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A comparative study of rainfall spells in Bangalore

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सार — वर्तमान अध्ययन बंगलौर के एक छोटे से क्षेत्र की वर्षा-विशेषताओं का स्थूल मौसम वैज्ञानिक विश्लेषण है। इस विश्लेषण के लिए बंगलौर की दो वेधशालाओं (नगर केन्द्र तथा 10 किलोमीटर के भीतर स्थित हवाई अड्डे) के 1977 से 1981 तक की अवधि के स्वतः लेखी वर्षा चार्टों का उपयोग किया गया था। इस अध्ययन में दोनों स्थानों के लिए दौरों की औसत संख्याओं, औसत अवधियों, औसत मात्रा, दौरों की औसत तीव्रता, दौरों के आरंभ तथा अन्त के समय तथा विभिन्न तीव्रता-अन्तरालों में वर्षा-दौरों के बंटन की तुलना तथा उन पर विचार विमर्श किया गया है। यह दिखाया गया है कि एक सीमित क्षेत्र में विशेषताओं का विचलन स्पष्ट दिखाई देता है और इन विचलनों को पवन की प्रचलित दिशाओं के परिप्रेक्ष्य और कोई सार्थक प्रतिरूप तैयार करने के लिए शहरी संरचनाओं/निर्माणों के प्रभाव को सामने रखकर देखना चाहिए।

ABSTRACT. The present study is a mesometeorological analysis of the rainfall characteristics over a small area in Bangalore. The autographic rainfall charts for the period 1977-81 of the two observatories (City centre and Airport located within a distance of 10 km) were used for this analysis. The mean number of spells, mean duration, mean amount and mean intensity of spells, the times of onset and of cessation of spells and the distribution of rainspells in different intensity-intervals for both the locations are compared and discussed. It has been shown that within a limited area, the variations of characteristics are quite apparent and these variations should be viewed against the back-drop of prevailing direction of winds and the influence of urban structures for deriving any meaningful pattern.

1. Introduction

It is important to appreciate quantitatively the variations in the characteristics of rainfall spell over a small area. It helps one appreciate the limits on forecast accuracy (Gedzelman 1981). It also helps one consider the need for rewording and restructuring the local forecast in such a way as to bring out the expected likely variations of rainfall in different sectors of the locality depending upon the seasonal characteristics like wind-flow etc and like terrain features. This mesometeorological analysis enables one to estimate the extent of the representativeness of a reported rainfall and plan the agricultural operations more realistically in the light of the analysis of the reported rainfall. As a result of an interesting study conducted in the olive-producing areas in China, it was recommended by FAO, that for a satisfactory culture, the climatological conditions and their local differences must be closely analysed (FAO 1980). This kind of study would also throw light on the causes of the variations within such short distances. The present study in an attempt in this direction has been undertaken in respect of Bangalore.

2. Method of study

There are two well-maintained observatories of the India Meteorological Department, one in the central parts of the city. (Lat. 12 deg. 58′ N, Long. 77 deg. 35′ E) and the other in the airport area (Lat. 12 deg. 57′ N and Long. 77 deg. 38′ E). The heights of the city central observatory and airport observatory respectively are 921 m and 881 m a.s.l. The latter observatory is located about 9.5 km nearly to the east of the city central observatory (*see* Fig. 1).

For the present study, the period considered is from 1977 to 1981, both the years included. The autographic rainfall charts were collected and analysed. Each period of continuous rain having an amount not less than 0.1 mm was taken as one spell. The times of commencement and the cessation and the amount of each spell were noted. For the purposes of present study each period was divided into three phases, the first phase is the period from 0000 IST of the first day to the 2400 IST of the tenth day. The second phase of a month is the period from the end of the first phase to the 2400 IST of the twentieth day of the month. Rest of the month is the third phase of the month.

