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Trend Analysis of Temperature and rainfall in Kashmir Valley

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Abstract: Weather is the key source of uncertainty affecting crop yield especially in the context of climate change. Among variables relevant to weather, rainfall and temperature are two important factors which have a large effect on crop yield. Typically, temperature affects the length of the growing season and rainfall affects plant production.
Rainfall and temperature are important climatic inputs for agricultural production, especially in the context of climate change. The interdependence of rainfall and temperature has a direct influence on the output of agriculture, occurrence and design of hydraulic structures. Earlier the correlation of temperature and rainfall could not be studied with precision but the developments in the meteorology science have however rendered the study possible and precise.
The study of temporal and spatial variation of temperature and rainfall of six stations of Kashmir valley for the period of thirty years which has been used for determination of various rainfall-temperature graphs. The rainfall-temperature curve has been further used to determine the trend or pattern in temporal and spatial variation and to determine periods of maximum and minimum rainfall and temperature and also the stations of maximum and minimum rainfall and temperature. The study also computes correlations between temperature and rainfall in Kashmir valley for each station and for each month of the corresponding stations. Modern statistical methods were used to test thestatistical significance of our results.
Keywords: Rainfall, Temperature, Correlation, Temporal, Spatial, Statistical methods

I. INTRODUCTION

The rapid growth of the human population and strained resources particularly as regards tofood production and water supply for people and for agriculture, has imparted the importance of study of correlations among different physical variables of climate such as rainfall and temperature over a region. Agriculture is one of the most important activity engaging more than 70% of the population in Kashmir. In order to increase agricultural production, effective utilization of water resources is of prime importance. The relationship between rainfall and temperature is the major parameter influencing agricultural activity and its analysis is thus an important prerequisite for agricultural planning in Kashmir valley.

The pattern and amount of rainfall are among the most important factors that affect agricultural systems. Along with temperature, the occurrence and variability of precipitation, to a large extent determine which crops can be grown in different regions throughout the world. The influence of temperature on rainfall has been incorporated in anindirect, or sometimes a direct way in a number of studies. Temperature influences rainfallin many ways; such that in some cases high temperatures may result in exceedingly high rates of potential evaporation and low precipitation. This results in an area being dominated by an arid or semi-arid landscape. In other cases, high temperatures lead to more evaporation and consequently increased condensation leading to high rainfall.

The characteristics of rainfall are of considerable interest to farmers, water resourcemanagers and other user groups. Rainfall is a key factor in shaping the vegetation, hydrology, and water quality throughout the Earth. Since temperature and rainfall are critical determinants of crop yield, accurate simulation of temperature and rainfall is important not only for meteorology but also for agricultural economics. However, in reality it is difficult to simulate rainfall and temperature simultaneously due to the interdependence (correlation) between them. Spatially, it is generally believed that there exists significant correlation between rainfall and temperature over tropical oceans and land. Temporally, it is generally believed that the correlation between rainfall and temperature changes between months.

II. METHODOLOGY

The methodology has been divided into four major parts namely:

A. Data collection

The monthly rainfall and average temperature of six stations of the Kashmir valley is used as the data set to determine correlation between the temperature andrainfall.

The data for the study was collected from Agromet Field Unit (AMFU) Srinagar, a unit of Agrometeorology in the Division of Agronomy, SKUAST-K. The data was collected for a period of 1991-2020. The World Meteorological Organization (WMO) suggests using 30 year rainfall and temperature data for analysis, but when analyzing variations over time, data for shorter periods (10 or 20 years) can also be used. The data set of the study contains monthly rainfall and temperature with record length of 30 years.

B. Preparation of data

Before using the rainfall records of a station, it is necessary to first check the data for continuity and consistency. The continuity of a record may be broken with missing data due to many such reasons like fault in a rain guage or a thermometer during a period. The missing data may be estimated by using the data of the neighbouring stations. In these calculations, the normal data is used as a standard of calculation. The term normal annual precipitation at a station means the average precipitation based on a specified 30 years of record.

