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Research Paper

Monthly Trend Analysis and Variability of Climatic Variables Tarai Region of Uttarakhand

Statistics

KEYWORDS : Trend analysis, Climatic variable, Rainfall, Rainy day, Temperature, Q. Q. Plots.

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ABSTRACT

This present study focuses on the climate change, trend and variability in the tarai region of Uttarakhand. The monthly data (January to December) of climatic parameters over a period of 33 years (1981–2013) has been processed, analyzed to detect out trend and variability. Detection of monthly trend and variability is an objective to achieve the goal and observed an increasing trend in maximum and minimum temperature, rain fall, relative humidity and a decreasing trend in rainy days and wind speed. The Statistical analysis indicates a mean increase in maximum temperature is 0.002288o C and minimum temperature a mean increase is 0.03277 o C. Rainfall mean increase about 2.0378 mm over the region; with slightly mean decrease in rainy days is 0.0126 day. The mean relative humidity 712 and 1412 indicates an increase is 0.0555% and 0.0909%. Wind speed indicates slightly mean decrease about 0.0308 km/hour. Pearson's correlation coefficient was applied to measure degree of relationship between mean rainy days and mean rainfall, (January to December) and observed the significant positive correlation 'r' is 0.988.Climatic parameters of tarai region maximum, minimum temperature, rainfall, rainy days, relative humidity 712 , 1412 and wind speed observed fluctuations, variations,an increasing and decreasing trend.

INTRODUCTION

Study of climate change is most important to increase agriculture production, the food for poor peoples, which can have a smile on women's face, because the women's are much affected by the loss of crops, economy of the farmers, which causes deaths of farmers. Agricultural metrological information plays a key role in the decision making process for sustainable agriculture, reduction of natural disaster, heavy rainfall during the period 16th –18th June 2013 in Uttarakhand, caused the flood, loss of lives at a large scale, landslides and damages of properties. The weather variables are the most important physical parameters to study the impact of climate change of a particular region which has emerged as one of the biggest environmental challenges facing the world. Climate change is considered as one of the main environmental problem of the 21st century (Pytrik et.al. 2010). Climate change threatens to reverse the gains achieved in human development as droughts, floods, intermittent rainfall and extremes of temperature, among other variables induced by climate change, compromise potential food and income security (Dervis, 2007). Global warming is likely to cause major changes in various weather variables such as temperature, absolute humidity, precipitation and global solar radiation *etc.* (Mimi *et al.*, 2010).The air temperature indicates climate changes both on global and regional scale, (Jones *et al.*, 1992). The Intergovernmental Panel on Climate Change (IPCC, 2007a) has projected that increase in temperature is expected to be in the range of 1.8 to 4.0°C by the end of 21st Century, for the Indian region (South Asia), the IPCC projected rise in temperature will be 0.5 to 1.2°C by 2020, 0.88 to 3.16°C by 2050 and 1.56 to 5.44°C by 2080, depending on the future human activities (IPCC, 2007b) and the rise in temperature will be higher during the winter season than in the rainy season. Various studies indicated that significant climatic changes are observed over different regions (Sinha *et al.*, 1998a).

Natural variability continues to play a key role in weather; climate change has shifted the odds and changed the natural limits, making certain types of extreme weather more frequent and more intense. The kinds of weather events that would be expected to occur more often in a warming world are indeed increasing. Due to chaotic nature of the atmosphere, the massive computational power is required to predict and forecast atmospheric processes (De, *et al.*, 2005). In the perspective of climate change, it is significant to establish whether, the characteristics of regional weather conditions are also changing. Climate change is affecting the temperature, as well as rainfall patterns in the densely populated regions that would have enormous significance for livelihood and wellbeing of the people of the region. Climate change will have environmental and social impacts that will likely increase uncertainty in water supplies and agricultural production for people across India. The cascading effects of rising temperatures are already affecting water availability, biodiversity, ecosystem boundaries, and global feedbacks (Amin, *et al.*, 2004). The influence of weather and climate on human wellbeing and the inherent impact on the environment are well known. If we know the status of the climate today and the differences between this and recent past, we can begin to plan for the future. There is a need to prepare the people, to anticipate the consequences of climate change and evolve suitable and cost-effective adaptation responses (Tadross, *et al.*, 2005).

Changes in variability could greatly differ from season to season, and were highly dependent upon local physical processes (Gregory and Mitchell, 1995). Karl and Easterling (1999) found that during 1951–1990 global day time and daily mean temperature increased by three times as much by 0.28°C while the night time temperature (daily minimum) temperature increased three times as much by 0.84°C.In other words, the warming in daily minimum is stronger than that of minimum temperature. Rao, Murty and Joshi (2005) analyzed that the extreme weather events, such as high and low temperatures, heavy rain fall in connection with the climate change over India and concluded that during summer 60–70% of the coastal stations are showing an increasing trend in critical extreme maximum day temperature and increased in night temperature.

The aim of present research is to study climate change in tarai region, to detect the trend and variability of climatic parameters, monthly data (January to December) over a period of 33 years (1981–2013). This is an effort to detect the possible monthly trend and variability of maximum, minimum temperature, rainfall, rainy day, relative humidity and wind speed.

METHODOLOGY

Study Area

Meteorological monthly data were collected at Agro-metrological observatory, CRC, G.B.P.U.A.&T., Pantnagar-263145,Uttarakhand which is situated in the southern part of the outer foothill of the Himalaya and located 28°26' N latitude and between 78°53' and 80°0' E longitude. Its altitude above the mean sea level is 243.8 meters. The tarai is a belt of marshy grassland, savannas, and forests. Climate of tarai region is characterized by important monthly variations in temperature as well as rainfall. Winter temperature is too low while, summer

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temperature is very high. The temperature is lowest (2–4°C) in December-January and highest (40–42°C) in May-June. The variability in rainfall within different seasons is greater with high relative humidity throughout the year.

