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AN ANALYSIS OF SOME IMPORTANT CHARACTERISTICS OF RAINFALL IN MANIPUR

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Abstract

This research paper seeks to explain some important phenomena of rainfall in Manipur. This important phenomenon of rainfall includes the variation of rainfall, rainy days, rainfall intensity and their trends from 1950 to 2010. Variation of rainfall, rainy day and intensity are found to occur highly significant in the state. The trends of rainfall, rainy day and intensity have displayed their highly fluctuated pattern. Except rainy day, the two other above mentioned rainfall phenomena are shown their trends insignificantly decrease. Most of the years during the stipulated time period have received around 1500mm of rainfall. This fluctuation in rainfall is the main cause of floods and droughts.

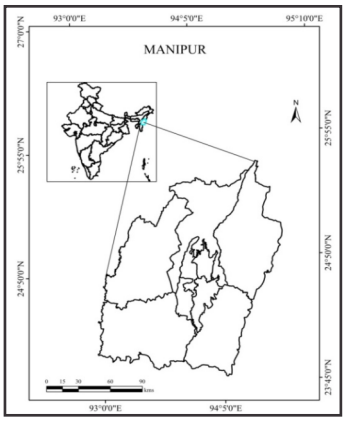
Key words: *Rainfall, Rainy day, intensity, error bar, trend.*

Introduction :

Precipitation stands one of the most important elements to determine weather and climate of a region. According to the primary mode of uplift of the air three main types of precipitation exist, convectional, orographic and cyclonic or frontal (Roger Bery G. etal, 2003)

About 80 percent of rainfall for the whole India is contributed by the summer monsoon. Thus it is a very important source of water in India. Most studies during the last four decades have clearly shown that monsoon rainfall becomes trendless, that means, very random in nature all over the India (KhullarDv.R. et al, 2003).. The amount of monsoon rain is affected by warm and dry wind from north western part, tropical cyclones which can influence up to eastern Uttar Pradesh (Katiyar V.S., 1990). The onset of the monsoon varies according to year and region. It is said that the history of rainfall in India is really history of South West Monsoon. Subrahmanyam V.P., 1983 opined,. The north east region of India enjoys typical monsoonal climate with ranging from tropical to temperate conditions. The rapid changes of topography overhereare responsible for the climatic variations within short distances (Singh R.L., 1998).

For a small area-system, precipitation is one of the most vital weather elements (Cauchlive, King A.M., 1980. The study of rainfall variability can indicate the variability of rainfall in long-run in a particular place (SourabhBal and M. Bore, 2010). In India the heavy precipitation in summer monsoon is said to herald over Kerela on 1 June with a standard deviation of about 8 days.



The behavior of south Asian summer monsoon and its variability have been analysed by Achuthavarier, D. et al (2011). Somescholars such asAnnuamadei, H. and Slingo J.M.(2001) study about the intra-seasonal variation of the Asian summer monsoon. Thus, fluctuation of amount of rainfall and its intensity have been diagnosed. The intra-seasonal periodicities in Indian rainfall are discussed by Hartman, DL. etal(1989). The relationship between Indian monsoon variability and surface temperature are analysed by Kirtman B.P.

In the state of Manipur, the rainy season commences in April and continues upto September. During the months of April and May the rains are due to convection associated with thunder and lightening. They occur usually in the afternoon (Ansari, 1976). The places where these winds travel over first get the maximum rainfall, thus the western parts of the state enjoys more rainfall than the eastern parts. The seasonal break up of rainfall is a common phenomenon.

Fig. 1: Study area

The number of rainy days on which there are 2.5mm varies from 100 to 150 (Sing R.P., 1982)

Study Area Manipur is situated in the north eastern part of the mainland of India. It lies just beyond the tropic of cancer. The latitudinal and longitudinal extensions are from 23051/ North to 25041/ North and from 93002/ East to 94047/ East respectively. This is shown in the Figure 1. Manipur is a landlocked state. The distance of the location of the state from the geographical equator (00) is about 2,600 km. The south west part of the state lies 250 km away from the Bay of Bengal. The surface area of Manipur is very small and has only 22,327 sq. km. which is 0.7 percent of the total surface area of India

Objective: The overall aim of the research work is to find out some valuable phenomena of rainfall in Manipur. Thus an attempt has been made to analyse the variation of monthly rainfall, rainy day and intensity. It also tried to analyse the annual trends of the above mentioned phenomena of rainfall.