1) The missing rainfall data can be estimated by the following two methods:

a) *Arithmetic Mean Method*

If the normal annual precipitation is within about 10% of the normal annual precipitation at station X , then a simple arithmetic average procedure is followed to estimate P_x. Thus,

$$P_X = \frac{1}{M} \times (P_1 + P_2 + P_3 + P_4 + \cdots + P_M) \qquad (3.1)$$

Where,

P_x= annual rainfall at station X to be estimatedM= Number of neighbouring stations

$P_1, P_2, P_3, P_4, \ldots\ldots P_M$ = Annual rainfall at neighbouring stations

b) *Normal Ratio Method*

If the normal precipitations vary considerably, then P_x is estimated by weighingthe precipitations at various stations by the ratios of normal annual precipitations. This method known as normal ratio method gives P_x as:

$$P_X = \frac{N_X}{M}\left(\frac{P_1}{N_1} + \frac{P_2}{N_2} + \frac{P_3}{N_3} + \frac{P_4}{N_4} + \cdots + \frac{P_M}{N_M}\right) \qquad (3.2)$$

Where,

P_X = Annual rainfall at station X to be estimatedN_X = Normal annual precipitation at station X

$P_1, P_2, P_3, P_4, \ldots\ldots P_M$ = Annual rainfall at neighbouring stations

$N_1, N_2, N_3, N_4, \ldots\ldots N_M$ = Normal annual rainfall at neighbouring stations

M= Number of neighbouring stations

2) The missing temperature data can be estimated by choosing any one among the following seven methods:

a) *Method of Ignoring Instances with Unknown Feature Values:* This method is the simplest: just ignore the instances, which have at least one unknown featurevalue.
b) *Most Common Feature Value:* The value of the feature that occurs most oftenis selected to be the value for all the unknown values of the feature.
c) *Concept Most Common Feature Value*: This time the value of the feature, which occurs the most common within the same class is selected to be the value for all the unknown values of the feature.
d) *Mean substitution:* Substitute a feature's mean value computed from available cases to fill in missing data values on the remaining cases. A smarter solution than using the "general" feature mean is to use the feature mean for all samplesbelonging to the same class to fill in the missing value
e) *Regression or classification methods*: Develop a Regression or classification model based on complete case data for a given feature, treating it as theoutcome and using all other relevant features as predictors.

f) *Hot deck imputation*: Identify the most similar case to the case with a missing value and substitute the most similar case's Y value for the missing case's Y value.
g) *Method of Treating Missing Feature Values as Special Values:* Treating "unknown" itself as a new value for the features that contain missing values.

C. Data Analysis And Interpretation

Analysis of the collected data has been divided into three stages and these are:

1) Temporal Variation Of Rainfall And Temperature

In this stage, the monthly variation of rainfall at each station is studied with respect to time. In monthly rainfall analysis, the months of max. and min.
rainfall are determined and also a trend in rainfall pattern is determined for each station and also for the mean rainfall of the six stations.
For temperature variation, the monthly variation of temperature at each station is studied with respect to time. In monthly temperature analysis, the months of max. and min. temperature are determined and also a trend in temperature fluctuation is determined for each station and also for the meantemperature of the six stations.

2) Spatial Variation Of Rainfall And Temperature

In spatial variation of rainfall, the monthly variation of rainfall is studied with respect to space, i.e., from station to station. In monthly rainfallanalysis, the station of max. and min. rainfall intensities are determined andalso a trend in rainfall pattern for each month is determined.
For temperature variation, the monthly variation of temperature is studied with respect to space, i.e., from station to station. In monthly temperature analysis, the station of max. and min. temperature are determined and also atrend in temperature fluctuation for each month is determined.

3) Interdependence Of Rainfall And Temperature

In this stage, the monthly average rainfall variation is studied with respectto monthly average temperature i.e., correlation graphs are plotted for each month and for each station and also for the mean of six stations. Correlationcoefficients and corresponding *p-values* are determined for each graph.

D. Data Presentation And Output

Finally, the data has been presented by preparing various charts and diagrams using Microsoft Excel and various results are obtained which are discussed in next chapters.

III. COORDINATES OF SIX STATIONS

S.No	Name of station	Longitude	Latitude
1.	Srinagar	$34^{o}05'$	$74^{o}50'$
2.	Gulmarg	$34^{o}03'$	$74^{o}24'$
3.	Kupwara	$34^{o}25'$	$74^{o}90'$
4.	Pahalgam	$34^{o}02'$	$75^{o}20'$
5.	Kokernag	$33^{o}35'$	$75^{o}30'$
6.	Qazigund	$33^{o}37'$	$75^{o}05'$

IV. DATA ANALYSIS

A. Descriptive Statistics

Descriptive statistics are brief descriptive coefficients that summarize a given data set, which can be either a representation of the entire population or a sample of a population. Descriptive statistics are broken down into measures of central tendency and measures of variability (spread). Measures of central tendency include the mean, median, and mode, while measures of variability include standard deviation, variance, minimum and maximum variables.