In the present research monthly means of weather parameters viz., maximum, minimum temperature, rainfall, rainy day, relative humidity and wind speed data were collected over a period of 33 years (1981–2013) of tarai region of Uttarakhand and statistical analysis was carried out, application of parametric statistics test, regression analysis, coefficient of determination R^2, Q. Q. Plot or Normal plot for rainfall, trend as general movement of weather parameters over an extended period of time, weather parameters under study were not normally distributed we have calculated median, standard error of median, confidence interval for the above weather parameters.

If the observations are not normally distributed and some data are summarized, then the median $\tilde{x}$ with its standard error $s_{\tilde{x}}$ is stated: $\tilde{x} \pm s_{\tilde{x}}$. Arranging the observations in ascending order, the standard error of median is estimated by [1/3.4641] {[the value of the $(n/2 + \sqrt{3n}/2)^{th}$ observation] – [the value of the $(n/2 - \sqrt{3n}/2)^{th}$ observation]}, with both values round up to the next whole number. If the observations are a random sample, it is better to generalize in giving the confidence interval for median of the population.

Confidence interval (CI) for the median ($\tilde{\mu}$): 95% CI and 99% CI for $\tilde{\mu}$: $n \leq 100$ by means of tables MacKinnon, (1964) above 5% and 1% columns, according to **LB** $\leq \tilde{\mu} \leq 1 +$ **RB** , when populations are not normally distributed. If the n observations, ordered by magnitude, are written as:

$x_{(1)}, x_{(2)}, x_{(3)}, \ldots, x_{(n)}$,then the distribution-free confidence interval for median ,the 95%,and the 99% CI for $\tilde{\mu}$ are given by $x_{(h)} \leq \tilde{\mu} \leq x_{(n-h+1)}$.For $n > 50$ and the confidence probabilities 90%, 95%, and 99% can be approximated by $h = (n - z\sqrt{n-1})/2$,with z = 1.64,1.96 and 2.58 respectively.

RESULTS AND DISCUSSIONS

Table-1 shows monthly variation, in time series over the period of 33 years (1981-2013) of maximum mean temperature, the lowest temperature is 19.624°C in January, highest is 37.28°C in May, an average temperature is 29.7560 °C and observed an average increase rate is 0.00228°C (January to December). Coefficient of variation lowest in August is 2.4109% and highest in February is 23.381%. Monthly maximum temperature data did not follow normal distribution because the skewness, $\gamma_1 \neq 0$ and the kurtosis i.e. $\beta_2 \neq 3$, then median $\tilde{x}$ with its standard error $s_{\tilde{x}}$ and confidence interval (CI) for the median is calculated.

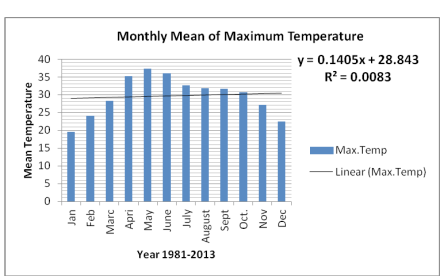

Figure-1:Monthly mean of maximum Temperature

Figure-1 shows regression analysis indicates a trend line for monthly mean of maximum temperature agaist time is increasing, $\beta = 0.1405$, indicates a positive linear relationship between monthly maximum mean temperature and time, the coefficient of determination $R^2 = 0.0083$, indicating only 0.83% variation in maximum temperature monthly time series over the period of 33 years (1981-2013).

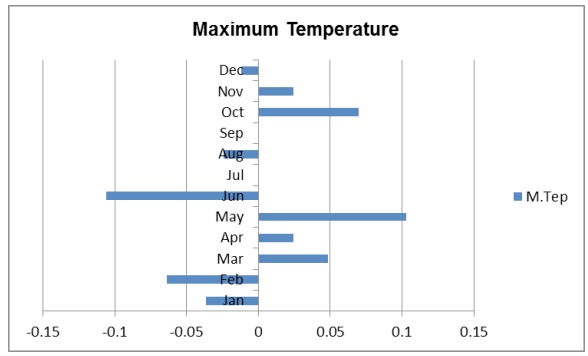

Figure-1(a) Trend of individual month of maximum Temperature

Figure-1(a) Shows a decreasing trend of maximum temperature in month of January, Feburary,June, August and December, an increasing trend, in month of March, April, May, October and November, stable in month of July and September.

Table-1 shows monthly variation, in time series over the period of 33 years (1981-2013), of minimum mean temperature, the lowest temperature is 6.5181°C in January, highest is 25.4969 °C in July, an average temperature is 16.7955°C and observed an average increase rate is 0.03277°C (January to December). Coefficient of variation lowest in August is 1.7398% and highest in January is 16.5877%. Monthly minimum temperature data did not follow normal distribution because the skewness, $\gamma_1 \neq 0$ and the kurtosis i.e. $\beta_2 \neq 3$, then median $\tilde{x}$ with its standard error $s_{\tilde{x}}$ and confidence interval (CI) for the median is calculated.

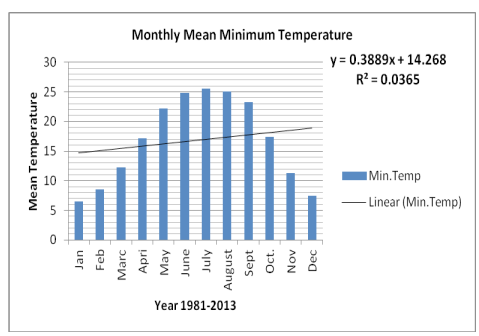

Figure-2 Monthly mean of minimum temperature

Figure-2 shows, regression analysis indicates a trend

line for monthly mean of minimum temperature agaist time is increasing, $\beta = 0.3889$ indicates a positive linear relationship between monthly minimum mean temperature and time the coefficient of determination $R^2 = 0.0365$ indicating only 3.65% variation in minimum temperature, monthly time series over the period of 33 years (1981-2013).