Methodology Rainfall data from 1959 to 2010 have been collected from different weather recording stations such as Tulihal, Tinlong, Maram, Ukhrul, Jiribam, Thanlon, C.C Pur, Waybal, etc.which are located in the state to achieve the objective of this research paper. All the data are being used in the analysis by employing various effective statistical methods. Error bar is a line drawn through a point on a graph which is parallel to one of the axis and representing the variation of the corresponding coordinate of the point. Standard deviation and mean are used to construct the error bar. Linear and growth model is also applied for the analysis of trend of rainfall.

Analysis and discussion:

Among the four selected months, the least variation in rainfall with the mean of 10.28±5.57 with 95 percent confidence interval (CI): 6.91-13.65 is observed in December and the highest variation of rainfall is found in July (295.5685.33 with 95 per cent CI: 244.00-347.13). In the analysis, April is more pronounced with 95 per cent CI: 89.94– 130.95 than that of the October, with 95 per cent CI: 106.13- 106.13- 135.31 (Table 1).

Table 1: Analysis of Variation of Monthly (Selected) Rainfall (mm)

Month			95%CI Lower	Upper	Test value
	Mean	SD			
December	10.28	5.57	6.91	13.65	
April	110.44	33.93	89.94	130.95	F=80.73
July	295.56	85.33	244.00	347.13	P<0.01
October	120.72	24.15	106.13	135.31	
Total	134.26	113.45	102.67	165.34	

The error bar graph has depicted that the bar of the July is the longest among the four error bars. It indicates the maximum variability of rainfall is found to occur in this month all over the state. The reason of it may be local physiographic differences. Thus the hilly parts of the state receive more rainfall than the central valley. Tamenglong is the place where the highest rainfall is occured. The valleyward side of Churchandpur receives lowest rainfall(194.4mm) in July. Most parts of the central valley receive an amount of rainfall which is little above 200mm during this month. Both hilly and valley areas have got less than 20mm of rainfall in the month of December. The variation of rainfall for this month is small which is statistically proved. The quantity of rainfall for the month of April and October are more or less similar, the value being in an around 100mm December is the driest month and July is the wettest month in Manipur. The pattern of variation may also be noted from the graphical presentation by using error bars in Figure 5.11. In this interpretative analysis, the variation in rainfall is highly significant and is witnessed by ANOVA' F-value 96.51 (P<0.01).