Although descriptive statistics may provide information regarding a data set, they do not allow for conclusions to be made based on the data analysis but rather provide a description of the data being analysed. Descriptive statistics can be useful for two purposes:

1) to provide basic information about variables in a dataset, and
2) to highlight potential relationships between variables

B. Descriptive Statistics For Monthly Rainfall For Six Stations

The average monthly rainfall of 30 years period (1991-2020) calculated at the six stations have been used for preparing various diagrams. The descriptive statisticsof the six stations and also for Kashmir valley (mean of six stations) is shown in the successive tables:

Table 1. Descriptive Statistics for monthly rainfall in mm pooled data from 1991-2020 at Srinagar

Month	Jan	Feb	Mar	Apr	May	June
Maximum	168.10	277.50	440.30	186.60	170.20	182.60
Minimum	0.00	0.30	1.20	1.40	1.00	1.60
Mean	65.58	84.73	105.65	88.70	61.30	42.91
Standard deviation	48.25	68.05	103.65	57.68	41.37	41.20
Month	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	297.50	178.40	211.10	100.70	82.50	147.40
Minimum	0.30	0.80	0.00	0.00	0.00	0.00
Mean	75.94	76.88	39.01	22.73	22.03	27.78
Standard deviation	74.49	58.70	45.20	26.53	21.72	33.32

Table 2. Descriptive Statistics for monthly rainfall in mm pooled data from 1991-2020 at Gulmarg

Month	Jan	Feb	Mar	Apr	May	June
Maximum	383.40	360.60	372.70	258.10	342.70	242.40
Minimum	16.80	49.80	21.50	15.20	44.30	33.60
Mean	125.71	139.02	170.32	140.96	123.66	92.09
Standard deviation	84.21	74.30	95.94	57.18	70.28	49.27
Month	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	221.20	245.20	329.20	172.00	230.80	311.90
Minimum	23.00	42.20	20.20	0.40	0.00	0.00
Mean	99.20	107.45	88.21	39.78	53.32	54.78
Standard deviation	47.86	47.21	62.62	41.28	52.21	60.53

Table 3. Descriptive Statistics for monthly rainfall in mm pooled data from 1991-2020 at Pahalgam

Month	Jan	Feb	Mar	Apr	May	June
Maximum	303.20	366.20	410.50	299.20	342.70	187.80
Minimum	3.30	59.30	21.50	15.40	51.10	34.00
Mean	116.27	147.27	160.52	142.86	118.88	90.12
Standard deviation	78.56	78.79	104.58	63.71	74.93	39.35

Month	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	219.60	210.60	276.30	154.60	170.50	311.90
Minimum	43.60	42.20	15.60	0.00	0.00	0.00
Mean	109.53	107.54	92.41	43.20	48.03	59.49
Standard deviation	44.69	46.27	58.28	36.38	42.83	60.64

Table 4. Descriptive Statistics for monthly rainfall in mm pooled data from 1991-2020 at Qazigund

Month	Jan	Feb	Mar	Apr	May	June
Maximum	297.20	414.50	434.10	246.80	255.30	262.20
Minimum	1.00	31.60	10.80	7.00	23.20	6.20
Mean	144.39	166.57	166.58	118.95	93.06	78.30
Standard deviation	87.37	99.70	112.13	57.18	53.22	54.62
Month	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	285.90	360.80	625.40	141.10	268.80	376.10
Minimum	19.00	10.00	3.20	0.00	0.00	0.00
Mean	88.85	99.26	83.85	30.92	48.10	71.51
Standard deviation	57.05	76.52	119.78	33.02	54.88	82.78

Table 5. Descriptive Statistics for monthly rainfall in mm pooled data from 1991-2020 at Kupwara

Month	Jan	Feb	Mar	Apr	May	June
Maximum	234.00	339.60	413.00	277.00	246.60	152.10
Minimum	8.00	21.80	15.40	13.20	21.90	5.80
Mean	99.97	138.76	174.40	145.96	91.37	57.03
Standard deviation	69.65	72.39	96.11	69.49	52.07	32.81
Month	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	216.90	159.00	160.30	172.50	295.30	204.30
Minimum	11.90	13.90	2.20	0.00	0.00	0.00
Mean	77.62	69.18	45.53	37.04	55.60	54.58
Standard deviation	59.81	38.98	43.39	39.56	64.86	51.40

Table 6. Descriptive Statistics for monthly rainfall in mm pooled data from 1991-2020 at Kokernag

Month	Jan	Feb	Mar	Apr	May	June
Maximum	257.40	321.10	369.00	346.30	249.90	260.30
Minimum	1.40	11.80	12.60	8.40	15.00	17.30
Mean	93.71	119.05	139.79	122.20	104.59	80.73
Standard deviation	67.56	64.96	88.07	66.37	50.92	60.62
Month	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	246.20	256.30	483.50	131.80	267.30	232.60
Minimum	22.40	13.10	7.60	0.00	0.00	0.00
Mean	93.46	86.98	67.39	29.15	40.80	44.06
Standard deviation	65.17	57.36	88.40	31.11	54.66	51.04