A spell which commenced and ceased in a given phase is naturally counted as a spell in that phase. As regards spell which commenced in a given phase but ceased in the succeeding phase, it was reckoned as a spell of that phase, where the percentage of its duration is larger. For instance, if rainfall commenced in 2200 IST of 20 May (second phase of May)

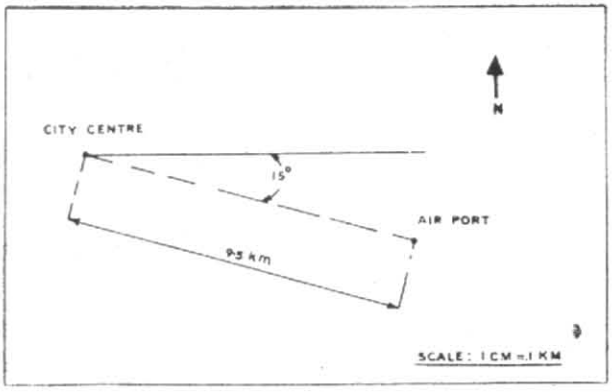

Fig. 1. Relative position of "C.C." & "A.P." observatories in Bangalore city

TABLE 1

Mean characteristics of rain spells in Bangalore

Phase		Mean number of spells		Mean duration of a spell (minutes)		Mean amount of a spell (mm)	
		Bangalore C.C.	Bangalore A.P.	Bangalore C.C.	Bangalore A.P.	Bangalore C.C.	Bangalore A.P.
Jan	I	0.2	0 0	17.0	00.0	1.2	0.0
	II	0.0	0.0	0.0	0.0	0.0	0.0
	III	0.2	0.2	3.0	4.0	0.3	0.4
Feb	I	0.2	0.0	35.0	0.0	0.4	0.0
	II	2.2	0.0	87.5	30.5	3.9	4.0
	III	1.0	2.2	35.0	29.6	5.6	2.2
Mar	I	0.6	0.4	11·7	1.2	0.4	0.6
	II	1.8	1.8	23.3	41.2	3.8	10.3
	III	2.4	1.6	38.0	26.7	9.8	3.1
Apr	I	1.2	0.6	18.2	16.7	1.8	3.3
	II	2.6	4.6	26.8	14.0	2.9	3.1
	III	5.0	4.6	39.0	37.6	5.1	3.5
May	I	7.6	8.4	42.1	24.7	5.9	3.2
	II	5.8	5.6	33.0	30.9	2.9	3.6
	III	10.6	11.2	42.4	30.9	5.0	3.1
June	I	5·0	4·8	51·7	75·7	5.3	3·1
	II	10.4	7.0	46.9	27.6	4.3	3.4
	III	10.2	8.0	29.6	21.9	0.9	1.5
Jul	I	9.0	7.0	16.3	20.1	1.4	1.3
	II	11.0	10.6	42.1	34.1	3.5	4.6
	III	13.6	10.6	52.4	49.9	4.4	4.2
Aug	I	13.6	11.4	28.1	22.0	2.1	2.3
	II	12.4	9.0	47.6	55.9	2.5	2.9
	III	10.4	10.0	60.8	50.8	3.6	2.8
Sep	I	10.0	7.2	55.7	72.3	6.5	6.7
	II	16.6	14.0	56.5	34.5	6.4	6.3
	III	16.0	10.6	48.1	56.9	4.1	4.3
Oct	I	10.2	10·0	67.2	59.6	7.3	8.7
	II	6.0	7.2	42.1	26.4	4.0	3.4
	III	11.4	12.4	47.3	43.4	2.3	3.3
Nov	I	11.2	8.6	44.1	61.6	2.5	3.4
	II	11.2	11.6	70·7	44.6	2.6	2.1
	III	6.2	7.4	43.8	49.7	1.5	1.9
Dec	I	2.2	2.4	30.5	17.3	1.1	1.4
	II	0.2	0.0	10.0	0.0	0.3	0.0
	III	3.2	3.0	104.7	48.1	1.2	0.9