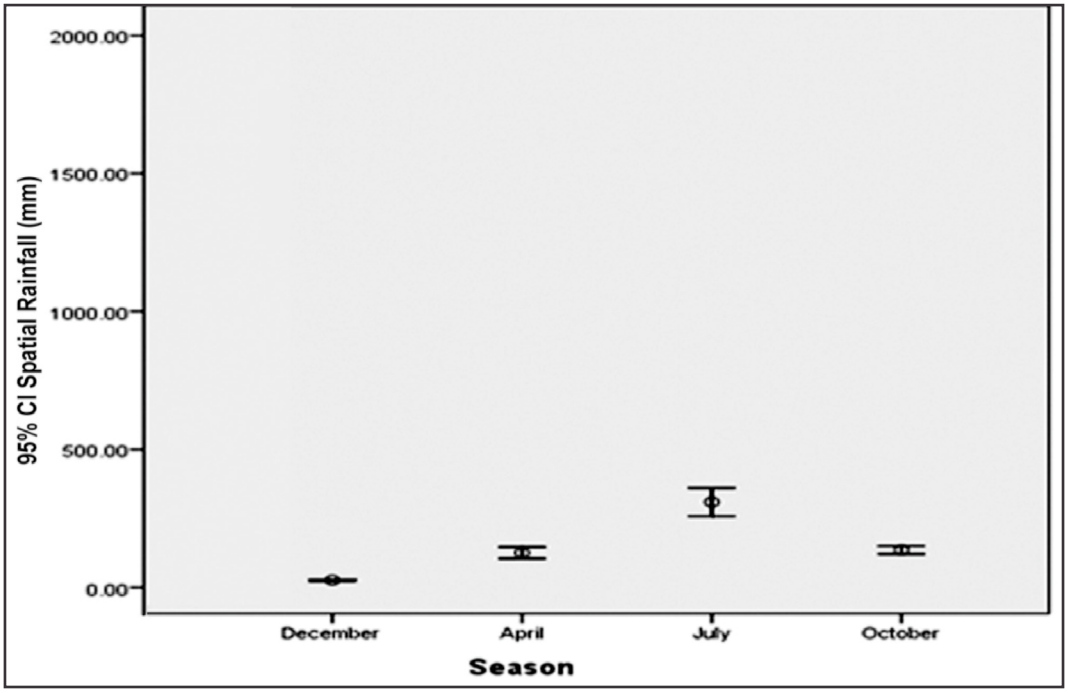


Fig.2: Error Bars of Selected Months Rainfall

The variation in number of rainy day is highly significant as, advocated by F=236.71 with P<0.01. In case of rainy day July has the largest number of rainy day, most of them above 15. Other months which have larger number of rainy day are June, August, and September. The least number of rainy day is found in December, the value being ranges from 1 to 2. The error bar graph of monthly rainy day shows that the length of the bars is decreasing towards both sides of July in a regular pattern.

Table 2: Spatial Variation of Rainy Days

Month	Mean	SD	95%CI Lower	Upper	Test value
January	1.20	.11	1.00	1.57	
February	2.31	.48	2.02	2.60	
March	4.62	1.38	3.78	5.45	
April	7.08	1.49	6.17	7.98	
May	9.85	1.40	9.00	10.70	F=236.71 P<0.01
June	15.69	1.88	14.55	16.83	
July	16.85	2.19	15.52	18.17	
August	14.08	1.11	13.40	14.75	
September	10.85	1.95	9.67	12.03	
October	6.62	1.04	5.98	7.25	
November	2.62	.65	2.22	3.01	
December	.77	.59	.41	1.13	
Total	7.69	5.65	6.80	8.59	

The number of rainy days is highly irregular in July, indicated by Mean of 16.85 ±2.19 with 95 per cent CI: 15.52 – 18.17 (Table 2). The variation is lowest in case of January (95 per cent CI; 1.00 – 1.57) as shown in (Fig.3).

The variation in monthly rainfall intensity is highly significant as advocated by F=4.65 with P<0.01. The error bar graph of intensity of rainfall shows the more or less similar pattern with that of rainy day. Maximum variation is found in July and it has been falling towards both sides of it upto January in the left bottom corner and December in right bottom corner. June, July and August have larger value of intensity of rainfall in the state and floods are common phenomenon during these months.However droughts are also occurred in the state when there is less quantity of rainfall during the southwestmonsoon season. Drought is also occurred due to early arrival as well as withdrawal of southwest monsoon wind and it affects the inhabitants of the state severely.