Table 7. Descriptive Statistics for monthly rainfall in mm pooled data from 1991-2020 at Kashmir valley (mean of six stations)

Month	Jan	Feb	Mar	Apr	May	June
Maximum	144.39	166.57	174.4	145.96	123.66	92.09
Minimum	65.58	84.73	105.65	88.7	61.3	42.91
Mean	107.61	132.57	152.88	126.61	98.81	73.53
Standard deviation	25.08	25.57	23.86	19.83	20.61	19.51
Month	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Maximum	109.53	107.54	92.41	43.2	55.6	71.51
Minimum	75.94	69.18	39.01	22.73	22.03	27.78
Mean	90.77	91.22	69.4	33.8	44.65	52.03
Standard deviation	11.74	14.74	20.77	6.92	11.14	13.54

1) Descriptive Statistics for monthly temperature for six stations

The average monthly temperature of 30 years period (1991-2020) calculated at the six stations have been used for preparing various diagrams. The descriptive statistics of the six stations and also for Kashmir valley (mean of six stations) is shown in the successive tables:

Table 8. Descriptive Statistics for monthly average temperature in pooled datafrom 1991-2020 at Srinagar

Month	Jan	Feb	Mar	Apr	May	June
Maximum	11.40	14.00	21.20	25.00	28.80	30.50
Minimum	-6.60	-1.90	1.50	4.90	7.60	10.80
Mean	2.08	4.86	9.08	13.29	17.07	20.91
Standard deviation	4.99	5.12	6.15	6.88	7.55	7.51
Month	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Maximum	31.70	31.60	30.50	25.60	18.30	12.30
Minimum	14.90	14.80	9.90	2.70	-1.80	-5.50
Mean	23.53	23.05	19.62	13.80	7.86	3.70
Standard deviation	6.53	6.50	7.86	8.78	7.44	5.85

Table 9. Descriptive Statistics for monthly average temperature in pooled datafrom 1991-2020 at Gulmarg

Month	Jan	Feb	Mar	Apr	May	June
Maximum	8.20	10.40	17.90	22.20	26.10	27.30
Minimum	-11.40	-8.70	-4.20	-0.70	3.30	6.40
Mean	-1.91	0.32	4.45	8.97	12.58	15.67
Standard deviation	5.77	5.78	6.48	6.96	7.53	7.52
Month	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Maximum	27.60	26.50	26.40	22.80	16.00	10.50
Minimum	9.30	9.90	7.00	0.70	-3.50	-7.40
Mean	18.12	17.93	15.08	10.14	4.87	1.02
Standard deviation	6.27	6.18	7.14	7.92	7.06	5.86

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Table 10. Descriptive Statistics for monthly average temperature in pooled datafrom 1991-2020 at Pahalgam

Month	Jan	Feb	Mar	Apr	May	June
Maximum	11.50	12.60	21.10	22.60	26.10	28.70
Minimum	-11.10	-7.00	-2.70	1.80	3.40	6.90
Mean	-0.38	1.89	6.44	10.79	13.92	16.97
Standard deviation	6.02	5.87	6.82	7.35	8.05	7.89
Month	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	30.70	29.20	29.50	25.50	20.20	12.20
Minimum	11.10	10.10	6.70	0.70	-3.30	-6.60
Mean	19.67	19.51	16.47	11.51	6.03	1.85
Standard deviation	6.47	6.38	7.86	8.85	7.58	6.35

Table 11. Descriptive Statistics for monthly average temperature in pooled datafrom 1991-2020 at Qazigund

Month	Jan	Feb	Mar	Apr	May	June
Maximum	11.30	13.70	20.60	24.80	27.50	29.00
Minimum	-7.40	-4.10	1.00	5.20	7.80	11.20
Mean	1.78	4.62	8.96	13.24	16.68	20.17
Standard deviation	5.48	5.46	6.23	6.89	7.28	6.96
Month	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	30.70	29.30	29.50	24.80	18.20	13.30
Minimum	14.70	14.40	8.60	2.70	-1.60	-4.20
Mean	22.46	21.82	18.62	13.58	8.27	4.07
Standard deviation	5.78	5.97	7.56	8.57	7.54	6.11

Table 12. Descriptive Statistics for monthly average temperature in pooled datafrom 1991-2020 at Kupwara

Month	Jan	Feb	Mar	Apr	May	June
Maximum	11.50	14.30	21.10	26.70	30.00	31.00
Minimum	-6.80	-3.40	0.10	5.10	7.70	10.30
Mean	2.23	4.41	9.01	13.56	17.33	20.92
Standard deviation	5.45	5.42	6.56	7.27	7.98	7.89
Month	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	33.30	32.10	31.60	27.10	20.20	12.80
Minimum	14.20	13.40	9.10	2.80	-2.60	-6.00
Mean	23.66	23.31	19.97	14.30	8.17	3.76
Standard deviation	6.99	7.15	8.74	9.38	8.10	6.31