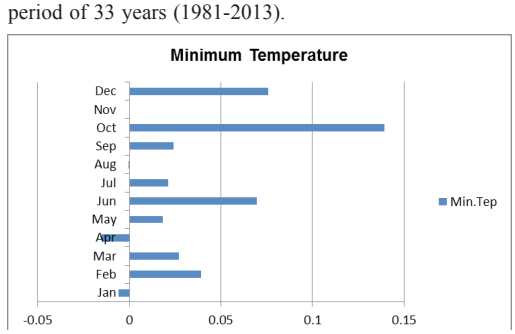

Figure-2(a) Trend of individual month of minimum Temperature

Figure-2(a) Shows a decreasing trend of minimum temperature in the month of January, April, and an increasing trend, in month of Feburary March, May, June, July, September, October, December, Stable in month of August and November.

Table-1, shows monthly variation, in time series over the period of 33 years (1981-2013), of mean rainfall, the lowest rainfall is 4.1575 mm in November, highest is 479.7406mm in August, an average rainfall is 134.7573mm and observed an average increase rate is 2.0378mm (January to December).Coefficient of variation lowest in July is 41.0930% and highest in October is 196.7473 %. Monthly rainfall data did not follow normal distribution because the skewness, $\gamma_1 \neq 0$ and the kurtosis i.e. $\beta_2 \neq 3$, then median $\tilde{x}$ with its standard error $s_{\tilde{x}}$ and confidence interval (CI) for the median is calculated.

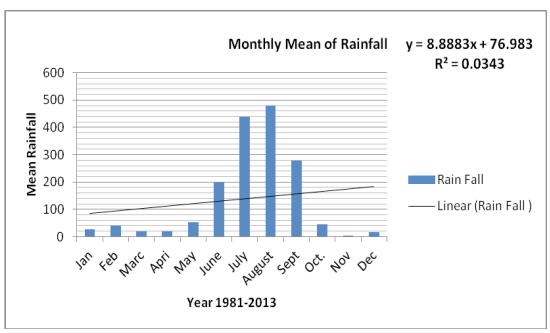

Figure-3 Monthly mean of Rainfall

Figure-3 shows regression analysis indicates a trend line for monthly mean of rainfall agaist time is increasing, $\beta = 8.8883$ indicates a positive linear relationship between monthly rainfall and time,the coefficient of determination $R^2 = 0.0343$,indicating only 3.43% variation in rainfall.

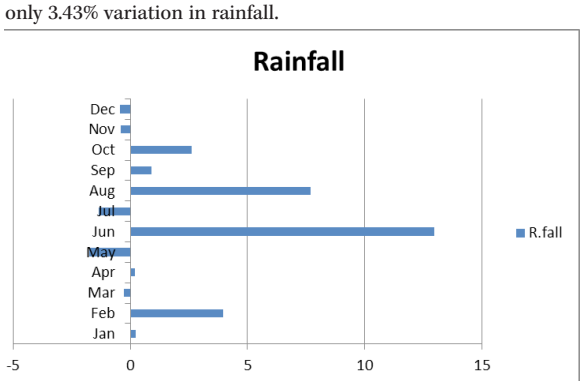

Figure-3(a) Trend of individual month of mean Rainfall

Figure-3(a) Shows individual month trend of mean Rainfall, decreasing trend in the month of March, May, July, Novenber and December and an increasing trend in the month of January, Feburary, April, June, August September and October.

Figure-4 Shows Quantile-Quantile plot, monthly rainfall trend test and observed a thin tail, of time series monthly rainfall over the period of 33 years (1981-2013).

Pearson's correlation coefficient was applied to measure degree of relationship between mean rainy days and mean rainfall, (January to December) at $\alpha = .01$, level of significance (two tailed test) and observed the highly significant positive correlation 'r' is 0.988 and p-value is 0.000.

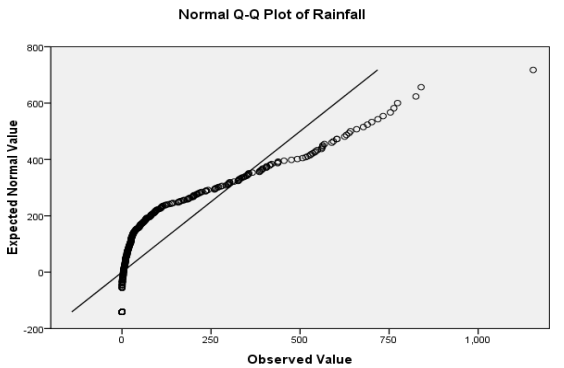

Figure-4 Quantile-Quantile plot for monthly rainfall time series

Table-1 shows monthly variation, in time series over the period of 33 years (1981-2013) of mean rainy day, lowest mean of rainy day is 0.7272 in November, highest is 17.8750 in August an average rainy day is 6.4172 and observed an average decrease rate is 0.01262 day (January to December). Coefficient of variation lowest in August is 19.2095% and highest in November is 138.6669 %. Monthly rainy day data did not follow normal distribution because the skewness, $\gamma_1 \neq 0$ and the kurtosis i.e. $\beta_2 \neq 3$, then median $\tilde{x}$ with its standard error $s_{\tilde{x}}$ and confidence interval (CI) for the median is calculated.

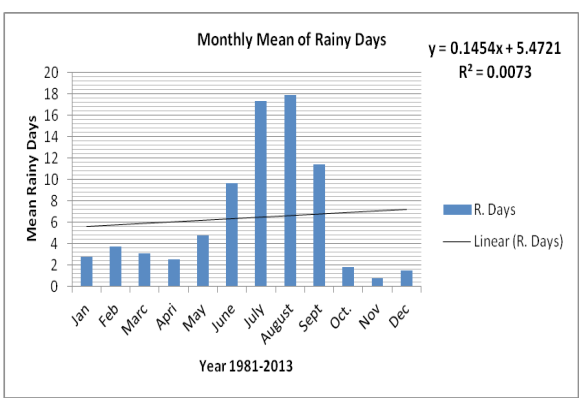

Figure-5 Monthly mean of Rainydays

Figure-5 shows regression analysis indicates a trend line for monthly mean of rainy days agaist time is increasing $\beta = 0.1454$, indicates a positive linear relationship between monthly rainy days and time the coefficient of determination $R^2 = 0.0073$ indicating only 0.73% variation in rainy days monthly time series within the period of 33 years (1981-2013).