TABLE 2

Duration and amounts of rainfall in various phases and their percentages

Phase		Duration (mts)		% of the total period of the phase		% of the total duration of the rainfall in a year		Amount (mm)		% of total yearly amount	
		C.C.	A.P.	C.C.	A.P.	C.C.	A.P.	C.C.	A.P.	C.C.	A.P.
Jan	I	3.4	0.0	0.02	0.00	0.03	0.00	0.0	0.0	0.03	0.00
	II	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.00	0.00
	III	0.6	4.0	0.00	0.03	0.01	0.04	0.1	0.8	0.01	0.10
Feb	I	7.0	0.0	0·05	0.00	0.06	0.00	0.1	0.0	0.01	0.00
	II	192.5	41.9	1·34	0.47	1.70	0.74	8.6	8.8	0.94	0.10
	III	35·0	65.1	0·30	0.57	0.31	0.72	5.6	4.8	0.61	0.61
Mar	I	7.0	0.0	0.05	0.00	0.06	0.00	0.2	0.2	0.03	0.03
	II	41.9	74.2	0.29	0.52	0.37	0.82	6.8	18.5	0.75	2.34
	III	91.2	42.7	0.58	0.27	0.81	0.47	23.5	5·0	2 56	0·62
Apr	I	21·8	10·0	0·15	0.07	0·19	0·11	2.2	2·0	0·23	0·25
	II	69·7	64·4	4·83	0.45	0.62	0·71	7.5	14·3	0·82	1·80
	III	195·0	173·0	1·35	1.20	1·72	1·91	25.5	16·3	2·78	2·05
May	I	320·0	207·5	2·22	1·44	2·83	2·29	44.8	26·9	4.89	3·39
	II	191·4	173·0	1·33	1·20	1·69	1·91	16.8	20·2	1.83	2·72
	III	449.4	346·1	2·83	2·18	3·98	3·82	53.0	34·7	5.78	4·37
Jun	I	258·5	363.4	1·80	2.52	2·29	4·01	26·5	14.9	2.89	1·87
	II	487·8	193.2	3·39	1.34	4·31	2.13	44·7	23.8	4.87	3.00
	III	301.9	175.2	2.10	1.22	2.67	1.93	9.2	12.0	1.00	1.51
Jul	I	146.7	140.7	1.02	0.97	1.30	1.55	12.6	9.1	1.37	1.15
	II	463.1	361·5	3.22	2.51	4.10	3.99	38.5	48.8	4.19	6.14
	III	712.6	528.9	4.50	3.34	6.30	5.84	59.8	44.5	6.52	5.61
Aug	I	382.2	250.8	2.65	1.74	3.38	2.77	28.6	26.2	3.11	3.30
	II	590.2	503.1	4.10	3.49	5.22	5.55	31.0	26.1	3.38	3.29
	III	632.3	508.0	3.91	3.21	5.59	5.60	37.4	28.0	4.08	5.53
Sep	I	557.0	520.6	3.87	3.62	4.93	5.74	65.0	48.2	7.08	6.08
	II	937.9	763.0	6.51	5.30	8.30	8.42	106.2	88.2	11.58	11.11
	III	769.6	603.1	5.34	4.19	6.80	6.65	65.6	45.6	7.15	5.74
Oct	I	685.4	596.0	4.76	4.14	6.06	6.58	74.5	87.0	8.11	10.96
	II	252.6	190.1	1.75	1.32	2.23	2.10	24.0	24.5	2.61	3.08
	III	539.2	538.2	3.40	3.73	4.77	5.94	26.2	40.9	2.86	5.15
Nov	I	493.9	529.8	3.43	3.68	4.36	5.84	28.0	29.2	3.05	3.68
	II	791.8	517.3	5.50	3.59	7.00	5.71	29.1	24.3	3.17	3.07
	III	271.6	367.8	1.89	2.55	2.40	4.06	9.3	14.1	1.01	1.77
Dec	I	67.1	41.5	0.47	0.29	0.60	0.46	2.4	3.4	0.26	0.42
	II	2.0	0.0	0.01	0.00	0.02	0.00	0.1	0.0	0.01	0.00
	III	335.0	144.3	2.33	0.91	2.96	1.59	3.8	2.7	0.42	0.34
Annual		11304.5	9064.2			100.00	100.00	917.7	794.0	100.00	100.00

and ceased by 0300 IST of 21 May (third phase of May) then it was taken as a spell of the third phase of May.

3. Discussion

Table 1 gives the mean number of spells, mean duration of a spell (in minutes), and mean amount in a spell (in mm) for the central area of the city designated as C. C. and airport area of the city designated as A. P.

Table 2 gives the duration of the rainfall in a given phase, the percentage of the duration of rainfall to the total period of the phase, *i.e.*,

$$\frac{\text{Duration of rainfall in a given phase}}{\text{Duration of the phase}} \times 100$$

and the percentage of the duration of rainfall to the annual duration of rainfall, *i.e.*,

$$\frac{\text{Duration of rainfall in a given phase}}{\text{Duration of rainfall in the entire year}} \times 100$$

for Bangalore C.C. and A.P.

Table 2 also gives the total amount of rainfall in a given phase and gives the percentage of this amount to the annual total.

TABLE 3

Percentage of the total number of spells of the airport area when rain commenced/ceased within the specified interval (mts) of the commencement/cessation of rain in Bangalore C.C.