Table 13. Descriptive Statistics for monthly average temperature in pooled datafrom 1991-2020 at Kokernag

Month	Jan	Feb	Mar	Apr	May	June
Maximum	11.50	12.50	20.70	24.50	28.30	28.90
Minimum	-7.40	-3.60	-2.10	2.50	6.80	8.70

Mean	1.24	3.56	8.07	12.60	16.36	19.73
Standard deviation	4.99	5.15	6.11	6.64	7.17	7.12
Month	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	29.40	29.10	28.30	25.70	20.40	12.60
Minimum	11.00	13.00	9.40	4.70	-1.10	-7.10
Mean	21.79	21.47	18.85	14.21	8.23	3.82
Standard deviation	6.18	5.99	6.85	7.23	6.27	5.32

Table 14. Descriptive Statistics for monthly average temperature in pooled datafrom 1991-2020 at Kashmir valley (mean of six stations)

Month	Jan	Feb	Mar	Apr	May	June
Maximum	2.23	4.86	9.08	13.56	17.33	20.92
Minimum	-1.91	0.32	4.45	8.97	12.58	15.67
Mean	0.84	3.27	7.67	12.07	15.66	19.06
Standard deviation	1.50	1.65	1.71	1.66	1.77	2.02
Month	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	23.66	23.31	19.97	14.3	8.27	4.07
Minimum	18.12	17.93	15.08	10.14	4.87	1.02
Mean	21.54	21.18	18.11	12.92	7.24	3.04
Standard deviation	2.02	1.91	1.76	1.55	1.31	1.16

2) Correlation Of Temperature And Rainfall

The relationship of one or more variables to one or more other variables is often called correlation. There are several procedures to obtain some idea of this correlation. The Pearson Correlation Coefficient (PCC) is a statistical measure of the strength of a linear relationship between two data sets. PCC was employed to measure the linear dependence between temperature and rainfall. Monthly averages of rainfall for each year (from 1991 to 2020) were correlated with monthly average temperatures for each year (from 1991 to 2020). One of the most significant features determines the strength or weakness of the monotonic association between variables through positive or negative correlation which ranges between –1.00 to + 1.00 (Table 4.15)

PCC is expressed by the following statistic:

$$r = \frac{\Sigma XY - \frac{\Sigma X \Sigma Y}{N}}{\sqrt{\left(\Sigma X^2 - \frac{(\Sigma X)^2}{N}\right)}\sqrt{\left(\Sigma Y^2 - \frac{(\Sigma Y)^2}{N}\right)}} \qquad (4.1)$$

Where,

N = represents the number of pairs of data,

X = x-score,

Y = y-score

A key mathematical property of the PCC is that it is invariant to changes inlocation and scale. The PCC also takes into account magnitude and direction.

Table 15. Interpretation of the correlation coefficient (Ratner 2009)

Correlation Coefficient	Interpretations
0 to 0.3	Weak positive linear relationship
0.3 to 0.7	Moderate positive linear relationship
0.7 to 1.0	Strong positive linear relationship
0 to -0.3	Weak negative linear relationship
-0.3 to -0.7	Moderate negative linear relationship
-0.7 to -1.0	Strong negative linear relationship

In the statistical test procedure p-values are generated to determine the significance of the results as an indicator of whether a correlation exists between the selected variables.
Table 4.16 specifies the p-values and the related significance levels.

Table 16. p-values and the related significance level (Bühl 2012)

Significance level		Specification
$p > 0.05$		Not significant
$p \leq 0.05$	(5%)	Significant
$p \leq 0.01$	(1%)	Very Significant
$p \leq 0.001$	(0.1%)	Highly Significant

Table 17. Correlation matrix of Temperature vs Rainfall (pooled data from 1991-2020) of Srinagar

Month	Jan	Feb	Mar	Apr	May	Jun
r value	-0.087	-0.488	-0.712	-0.753	-0.623	-0.204
p value	0.647	0.006	0.000	0.000	0.000	0.279

Month	Jul	Aug	Sep	Oct	Nov	Dec
r value	-0.251	-0.350	-0.594	-0.420	-0.093	0.028
p value	0.181	0.058	0.001	0.021	0.624	0.883

Table 18. Correlation matrix of Temperature vs Rainfall (pooled data from 1991-2020) of Gulmarg