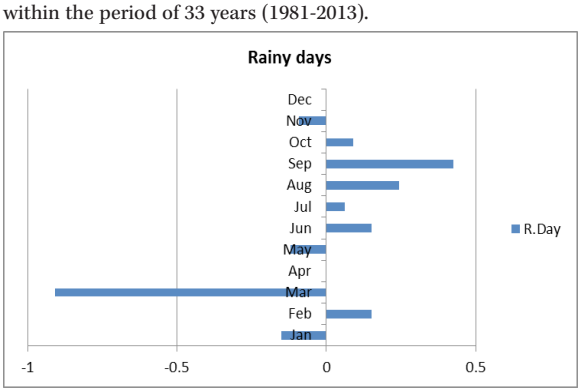

Figure-5(a) Trend of individual month mean of Rainy days

Figure-5(a) Shows individual month , trend of mean of Rainy

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days ,decreasing trend in the month of January, March, May and November and an increasing trend in the month of Feburary, June, July, August, September and October, stable in month of April and December.

Table-1 shows monthly variation, in time series over the period of 33 years (1981-2013) of mean of relative humidity 712 the lowest mean relative humidity is 62.9697% in May and highest is 92.7272% in January and an average humidity is 84.6896% and observed an average increase rate is 0.0555%. Coefficient of variation lowest in January is 2.1275% and highest in June is 9.3514 %. Monthly relative humidity data did not follow normal distribution because the skewness, $\gamma_1 \neq 0$ and the kurtosis i.e. $\beta_2 \neq 3$, then median $\tilde{x}$ with its standard error $s_{\tilde{x}}$ and confidence interval (CI) for the median is calculated.

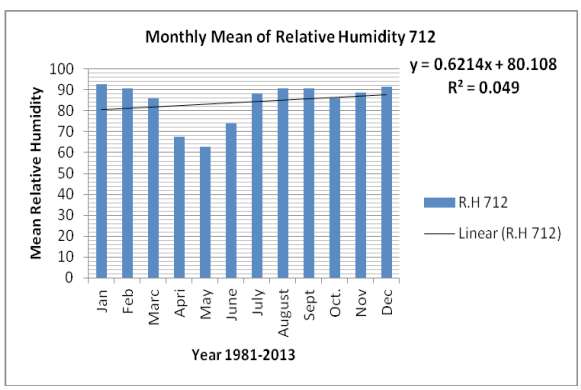

Figure-6 Monthly mean of relative Humidity712

Figure-6 shows regression analysis indicates a trend line for monthly mean of relative humidity 712 agaist time is increasing $\beta = 0.6214$ indicates a positive linear relationship between relative humidity 712 and time the coefficient of determination $R^2 = 0.049$ indicating only 4.9% variation in relative humidity 712 monthly time series over the period of 33 years (1981-2013).

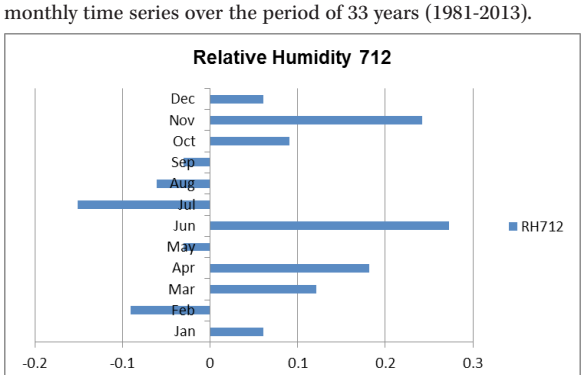

Figure-6(a) Trend of individual month mean of relative Humidity712

Figure-6(a) Shows individual month trend of mean of relative humidity 712 , decreasing trend in the month

of Feburary, May, July, August and September and an increasing trend in the month of January, March, April, June, October, November and December.

Table-1 shows monthly variation, in time series over the period of 33 years (1981-2013),mean of relative humidity 1412 the lowest mean relative humidity is 25.606% in April, highest is 72.8438% in August, an average humidity is 50.1503% and observed an average increase rate is 0.0909%. Coefficient of variation lowest in July is 7.8152% and highest in April is 29.2074 %. Monthly relative humidity data did not follow normal distribution because the skewness, $\gamma_1 \neq 0$ and the kurtosis i.e. $\beta_2 \neq 3$ then median $\tilde{x}$ with its standard error $s_{\tilde{x}}$ and confidence interval (CI) for the median is calculated.

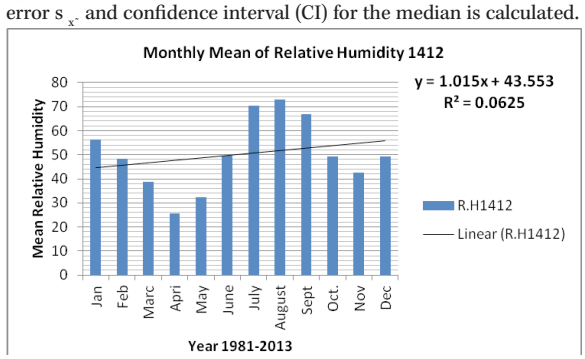

Figure-7 Monthly mean of relative Humidity1412

Figure-7 shows regression analysis indicates a trend line for monthly meanof relative humidity 1412 agaist time is increasing $\beta = 1.015$ indicates a positive linear relationship between monthly relative humidity 1412 and time the coefficient of determination $R^2 = 0.0625$ indicating only 6.25% variation in relative humidity, monthly time series over the period of 33 years (1981-2013).

