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A study of heavy rainfall over the Jaldhaka basin

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सार – आठ वर्षों (1975–82) की वर्षा के आंकड़ों पर आधारित जलढ़ाका बेसिन में हुई भारी वर्षा के दौरों का विश्लेषण समवर्षण (आइसोहाइटल) विधि द्वारा किया गया है। इस अवधि के दौरान इस बेसिन में 1 से 5 दिन की अवधि वाले 48 वर्षा तूफान आये। इनका अध्ययन इनकी सिनॉप्टिक अवस्थाओं के सन्दर्भ में किया गया है तथा इस बेसिन में वर्षा वितरण के मुख्य लक्षणों की विवेचना की गई है।

ABSTRACT. Based on 8 years' (1975-82) rainfall data, the heavy rainspells which occurred over the Jaldhaka basin were analysed by isohyetal method. During this period 48 rainstorms of durations 1 to 5 day occurred over this basin. These have been studied together with their associated synoptic situations and the salient features of rainfall distribution over the basin have been discussed.

1. Introduction

The *Jaldhaka* is one of the major rivers of north Bengal. It originates from Bitang lake in the mountaineous region of southeast Sikkim at an altitude of about 4400 metres and flows through Sikkim, Bhutan and Jalpaiguri and Cooch Behar districts of West Bengal (*see* Fig.1). It finally enters Bangladesh where it joins the *Brahmaputra*. The total catchment area of this river is 4842 sq km. The Jaldhaka drains about 78 sq km in Sikkim, 942 sq km in Bhutan, 3568 sq km in West Bengal and 254 sq km in Bangladesh. During its course, Jaldhaka is joined by many tributaries of which *Murti, Diana, Mujnai, Sutanga, Dharala, Buri* and *Giridhari* are important. The river *Jaldhaka* is also known as the *Mansai* below Mathabhanga town of Cooch Behar district.

In the past several floods occurred in this river causing much devastation. In the year 1954, three successive floods were experienced and 1968 flood was, however, unprecedented.

Abbi *et al.* (1970) and Gupta and Abbi (1972) have made rainstorm studies that occurred over river basins of north Bengal. In recent years more rainfall data are available with the installation of new rainfall stations under the Flood Met Scheme. In this paper, an attempt has been made to study (*i*) rainfall distribution, (*ii*) major rainstorms and (*iii*) their associated synoptic situations over this catchment.

2. Data used

The present study is based on available rainfall data for the period 1975-82 of eight stations, *viz*, Gnathang, Ronge, Changmari (Diana), Nagrakata, Murti, NH-31 Road Bridge over Jaldhaka, Falakata and Mathabhanga* within the catchment and also of fourteen other neighbouring stations as shown in Fig. 1.

3. Salient features of rainfall distribution

The average annual rainfall of the basin is 306 cm, of which 249 cm (81 per cent) is recorded during the southwest monsoon season. The monthly break up of of the annual rainfall is given in Table 1. It is evident from the table that July is the rainiest month followed by August and June. The above figures are slightly higher than those obtained by Gupta and Abbi (1972). According to them July was the rainiest month followed by June and August. The pre-monsoon rainfall of the basin is also considerably high (52 cm). This rainfall is caused mainly due to local thunderstorm activity which is occasionally accentuated by moving troughs in the westerlies.

*All of these eight stations, except Gnathang, were installed during 1970's under Flood Met Scheme.