Month	Jan	Feb	Mar	Apr	May	Jun
r value	-0.265	-0.248	-0.348	-0.490	-0.307	-0.451
p value	0.157	0.186	0.060	0.006	0.099	0.012

Month	Jul	Aug	Sep	Oct	Nov	Dec
r value	0.210	0.025	-0.328	-0.361	-0.529	-0.275
p value	0.266	0.898	0.077	0.050	0.003	0.142

Table 19. Correlation matrix of Temperature vs Rainfall (pooled data from 1991-2020) of Pahalgam

Month	Jan	Feb	Mar	Apr	May	Jun
r value	-0.457	-0.120	-0.688	-0.453	-0.396	-0.324
p value	0.011	0.526	0.000	0.012	0.030	0.080

Month	Jul	Aug	Sep	Oct	Nov	Dec
r value	-0.035	-0.170	-0.473	-0.247	-0.440	-0.224
p value	0.855	0.368	0.008	0.189	0.015	0.234

Table 20. Correlation matrix of Temperature vs Rainfall (pooled data from 1991-2020) of Qazigund

Month	Jan	Feb	Mar	Apr	May	Jun
r value	-0.281	-0.487	-0.702	-0.710	-0.639	-0.460
p value	0.132	0.006	0.000	0.000	0.000	0.010

Month	Jul	Aug	Sep	Oct	Nov	Dec
r value	-0.232	-0.230	-0.426	-0.538	-0.612	-0.316
p value	0.218	0.222	0.019	0.002	0.000	0.089

Table 21. Correlation matrix of Temperature vs Rainfall (pooled data from 1991-2020) of Kupwara

Month	Jan	Feb	Mar	Apr	May	Jun
r value	0.172	-0.051	-0.221	-0.489	-0.427	-0.187
p value	0.364	0.789	0.242	0.006	0.019	0.324

Month	Jul	Aug	Sep	Oct	Nov	Dec
r value	-0.214	0.196	-0.268	-0.213	-0.245	0.249
p value	0.257	0.300	0.152	0.257	0.192	0.185

Table 22. Correlation matrix of Temperature vs Rainfall (pooled data from 1991-2020) of Kokernag

Month	Jan	Feb	Mar	Apr	May	Jun
r value	-0.434	-0.323	-0.566	-0.517	-0.496	-0.350
p value	0.017	0.081	0.001	0.003	0.005	0.058

Month	Jul	Aug	Sep	Oct	Nov	Dec
r value	-0.178	-0.168	-0.479	-0.381	-0.284	-0.051
p value	0.346	0.374	0.007	0.038	0.128	0.787

Table 23. Correlation matrix of Temperature vs Rainfall (pooled data from 1991-2020) of Kashmir Valley (mean of six stations)

Month	Jan	Feb	Mar	Apr	May	Jun
r value	-0.416	-0.262	-0.372	-0.475	-0.815	-0.811
p value	0.412	0.616	0.468	0.341	0.048	0.050
Month	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
r value	-0.859	-0.887	-0.820	-0.667	-0.327	-0.156
p value	0.028	0.018	0.046	0.148	0.527	0.768

V. RESULTS AND DISCUSSION

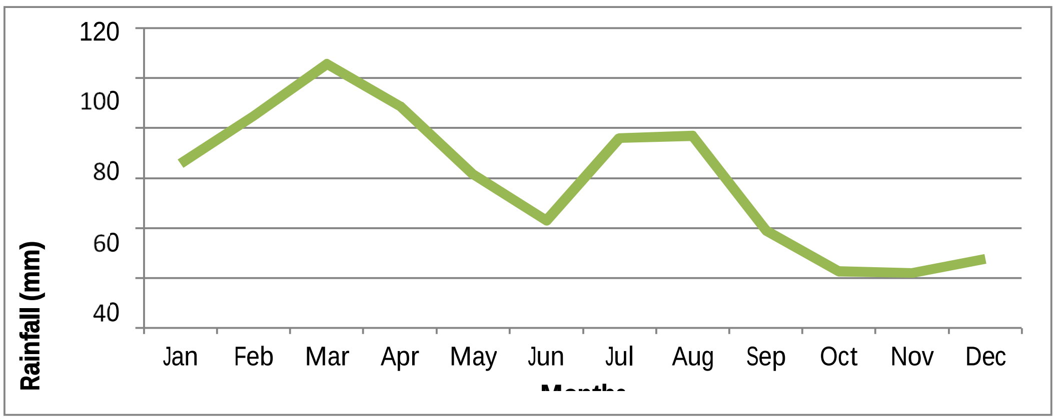
1) *Temporal Variation Of Monthly Rainfall And Temperature*