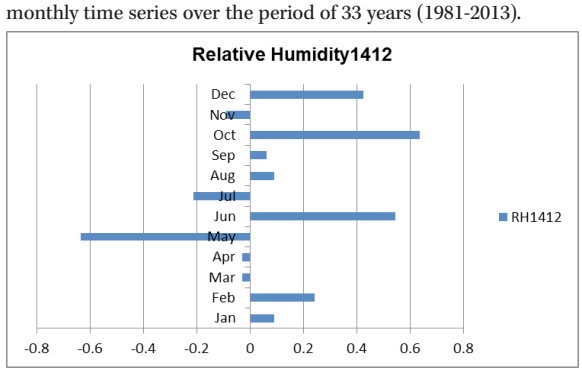

Figure-7(a) Trend of individual month mean of relative Humidity1412.

Figure-7(a)Shows individual month trend of Relative humidity 1412 a decreasing trend in the month of March, April, May, July and November and an increasing trend in the month of January, Feburuary, June, August, September, October and December.

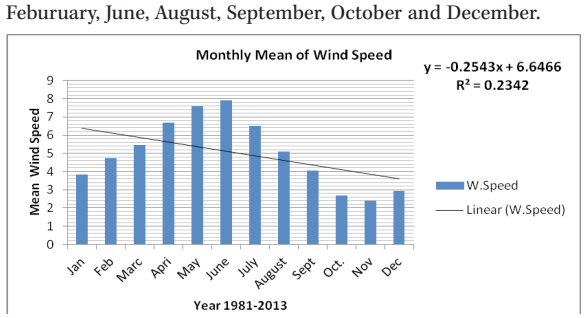

Figure-8 Monthly mean of Wind speed

Table-1 shows monthly variation, in time series over the period of 33 years (1981-2013) mean of Wind speed the lowest Wind speed is 2.3878 km/hour in November, highest is 7.9303km/hour in June, an average Wind speed is 4.9938 km/hour and observed an average decrease rate is 0.03086 km/hour. Coefficient of variation lowest in August is 22.5819% and highest in December is 41.8193 %. Monthly Wind speed data did not follow normal distribution because the skewness, $\gamma_1 \neq 0$ and the kurtosis i.e. $\beta_2 \neq 3$, then median $\tilde{x}$ with its standard error $s_{\tilde{x}}$ and confidence interval (CI) for the median is calculated.

Figure-8 shows regression analysis indicates a trend line for monthly mean of Wind speed agaist time is decreasing $\beta = -$

0.2543 indicates a negative linear relationship between monthly wind speed and time, the coefficient of determination R^2 = 0.2342 indicating only 23.42 % variation in Wind speed, monthly time series over the period of 33 years (1981-2013).

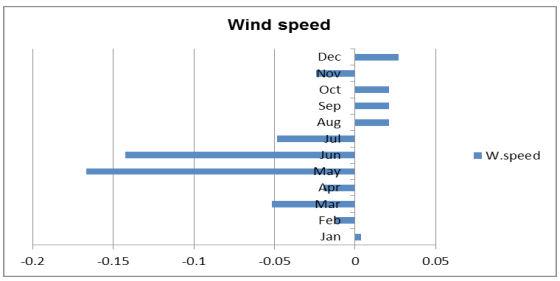

Figure-8(a)Trend for individual month mean of Wind speed

Figure-8(a) Shows individual month trend of mean of Wind speed, decreasing trend in the month Feburary, March, April, May June, July and November and an increasing trend in the month of January, August, September, October and December.

CONCLUSIONS

The maximum, minimum temperature, rainfall, rainy days, relative humidity 712, 1412 and wind speed climatic parameters, observed an increasing and decreasing trend. The Statistical analysis indicates a mean increase in maximum temperature is 0.02288 ° C and minimum temperature a mean increase is 0.03277 ° C. Rainfall mean increase about 2.0378 mm over the region; with slightly mean decrease in rainy days is 0.0126 day. The mean relative humidity 712 and 1412 indicates an increase is 0.0555% and 0.0909% .Wind speed indicates slightly mean decrease about 0.0308 km/hour. Pearson's correlation coefficient was applied to measure degree of relationship between mean rainy days and mean rainfall and observed the significant positive correlation 'r' is 0.988. Climatic parameters, monthly (January to December) maximum, minimum temperature, rainfall, rainy days, relative humidity 712, 1412 and wind speed observed fluctuations, variations, an increasing and decreasing trend in tarai region of Uttarakhand.

Table 1: Monthly Statistical analysis of weather parameters over a period of 33 years (1981-2013)

