulnerability technical summary of working group II. To Fourth Assessment Report Inter-governmental Panel on Climate Change. Parry, M.L., Canziani, O.F., Paultikof, J.P., van der Linden, P.J. and Hanon, C.E. (Eds.) Cambridge Univeristy Press, Cambridge, UK

Saleh A. Wasimi. 2009. Climate change trends in bangladesh. 2nd International Coriference on Water & Flood Management (ICWFM)

Owusu-Sekyere, J. D. J. Andoh, and K. Nyarko, 2011. Climate Change and Crop Production in the Mfantseman Area of Ghana. J. Appl. Environ. *Biol. Sci.,* 1, 134-141.

Tanarhte, M., Hadjinicolaou, P., Lelieveld, J. 2012. Intercomparison of temperature and precipitation data sets based on observations in the Mediterranean and the *Middle East. J. Geophys. Res.,* 117.

Rajeevan, M., Pai, D.S., Thapliyal, V. 1998. Spatial and temporal relationships between global land surface air temperature anomalies and Indian summer monsoon rainfall. Meteorol. *Atmos. Phys.* 66, 157–171

Chandan Kr, Pandit: A.K. 2023. Lal; Uma. Singh; Rainfall Variability Trend in Ranchi, Jharkhand. IJCRT 2023,Volume 11, Issue 2 February, d45-d50 | DOI : http://doi.one/10.1729/Journal.33125

Barsugli, J., Anderson, C., Smith, J., Vogel, J. 2009. Options for Improving Climate Modeling to Assist Water Utility Planning for Climate Change; Water Utility Climate Alliance: Clearwater, FL, USA.

Brekke, L.D. 2009. Climate Change and Water Resources Management: A Federal Perspective; DIANE Publishing: Darby, PA, USA.

****