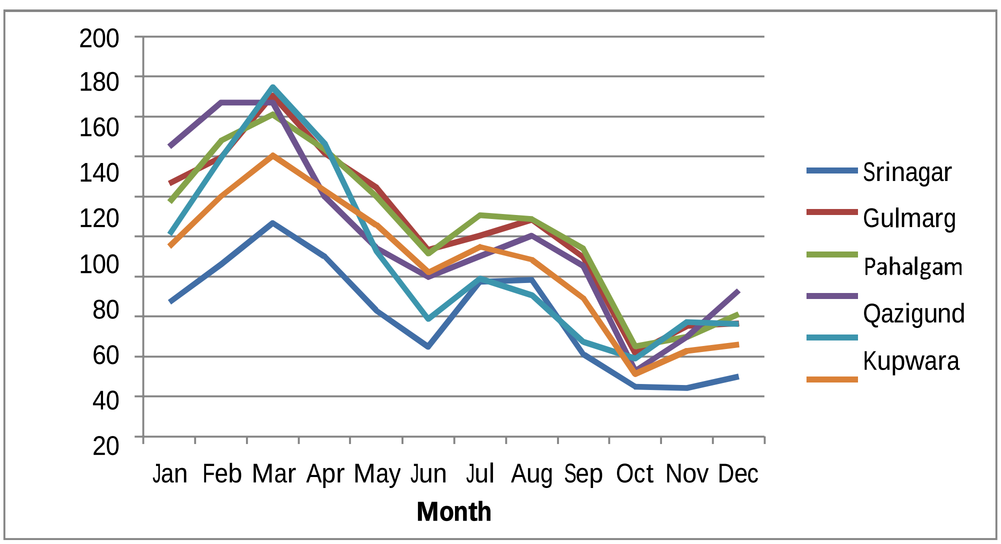
Temporal variation means the variation with respect to time. In this section, the time variation refers to the monthly variation. The easiest way of studying the monthly temporal variation of rainfall in mm (or temperature in °C) and the time in months. These graphs were plotted for each station.

Srinagar

2) *Spatial Variation Of Monthly Rainfall And Temperature*

Spatial variation of rainfall is best understood from the comparison of the rainfall- time graphs of the six stations. Subsequent figure shows the comparison. The spatial variation of rainfall for all the twelve months can be clearly studied fromthe figure.





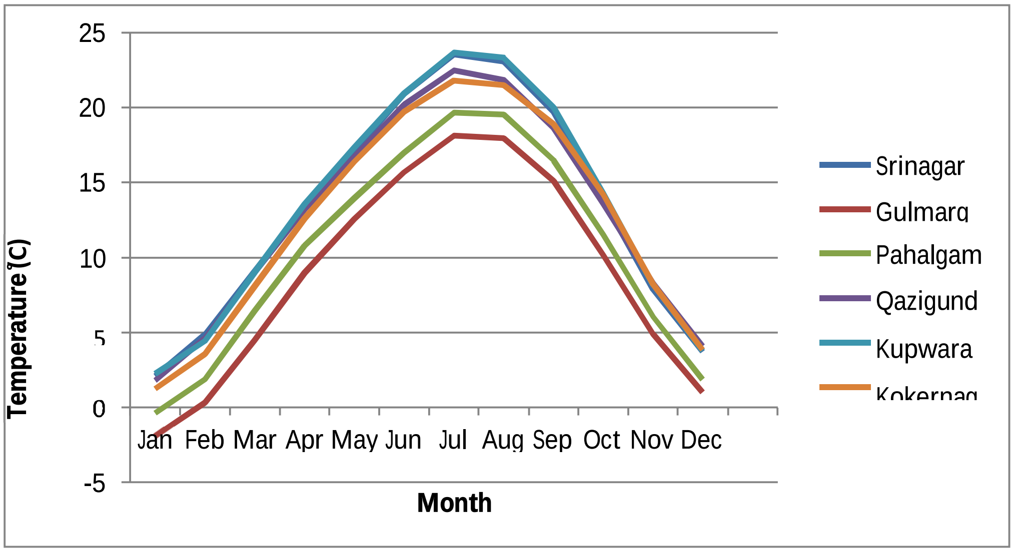
Comparison of the Rainfall-time graphs of six stations

It is clearly visible that the maximum rainfall happens to be at Kupwara station. Minimum rainfall happens to be at Srinagar station throughout the year. The decreasing order of peakmonthly rainfall, which is for the month of March, at the six stations is as:

Kupwara > Gulmarg > Qazigund > Pahalgam > Kokernag > Srinagar

The decreasing order of monthly rainfall, at the six stations, for each month can be detected from the graph. The variation with stations is maximum in first half year and thenthere is a little irregular variation in rainfall between the six stations.

