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Analysis of weekly rainfall of different period during rainy season over Safdarjung airport of Delhi for 20th century – A study on trend, decile and decadal analysis

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सार – इस शोध–पत्र में प्रवृति एवं दशमक प्रौद्योगिकी का उपयोग करते हुए सफदरजंग हवाई अड्डे पर हुई साप्ताहिक वर्षा तथा वर्षा ऋतु के दौरान भिन्न–भिन्न अवधि के वर्षा आकड़ों का विशलेषण करने का प्रयास किया गया है। संपूर्ण अवधि के दौरान हुए परिवर्तनों को जानने के लिए दशकवार विशलेषण करने का प्रयास किया गया है। वर्ष में सप्ताह सं. 23 से 38 वें के दौरान जा वर्षा होती है उसे वर्षा ऋतु कहा जाता है। इस शोध पत्र में वर्ष 1901 से 2000 तक की अवधि के साप्ताहिक वर्षा आकड़ों का उपयोग किया गया है। चूँकि ऋतु में हुई वर्षा का विशलेषण करने के लिए सप्ताह एक छोटी अवधि होती है इसलिए चार सप्ताहों के अलग–अलग समूह बनाए गए है जैसे :– 1 से 4 को ए. समूह, 5 से 8 को बी. समूह और इसी प्रकार डी. तक के समूह। प्रगामी ऋतु के अध्ययन के लिए समूहों के सम्मिलन जैस ए. +बी., ए.+बी.+सी. तथा ए.+बी.+सी.+डी. के सभी विशलेषण की आवश्यकता है जैसा कि इस शोध–पत्र में साप्ताहिक एवम समूह के लिए किया गया है।

100 वर्षों के औसत साप्ताहिक वर्षा वितरण के बहुपदी वक्र (पोलिनोमियल कर्व) 1 प्रतिशत स्तर पर सहसंबंध गुणांक (0.94) का मान बहुत अधिक घनात्मक दर्शाता है। साप्ताहिक औसत वर्षा के भिन्नता गुणांक में 5 वें से 8 वें तथा 10 वें दशक में समरूपता दिखती है। 100 वर्षों के साप्ताहिक वर्षा के औसत भिन्नता गुणांक के प्रोफाइल में चौथे सप्ताह से 11 वें सप्ताह तक समरूपता दिखती है। 8 वें सप्ताह में वर्षा चरम सीमा पर होती है। साप्ताहिक वर्षा के संपूर्ण दशमक के विशलेषण से पता चला है कि सभी दशमकों में सप्ताह सं. 1 से 8 तक में वर्षा में वृद्धि की प्रवृति दिखी है और उसके बाद सप्ताह सं. 9 से आगे सभी दशमक मानों के लिए गिरावट की प्रवृति देखी गई है। समूह सी. का प्रवति विशलेषण मुख्य रूप से घनात्मक प्रवृति को दर्शाता है जिसका सहसंबंध 5 प्रतिशत स्तर पर 0.20 अधिक है। हालाँकि सभी समूहों के दशमकों के प्रवति विशलेषण 1 प्रतिशत स्तर पर बहुत उच्च सहसंबंध गुणांक (सी.सी.) लगभग +0.95 को दर्शाते हैं। समूहों के सम्मिलित प्रवृति विशलेषण ए.+बी. +सी. तथा ए.+बी.+सी.+डी. समूहों के लिए घनात्मक प्रवृतों को दर्शातें है जिसका सहसंबंध गुणांक 5 प्रतिशत स्तर पर 0.25 एवं 0.20 है। इन समूहों के लिए दशमकों की प्रवृति में भी बहुत अधिक सहसंबंध गुणांक 1 प्रतिशत स्तर लगभग 0.95 से अधिक दिखता है। सफदरजंग हवाई अड्डे पर औसत वर्षा, अत्यधिक वर्षा और कम वर्षा पाँचवें, सातवें तथा चौथें दशमक में देखी गई है जिनके मान क्रमश : 594 मि. मी., 708 मि.मी. तथा 472 मि. मी. पाए गए है। दो आधी शताब्दी जैसे :– 1901 से 1950 एवं 1951 से 2000 तक की अवधि के विश्लेषण से किसी महत्वपूर्ण प्रवृति का पता नहीं चला है।

ABSTRACT. The analysis of weekly rainfall and of different period during rainy season of Safdarjang airport using techniques like trend and decile have been attempted. Decadal analysis is also attempted to see any changes during the entire period. Rainy season is defined as rainfall received from week no. 23rd to 38th. Weekly rainfall data for period 1901 to 2000 is utilized for this location. As week is a shorter period to analyze rainfall for the season groups of different periods consisting of 4 weeks such as 1-4 as 'A', 5-8 as 'B' and so on up to 'D' is formed. For study of progressive season combination of groups such as 'A+B', A+B+C and 'A+B+C+D' are also subjected to analysis as done for weekly as well for group.

