

Mesoscale study of heavy rainfall of Delhi

A. T. SAHA

Meteorological Office, New Delhi

(Received 6 August 1966)

ABSTRACT. In this study an attempt has been made to examine (1) The striking features of the spatial distribution of heavy rainfall (2" or more in 24 hours), during monsoon (June to October), at Delhi and neighbourhood (about 25 miles around the National Physical Laboratory (N.P.L.) and (2) Any influence of the hillocks on the southeastern parts of Delhi and neighbourhood on the rainfall distribution.

1. Introduction

Delhi (Safdarjung), Lat. $28^{\circ} 35' N$, Long. $77^{\circ} 12' E$, height 709 ft a.s.l. is at a distance of about 600 to 800 miles from the windward seas. The southeastern parts of Delhi and neighbourhood have broken hillocks with ranges 750 to 1000 ft a.s.l (Fig. 1). It is seen that 83 per cent of the annual rain of Delhi falls in the monsoon period (June to October). In this study an attempt has been made to examine (1) The striking features of the spatial distribution of heavy rainfall during monsoon (1940 to 1964) over Delhi and neighbourhood on the occasions when about 40 per cent or more of the stations (about 38 raingauge stations, fewer before 1958), had reported rainfall of 2" or more during 24 hours and (2) To find out whether there is any influence of the hillocks on the southeastern parts of Delhi and neighbourhood on the above rainfall distribution.

2. Source of data

The rainfall data, used in this study were from eight raingauge stations, namely, Narela, Badli, Alipur, Nangloi, Shahdara, Delhi Sadar, Najafgarh, and Mehrauli, maintained by Delhi State, and from the stations Palam, Safdarjung, Delhi University, Okhla and Chandrawal. The rainfall data of Pusa observatory have been received through the courtesy of the Director, Agronomy Division of the Indian Agricultural Research Institute, Pusa. In addition, the rainfall data of 24 raingauge stations, viz., Powerhouse, Loni, Ristal, Burari, Basaidarapur, Pehladpur-Dabas, Bakhtawarpur, Kanjhawala, Nilwal, Mubarakpur, Sahabpur Majra, Sanoth, Gurukul-Indraprastha, Fatehpur-Beri, Chirag-Delhi, Gazipur, Badarpur, Harinagar, Chhawala, Mehpalpur, Hastasal, Sahabad-Muhammadpur, Kapashera, Ghitori, maintained by N. P. L. since 1958, have been obtained from the Rain and Cloud Physics Research Unit, N. P. L., New Delhi.

The rainfall data of the above mentioned eight raingauge stations, maintained by Delhi State, are available since 1940 but with breaks in each

case. The rainfall data of Pusa observatory are available since 1940 without any breaks, just like Safdarjung observatory.

3. Study

On an examination of the daily, monthly and annual rainfall of the above stations, it has been observed that these vary considerably both in space and intensity. The annual rainfall of Delhi was, sometimes, found to be more than double or about half of the normal fall of $25.99''$ (660.1 mm). Twentyfour hours rainfall at some of the stations on 21 July 1958 was as much as the lowest annual rainfall of Delhi (1938). The rainfall in October in some years was more than July and August.

On study of the monsoon rainfall in respect of Palam, Safdarjung, Delhi University and Pusa for 12 years (1952-63), it is found that the mean monsoon rainfall over Palam-Safdarjung area is higher than that of Pusa-Delhi University area. Agarwala (1961) made similar study taking a shorter period.

Table 1(a) shows that the frequency of heavy rain decreases from Palam towards Delhi University. Table 1(b) shows that Mehrauli, Safdarjung and Shahdara, situated at the SE-sector of Delhi have more showers than other stations. Mooley (1959) also observed that in Delhi State the frequency on heavy rain is highest for Mehrauli and lowest for Nangloi. Study of rainfall by Srivastava (1959) and Roy *et al.* (1961) covers much wider area of 60 miles around Delhi and thus may escape the orographic effects of Delhi and neighbourhood on its rainfall.

Intensity of rainfall — On scrutiny of S. R. records of Safdarjung during the period June to October of 1951-64, when the 24-hr rainfall was 2" or more, it is seen that (i) Showers generally consists of 1-3 spells, (ii) Span of showers have a mean period of 8 hours and (iii) Rainfall during an hour centering the highest peak, on 50 per cent occasions, varies from 1.40 to 1.90 inches.