Phase		0-30		31-60		61-120		121-180	
		+	—	+	—	+	—	+	—
Jan	I	—	—	—	—	—	—	—	—
	II	—	—	—	—	—	—	—	—
	III	100/100	—	—	—	—	—	—	—
Feb	I	—	—	—	—	—	—	—	—
	II	11.8/23.5	11.8/11.5	11.8/—	—/11.8	5.9/	—	5.9/—	—
	III	27.3/18.2	—/18.2	9.1/—	—	—	—	—	—
Mar	I	—	—	—	—	—	—	—	—
	II	33.3/11.1	11.1/11.1	—/33.3	—	—	11.1/—	—	—
	III	62.5/12.5	—/25.0	—/12.5	—/25.0	12.5/—	—	—	—
Apr	I	33.3/—	—/33.3	—	—	33.3/33.3	—	—	33.3/33.3
	II	4.3/4.3	13.0/13.3	—/4.3	8.7/8.7	4.3/—	4.3/—	—	—/4.3
	III	26.1/21.6	8.7/8.7	4.3—/—	4.3/—	—	—/8.7	—/8.7	4.3/—
May	I	16.7/11.9	23.8/33.3	7.1/2.4	7.1/2.4	2.4/2.4	2.4/7.1	2.4/2.4	—/2.4
	II	21.4/25.0	17.9/17.9	3.6/3.6	7.1/3.6	3.6/—	—	—	—
	III	21.4/18.0	23.2/23.4	7.1/5.4	8.9/12.3	7.1/8.9	1.8/1.8	3.6/—	—/1.8
Jun	I	20.8/12.4	12.4/8.3	—	—/4.2	—	8.3/4.2	—	—/4.2
	II	60.0/54.2	17.1/5.7	2.9/8.6	—/8.6	2.9/2.9	—	—	—
	III	30.0/47.5	25.0/17.5	5.0/—	5.0/5.0	5.0/2.5	2.5/—	—	—
Jul	I	40.0/40.0	14.3/20.0	2.9/—	8.6/5.7	—	2.9/2.9	—/2.9	—
	II	30.2/32.0	22.6/17.0	5.7/13.2	5.7/1.9	—	—	1.9/—	1.9/1.9
	III	47.2/43.4	13.2/7.5	5.7/5.7	5.7/9.5	1.9/3.8	—/1.9	1.9/1.9	—
Aug	I	43.9/36.8	15.8/15.8	5.3/7.0	1.7/8.8	1.7/1.7	3.5/5.3	—	1.7/—
	II	57.8/55.6	8.9/8.9	6.7/8.9	—	4.4/2.2	4.4/2.2	—	—/4.4
	III	30.0/24.0	26.0/24.0	8.0/2.0	4.0/12.0	—	—/8.0	4.0/2.0	—/2.0
Sep	I	33.6/30.8	13.9/8.3	5.5/13.9	5.5/5.5	5.5/2.8	—/8.3	5.5/2.8	2.8/—
	II	31.4/20.0	21.4/30.0	2.9/1.4	5.7/5.7	2.9/4.3	4.3/4.3	—/2.8	—
	III	24.5/22.6	26.4/16.7	5.7/15.1	7.5/15.2	5.7/9.5	3.8/—	1.9/—	1.9/1.4
Oct	I	14.0/22.0	20.0/14.0	6.0/4.0	16.0/2.0	6.0/6.0	—/8.0	—/2.0	—/4.0
	II	5.5/5.5	36.1/30.8	2.8/2.8	11.1/16.7	5.5/2.8	—/2.8	2.8/—	2.8/2.8
	III	14.5/12.9	29.0/35.5	3.2/4.8	12.9/4.8	1.6/—	6.5/9.7	—	1.6/1.6
Nov	I	18.6/23.3	37.2/27.9	4.6/4.6	4.6/6.9	2.3/6.9	2.3/2.3	—	—
	II	17.5/12.3	36.8/33.3	—/1.7	7.0/7.0	—/7.0	1.7/3.5	1.7/3.4	1.7/—
	III	13.5/13.5	24.3/27.0	2.7/2.7	8.1/2.7	—	—	—/2.7	2.7/2.7
Dec	I	16.7/33.3	41.7/25.0	—	—	—	—	—	—
	II	—	—	—	—	—	—	—	—
	III	6.7/6.7	33.3/26.7	—	20.1/6.7	6.7/6.7	—/13.3	13.3/6.7	6.7/6.7