The average weekly rainfall distribution indicates very high positive value of coefficient of correlation (0.94) significant at 1% level. The coefficient variation (C.V.) of weekly average rainfall shows consistency from decade 5th to 8th and 10th. Profile of average C.V. of weekly rainfall for 100 years shows consistency from week 4 to 11. Week no. 8 shows peak of rainfall. Overall decile analysis of weekly rainfall shows increasing tendency from week no. 1 to 8 for all deciles and then decreasing tendency from week no. 9 on words for all decile values. Trend analysis of group 'C' shows significant positive tendency with correlation as +0.20 significant at 5% level. However trend analysis of deciles of all groups shows very high C.C. around +0.95 at 1% level. Trend analysis of combination of groups shows positive trend for A+B+C and for A+B+C+D with a C.C. of 0.25 and 0.20 at 5% level. Trend of deciles for these groups also shows very

high C.C. values around +0.95 at 1% level. Average, excess and deficient rainfall seen at Safdarjung airport is 5th, 7th and 4th decile with values as 594, 708 and 472 mm respectively. Analysis of two halves of century, *viz*., 1901-50 and 1951-2000 shows no significant trend.

Key words – Week, Rainfall, Decile, Trend, Decade, Analysis, Safdarjang, Rainy season.

1. Introduction

Meteorological parameters at particular location has been studied by many scientists in the past using different techniques. Rainfall phenomenon, being most important parameter, particularly during monsoon season has got large scope to analyze for country as a whole or even for a particular location. Many authors have attempted to study this parameter in the past for entire country, state, sub-division, and district and even for a station. Recently Basu *et al*. (2004) did a statistical analysis of rainfall distribution and trend of rainfall anomalies of districts of West Bengal during monsoon and showed that there is an increase in trend of monsoon rainfall anomalies for Coochbehar district, sub-division Gangetic West Bengal and for Nadia district. Recent trends in rainfall of Bangalore have been studied by Mohapatra (2002). Analysis of daily rainfall at Coimbatore has been studied by Krishnan *et al.* (1995). Time series analysis of annual rainfall over different locations of India has been studied by Alvi and Koteshwaram (1985). Trend and fluctuations of seasonal and annual rainfall of Tamilnadu has been studied by Dhar *et al*. (1982). Decile techniques have been used on drought analysis during monsoon season by Das *et al.* (2003) for six selected locations in the country including Delhi. As far as Delhi is concerned, Lal *et al*., (1992) have studied trends and periodicities of monsoon and annual rainfall of 12 districts of Haryana and Delhi and observed significant increasing trend in mean annual and seasonal rainfall over Delhi and Rohatak.

With this background the authors has attempted to see the changes in weekly rainfall and of different groups of weeks during rainy season for 20th century. The study is further extended to work out the probable amount of rainfall at certain probability.

2. Data and methodology

In this paper weekly rainfall analysis of Safdarjang observatory of Delhi during rainy season is studied by using weekly rainfall data. Safdarjang observatory is chosen keeping in view its central location in Delhi and proximity to Parliament house, Rashtrapati Bhavan, different ministries and embassies. The 'Rainy Season' for this study is defined as 'Rainfall received during period from 4th June to 23rd September'. The initial date of season is chosen considering the standard week which begins from 4th in the month of June. The last date of season is chosen as 28th September as no occurrence of significant rainfall is observed after week no. 38th (22nd to 28th Sept.). Thus, the study involves 16 weeks of rainfall during the defined season. The weekly rainfall data has been taken from National Data Center (NDC), Pune. It is to mention that the daily data is initially scrutinized by Regional Meteorological Centre (RMC), New Delhi and then sent to NDC for processing. It involves mainly quality and consistency checks. Errors found are communicated to RMC, New Delhi for verification. After receiving verification list, the data is then made available for archival. Further as a product, weekly rainfall are prepared as per standard table for users (Table 1).

