

# Diurnal variation of rainfall in the upper catchments of north Bengal rivers

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**ABSTRACT.** A study of the diurnal variation of the rainfall during monsoon season, at six selected stations in upper catchment areas of four north Bengal rivers, viz., *Teesta, Jaldhaka, Torsa* and *Raidak* has been attempted on the basis of available data for the period from 1971 to 1976. The different patterns of diurnal variation observed have been discussed.

## 1. Introduction

Prasad (1970) has made a study of diurnal variation of rainfall for three hill stations, four coastal stations and eight inland stations in India. Studies for diurnal variation of rainfall for the country as well as for some individual stations were also made in the past by several workers like Rao and Raman (1958), Rao (1960), Mulky (1958) and Paramanik and Rao (1952). In his study, Prasad has observed that the rainfall over India has one of three patterns of diurnal variation, viz., afternoon/evening maximum, night/early morning maximum and mid-day/afternoon maximum.

Recently, a number of recording rain gauges have been installed under Flood Met. Scheme, in the upper catchment areas of five north Bengal rivers, viz., *Teesta, Jaldhaka, Torsa, Raidak* and *Sankosh*, and hourly values of rainfall for the monsoon months during the period from 1971 to 1976 are available for some of the stations in these areas. As these rivers are prone to flash floods during the southwest monsoon, a knowledge on the time of occurrence of maximum rainfall during each month of the season, over upper catchment areas of these rivers together with a knowledge on the antecedent moisture condition of the basin may provide an idea of time of occurrence of flood peaks at some downstream points of the rivers when heavy rain is expected to occur in these areas. With this end in view, a study of the diurnal variation of rainfall during the months from May to October for six selected stations in these areas have been made on the basis of the available data and the results presented in this paper. The details of the stations considered for the study are given in

Table 1. The locations of these stations in the basin areas are shown in Fig. 1.

TABLE 1

Station	River catchment	Ht. (m) (a.m.s.l.)	Lat. (°N)	Long. (°E)
Darjeeling	Teesta	2128	27° 03'	88° 16'
Garubathan	Do.	300	26 56	88 42
Bagrakote	Do.	204	26 52	88 33
Rongo	Jaldhaka	1189	27 04	88 52
Phuntsholing	Torsa	206	26 51	89 21
Buxaduar	Raidak	824	26 45	89 35

## 2. Data used

The mean values of rainfall during each hour of the day in the months from May to October have been determined. The hourly values of rainfall from 1971 to 1976 were generally considered for this study except for Garubathan, as this station was established only in 1973. Thus, the rainfall data of Garubathan was considered only for the years from 1973 to 1976. The data of Rongo and Bagrakote had breaks in 1972.

## 3. Discussion

On an examination of the patterns of rainfall experienced by these stations it is found that June and July are the rainiest months and pronounced maxima, in general, have been noticed for all these stations, except for Darjeeling, in the night hours and early morning. For Darjeeling, no such pronounced maximum has been

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TABLE 2

Maximum and minimum rainfall during monsoon season in respect of various stations under consideration