Month January Statistics 1981-2013											
Weather parameters	Mean $\bar{X}$	σ	C.V. %	Median $\tilde{x}$	Standard error $\bar{x} \pm S_{\bar{x}}$	95% CI for Median LB ≤ μ̃ ≤ 1+RB	Skewness	Kurtosis	Range	Minimum	Maximum
Max Temp.	19.6242	1.71045	8.7160	20.1000	20.1 ± 1	19.0 ≤ 20.1 ≤ 20.4	-1.046	1.127	7.80	14.50	22.30
Min Temp.	6.51818	1.08121	16.587	6.6000	6.6 ± 1	5.9 ≤ 6.6 ≤ 6.9	0.53	1.954	5.60	4.30	9.90
R.H.712	92.7272	1.97282	2.1275	92.0000	92.00 ± 1	92 ≤ 92 ≤ 93	-0.374	0.701	9.00	87.00	96
R.H.1412	56.4242	8.00402	14.185	56.000	56 ± (-3)	52 ≤ 50 ≤ 60	0.345	0.34	35.00	41.00	76
Rain Fall	27.8909	28.0392	100.53	22.6000	28.03 ± 11	3.8 ≤ 20.6 ≤ 29.6	0.995	0.100	97.60	.00	97.60
Rainy days	2.7575	2.0771	75.323	2.0000	2.00 ± 1	1≤ 2.00 ≤ 4	0.412	-0.786	7.00	.00	7.00
W. Speed	3.84242	1.02439	26.660	3.9000	3.90 ± 1	3.6 ≤ 3.9 ≤ 4.1	0.306	0.876	4.80	1.40	6.20
Month February Statistics 1981-2013											
Weather parameters	Mean $\bar{X}$	σ	C.V. %	Median $\tilde{x}$	Standard error $\bar{x} \pm S_{\bar{x}}$	95% CI for Median LB ≤ μ̃ ≤ 1+RB	Skewness	Kurtosis	Range	Minimum	Maximum
Max Temp.	24.0757	5.62933	23.381	23.100	23.10 ± 1	22.3 ≤ 23.1 ≤ 23.8	5.221	28.88	33.50	21.00	54.50
Min Temp.	8.57878	1.23510	14.397	8.7000	8.70 ± 1	8.2 ≤ 8.7 ≤ 9.0	-0.050	0.509	5.80	5.70	11.50
R.H.712	90.8787	2.23267	2.4567	91.0000	91.00 ± (-1)	90 ≤ 91 ≤ 93	0.054	0.063	10.00	86.00	96.00
R.H.1412	48.2424	6.33951	13.140	50.000	50.0 ± 2	46 ≤ 50 ≤ 52	-0.632	-0.315	24.00	34.00	58.00
Rain Fall	40.4030	48.0479	118.92	19.50	19.50 ± 13	10.3 ≤ 19.5≤ 41.4	1.361	0.795	160	.00	160
Rainy days	3.7272	2.7188	72.944	3.00	3.00 ± 1	2 ≤ 3.00 ≤ 5	1.012	1.347	12	.00	12
W. Speed	4.73636	1.52926	32.287	4.5000	4.50 ± 1	4.0 ≤ 4.5≤ 5.0	2.117	7.278	8.10	2.80	10.90
Month March Statistics 1981-2013											
Weather parameters	Mean $\bar{X}$	σ	C.V. %	Median $\tilde{x}$	Standard error $\bar{x} \pm S_{\bar{x}}$	95% CI for Median LB ≤ μ̃ ≤ 1+RB	Skewness	Kurtosis	Range	Minimum	Maximum
Max Temp.	28.2639	1.99653	7.0639	28.7000	28.70 ± 1	27.7 ≤ 28.7 ≤ 29.1	-1.281	3.471	10.40	21.30	31.70
Min Temp.	12.2606	0.90240	7.3602	12.4000	12.40 ± 1	11.8 ≤ 12.4 ≤ 12.6	0.104	-0.574	3.60	10.70	14.30
R.H.712	86.0030	3.08630	3.5886	86.000	86.00 ± 1	85 ≤ 86≤ 88	-0.758	0.388	13.00	78.00	91.00
R.H.1412	38.6030	5.99585	15.532	37.000	37.00 ± 2	36 ≤ 37 ≤ 41	0.125	-0.293	25.00	28.00	51.00
Rain Fall	18.3787	23.4463	127.57	8.200	8.20 ± 6	3.4 ≤ 8.2 ≤ 22	1.778	2.806	89.60	.00	89.60
Rainy days	3.0606	2.5852	84.469	3.00	3.00 ± 1	1 ≤ 3.00 ≤ 3	1.107	1.394	11.00	.00	11.00
W. Speed	5.46060	1.99936	36.614	5.3000	5.30 ± 1	4.5 ≤ 5.3 ≤ 6.3	1.674	6.519	11.70	1.60	13.30

Month April Statistics 1981-2013											
Weather parameters	Mean $\bar{X}$	σ	C.V. %	Median $\tilde{x}$	Standard error $\bar{x} \pm S_{\bar{x}}$	95% CI for Median LB ≤ $\tilde{\mu}$ ≤ 1+RB	Skewness	Kurtosis	Range	Minimum	Maximum
Max Temp.	35.1484	1.80349	5.1310	35.2000	35.20 ± 1	34.8 ≤ 35.2 ≤ 35.7	-0.594	2.039	9.10	30.00	39.10
Min Temp.	17.1000	1.10989	6.4906	17.1000	17.10 ± 1	16.7 ≤ 17.1 ≤17.6	-0.060	-0.150	4.70	14.40	19.10
R.H.712	67.5757	4.87359	7.2120	68.000	68.00 ± 2	66 ≤ 68 ≤ 70	-0.22	0.213	22.00	58.00	80.00
R.H.1412	25.6060	7.47888	29.207	23.000	23.00 ± 2	21≤ 23 ≤ 28	1.46	3.387	40.00	12.00	52.00
Rain Fall	18.4848	22.8221	123.46	10.00	10.00 ± 4	5.8≤ 10.0 ≤ 18	1.795	2.510	83.20	.00	83.20
Rainy days	2.4848	1.9222	77.359	2.00	2.00 ± 1	2 ≤ 2.00 ≤ 3	1.275	2.941	9.00	.00	9.00
W. Speed	6.7000	2.09284	31.236	6.6000	6.60 ± 1	6.0 ≤ 6.6 ≤ 7.2	1.399	4.230	10.80	3.40	14.20
Month May Statistics 1981-2013											
Weather parameters	Mean $\bar{X}$	σ	C.V. %	Median $\tilde{x}$	Standard error $\bar{x} \pm S_{\bar{x}}$	95% CI for Median LB ≤ $\tilde{\mu}$ ≤ 1+RB	Skewness	Kurtosis	Range	Minimum	Maximum
Max Temp.	37.2878	1.53658	4.1208	37.1000	37.10 ± 1	36.6 ≤ 37.1 ≤ 38.1	0.165	-0.96	5.20	34.80	40.00
Min Temp.	22.2181	1.68438	7.5811	22.7000	22.70 ± 1	21.6 ≤ 22.7 ≤ 23.2	-0.784	1.757	8.70	17.10	25.80
R.H.712	62.9697	5.65400	8.9789	63.000	63.00 ± 2	61 ≤ 63 ≤ 66	-0.334	0.16	24.00	49.00	73.00
R.H.1412	32.4242	8.98968	27.725	32.000	32.00 ± 3	28 ≤ 32 ≤ 36	-0.749	3.255	51.00	2.00	53.00
Rain Fall	53.3151	62.2734	116.80	37.2000	37.20 ± 10	25.4 ≤ 37.2 ≤ 58.4	2.950	11.229	325.8	.00	325.80
Rainy days	4.7272	2.8092	59.427	5.00	5.00 ± 1	4 ≤ 5.00 ≤ 6	0.054	-0.324	11.00	.00	11.00
W. Speed	7.58484	2.54486	33.551	7.9000	7.90 ± 1	7.1≤ 7.9 ≤ 9.0	-1.059	1.855	12.60	.00	12.60
Month June Statistics 1981-2013											
Weather parameters	Mean $\bar{X}$	σ	C.V. %	Median $\tilde{x}$	Standard error $\bar{x} \pm S_{\bar{x}}$	95% CI for Median LB ≤ $\tilde{\mu}$ ≤ 1+RB	Skewness	Kurtosis	Range	Minimum	Maximum
Max Temp.	36.0273	2.23764	6.2109	36.3000	36.30 ± 1	35.2 ≤ 36.3 ≤ 37.4	-0.092	-0.950	8.10	32.00	40.10
Min Temp.	24.8181	0.68713	2.7686	24.9000	24.90 ± 1	24.5≤ 24.9 ≤ 25.2	-0.312	-0.368	2.70	23.30	26.00
R.H.712	73.9393	6.91438	9.3514	75.000	75.00 ± 3	73 ≤ 75 ≤ 77	-0.310	-0.801	24.00	62.00	86.00
R.H.1412	49.5757	12.8938	26.008	49.000	49.00 ± 3	45 ≤ 49 ≤ 53	0.269	1.047	66.00	19.00	85.00
Rain Fall	196.936	151.635	76.997	163.800	163.80 ± 35	108.6≤163.8≤212.2	1.582	2.114	589.2	14.20	603.40
Rainy days	9.6363	4.1217	42.772	9.00	9.00 ± 1	9 ≤ 9.00 ≤ 10	0.308	-0.210	17.00	2.00	19.00
W. Speed	7.93030	2.14468	27.044	8.000	8.00 ± 1	7.2≤ 8.0 ≤ 8.9	-1.356	4.848	12.10	.00	12.10