The rainfall analysis includes of average weekly rainfall distribution, trend of weekly rainfall for 100 years of period and weekly, decadal & decile analyse. Weekly

TABLE 1

Standard week no. & corresponding period

Week No. & Month	Period	Week No. & Month	Period
1 January	1 – 7	27 July	2-8
2 ″	8 – 14	28 ″	9 – 15
3 ″	15 – 21	29 ″	16 – 22
4 ″	22 – 28	30 ″	23 – 29
5 ″	29 – 4 February	31 ″	30 – 5 August
6 February	5 – 11	32 August	6 – 12
7 ″	12 – 18	33 ″	13 – 19
8 ″	19 - 25	34 ″	20 – 26
9 ″	26 – 4* March	35 ″	27 – 2 September
10 March	5 – 11	36 September	3 – 9
11 ″	12 – 18	37 ″	10 - 16
12 ″	19 – 25	38 ″	17 - 23
13 ″	26 – 1 April	39 ″	24 – 30 September
14 April	2 – 8	40 October	1 – 7
15 ″	9 – 15	41 ″	8 – 14
16 ″	16 – 22	42 ″	15 – 21
17 ″	23 – 29	43 ″	22 – 28
18 ″	30 – 6 May	44 ″	29 – 4 November
19 May	7 – 13	45 November	5 – 11
20 ″	14 – 20	46 ″	12 – 18
21 ″	21 – 27	47 ″	19 - 25
22 ″	28 – 3 June	48 ″	26 – 2 December
23 June	4 – 10	49 December	3 – 9
24 ″	11 – 17	50 ″	10 – 16
25 ″	18 – 24	51 ″	17 – 23
26 ″	25 – 1 July	52 ″	24 – 31#

* In leap year week no. 9 will be 26 February – 4 March
\# Last week no. 52 will have 8 days from 24 – 31 December