Phase		181-240		241-360		>360	At A.P. only	
		+	—	+	—	+	—	—
Jan	I	—	—	—	—	—	—	—
	II	—	—	—	—	—	—	—
	III	—	—	—	—	—	—	—
Feb	I	—	—	—	—	—	—	—
	II	—	—	—	—	—	—	52.9
	III	—	—	—	—	—	—	63.6
Mar	I	—	—	—	—	—	—	—
	II	—	—	—	—	—	—	44.4
	III	—	—	—	—	—	—	25.0
Apr	I	—	—	—	—	—	—	00.0
	II	—	—	—	—	—	—	65.2
	III	—	—	—	4.3/4.3	—	—	47.8
May	I	—	2.4/—	—	—	—	—	35.7
	II	—	—/3.6	—	—	—	—	46.4
	III	—	—/1.8	—	—	—	—	26.8
Jun	I	—/4.2	—/4.2	—	—	—	—	58.3
	II	—	—/2.9	—	—	—	—	17.1
	III	—	—	—	—	—	—	27.5
Jul	I	2.9/—	—	—	—	—	—	28.6
	II	—	—	—	—/1.9	—	—	32.0
	III	—	—	—	—	—	—	26.4
Aug	I	1.7/1.7	—	3.5/1.7	—	—	—	21.1
	II	2.2/—	2.2/2.2	—	—/2.2	—	—	13.3
	III	—	4.0/2.0	—	—	—	—	24.0
Sep	I	2.8/2.8	2.8/—	2.8/5.5	—	2.8/2.8	—	16.7
	II	—	—	—	—	—	—	31.4
	III	1.9/—	—	3.8/1.4	—	—/1.4	—	16.7
Oct	I	—	—	2.0/2.0	—	—	—	36.0
	II	—/2.8	—	—	—	—	—	33.6
	III	—	1.6/1.6	—	—	1.6/1.6	—	27.4
Nov	I	—	—	2.3/—	—	—	—	27.9
	II	1.7/—	—	—	—	—	—	31.6
	III	—	—	—	—	—	—	48.6
Dec	I	—	—	—	—	—	—	41.7
	II	—	—	—	—	—	—	00.0
	III	—	—/13.3	—	—	—	—	13.3