Similar observations about the intensity have also been pointed out (India met. Dep. 1958, 1961).

TABLE 1
Frequency of 24 hours' Rainfall

Rainfall in 24 hrs (in. / mm)	(a) 1952—1963				(b) 1940—1948									
	Safdar- jung	Delhi Univ.	Palam	Pusa	Narela	Alipur	Badli	Nang- loi	Shah- dara	Najaf- garh	Delhi Sadar	Safdar- jung	Pusa	Meh- rauli
2.00—3.00/50.8 — 76.2	20	18	24	18	12	8	12	8	17	16	10	14	14	21
3.01—4.00/76.5 —101.6	5	4	7	8	3	1	2	2	2	2	2	6	1	7
4.01—5.00/101.9—127.0	2	3	6	2	2	1	0	0	1	0	2	3	1	3
5.01—6.00/127.3—152.4	1	1	2	3	0	0	0	0	1	0	0	0	1	1
6.01—7.00/152.7—177.8	3	1	1	2	1	0	0	0	0	0	0	0	0	0
>7.00/>177.8	2	2	0	1	1	0	0	0	0	0	0	0	0	0
Total	33	29	40	34	19	10	14	10	21	18	14	23	17	32

4. Meso-scale study of showers

Twenty-four hours rainfall on an area of about 25 miles sq. around Pusa (NPL) with some 38 rain gauge stations (fewer before 1958) were plotted on a suitable base map. Occasions when 40 per cent or more stations reported rainfall of 2" or more in 24 hours during the summer monsoons (June to October) of 1940-1964 were selected and isohyets were drawn. On an examination of these isohyetal maps (48 in number) it has been observed that—

- (i) The distribution of rainfall even in intense monsoon is not at all uniform. The difference in distribution of rainfall increases with the increase of the intensity of rainfall.
- (ii) The showers (40 per cent stations reporting rainfall 2"—3") seem to be extremely localised and patchy.
- (iii) The heavy showers (more than 40 per cent stations reporting rainfall >3") show some circular or elliptical isohyetal patterns with single (double in two cases) concentrated core inside, and most of the heavy showers (>75 per cent), particularly of heavy ones have the core of maximum precipitation in the eastern or southeastern sector of Delhi State. Figs. 2, 3 and the isohyetal maps published in *Indian Journal of Meteorology & Geophysics* (India met. Dep. 1958, 1961) reveal the above situations. The

isohyetal map in Fig. 4 indicates concentrations of rainfall towards NW sector.

5. Discussion

The orography of Delhi State (Fig. 1) indicates that the 750 ft contour lines generally cover the SE parts, whereas 1000 ft contour lines cover the only extreme south corner of Delhi State with considerable adjoining area south of Delhi. Excepting south Delhi, the Ridge area (covered by 850-ft contour line) is the highest area in the rest State. The SE parts of Delhi and neighbourhood (generally covered by 750-ft contour lines) have broken relief of hillocks.

Now, it has been found out that 12 year mean rainfall during monsoon season over Palam-Safdarjung area is more than that of Pusa-Delhi University area. Table 1(a) shows that the frequency of heavy rain decreases from Palam towards Delhi University and Table 1(b) reveals that SE sector of Delhi have more showers than other stations. The isohyetal study confirms that most of the heavy showers (>75 per cent) have the core of maximum precipitation in the eastern or south-eastern parts of Delhi. Mooley (1959) also observed that the frequency of heavy rain is highest for Mehrauli and lowest for Nangloi.

From the above, it may be inferred that the concentration of heavy rainfall, particularly those of very heavy ones in the eastern or southeastern parts of Delhi may be due to the influence of broken relief of hillocks in these parts of Delhi State and neighbourhood.

REFERENCES

- Agarwala, K. S.
India met. Dep.
- Mooley, D. A.
Roy, A.K. *et al.*
Srivastava, R. C.
- 1961 *Indian J. Met. Geophys.*, 12, 4, pp. 579-582.
1958 *Ibid.*, 9, 4, pp. 386-388.
1961 *Ibid.*, 12, 4, pp. 658-660.
1959 *Ibid.*, 10, 1, p. 59.
1961 *Ibid.*, 12, 3, p. 403.
1959 Proc. Symp. of Meteorological and Hydrological
Aspects of Floods and Droughts in India, p. 115.
Published by India met. Dep.
-