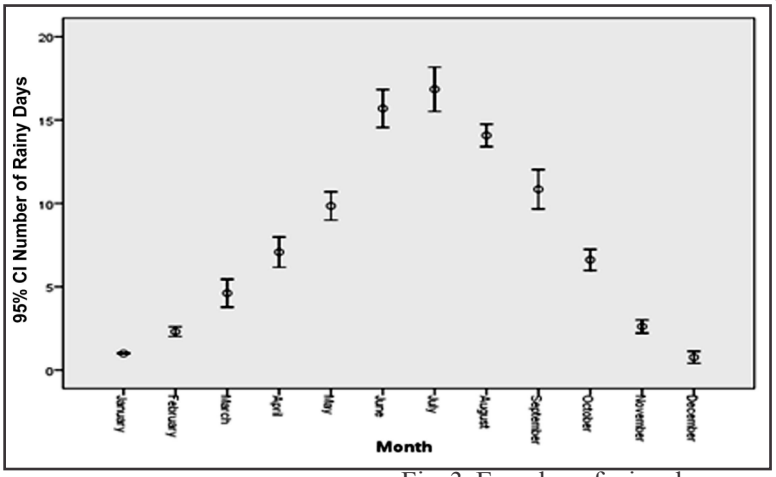


Fig. 3: Error bar of rainy days

From the Error bars (Fig.4) it is known that the highest variation in monthly intensity of rainfall is in November (12.28 ±.4.77; 95 per cent CI: 7.87 – 16.70). Next comes to the month of February with its value of variation 12.06 .4.73;95 per cent CI: 7.68-16.45. The third highest variability of intensity of rainfall in the state is represented by the month of December. The fourth highest variation in this regard is in July with its 95 per cent CI:15.48 – 22.90 and the value of standard deviation being 4.01 along with its mean value of 19.19. September and March also have shown large variation of intensity with their values of standard deviation 3.62 and 3.32 respectively.

The least variation is observed in October and its 95 per cent CI: being 15.42 – 18.63 (Table 3). The value of F-statistics, F - 4.65 ; P <0.01, of intensity of rainfall is smaller than that of the rainy day. This indicates that the variability is more in the later one. Both these two rainfall phenomena markedly influence the amount of rainfall in Manipur. In the year 1950 the state received around 1600mm of rainfall and then it started decreasing gradually till 2010. However the rate of decrease is not sharp as has been shown by the trend graph. This has been shown in the figure 5. A large variation in the amount of annual rainfall can be witnessed from the graph. This variation is easily shown in the graph in such a way that the observed values are highly randomly spread above and below the trend line. In some years rainfall is exceptionally high and in other few years it is exceptionally low which lead to floods and droughts respectively. This pattern of decreasing trend of rainfall is highly uneven.

Table 3: Variation in Monthly Intensity of Rainfall (mm/days)

Month	Mean	SD	95%CI		Test value
			Lower	Upper	
January	11.21	2.66	8.75	13.67	
February	12.06	4.73	7.68	16.45	
March	11.63	3.32	8.55	14.70	
April	13.60	2.78	11.02	16.17	F=4.65
May	14.01	2.61	11.59	16.43	P<0.01
June	19.19	4.01	15.48	22.90	
July	15.55	2.22	13.49	17.60	
August	15.43	2.80	12.83	18.03	
September	15.59	3.62	12.23	18.94	
October	17.03	1.73	15.42	18.63	
November	12.28	4.77	7.87	16.70	
December	9.34	4.04	5.60	13.08	
Total	13.91	4.15	13.01	14.81	

Table-4: Model Summary and Parameter Estimates(Rainfall in mm, Rainy Days and Intensity of Rainfall in mm/days).

	Model Summary			Parameter Estimates		
Variable	Model	R-Square	F	P-value	Constant	b (coef.)
Amount of	Linear	.004	.180	.673	3599.056	-1.033
rainfall (mm)	Growth	.008	.328	.570	9.084	.000
No. of rainy day	Linear	.018	.795	.377	-106.088	.101
	Growth	.019	.851	.361	2.319	.001
Intensity of	Linear	.057	2.595	.115	76.672	-.030
rainfall	Growth	.070	3.218	.080	6.798	-.002

Applying the linear and growth models, the significance of trend of three parameters can be examined further. The trend of annual rainfall shown in Figure 5expresses that there exists a negative moving trend. However, this decreasing trend is insignificant as has been observed from its test value of F which is equal to 0.180 at P>0.05 in linear model (Table-4). The trend line can explain
only 0.04 per cent in the total variation in annual rainfall (R2 = 0.004 in linear model). The trend of rainy days is found to be increasing (Figure 6).