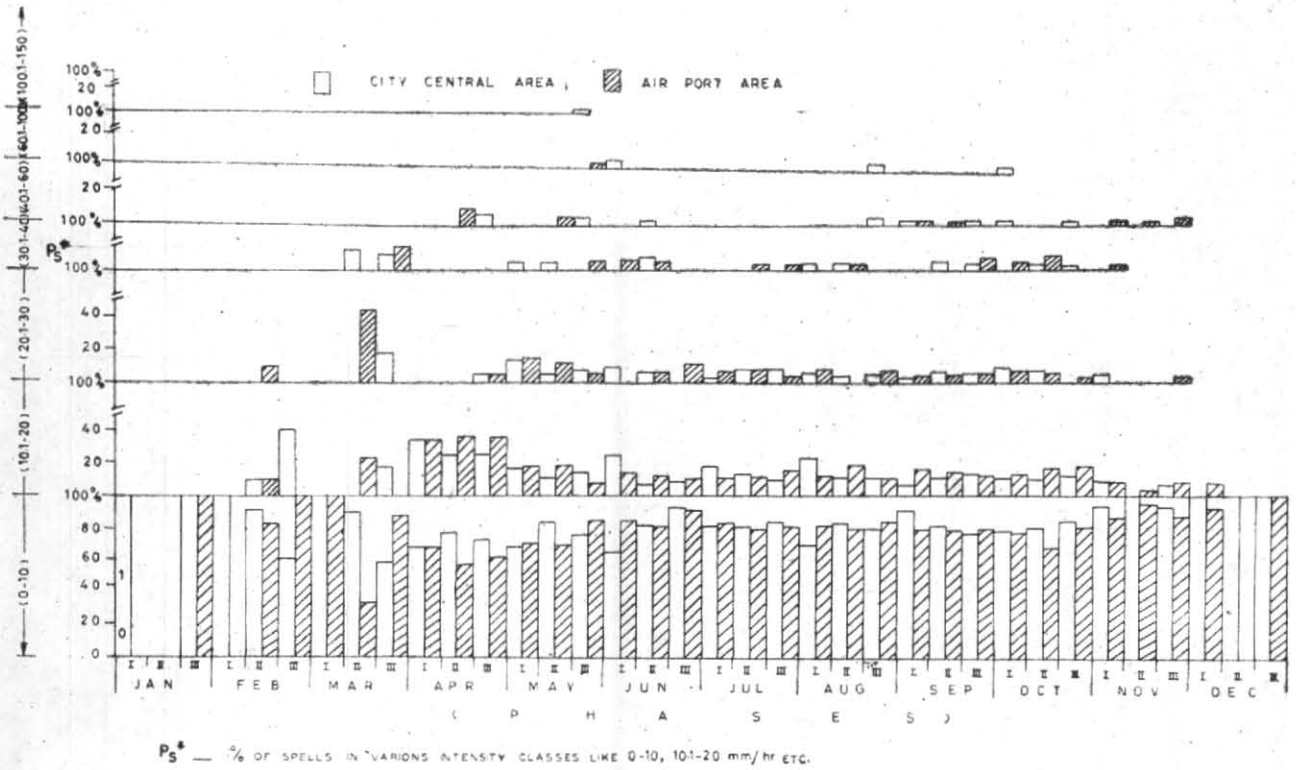

Fig. 2. Percentage of spells in various intensity classes

TABLE 4

Mean characteristics of rain spells for different seasons

Season	Mean No. of spells		Mean duration of a spell (minutes)		Mean intensity of a spell (mm/hr)	
	C.C.	A.P.	C.C.	A.P.	C.C.	A.P.
Winter (Jan-Feb)	3.8	2.4	62.76	56.84	3.7	6.4
Pre-monsoon (Mar-May)	37.6	38.8	36.90	28.12	7.8	7.6
Monsoon (Jun-Sep)	116.2	110.2	53.68	44.57	5.0	5.1
Post-monsoon (Oct-Dec)	65.2	62.2	52.74	47.02	3.4	4.6

Table 3 provides the percentage of number of occasions of various classes of time-delay (+ve or —ve) of the commencement and cessation of rains in the airport area (A.P.) with respect to those in the city Centre (C.C.).

Table 4 gives the mean number of spells, mean duration of a spell and mean intensity of a spell for both the places for different seasons.

Fig. 2 gives the percentage distribution of spells in specified intensity-intervals for C.C. & A.P. and Fig. 3 provides the percentage of number of occasions of various classes of inter-spell durations of C.C. and A.P.

With the help of the aforesaid tables and figures, rainfall characteristics of the airport area and the city centre were compared and the salient features of this comparative study are presented in Table 5.

Now the amount of rainfall in a season is given by : the number of rain-spells × intensity of a spell × duration of a spell.

During the winter, the amount is nearly the same in both the places. But the intensity of a spell is less in C.C. This smaller intensity is made up by the greater number of spells and larger duration of a spell in the case of C.C. to give nearly the same seasonal amount as the A.P.

During the post-monsoon season, obviously the intensity criterion prevails with the result that the rainfall amount of the post-monsoon season is *less* in C.C. than in A.P., because even though the mean duration of a spell and mean number of spells are larger in C.C. the mean intensity is less.

On the other hand, during the monsoon season, even though intensities are nearly equal, the number of spells and the mean duration are larger in C.C.

