551.577·31(541.38)

The diurnal variation of rainfall at Barahkshetra and Kathmandu during monsoon months

O. N. DHAR

Meteorological Office, New Delhi

(*Received 5 March 1959*)

1. Introduction

Barahkshetra (26° 52′ N, 87° 10′ E) and Kathmandu (27° 42′N, 85° 12′ E) are stations in Eastern and Central Nepal. Kathmandu (4300 ft) is situated in a fairly broad valley in the interior of Central Himalayas while Barahkshetra (470 ft) is a small town in the eastern Nepal-Terai just at the foot of the Shiwalik range where the Kosi river debouches into the plains. Under the Kosi Project, a class II hydrometeorological observatory was started at Barahkshetra in March 1947, and a class I hydrometeorological observatory started functioning at Kathmandu two years later in January 1949. In addition to self-recording and other meteorological instruments, both these observatories are equipped with natural syphon raingauges. Continuous records of self-recording raingauges are available for these two stations for a period of 11 to 13 years. An attempt has been made in this note to study the diurnal variation of rainfall in respect of these two stations from the examination of all available raingauge records.

2. Data

According to Foster (1949) diurnal variation of rainfall will be small at places where precipitation is mainly caused by the cyclonic storms or depressions as these phenomena act irrespective of time of the day. It will be more at places where rainfall is more or less controlled by the local surface heating. Although Barahkshetra and Kathmandu do not lie in the direct path of cyclonic storms or depressions which travel from the head Bay into the interior of the country during the monsoon season, both these places receive more than 80 per cent of the annual rainfall during the four monsoon months from June to September. This is evident from the mean monthly and annual rainfall of Barahkshetra and Kathmandu given in Table 1.

From Table 1, it is seen that July and August are the principal rainy months during which more precipitation is recorded than in the other two monsoon months (*viz.*, June and September).

The onset of monsoon in June is associated with the advance of monsoon current over the Gangetic plains which normally reaches Barahkshetra and neighbourhood by about 8 June and Kathmandu valley on or about 12 June. Monsoon normally withdraws from this area sometime within the first week of October.

For the purpose of this study the available self-recording raingauge data (monsoon months) of Barahkshetra for the period 1947-59 (13 years) and of Kathmandu for the period 1949-59 (11 years) were used. All hourly rainfall amounts of one cent (0·01 inch) or more for each clock-hour of the day for the four monsoon months were tabulated for the above period. Similarly, the occasions of precipitation in each hour were also tabulated. If one cent (0·01 inch) or more of rainfall had occurred during any clock-hour that was counted as a precipitation occurrence under that hour. For each month the total rainfall for each hour of the day for

TABLE 1

Mean monthly and annual rainfall (inches) at Barahkshetra and Kathmandu

	Mean monthly rainfall													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Monsoon rainfall as percentage of annual
Barahkshetra	0·73	0·64	1·35	1·78	5·04	16·10	23·55	26·39	14·10	4·32	0·72	0·03	94·75	84·6
Kathmandu	0·59	0·50	1·10	1·75	4·43	8·77	15·99	14·71	5·86	1·29	0·33	0·11	55·43	81·8

TABLE 2

Highest clock-hour rainfall (in inches) for each monsoon month

Hours	BARAHKSHETRA				KATHMANDU			
	Jun	Jul	Aug	Sep	Jun	Jul	Aug	Sep
1	1·4	2·2	1·7	1·5	2·3	1·1	0·9	0·6
2	1·0	0·9	1·8	1·0	0·7	1·0	0·6	0·4
3	1·6	1·4	1·2	1·1	0·5	0·9	0·8	0·7
4	1·0	1·6	1·6	1·5	0·3	0·7	1·0	0·3
5	0·9	1·1	0·8	0·5	0·5	0·5	0·7	0·4
6	0·7	1·7	0·8	0·3	0·3	0·4	0·5	0·7
7	0·9	0·5	1·6	0·5	0·3	0·3	0·5	0·6
8	1·7	0·5	1·4	0·6	0·3	0·3	0·5	0·2
9	0·7	1·1	0·7	0·3	0·5	0·3	0·2	0·1
10	1·2	1·1	0·6	0·3	0·2	0·1	0·4	0·1
11	0·7	1·1	2·7	0·9	0·7	0·3	0·4	0·2
12	1·2	1·7	1·9	1·7	0·3	0·6	0·4	0·3
13	1·7	1·9	2·7	1·4	0·3	0·3	0·2	1·1
14	1·7	1·7	2·3	1·4	0·8	1·0	0·5	0·2
15	1·3	1·2	1·3	1·3	1·0	0·7	1·1	1·4
16	1·1	1·3	1·6	1·4	0·5	0·4	0·6	1·0
17	0·8	1·4	0·9	1·1	0·4	0·5	0·9	0·4
18	1·6	1·2	1·1	0·5	1·3	1·1	0·7	0·4
19	1·0	1·4	1·5	0·6	0·3	0·6	1·4	0·4
20	0·6	1·6	1·7	0·6	0·5	1·6	0·7	0·6
21	1·5	1·0	2·0	0·8	0·4	1·1	1·0	0·3
22	3·1	2·2	1·9	0·9	0·9	1·1	0·6	0·4
23	1·1	1·3	1·6	1·1	0·6	0·9	0·7	0·3
24	1·3	1·4	0·9	2·7	0·8	0·7	0·6	0·6