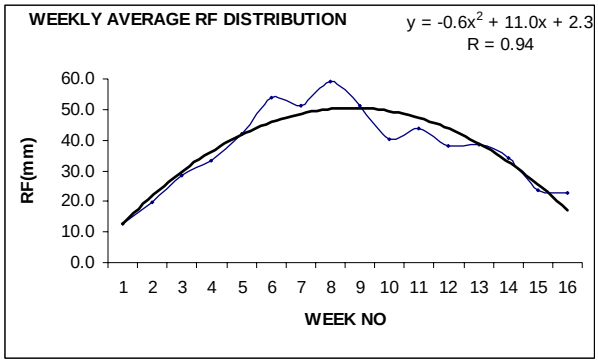


Fig. 1. Weekly average rainfall distribution

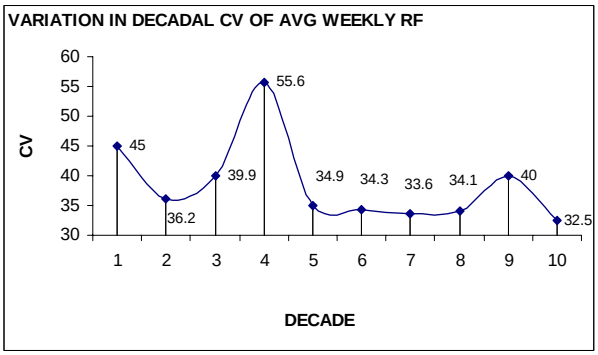


Fig. 3. Variation in decadal CV of average weekly rainfall

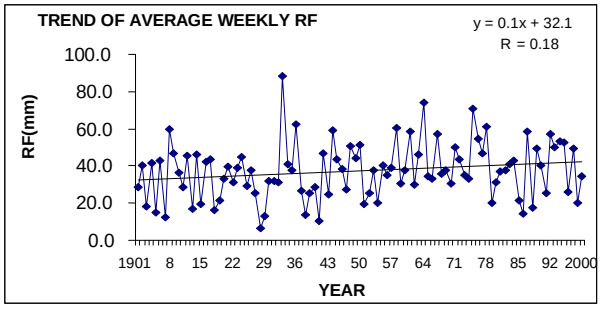


Fig. 2. Trend of average weekly rainfall

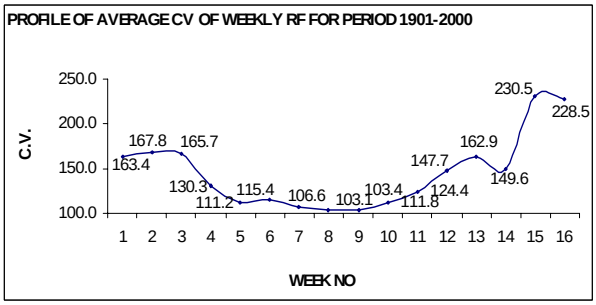


Fig. 4. Profile of average of CV weekly rainfall for period 1901-2000

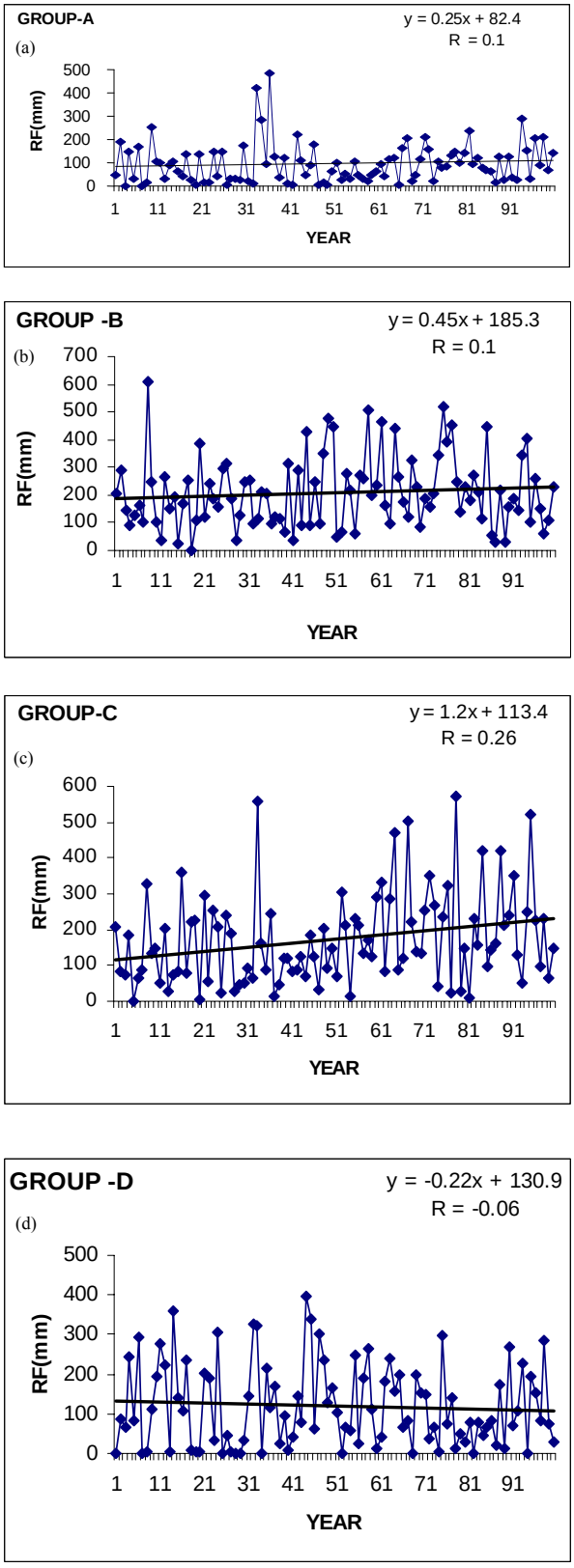
rainfall data is represented by forming intervals such as 5-10, 10-20 mm etc. for each decile. Actual values for rainfall more than 5 mm are furnished in tabular form for detailed study. As week is a short period for studying rainfall pattern for the period of 16 weeks, the study is extended by forming groups of four weeks each following Das *et al*., (2003). The behaviour of rainfall has been observed for different groups consisting of four weeks since week number 23rd (4th June to 10th June) to 38th (15th Sept to 21st Sept). Each group is identified as 'A' (week 23rd to 26th), 'B' (week 27th to 30th), 'C' (week no. 31st to 34th) and 'D' (week no. 35th -38th). To study the pattern of progressive season the groups have been further extended by combination such as 'A+B', 'A+B+C' and 'A+B+C+D'.

The changes, if any, in weekly rainfall pattern and of all groups is studied by applying trend analysis. Gibs and Maher (1967) recognized that common statistical measures such as 'arithmetic mean', 'average' and 'normal' are often poor indicators of event like rainfall. They surmised that same rainfall amounts are not normally distributed so it could be best described by quoting the limits of certain proportion of the occurrences. The method proposed by them is based on limits of each of 10% or decile of the ordered distribution of rainfall. The series of rainfall of 100 years of period containing all the groups is arranged in increasing order from 1901-2000 and decile values from 1 to 9 are found out for analysis. As the 10th decile value is the extreme rainfall value, 10th decile, naturally shows very high amount of rainfall and practically seems to be abnormal, hence it is not taken into account. Rainfall amount (mm) received at each decile for all the groups is plotted to see the tendency. Linear tendency suggests that rainfall amount observed at each decile is increasing proportionately. This helps to find out the probability in terms of decile of certain amount of rainfall and *vice versa*. The results of study provide information on some of climatological aspects of monsoon rainfall of 20th century. The changes, if any, of rainfall climatology for two periods, *viz*., from 1900-1950 and 1951-2000 are also studied and compared.