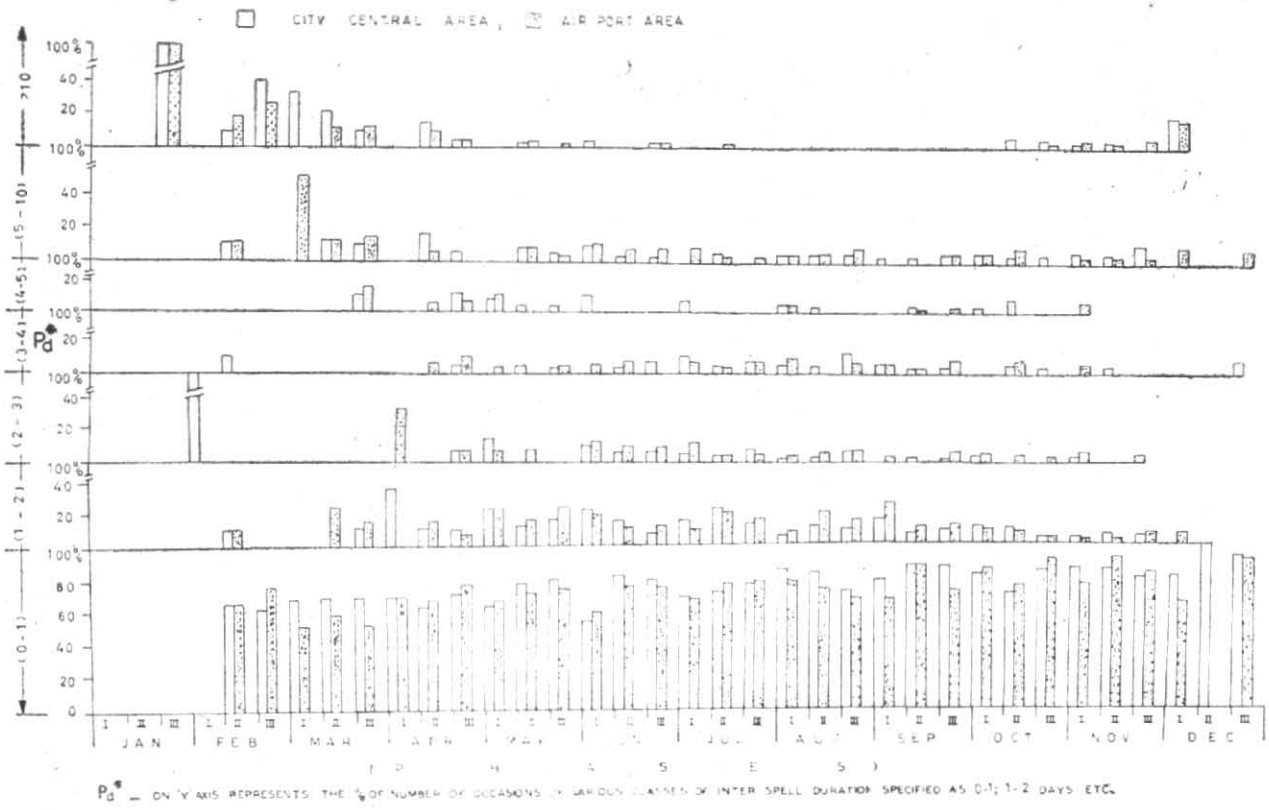

Fig. 3. Percentage of number of occasions of various classes inter spell duration of rainfall in Bangalore

TABLE 5

A comprehensive comparison of the salient features of rainfall characteristics in Bangalore stations

Item	City Centre (C.C.)	Airport (A.P.)	Remarks
	A. Duration		
1. Average duration of the entire annual rainfall	7.85 days (2.15% of the year)	6.29 days (1.72% of the year)	Larger in C.C. (*see* Tables 1 & 2)
2. The average duration of seasonal rainfall	—	—	Generally greater in C.C. The difference is most pronounced in September followed by August, June and July (About 5 to 6 hr) and May (4 hr).
3. Duration of rainfall in each month	About 26 hr (Monsoon) 19 hr (Post-monsoon) 8 hr (Premonsoon) 2 hr (Winter)	About 20 hr (Monsoon) 16 hr (Postmonsoon) 6 hr (Pre-monsoon) 1 hr (Winter)	Generally greater in C.C.
4. Percentage of duration seasonal rainfall to that of annual rainfall of the concerned station	About 55.2% (Monsoon) 30.4% (Post monsoon) 12.3% (Pre-monsoon) 2.1% (Winter)	About 54.2% (Monsoon) 32.3% (Post monsoon) 12.0% (Pre-monsoon) 1.5% (Winter)	Nearly same in both the places.
5. Progression of duration of rainfall monthwise	—	—	In both the cases duration of rainfall generally increases upto September from January, decreases in October and again increases in November to decrease in December.
	B. Amount		
1. Mean annual rainfall	918 mm	794 mm	Rainfall in C.C. is 16% higher than that of A.P. (with A.P. rainfall as the base) (*see* Tables 1 & 2).