Fig. 1. Jaldhaka basin showing raingauge network

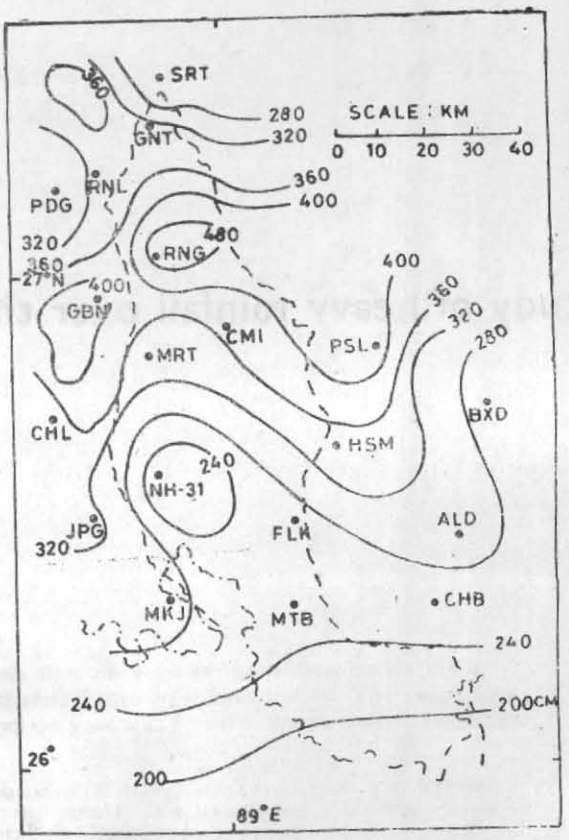

Fig. 2. Mean annual isohyetal map of Jaldhaka basin

TABLE 1

Average monthly and annual rainfall (cm) of the Jaldhaka basin (1975-82)

Month	Rainfall (cm)	Month	Rainfall (cm)
Jan	0.8	Jul	78.0
Feb	1.6	Aug	59.0
Mar	3.7	Sep	43.8
Apr	15.0	Oct	16.1
May	32.9	Nov	1.8
Jun	52.2	Dec	1.2
Annual	306.1≃306 cm		
SW monsoon	249.1≃249 cm		
June to Oct	81% of the annual		

The normal isohyetal maps for annual and southwest monsoon (June to October) for this basin are presented in Figs. 2 and 3. From these figures, it is clear that the maximum rainfall occurs around Rongo, from where it gradually decreases towards north and south of the catchment. Dhar (1977) has observed that Rongo and two other nearby stations, *viz.*, Paren and Samsing, receive a mean annual rainfall of 500 cm or more. This appears to be due to the fact that these stations are located on the southern slope of the eastern Himalayas and highly humid air currents ascend over these areas, during favourable synoptic situations causing heavy rainfall.

4. Rainstorm studies

Daily rainfall data of the stations in and around the basin were analysed by isohyetal method for determining the average areal precipitation. Since the Jaldhaka catchment is prone to heavy and persistent rainfall during SW monsoon season, an average rain depth of 5.0 cm or more was chosen for 1-day storm, while 10.0 cm or more, 15.0 cm or more, 20.0 cm or more and 25.0 cm or more were taken for 2-day, 3-day, 4-day and 5-day rainstorms respectively.

Based on the above criteria, 48 rainstorms of durations ranging from one to five days were selected for this study. The average rain depths of these rainstorms for different durations are given in Table 2. The monthwise distribution of rainstorms (of different durations) is given in Table 3.

Out of 48 rainstorms, 35 are of 1-day, 8 of 2-day, 3 of 3-day, 1 of 4-day and 1 of 5-day durations. Rainstorms of 1-day are obviously most frequent. Majority of the storms have occurred during the months of June and July. The rainstorms of 21 August 1979, 15-16 September 1977, 14-16 July 1978, 12-15 August 1977 and 11-15 August 1977 contributed the highest 1-day, 2-day, 3-day, 4-day and 5-day rain depths respectively. During the period under study, no rainstorm longer than 5-day duration has been experienced over this basin.

5. Synoptic situations associated with major rainstorms

An examination of the synoptic situations associated with the major rainstorms listed in Table 2 has revealed