3. Results and discussions

3.1. *Weekly rainfall climatology*

Fig. 1 shows the profile of weekly average rainfall worked out for 100 years period. When a polynomial curve is fitted for this distribution, it is clearly seen that there is a systematic rise in rainfall from week number 1 to 9 and fall thereafter. This kind of picture provides a



Figs. 5(a-d). Trend of rainfall for different groups

valuable input to agricultural and hydrological planners. There is very high coefficient of correlation of 0.94 significant at 1% level between weekly rainfall and week number based on the second order polynomial fitted to the data. Using this equation in general prediction of weekly rainfall can be worked out for a given season.

Fig. 2 shows the trend analysis of average weekly rainfall worked out for 16 weeks during the period under consideration. The equation of trend line shows positive non-significant trend with time. The highest average weekly rainfall was observed as 88.5 mm in 1933 and lowest as only 6.3 mm in 1928. However, the mean of average weekly rainfall of rainy season of 100 years is worked out to be 37.3 mm.

Coefficient of variation (CV) has been calculated for each decade for weekly rainfall and shown in Fig. 3. As CV is the measure of comparative analysis of variation, it indicates the homogeneousness, consistency of the values for the period under consideration. In other words this is an indicator which shows the comparative variations of rainfall for every 10 years of period. The higher CV indicates inconsistency and in homogeneity series and *vice versa*. Fig. 3 shows that the highest value of CV (55.6) is observed in 4th decade (1931-40). There is a secondary peak during 1981-90 and 1901-10. However it shows almost the consistent values of CV of the range 32 to 36% in the remaining period.

Fig. 4 shows the profile of weekly average CV of rainfall data. It is seen that from 10th week there is increasing trend. The CV rapidly increases during last two weeks. The weekly rainfall is more stable with less inter-annual variation during weeks (5-10) covering July and first half of August. It is more random in September followed by June.

3.2. *Decile analysis*

Table 2 shows the decile values from 1 to 9 of rainfall from week no. 1 to 16. Rainfall analysis of all weeks for all deciles is carried out by forming intervals, *viz*., ≥ 5 - 10 mm, >10 - 20 mm, > 20 - 30 mm, > 30 – 40 mm, > 40 - 50 mm, > 50 – 60 mm, > 60 - 70 mm, > 70 - 80 mm, > 80 - 90 mm, > 90 – 100 mm, > 100 – 120 mm and > 120 mm.

Week no. 1 does not represent any interval from Decile 1 to 5. Even at Decile 6 and 7 it shows rainfall below 10 mm. Declie 8 represents interval 20 - 30 mm and 9 interval 40 - 50 mm with a value of 26.2 mm and 40.8 mm respectively. It means the chances of rainfall ≥ 20 mm and ≥ 40 mm is only 20% and 10% respectively. Hence the period from 4th to 10th June, *i.e*., week no. 23rd

TABLE 2

Decile values at different intervals of rainfall for week-1 to 16

Week No.→	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
D-1 RF ≥ 5-10 mm																
D-2 RF ≥ 5-10 mm						5.1	7.2	6.6	5.3							
D-3 RF ≥ 5-10 mm				5.0												
10-20 mm					10.6	15.7	15.0	15.6	10.1	10.9	11.0					
D -4 RF ≥ 5-10 mm				9.2										8.4		
RF > 10-20 mm					16.1						14.5					
RF > 20-30 mm						21.1	23.4	29.2	24.2	23.7						
D-5 RF ≥ 5-10 mm		6.9	8.4										8.9	6.0		
RF > 10-20 mm				16.1								14.3				
RF > 20-30 mm					21.1						24.2					
RF > 30-40 mm						29.0	35.0	44.0	39.7	31.2						
D-6 RF ≥ 5-10 mm	6.0															
RF > 10-20 mm		12.4	16.8													
RF > 20-30 mm				24.1								24.8	21.2	16.2		
RF > 30-40 mm					34.4					39.4	33.0					
RF > 40-50 mm						45. 0	42.6		49.8							
RF > 50-60 mm																
RF > 60-70 mm								64.4								
D-7 RF ≥ 5-10 mm	9.1															
RF > 10-20 mm		19.7													6.1	7.4
RF > 20-30 mm			25.3													
RF > 30-40 mm				37.9										36.2		
RF > 40-50 mm										47.8	49.7	48.6	46.4			
RF > 50-60 mm					52.7											
RF > 60-70 mm						67.8	66.0		64.8							
RF > 70-80 mm								79.6								
D-8 RF ≥ 5-10 mm																
RF > 10-20 mm																
RF > 20-30 mm	26.2															23.6
RF > 30-40 mm		30.7													33.5	
RF > 40-50 mm																
RF > 50-60 mm			52.1	54.9										59.6		
RF > 60-70 mm										64.9		63.4	69.4			
RF > 70-80 mm											78.2					
RF > 80-90 mm					87.1											
RF > 90-100 mm						97.2	91.2	98.7	92.1							
D-9 RF ≥ 5-10 mm																
RF > 10-20 mm																
RF > 20-30 mm																
RF > 30-40 mm																
RF > 40-50 mm	40.8															
RF > 50-60 mm		53.7														
RF > 60-70 mm																
RF > 70-80 mm			77.6													77.0
RF > 80-90 mm															83.8	
RF > 90-100 mm				93.5												
RF 100 -120 mm										108.2		102.0	101.0	126.0		
RF > 120 mm					114.0	136.0	131.0	132.8	124.4		121.6					