Station	Month	Time of peak rainfall (IST)	Average hourly values of rainfall (mm) at peak (X)	Time of minimum rainfall (IST)	Average hourly values of rainfall (mm) at lull (Y)	Values at peak/lull (X/Y)	Max. 1-clock hour rainfall (mm) during 1971 to 1976	Occurrence of max. 1-clock hour rainfall	
								Date	Time (IST)
Darjeeling	Jun	03-04	1.2	06-07 08-09 11-12	0.3	4.0	48.0	11 Jun 75	1400-1500
	Jul	02-03	1.2	08-09 11-12 12-13	0.4	3.0	21.0	15 Jul 74	0200-0300
	Aug	00-01 02-03	0.9	04-05 08-09 11-12	0.3	3.0	27.5	15 Aug 76	0200-0300
	Sep	07-08 13-14 14-15	0.7	08-09 20-21 23-24	0.3	2.3	23.0	4 Sep 76	1400-1500
Garubathan	Jun	20-21	3.1	08-09	0.1	31.0	57.8	10 Jun 74	2000-2100
	Jul	23-24	3.0	10-11	0.3	10.0	50.1	27 Jul 74	2300-2400
	Aug	21-22	3.0	08-09	0.1	30.0	54.9	31 Aug 75	0700-0800
	Sep	00-01	2.1	08-09	0.1	21.0	42.5	7 Sep 76	0100-0200
Bagrakote	Jun	00-01	3.2	08-09 11-12	0.4	8.0	64.7	26 Jun 73	1400-1500
	Jul	23-24	3.1	08-09 10-11 11-12 12-13	0.5	6.2	86.0	28 Jul 74	2200-2300
	Aug	02-03	1.8	11-12	0.1	18.0	68.5	9 Aug 76	2200-2300
Rongo	Sep	00-01	2.0	10-11	0.3	6.7	78.0	3 Sep 71	2100-2200
	Jun	23-24	3.5	08-09	0.4	8.7	68.0	23 Jun 73	2200-2300
	Jul	19-20	4.8	08-09	0.2	24.0	60.5	29 Jul 74	2100-2200
	Aug	17-18	2.6	08-09	0.2	13.0	79.8	12 Aug 72	1700-1800
Phuntsholing	Sep	12-13	2.7	08-09	0.1	27.0	67.8	30 Sep 73	1500-1600
	Jun	02-03 03-04 23-24	2.5	08-09 18-19	0.5	5.0	60.0	23 Jun 73	2200-2300
	Jul	01-02	3.3	08-09 10-11	0.7	4.7	60.0	2 Jul 76	0100-0200
	Aug	00-01	1.9	08-09	0.3	6.3	64.0	28 Aug 74	0100-0200
Buxaduar	Sep	00-01 15-16	1.9	10-11	0.3	6.3	86.0	20 Sep 75	1500-1600
	Jun	02-03	3.7	21-22	0.5	7.4	70.0	26 Jun 75	0400-0500
	Jul	00-01	3.8	09-10 13-14	0.5	7.6	100.0	1 Jul 74	0400-0500
	Aug	00-01	2.7	07-08	0.4	6.7	50.8	20 Aug 71	1300-1400
Sep	02-03 14-15	1.3	09-10 17-18	0.5	2.6	85.0	4 Sep 73	1600-1700	

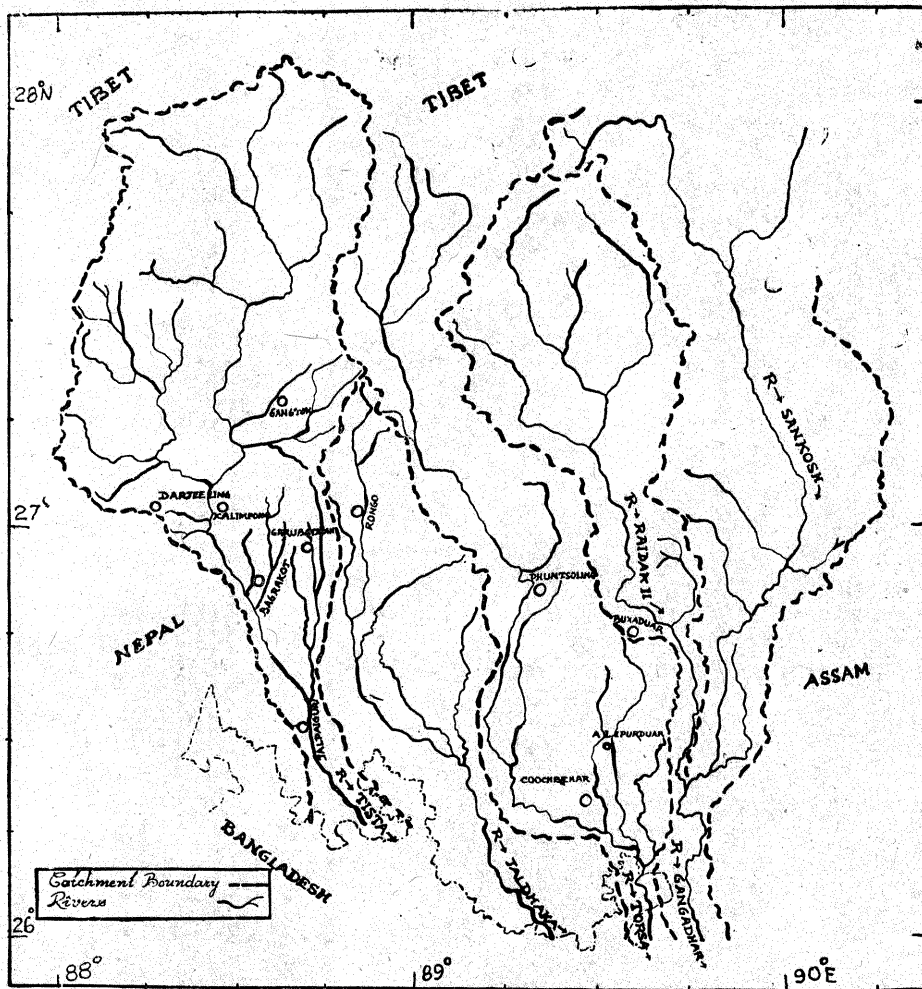


Fig. 1. Basin areas of five north Bengal rivers, viz., Teesta, Jaldhaka, Torsa, Raidak and Sankosh

noticed and the hourly distribution of rainfall for Darjeeling during June to September is more or less even. On a closer examination, the following details are revealed.

