Journal of Agrometeorology 18 (2) : 339-341 (December 2016)

Short Comminucation

Rainfall trend analysis and its possible implication on rainfed agriculture in Agra, Uttar Pradesh

K.K.SHARMA*, A.K.SINGH and S.K.DUBEY

ICAR-Indian Institute of Soil and Water Conservation, Research Centre, Chhalesar, Agra-282006, U.P. India

**E-mail:kks8498@rediffmail.com*

The rainfall is one of the important factors deciding success of rainfed agriculture of the particular agro-ecological region where the major part of the precipitation is rainfall. The productivity of the rainfed area is very low and uncertain due to total dependency on monsoon as compared to irrigated area. Crop growth and yield will be affected by the amount of rainfall received during the period and its distribution. Detailed knowledge of the rainfall pattern helps in planning crop calendar and designing ofdifferent soil and water conservation structures including water harvesting structures to meet out irrigation requirement during drought periods. The livelihood and socio- economic activities of people in the Agra region of Uttar Pradesh are heavily dependent on the rainfall pattern because of mainly rainfed agriculture. Region is facing severe water scarcity problem because of multiple regions like erratic rainfall, undulating topography, limiting soil depth, *etc.*Rainfall trends in response to climate change and probability analysis have been studied by various researchers (Singh and Kumar, 2016, Jayawardene *et al*., 2005; Kumar and Jain , 2010; Manikandan and Tamilmani, 2012,Patra and Kahya, 2006) and they have emphasized that the knowledge of location specific rainfall variations is essential for proper water harvesting and water management practices.A trend of increasing monsoon seasonal rainfall has been found along the west coast, northern Andhra Pradesh, and north western India (+10 % to +12 % of the normal over the last 100 years) while a trend of decreasing monsoon seasonal rainfall has been observed over eastern Madhya Pradesh, North- eastern India, and some parts of Gujarat and Kerala (6 to 8 % of the normal over the last 100 years). A comprehensive knowledge of the trend and persistence in rainfall of the area is great importance because of economic implications of rain sensitive operations (Sharma *et al.,* 2015, Jakhar *et al.* 2011). Keeping above in view, the present study has been conducted to analyze rainfall trend of long – term historical data of Agra district of UttarPradesh using parametric approaches.

This study was conducted at ICAR- Indian Institute of Soil and Water Conservation (ICAR-IISWC), Research Centre, Agra located between 27^0 10" north latitude and $78^0$02" east longitude at 168 m above mean sea level. Climate of the region is characterized as semi- arid with average annual rainfall around 650 mm Temperature ranged from 48.3^0C in the month of May-June to – 0.4 ^{0}C during December – January. Daily rainfall data of 51 years for the period 1965 to 2015 were collected from the meteorological observatory at research farm of ICAR-IISWC, research centre, Chhalesar, Agra, Uttar Pradesh. Monthly, seasonal *viz. kharif* (June – September*), rabi* (October – February) and summer (March – May) and annual rainfall data were computed from daily rainfall data. Annual, seasonal and monthly rainfalldata were also workout for trend analysis.Statistical parameters such as mean, median, standard deviation, range, coefficient of variation, skewness and kurtosis of these rainfalls were also calculated.

Linear regression analysis is a parametric model and one of the most commonly used methods to detect a trend in a data series. This model develops a relationship between two variables (dependent and independent) by fitting a linier equation to the observed data. The data is first checked whether or not there is relationship between the variables of interest. This can be done by using the scatter plot. If there appears no association between the two variable , linear regression model will not prove a useful model. A numerical measure of this association between the variables is the correlation coefficient , which range between -1 to +1. A correlation coefficient value of $\pm$ 1 indicates a perfect fit. A value near zero means that there is a random, nonlinear relationship between the two variables. The linear regression model is generally described by the following equation:

$$Y = m X + C$$

Where, Y is the dependent variable, X is the independent variable, m is the slope of the line and C is the intercept constant. The coefficient (m and C) of the model

Table1: Statistical properties of monthly, seasonal and annual rainfall at Agra

Rainfall/Rainy days series	Mean (mm)	CV (%)	Skewness	Kurtosis	Regression slope	Trend at 5% Significance level
Jan	10.3	124	1.67	3.76	-0.191	No trend
Feb	12.7	128	1.51	1.70	0.146	No trend
Mar	9.6	176	2.73	8.49	0.361	Rising
Apr	7.6	187	2.40	5.18	0.072	No trend
May	16.2	30	1.69	2.45	0.171	Rising
Jun	65.7	112	2.32	6.78	0.017	No trend
Jul	199.1	58	0.83	0.45	-0.225	No trend
Aug	210.4	56	0.27	0.79	-2.938	Falling
Sep	101.3	76	0.81	0.00	-0.541	No trend
Oct	28.4	149	1.76	2.52	0.129	No trend
Nov	4.8	271	3.04	9.00	-0.124	No trend
Dec	5.7	202	3.00	9.93	0.164	No trend
Annual R*	671.6	32	0.43	0.13	-3.165	Falling
Kharif R,	576.4	36	0.27	0.22	-3.688	Falling
Rabi R,	61.8	72	1.31	2.18	0.124	No trend
Summer R,	35.6	93	1.58	2.87	0.605	No trend

*R- Rainfall,

are determined using the least – squares method, which is the most commonly used method. The t – test was used to determine whether thelinear trends are significantly different from zero at the 5 % significance level.