TABLE 5 *contd.*

Item	C.C.	A.P.	Remarks
2. Monthly rainfall	Highest in Sept followed by Oct. Third rainiest month is May and the fourth July.	Highest in Sept followed by Oct. Third rainiest month is July and the fourth May.	—
3. Average seasonal rainfall	14.6 mm (Winter) 180.3 mm (Pre-monsoon)	14.4 mm (Winter) 138.1 mm (Pre-monsoon)	Nearly same in both the places. Rainfall in C.C. is about 31% higher than that in A.P.*
	525.1 mm (Monsoon)	415.3 mm (Monsoon)	Rainfall in C.C. is about 26% higher than that in A.P.*
	197.4 mm (Post-monsoon)	226.1 mm (Post-monsoon)	Rainfall in C.C. is about 13% less than that in A.P.* (*A.P. rainfall is taken as the base of comparison).
4. Percentage of seasonal rainfall to the annual rainfall of the station concerned	About 1.6% (Winter) 19.7% (Pre-monsoon) 57.2% (Monsoon) 21.5% (Post-monsoon)	About 0.8% (Winter) 17.6% (Pre-monsoon) 54.3% (Monsoon) 27.5% (Post-monsoon)	Nearly same in both places.
		C. Intensity	
1. Mean intensity of a spell		*see* Table 4	It is nearly same in both the places, in the pre-monsoon and monsoon seasons (Taking season as a whole). In the post-monsoon season, it is slightly less in C.C. than in A.P.In the winter, it is distinctly less in C.C. than in A.P. Mean intensity of a spell is largest in the pre-monsoon season (*see* Table 4 and Fig. 2).
2. Percentage of occurrences of spells in various intensity classes	—	—	The largest percentage of spells occur in 0.1-10 mm/hr range in both the places.
3. The phases when more than 20% of the spells have the intensity 10.1-20 mm/hr.	Feb III, April month, June I & August I	March II and April month	—
4. The percentage of occasions when spells have intensity 40 mm/hr or more	1.9 to 7.6%	1.4 to 8.7%	
		D. Inter-spell duration	
		see Fig. 3	The inter-spell duration is less than a day on about 77% of the occasions. The percentage of occasions of less than a day increases from winter to post-monsoon season. The inter-spell durations is more than 10 days on about 26% of the occasions in winter and it is so only on about 0.5% of the occasions in the monsoon season. The percentage of spells in various inter-spell durations is nearly the same in both the places.
		E. Commencement and cessation of rains	
		see Table 3	Rainfall does not occur at both the places always.
		The lowest percentage of occurrence when R/F occurs only in the A.P. is 13.3%	The percentage of occasions when rainfall commenced in A.P. area later than in the city centre is large in the monsoon season. The percentage of occasions when rainfall commenced later in A.P. area earlier than in the city centre is large in the post-monsoon season.
		On more than 50% of the occasions, rainfall commences, in the A.P. within ±minutes of its commencement in central areas.	Similarly in general the cessation of rain is later in the A.P. on a larger number of occasions than in C.C. during the monsoon and earlier in A.P. than in C.C. during the post-monsoon.

and this results in larger amount of rain in monsoon in C.C.

Thus, it is difficult to resist the implication that larger amount of rainfall is brought about in areas from where the wind blows, either through the mechanism of increased mean intensity of a spell or increase in the number of spells since the A.P. area is situated almost east of C.C. and the prevailing wind is mainly easterly in the post-monsoon season and mainly westerly in the monsoon season.

In the pre-monsoon season, the mean number of spells and the mean intensity of a spell are nearly the same. It is the mean duration of a spell which is larger in C.C. But this fact of spells having larger duration plays a significant role in causing the amount of rainfall being higher in C.C. than in A.P.

As to the reason, why in general, the mean duration tends to be higher in C.C. when intensities are nearly equal, the following explanation is offered. Since the intensities are nearly equal, but the duration is higher in C.C., it can be presumed that clouds tend to grow taller in C.C. before the onset of precipitation in C.C. The clouds tend to grow taller, because the low level convergence tends to be higher in C.C. on account of the increased mechanical obstructions like tall buildings and thermal influences brought into play by the increased urban structures in the city centre whereas the airport area is much more open.

From the remarks given in Table 5 under E, it is apparent that the commencement and cessation of rain, in general, is earlier in areas in the direction from which the wind blows.

This indicates that at least on quite a sizeable percentage of occasions the drift of the clouds along the direction of the prevailing winds can be taken to be responsible for the cause of the rain.

4. Conclusions

The amount of rainfall in the central parts of the city is in general larger, except in the post-monsoon season than in the airport area. It is difficult to resist the implication that the larger amount of rainfall is brought about in areas from where the wind blows either through the mechanism of increased intensity of a spell or increasing the number of spells. This mechanism seems to grow more efficient in the direction from which the wind blows.

The urbanisation and consequent increased convergence and thermal effects seem to cause enhanced thunderstorm precipitation in the pre-monsoon season over the central areas of the city.

Thus, even within a limited area, the rainfall varies considerably and this variation should be seen against the backdrop of the prevailing direction of winds and the influence of urban structures. Similar studies conducted for different but similar pairs of stations would prove very instructive.

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