Spatial variation of temperature is best understood from the comparison of the temperature-time graphs of the six stations. Subsequent figure shows the comparison. The spatial variation of temperature for all the twelve months can be clearly studied from the figure.



Comparison of the Temperature-time graphs of six stations

It is clearly visible that the maximum temperature happens to be at Kupwara station over the course of year except in February and March where the temperature at Srinagar station is more than that of Kupwara station. Minimum temperature happens to be at Gulmarg station throughout the year. The decreasing order of highest monthly temperature, which isfor the month of July, at the six stations is as:

Kupwara > Srinagar > Qazigund > Kokernag > Pahalgam > Gulmarg

The decreasing order of monthly temperature, at the six stations, for each month can be depicted from the graph above.

The variation with stations is more or less constant with respect to monthly mean temperature.

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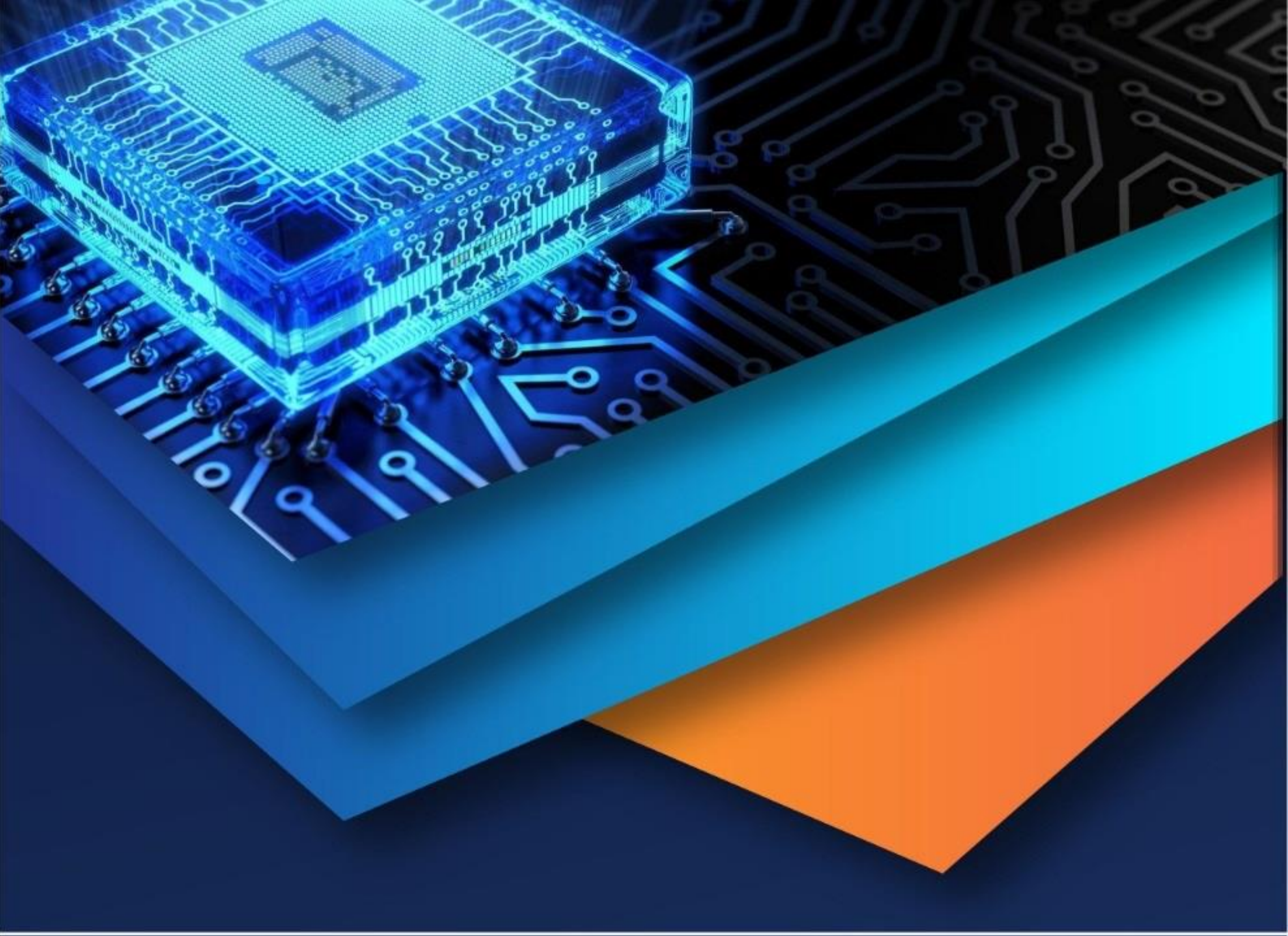

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