do not show occurrence of significant rainfall. Week no. 2 does not represent any interval from Decile 1 to 4. However it represents intervals from ≥5 - 10 mm, >10 - 20 mm, >30 - 40 mm and >50 - 60 mm at higher deciles. It shows 50% chances of occurrence of rainfall ≥ 6.5 mm, 30% of rainfall ≥ 10 mm, 20% of rainfall ≥ 30 mm and 10% of rainfall ≥ 50 mm. The period 11th to 17th June shows progress of rainy season. Week no. 3 also

does not represent any interval from Decile 1 to 4. It represents intervals from ≥ 5 - 10 mm, >10 - 20 mm, >20 - 30 mm > 50 - 60 mm and > 70 – 80 mm at higher deciles. It shows 50% chances of rainfall ≥ 5 mm, 40%, 30% and 20% chances of rainfall ≥ 10 mm, 20 mm and 50 mm respectively. With 10% probability it shows rainfall ≥ 70 mm. The period 18th to 24th June shows further progress of rainy season. Week no. 4 however represents all the intervals up to 90-100 mm indicating probability of occurrence of rainfall as 100%. Significant rainfall is seen from decile 5 onwards. Chances of occurrence of rainfall ≥ 10 mm, 20 mm, 30 mm, 50 mm and 90 mm are 50%, 40%, 30%, 20% and 10% respectively. This week represent period from 25th June to 1st July. Hence the period 25th June 1st July may be considered as the normal period for onset of monsoon over Delhi with rainfall as the criteria. It endorses the earlier finding (IMD 1943), the normal date of onset of monsoon as 29th June with standard deviation of 7 days.

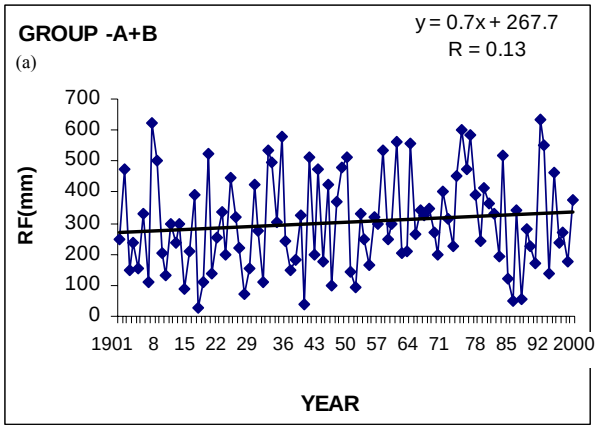
Week no. 5 shows occurrence of significant rainfall from decile 3 onwards and represents all the intervals up to 100-120 mm. Week (6, 7, 8 and 9) (period 16th - 22nd July) shows almost similar pattern of weekly rainfall but representing all the intervals from decile 2 to 9 with significant rainfall. However week 8 shows higher values of rainfall at each decile compared week no. 6, 7 and 9. The average weekly rainfall at decile 8 is 52.2 mm which almost coincides with the average weekly rainfall for 100 periods as discussed above. It means the period 23rd to 29th July shows the peak weekly rainfall period. Analysis of week no. 1 to 8 shows systematic increase in weekly rainfall up to week no. 8 and weeks (6-9) covering 9th July to 5th August are the rainiest period for Delhi.