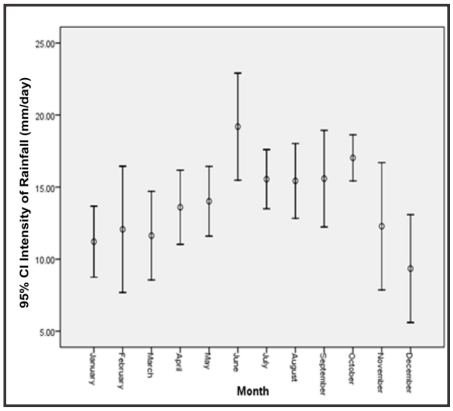


Fig.4:Error bar of intensity

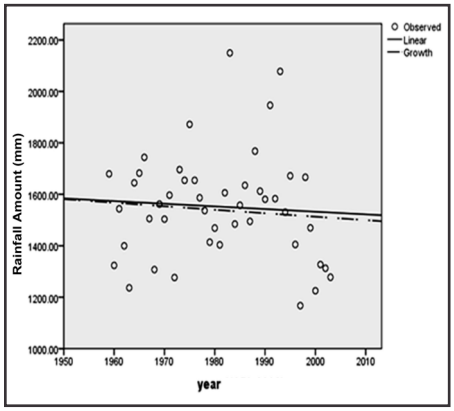


Fig.5:Trend of annual rainfal

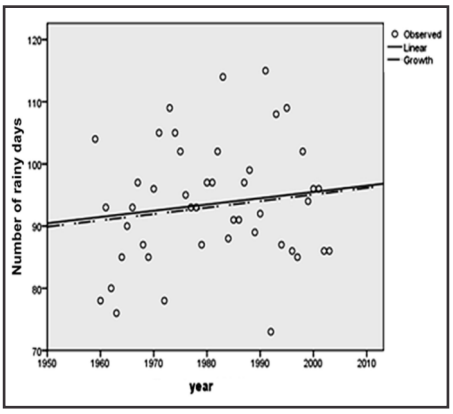


Fig.6:Trend of rainy days

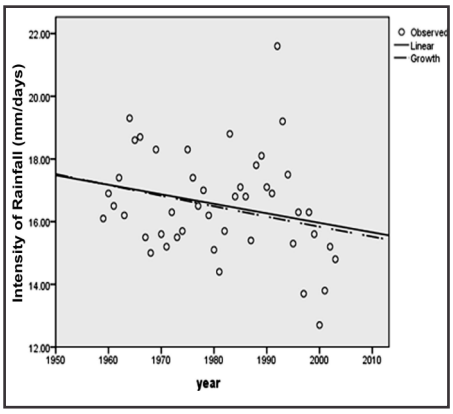


Fig.7: Trend of intensity of rainfall

But, this is not significant as has been explained by the model summary, F=0.795; P> 0.05 (P=0.377 in linear model. The R2 value being 0.018, can explain only 18 per cent in its total variation. The linear and growth models reveal that the intensity of rainfall is declining as seen in Figure 7. The statistical value of F is 2.595 at probability level of 0.115 (P>0.05). The variation in trend is explained upto 5.7 per cent by the linear model. The trend graph of rainy day exhibits slightly increasing trend from 1950 to 2010. The trend is highly uneven, most of the observed values spread randomly above and below the trend line in the graph. But this increasing trend is not significant.

So, the amount of rainfall decreases insignificantly even if the rainy day has been increase slightly. Another factor to make rainfall decrease in the state is the slightly falling intensity of rainfall. The trend line of intensity of rainfall has also been found decreasing randomly from 1950 to 2010.

Conclusion

From the above analysis it has been concluded the monthly rainfall, rainy day and intensity of rainfall have shown their distinct variations. According to the reports of F-test the variation in rainfall (F- 80.73 ; $P < 0.01$), variation in rainy day (F - 236.71 ; $P < 0.01$) and variation in intensity (F – 4.65 ; $P < 0.01$) are highly significant. The longest error bar is found in case of intensity of rainfall indicating the largest variation.

The trend of rainfall in the state during the study period is found to be slightly decreasing, but it is not statistically significantly (F– 0.180 ; $P > 0.05$). A little increasing trend is observed in case of rainy day but it is not significant. The main cause of falling in the amount of rainfall is due to the decrease in the intensity of rainfall (F – 0.115 ; $P > 0.05$). This study will be very useful because it has provided many important clues regarding the rainfall in Manipur.

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