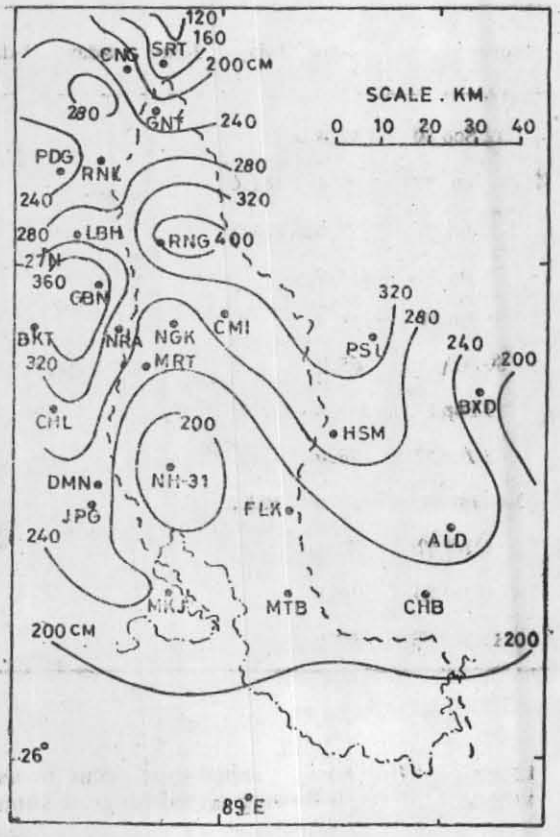

Fig. 3. Mean SW monsoon (Jun-Oct) isohyetal map

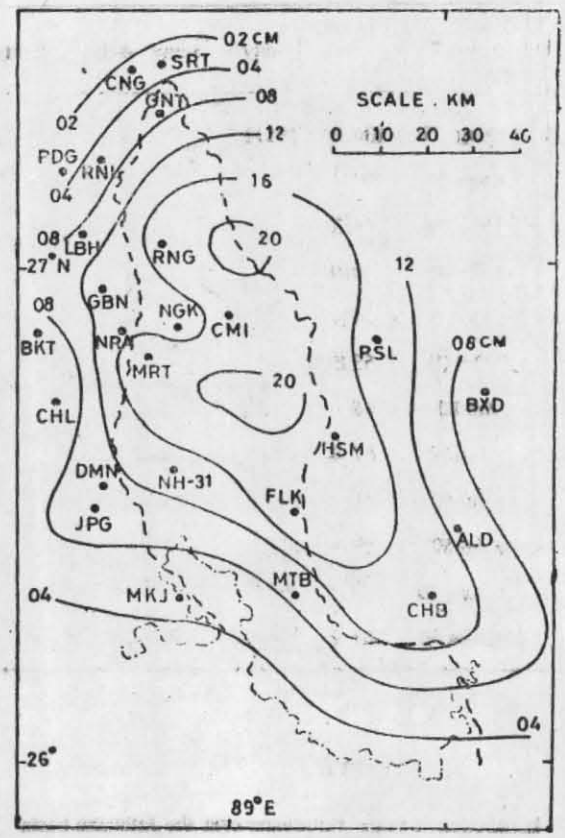

Fig. 4. 1-day rainstorm (21 Aug 1979)

TABLE 2

Average rain depths (in mm) for different durations of rainstorms over the Jaldhaka basin (1975-1982)

Storm period	1-day	2-day	3-day	4-day	5-day
15 Jun 75	64.5				
24 Jun 75	70.6				
20 Jul 75	67.5				
25-27 Jul 75	88.0	140.1	190.2		
1 Sep 75	57.6				
3 Oct 75	52.6				
9 Jun 76	79.4				
14 Jun 76	63.1				
24 Jun 76	54.0				
29 Jun 76	65.5				
1-4 Jul 76	94.7	150.0	202.2		255.0
18-20 Aug 76	54.2	106.1	156.2		
14 Jun 77	50.9				
11-15 Aug 77	67.0	133.2	198.7	264.5	327.0
17-18 Aug 77	69.8	130.0			
25 Aug 77	74.6				
15-16 Sep 77	132.9	208.5			
22-23 Jun 78	63.0	117.2			
4 Jul 78	63.3				
14-16 Jul 78	121.9	181.9	236.4		
2 Jul 79	92.7				
21 Jul 79	106.4				
23-24 Jul 79	117.3	191.6			
27 Jul 79	54.0				

TABLE 2 (*contd.*)