Month July Statistics 1981-2013											
Weather parameters	Mean $\bar{X}$	σ	C.V. %	Median $\tilde{x}$	Standard error $\bar{x} \pm S_{\bar{x}}$	95% CI for Median LB ≤ $\tilde{\mu}$ ≤ 1+RB	Skewness	Kurtosis	Range	Minimum	Maximum
Max Temp.	32.6333	1.04453	3.2008	32.4000	32.40 ± 1	32.1 ≤ 32.4 ≤32.9	0.774	0.242	4.50	30.60	35.10
Min Temp.	25.4969	0.68350	2.6807	25.4000	25.40 ± 1	25.1 ≤ 25.4 ≤ 25.7	1.071	2.053	3.40	24.30	27.70
R.H.712	88.4242	3.19208	3.6099	89.000	89.00 ± 1	87 ≤ 89 ≤ 90	-0.259	0.170	14.00	81.00	95.00
R.H.1412	70.4545	5.50619	7.8152	71.000	71.00 ± 2	69 ≤ 71 ≤ 74	-0.245	0.323	25.00	58.00	83.00
Rain Fall	439.690	180.682	41.093	394.200	394.20 ± 73	335≤ 394.2 ≤ 521.8	0.462	-0.401	750.8	89.20	840.00
Rainy days	17.363	4.1968	24.170	18.00	18.00 ± 1	17 ≤ 18.00 ≤ 19	-1.447	3.388	21.00	4.00	25.00
W. Speed	6.51818	1.74775	26.813	6.3000	6.30 ± 1	6 ≤ 6.3 ≤ 7.1	-0.034	1.969	9.10	2.40	11.50
Month August Statistics 1981-2013											
Weather parameters	Mean $\bar{X}$	σ	C.V. %	Median $\tilde{x}$	Standard error $\bar{x} \pm S_{\bar{x}}$	95% CI for Median LB ≤ $\tilde{\mu}$ ≤ 1+RB	Skewness	Kurtosis	Range	Minimum	Maximum
Max Temp.	31.9000	0.76622	2.4019	31.9000	31.90 ± 1	31.6 ≤ 31.9 ≤ 32.3	-0.335	0.433	3.50	30.10	33.60
Min Temp.	25.0750	0.43626	1.7398	25.2000	25.20 ± 1	25 ≤ 25.2 ≤ 25.3	-2.356	8.004	2.30	23.30	25.60
R.H.712	90.6250	1.99596	2.2094	90.000	90.00 ± 1	89 ≤ 90.0 ≤ 92	0.144	-1.004	7.00	87.00	94.00
R.H.1412	72.8438	3.29329	4.5210	72.000	72.00 ± 2	71 ≤ 72.0 ≤ 74	0.390	0.269	15.00	66.00	81.00
Rain Fall	479.740	198.580	41.393	465.000	465.00 ± 56	385.8≤ 465 ≤541.2	1.320	3.125	954.8	199.80	1154.60
Rainy days	17.8750	3.43370	19.209	18.00	18.00 ± 2	15 ≤ 18.00 ≤ 19	0.169	-0.51	12.00	12.00	24.00
W. Speed	5.1063	1.15310	22.581	5.000	5.00 ± 1	4.7 ≤ 5 ≤ 5.4	1.070	4.517	6.70	2.50	9.20