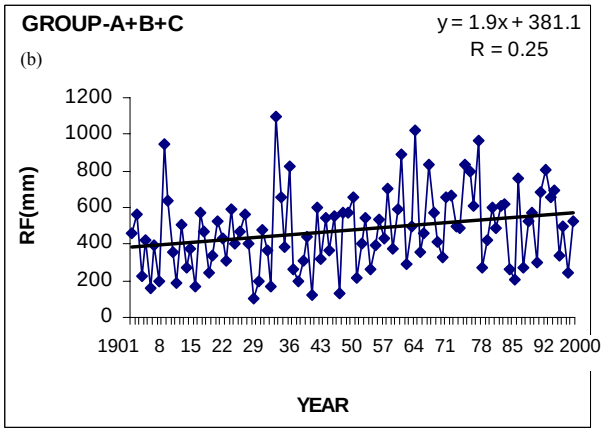
The rainfall gradually decreases from week 10. Week no. 10 shows occurrence of significant rainfall from decile 3 onwards and represents all the intervals up to 100-120 mm. However during week no. 12, *i.e.*, from period 20th to 26th August, there is a drastic decrease in rainfall and the rainfall again increases during week no. 13. It indicates that the weak monsoon condition normally prevails over Delhi during 20-26 August.

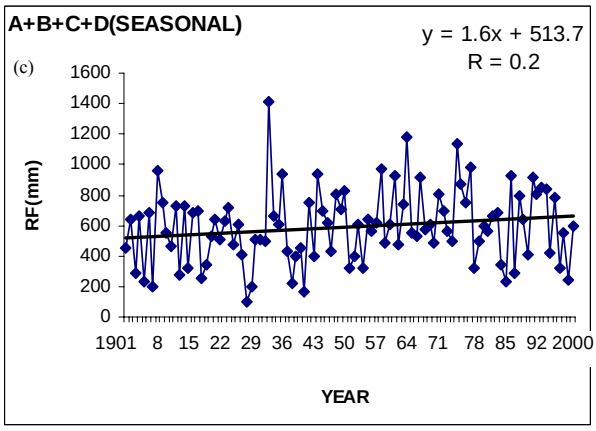
Week no. 15 (*i.e.*, from 10th to 16th Sept.) and week no.16 (*i.e.*, from 17th to 23rd Sept.) shows occurrence of significant rainfall for decile 8 and 9 only. Hence, there is a significant decrease in rainfall from the week of 10-16 September. According to IMD (1943), monsoon normally withdrawn from Delhi around 15th September.

3.3. *Inter-annual variation of monthly rainfall*

Figs. 5(a-d) shows the interannual variation of monthly rainfall during various sub-periods. The average

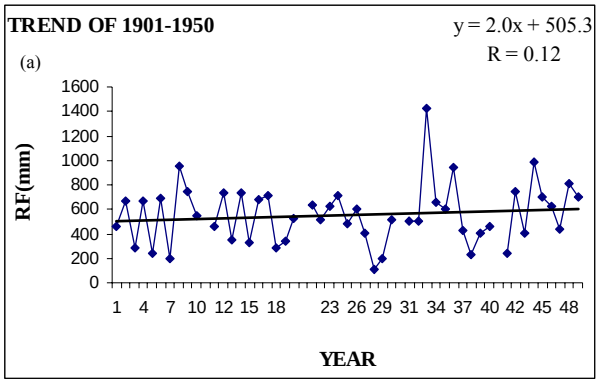


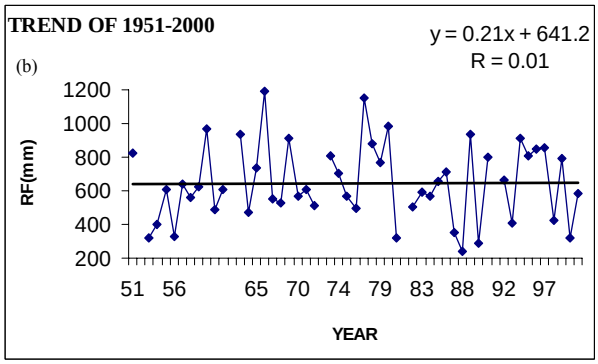




Figs. 6(a-c). Trend of rainfall for different sub-period of monsoon season

rainfall observed during Group 'A' (June) is 67.6 mm. No significant change in rainfall with time is seen for this period. Group 'B' (July) shows highest amount of average rainfall, *i.e.*, 181.9 mm out of all groups, indicating active phase of monsoon over the station which is well known fact. Trend analysis suggests no significant change in





Figs. 7(a&b). Trend of rainfall for period (a) 1901-50 and (b) 1951-2000

rainfall with time for this period. The average rainfall of Group 'C' (August), *i.e.*, 194.2 mm indicates continuation in active phase of monsoon. Positive tendency in rainfall is seen during this period with coefficient of correlation as 0.26 which is significant at 5% level. Group 'D' (September) shows no trend. Average rainfall of this period observed is 98.9 mm. Overall trend analysis shows significant positive tendency during week no. 31st to 34th *i.e.*, 30th July to 26th August.