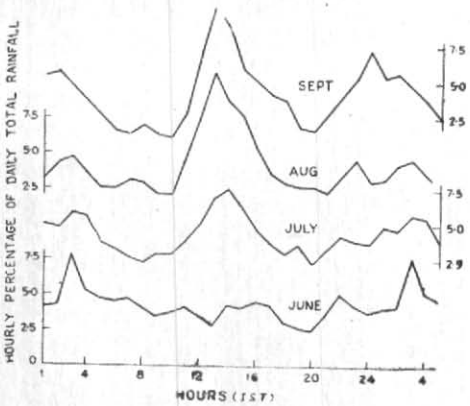

Fig. 1. Diurnal variation of rainfall amounts—Barahkshetra (1947—1959)

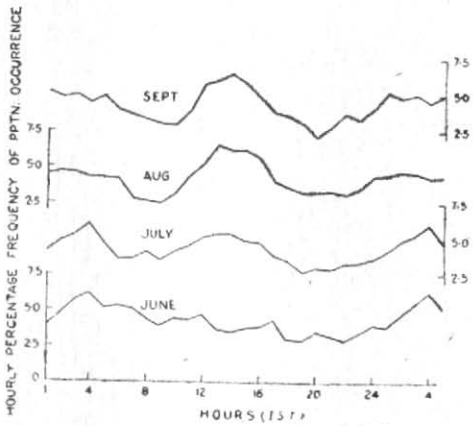

Fig. 2. Diurnal variation of precipitation occurrences—Barahkshetra (1947—1959)

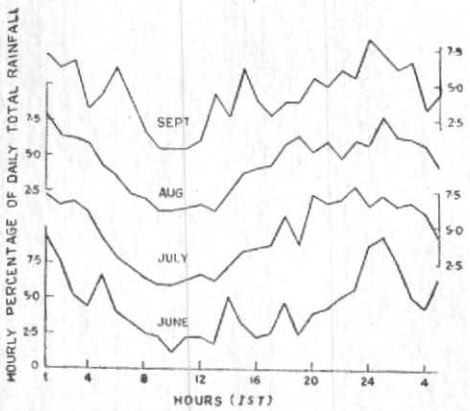

Fig. 3. Diurnal variation of rainfall amounts—Kathmandu (1949—1959)

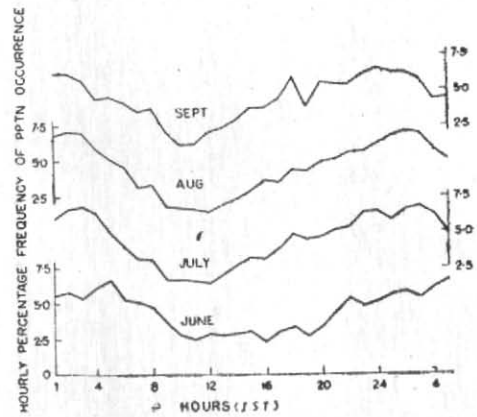

Fig. 4. Diurnal variation of precipitation occurrences—Kathmandu (1949—1959)

all the years was then calculated and from this the mean rainfall for each of the 24 hours was obtained. By adding the individual 24 values, the mean daily total rainfall for each month was computed. From this, the mean rainfall for each clock-hour was expressed as a percentage of mean daily total rainfall during the different months. In the same way, individual hourly percentage frequency (percentage of 24 hours total) of precipitation occurrences were also worked out for both these stations. The respective hourly values of rainfall and precipitation occurrences for different monsoon months have been plotted in Figs. 1-4 as curves of diurnal variation of precipitation.

3. Discussion

No special significance is attached to the short period fluctuations shown in curves (Figs. 1-4) as the data available are for a short period (*i.e.*, 11 to 13 years). The fluctuations may be due merely to random variations. If the average hourly values are

TABLE 3

Highest rainfall (in inches) ever recorded in any clock-hour

Station	June			July			August			September		
	Rain-fall	hr	Date (Year)	Rain-fall	hr	Date (Year)	Rain-fall	hr	Date (Year)	Rain-fall	hr	Date (Year)
Barahkshetra	3·1	22	17 (1948)	2·2	22	29 (1949)	2·7	13	6 (1956)	2·7	24	10 (1949)
				2·2	01	20 (1955)	2·7	11	30 (1956)			
Kathmandu	2·3	01	21 (1950)	1·6	20	19 (1952)	1·4	19	6 (1949)	1·4	15	13 (1953)

based on the data of a sufficiently long period to give stable means, then fluctuations will disappear.

(*a*) *Barahkshetra*—On examining monthly curves in Figs. 1 and 2, it is seen that there is similarity in the shape of the curves of July, August and September. All these three curves exhibit marked afternoon maximum between 13 and 14 hours with two sharp minima on either side. The first minimum occurs between 08 and 10 hours in the morning and the second minimum occurs late in the evening between 19 and 22 hours. There is also a second maximum, though not very prominent, at midnight between 23 and 04 hours. In the month of June, however, the marked maximum and minimum in the distribution of rainfall during the day are absent.

(*b*) *Kathmandu*—The noticeable feature of the monthly curves in Figs. 3 and 4 is the marked minimum in the late morning between 09 and 12 hours and a single maximum late in the night between 23 and 03 hours. Apparently, Kathmandu curves show only one maximum and one minimum during 24-hour period while Barahkshetra curves exhibit two maxima and two minima during the same period. For Kathmandu it is also observed that there is some similarity in shape between the curves for July and August and also those for June and September.

Besides the above study, the highest clock-hour rainfall for each monsoon month for these two stations has also been worked out from the available self-recording raingauge data and is given in Table 2 (p. 154). The highest rainfall ever recorded in any clock-hour for each monsoon month during the period of study has also been noted and is given in Table 3.

4. Acknowledgement

I am thankful to Shri J. Narayanan and Shri V. K. Bhalla for their help in the preparation of this note. I am grateful to Shri K. Parthasarathy, Meteorologist, for encouragement and guidance.

REFERENCE

Foster, Edgar E. 1949 *Rainfall and Runoff*, MacMillan Company, New York.