The average annual rainfall (51 years) of the region was 671.6 mm which ranged from241.4 to 1235.1 mm. It was estimated that about 86.6 % of annual rainfall received during monsoon season (June to September). The average seasonal rainfall during *kharif, rabi* and summer were worked out to be 576.4 mm (85.55 %), 61.8 mm(9.16 %) and 35.6 mm (5.29 %) respectively. Mean, coefficient of variation, skewness and kurtosis for monthly, seasonal and annual werecomputed and given in (Table 1). It is clear from the table that CV of rainfall is lowest during annual rainfall (32%)followed by *kharif* (36 %) *rabi* (72%) and summer (93%) season rainfall. It showed that more uniform rainfall received during *kharif* season results in assured cropgrowth without any supplemental irrigation. However, during *rabi* and summer, farming needs assured irrigation. The skewness data for monthly rainfall varied from 0.27 to 3.04. The monthly rainfall data showed positive skewness and shows that the data are right skewed. The Kurtosis of monthly rainfall varied from 0.00 to 9.93. Positive kurtosis shows a peaked distribution that means monthly rainfall data had peaked distribution during monsoon period. Similarly, skewness and kurtosis data of annual and seasonal time series showed positive data.

The average annual rainy days wasfound to be 37.8 and ranged between 15 to 55 days. Out of these, 28.98 rainy days occurred during monsoon season and 4.16 and 2.78 were respectively in *rabi* and summer season. The mean, coefficient of variation, skewness , kurtosis of rainy days showed high variability in *rabi* and summer season that the *kharif* season.The skewness data of rainy days varied from 0.16 to 0.79 and are right skewed. The Kurtosis data varied from -0.38 to 0.42 and showed peaked (positive kurtosis value) and flat distribution (negative kurtosis value).

The trend of different time series of rainfall was analyzed using linear regression method and values of regression slopes are given in Table 1. The monthly, seasonal and annual variation of rainfall revealed that rainfall of June month is showing increasing trend whereas month of July, August and September showing decreasing trend of monthly rainfall. The regression slope of August month rainfall was found very high which showed significant reduction in rainfall. It was found that month of October, December and February showed increasing trend whereas November and January decreasing trend of monthly rainfall. Moreover it was also evident that in all months from March, April and May, the rainfall showed increasing trend. This is something interesting to note for planning soil and water conservation measure including water harvesting and also for planning irrigation to summer crops. The time series data of seasonal and annual rainfall showed that annual and *kharif* (monsoon) rainfall is decreasing over the year whereas *rabi* and summer season rainfall showed increasing trend. The regression slope of annual and monsoon rainfall are almost close and have same pattern.

Test of significance (t-test) at 5 % significance level was carried out on the regression slopes for the cases studied. The falling trend of August month rainfall and rising trend of March and May month rainfall was found to be significant when analyzed the trend of monthly rainfall in Agra region. Moreover, annual and monsoon season rainfall and rainy days were also found to be decreasing at 5% significant level when data were analyzed on seasonal basis. In all other cases, no significant rising or falling trend was detected. Study revealed that month of August is very critical for *kharif* crop point of view in this region and rainfall of this particular month is decreasing significantly, hence there is need to harvest more rainfall of July month through construction of different in-situ and ex-situ water conservation and storage structures. This stored water can be useful for providing life saving irrigations during long dry spells because the numbers of rainy days were also found to be reduced significantly during monsoon season. Moreover, farmers need to make some changes in their cropping pattern to cope with changing rainfall pattern like switching over to less water demanding crops, such as pulse, millets etc. Another interesting finding of the study is that the rainfall of month of May has increased significantly, which means that farmers can take more vegetables, fodder crops and summer moong crop during summer seasonutilizing this very effective May month rainfall. Even, rain water can also be harvested during this period for recycling.

ACKNOWLEGEMNET

The authors are thankful to Dr. P.K. Mishra, Director, ICAR-IISWC,Dehradun for his encouragement and also to Sri B.P. Joshi, Technical Officer, ICAR-IISWC, Research Centre, Agra for his sincerity in taking data and maintaining them properly.

REFERENCES

Jakhar, P., Gowda, H.C.H., Naik, B.S. and Barman, D. (2011). Probability analysis of rainfall characteristics of Semiliguda in Koraput, Orissa. *Ind. J. Soil Cons.,* 39 (1): 9-13.

Jayawardene, H.K.W.I., Sonnadar, D.U.J. and Jayawardene, D.R. (2005). Trends of rainfall in Sri Lanka over the last century. *Sri Lanka J. Phy.,* 6:7-17.

Kumar, V. and Jain, S.K. (2010) Rainfall trends in Ganga – Brahmputra-Meghna river basins of India. *J. Hydrol.,* 33:59-66.

Manikandan, M. and Tamilmani, D. (2012). Statistical analysis of special pattern of rainfall trends in ParambikualamAliyar sub basin, Tamilnadu. *Ind. Water Resours. Soc., 32(1-2):*40-49

Parta, T. and Kahya, E. (2006) Trend analysis in Turkishh precipitation data. *Hydrol. Process*. 20 :2011-2026

Sharma, K.K., Singh, A.K. and Dubey, S.K. (2015). Analysis of one day probable maximum precipitation for designing soil and water conservation structures in Agra, U.P.*J. Agromet.*, 17(2):268-270.

Singh, S. and Kumar, S. (2016). Trend analysis of rainfall of Sagardistrict , Madhya Pradesh. *Ind. J. Soil Cons.,* 44(1):44-49.

Received :August 2016; Accepted: October 2016