3.4. *Inerannual variation of seasonal progressive total rainfall*

Periods 'A+B', 'A+B+C' and 'A+B+C+D' shows the progressive total monsoon rainfall representing June – July, June – August and June – September respectively over Delhi. All these periods show linear increasing tendency from decile 1 to 9 with significant coefficient of correlation at 5% level [Figs. 6(a-c)].

3.5. *Comparative study between two half of century of seasonal rainfall*

Figs. 7(a&b) shows the graph of weekly rainfall and time for the period 1901 to 1950 and 1951-2000. The trend shows non-significant trend during both the periods. The average rainfall is worked out to be 555.6 mm and 640.3 mm respectively during 1901-50 and 1951-2000. However, the highest is seen to be 1421.6 mm in 1933 which is 284% of the average and lowest in 108.6 mm in 1928 which is only 20% of the average during 1901-50. No trend is seen in this half century. The highest value is seen to be 1191.0 mm in 1965 which is 186% of average and lowest value is seen to be 236.2 mm in 1987 which is 36.9% of average. Overall comparison shows that there are no significant variations in seasonal rainfall in these two halves of the century.

4. Conclusions

The average weekly rainfall for 100 years indicates very high with the week number with CC of 0.94 significant at 1% level. The average weekly rainfall for the period 1901 to 2000 shows no significant trend. Variation in coefficient variation (C.V.) of weekly average rainfall shows highest value of 55.6 in decade 4th. However from decade 5th to 8th and 10th it shows lower value around 35.0 indicating consistency in the series. Profile of average C.V. of weekly rainfall for 100 years shows consistency from week 4 to 11. Weekly decile analysis of 1 to 3 does not represent significant rainfall up to decile 4. Rainfall ≥ 20 mm is seen only at decile 8 and 9. However from week no. 4 drastic rise in rainfall amount for all intervals up to 100-120 mm is observed mainly due to on set of monsoon. Week no. 5 to 8 shows further increase in tendency of rainfall which covers almost July month. Week no. 8 shows peak of rainfall with 70% chances of rainfall ≥ 15.6 mm, 50% of 44.0 mm, 30% of 79.6 mm and 10% of 132.8 mm. Week no. 9 to 12 shows the decreasing phase of weekly rainfall. Week 13 to 16 shows the pattern similar to week no. 1 to 4. Overall decile analysis of weekly rainfall shows increasing tendency from week no. 1 to 8 for all deciles and then decreasing tendency from week no. 9 onwards. The rainfall of group 'C' (August) shows significant positive trend. Trend analysis of combination of groups shows positive trend for A+B+C (June – August) and for A+B+C+D (June – September) with a C.C. of 0.25 and 0.20 at 5% level. Analysis of two halves of century, *viz.*, 1901-50 and 1951-2000 shows no significant trend. However, the average rainfall of rainy season for first and second half is seen to be 555.6 and 640.3 mm.

References

Alvi, S. M. A. and Koteswaram, P., 1985, "Time series analysis of annual rainfall over India", *Mausam*, **36**, 4, 479-490.

Basu, G. C., Bhattacharjee, U. and Ghosh, R., 2004, "Statistical analysis of rainfall distribution and trend of rainfall anomalies district wise during monsoon period over West Bengal", *Mausam*, **55**, 3, 409-418.

Das, H. P., Kore, P. A. and Jadhav, V. N., 2003, "An effective method of identification of drought in kharif season", *Mausam*, **54**, 4, 909-916.

Dhar, O. N., Rakecha, P. R. and Kulkarni, A. K., 1982, "Trend and fluctuation of seasonal and annual rainfall of Tamilnadu", *Proc. Indian Acad. Sci. Earth and Planet Sci*., **91**, 97-104.

Gibs, W. J. and Maher, J. V., 1967, "Rainfall deciles as drought indicators", Commonwealth Bureau of Meteorology, *Bulletin No. 48*, Melborne, Australia.

Krishnan R., Gopalswami N., Rangnathan C. R., Natarajan S. and Balasubramanian, T. N., 1995, "Analysis of daily rainfall at Coimbatore", *Mausam*, **46**, 1, 87-92.

Lal, B., Duggal, Y. M. and Panchu, Ram, 1992, "Trend analysis and periodicities of monsoon rainfall of districts of Haryana and Delhi", *Mausam*, **43**, 2,137-142.

Mohapatra, M., 2002, "Recent trends in climate at Bangalore", *Mausam*, **53**, 4, 425-438.

Rao, G. S. P., Jaswal A. K. and Kumar, M. S., 2004, "Effects of urbanization on meteorological parameters", *Mausam*, **53**, 3, 429-440.