Month September Statistics 1981-2013											
Weather parameters	Mean $\bar{X}$	σ	C.V. %	Median $\tilde{x}$	Standard error $\bar{x} \pm S_{\bar{x}}$	95% CI for Median LB ≤ μ̃ ≤ 1+RB	Skewness	Kurtosis	Range	Minimum	Maximum
Max Temp.	31.6844	0.79357	2.5046	31.8000	31.80 ± 1	31.4 ≤ 31.8 ≤ 32.1	-0.432	-0.259	3.20	29.90	33.10
Min Temp.	23.3187	0.63826	2.7374	23.4000	23.40 ± 1	31.4 ≤ 23.40 ≤ 32.1	-0.625	0.048	2.70	21.60	24.30
R.H.712	90.5625	2.50081	2.7614	90.5000	90.500 ± 1	89 ≤ 90.50 ≤ 91	0.192	-0.518	10.00	86.00	96.00
R.H.1412	66.8125	5.72734	8.7522	68.000	68.00 ± 1	65 ≤ 68.00 ≤ 68	-1.251	3.436	29.00	47.00	76.00
Rain Fall	277.646	196.680	70.838	220.6000	220.60 ± 84	183 ≤ 220.6 ≤271.6	1.056	0.298	736.0	27.00	763.60
Rainy days	11.3750	4.79751	42.154	10.00	10.00 ± 2	9 ≤ 10.00 ≤ 12	0.641	0.319	20.00	3.00	23.00
W. Speed	4.0469	1.18892	29.378	3.8500	3.85 ± 1	3.4 ≤ 3.85 ≤ 4.6	0.106	3.295	6.50	1.60	8.10

Month October Statistics 1981-2013											
Weather parameters	Mean $\bar{X}$	σ	C.V. %	Median $\tilde{x}$	Standard error $\bar{x} \pm S_{\bar{x}}$	95% CI for Median LB ≤ μ̃ ≤ 1+RB	Skewness	Kurtosis	Range	Minimum	Maximum
Max Temp.	30.7272	1.05808	3.4434	30.9000	30.90 ± 1	30.4 ≤ 30.9 ≤ 31.3	-0.878	0.092	4.50	28.10	32.60
Min Temp.	17.3969	1.11144	6.3887	17.4000	17.40 ± 1	30.4 ≤ 30.9 ≤ 31.3	0.233	-0.437	4.60	15.20	19.80
R.H.712	86.0606	3.50837	4.0766	87.000	87.00 ± 1	85 ≤ 86 ≤ 87	-0.026	1.877	19.00	77.00	96.00
R.H.1412	49.2121	6.98551	14.194	48.000	48.00 ± 2	45≤ 48≤ 52	0.311	-0.165	29.00	37.00	66.00
Rain Fall	44.7454	88.0354	196.74	4.4000	4.40 ± 9	0 ≤ 4.4 ≤ 24.4	2.477	5.592	354.2	0.00	354.20
Rainy days	1.8181	2.113	116.22	1.00	1.00 ± 1	0 ≤ 1.00 ≤ 3	1.121	0.823	8.00	0.00	8.00
W. Speed	2.67878	0.64505	24.080	2.7000	2.70 ± 1	2.3 ≤ 2.7 ≤ 2.8	0.176	-0.425	2.60	1.40	4.00
Month November Statistics 1981-2013											
Weather parameters	Mean $\bar{X}$	σ	C.V. %	Median $\tilde{x}$	Standard error $\bar{x} \pm S_{\bar{x}}$	95% CI for Median LB ≤ μ̃ ≤ 1+RB	Skewness	Kurtosis	Range	Minimum	Maximum
Max Temp.	27.1606	0.79762	2.9367	27.3000	27.30 ± 1	26.9 ≤ 27.3 ≤ 27.6	-1.040	1.531	3.60	24.70	28.30
Min Temp.	11.2939	1.00559	8.9038	11.1000	11.10 ± 1	10.7 ≤ 11.10 ≤ 11.8	0.512	-0.132	4.20	9.50	13.70
R.H.712	88.5757	2.69293	3.0402	89.000	89.00 ±1	86 ≤ 89.00 ≤ 90	-0.630	1.493	14.00	81.00	95.00
R.H.1412	42.4848	6.60076	15.536	42.000	42.00 ± 3	38≤ 42.00 ≤ 44	1.055	2.101	31.00	33.00	64.00
Rain Fall	4.15757	7.78745	187.30	.0000	.0000	0 ≤ 0 ≤ 1.2	2.117	3.797	29.20	.00	29.20
Rainy days	0.7277	1.0084	138.66	.0000	.00 ± 1	0 ≤.00 ≤1	1.177	0.192	3.00	.00	3.00
W. Speed	2.38787	0.81691	34.210	2.3000	2.30 ± 1	1.9 ≤ 2.30 ≤ 2.8	0.545	0.577	3.80	0.70	4.50
Month December Statistics 1981-2013											
Weather parameters	Mean $\bar{X}$	σ	C.V. %	Median $\tilde{x}$	Standard error $\bar{x} \pm S_{\bar{x}}$	95% CI for Median LB ≤ μ̃ ≤ 1+RB	Skewness	Kurtosis	Range	Minimum	Maximum
Max Temp.	22.5393	1.21164	5.3756	22.7000	22.70 ± 1	22.2 ≤ 22.7 ≤ 23.1	-1.870	5.774	6.30	17.90	24.20
Min Temp.	7.47121	1.04036	13.924	7.6000	7.60 ± 1	7.0 ≤ 7.6 ≤ 8.0	-0.138	0.978	5.00	4.90	9.90
R.H.712	91.4242	4.00023	4.3754	92.000	92.00 ± 1	91≤ 92 ≤ 93	-4.368	22.421	24.00	71.00	95.00
R.H.1412	49.1212	7.61477	15.502	47.000	47.00 ± 3	44 ≤ 47≤ 53	0.885	0.576	32.00	38.00	70.00
Rain Fall	15.6969	24.0981	153.52	9.000	9.00 ± 6	0 ≤ 9.0 ≤ 14.8	2.299	5.390	94.00	0.00	94.00
Rainy days	1.4545	1.6219	111.50	1.00	1.00 ± 1	0 ≤ 1.00 ≤ 2	1.116	0.756	6.00	0.00	6.00
W. Speed	2.93333	1.2267	41.819	2.7000	2.70 ± 1	2.3≤ 2.7 ≤ 3.1	1.006	0.860	5.00	1.10	6.10

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