3.1. *Darjeeling* — Rainfall is generally less in May. Heavier falls are noticed during 1100-1400 IST and again during 2000-2300 IST in this month. During June to September, there is no pronounced maximum, although between the hours 1800-0400 IST the amount of hourly rainfall is somewhat more than the rest period in June, July and August.

3.2. *Garubathan* — Pronounced maximum is noticed between the hours 1800-0400 IST in June, July, August and September. Thus, during the whole of the monsoon season, more rain is experienced in the night and early morning. Even in the height of the monsoon negligible rainfall is expected during the hours 0800-1200 IST.

3.3. *Bagrakote* — Rainfall maximum is noticed during night and early morning, particularly in June and July. Generally less rainfall per hour is noticed between 0800-1200 IST.

3.4. *Rongo* — Maximum rainfall is noticed between 1900-0500 IST in June and between 1900 & 0100 IST in July. Secondary maxima are also observed in these months between 1200 & 1600 IST. During August and September, maximum rainfall occurs between 1100 & 1800 IST and 1100 & 1400 IST respectively. For a couple of hours between 0800 & 1000 IST in the morning, the amount of rainfall per hour is generally less.

3.5. *Phuntsholing* — Maximum rainfall is noticed between 2200 & 0500 IST in all the four months. During June, August and September rather high hourly values of rainfall are also noticed in the afternoon. Between 0800 & 1000 IST, amount of rainfall per hour is generally less.

3.6. *Buxaduar* — Maximum rainfall is noticed between 0000 & 0500 IST in June, 2200 & 0500 IST in July and August. In August a secondary maximum is also noticed between 0900 & 1600 IST. In September no significant peak or lull is noticed.

Maximum and minimum rainfall during the monsoon in respect of stations under consideration are shown in Table 2.

#### 4. Summary

In the absence of hourly rainfall data for a longer period for the basin areas under study, the available data as presented in this paper may be taken as roughly representative of the rainfall climate of the region. The study brings out clearly that there is a marked tendency of occurrence of heaviest falls during night/early morning hours in the months from June to September at all the stations except Darjeeling. Therefore, the upper catchment areas of the four rivers, viz., *Teesta, Torsa, Jaldhaka* and *Raidak* may be expected to get more water to convert as effective run-off during the night/early morning hours in the monsoon months. Prasad (1970) has observed similar pattern of diurnal variation at Cherrapunji (Lat. 25° 15' N, Long. 91° 44' E and height 1313 m a.s.l.). At Darjeeling no pronounced maximum is observed. The patterns of diurnal variation at Rongo and Buxaduar show a tendency of double maxima, one at night/early morning and another during the afternoon in September.

It appears that as proposed by Bleeker and Andre (1951), at the height of the monsoon, when the moisture content in the air is high, the mechanism of rainfall may be influenced by

katabatic flow in the night. As commented by Prasad (1970), the radiation cooling at the top of the cloud may also be helpful in accentuating the convective activity during the night. The absence of pronounced maximum during night at Darjeeling may be due to the fact that the station is situated in the leeward side of the hill with respect to monsoon current and the katabatic flow is not in opposition with the current. During the month of September, with comparatively less amount of moisture charged in the wind, convective activity is more pronounced, giving rise to afternoon thundershowers at a few of the stations described above.

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#### References

- Bleeker, W. and Andre, M.J., 1951, *Quart. J.R. met. Soc.*, **77**, p. 260.
- Mulky, G.R., 1958, *Indian J. Met. Geophys.*, **9**, p. 403.
- Pramanik, S.K. and Rao, K.N., 1952, *Mem. India met. Dep.*, **28**, Pt. IV.
- Prasad, B., 1970, *Indian J. Met. Geophys.*, **21**, p. 443.
- Rao, K.N., 1960, *Mem. India met. Dep.*, **31**, Pt. II.
- Rao, K.N. and Raman, P.K., 1958, *Proc. Symp. Meteorological and Hydrological Aspect of Floods and Droughts in India*, India met. Dep., p. 186.