Storm period	1-day	2-day	3-day	4-day	5-day	Storm period	1-day	2-day	3-day	4-day	5-day
20-21 Aug 79	136.2	191.2				12 Sep 80	57.4				
4 Sep 79	100.4					27-28 Jun 81	96.4	181.6			
7 Sep 79	58.3					3-4 Jul 81	79.1	135.7			
10 Sep 79	70.0					28 Jul 81	128.0				
5 Oct 79	74.0					31 Jul 81	65.4				
7 Oct 79	55.5					30 Aug 81	65.0				
15 Jun 80	66.0					13 Sep 81	57.4				
18 Jun 80	61.4					8 Jun 82	78.0				
6 Jul 80	56.4					3-4 Jul 82	73.0	132.5			
16 Jul 80	50.4					6 Jul 82	52.6				
6 Aug 80	74.3					10 Jul 82	68.0				
15 Aug 80	61.2					13 Sep 82	50.0				

TABLE 3

Monthwise distribution of major rainstorms over the Jaldhaka basin (1975-1982)

Duration	Jun	Jul	Aug	Sep	Oct	Total
1-day	10	11	4	7	3	35
2-day	2	3	2	1	–	8
3-day	–	2	1	–	–	3
4-day	–	1	–	–	–	1
5-day	–	–	1	–	–	1
Total	12	17	8	8	3	48

TABLE 4

Significant amounts of rainfall (cm) during 11-15 Aug 1977 recorded at stations in and around the Jaldhaka basin

Station	Dates (Aug 1977)				
	11	12	13	14	15
Falakata	20	23	–	12	–
Jalpaiguri	18	15	–	–	–
Domohani	17	15	–	–	–
Mathabhanga	16	–	20	–	–
Cooch Behar	–	14	–	13	11
Hasimara	–	13	–	–	–
Rongo	–	–	10	–	11

that, over this basin, rainstorms occur in association with any of the following meteorological situations :

(*a*) 'Break' monsoon conditions, *i.e.*, shifting of the axis of monsoon trough close to the foot-hills of the Himalayas,

(*b*) Eastern end of monsoon trough lying north of Lat. 24°N,

(*c*) movement of troughs in westerlies across the eastern Himalayas, and

(*d*) low pressure systems lying over or to the west of the basin.

These include depressions/cyclonic storms originating in the Bay of Bengal and breaking up over the Himalayan foot-hills after moving inland.

It may be mentioned that the above synoptic situations are similar to those associated with heavy rainstorms over north Bengal (Abbi *et al.* 1970); particularly over the Teesta basin (Biswas and Bhadram 1984).

In the following paragraph, the different synoptic situations which combined and resulted in the 5-day rainstorm of 11-15 August 1977 are discussed.

A low pressure area appeared over northeast Madhya Pradesh and adjoining Bihar plateau with associated cyclonic circulation upto 3.6 km a.s.l on 10 August 1977. It moved into east Uttar Pradesh and adjoining Bihar plains on 11th. Moving further east it was located over

TABLE 5

Heaviest rainfall (mm) at stations in the Jaldhaka basin for duration of 1 to 24-hr

Name of station	Duration						24-hr ending	
	1-hr	2-hr	3-hr	6-hr	12-hr	24-hr	at (IST)	on (date)
Rongo	85.5	116.0	120.9	127.6	173.6	245.0	1900	21 Jun 1978
Diana (Changmari)	84.6	112.0	132.0	165.2	257.2	395.8	0800	16 Jun 1977
Nagrakata	75.5	149.5	167.0	188.0	205.5	223.4	1500	15 May 1978
Murti	32.0	51.0	61.0	83.8	91.0	125.6	1000	15 Aug 1980
							0830	26 Jun 1981
Falakata	69.6	86.2	124.2	241.2	262.4	297.6*	0200	30 Jun 1981
Mathabhanga	53.0	93.0	127.0	164.6	193.9	304.4*	0600	14 Aug 1977
NH-31	48.0	81.5	85.2	124.3	192.6	225.5	1300	15 Jul 1978
Highest or envelope values	85.5	149.5	167.0	241.2	262.4	395.8		

*The figures are much less than those mentioned by Dhar (1977)

Bihar plains and Sub-Himalayan West Bengal on 12th and the axis of eastern end of monsoon trough was passing through Motihari, Dhubri and Khonsa. This position of eastern end of monsoon trough corresponds to the synoptic condition (*b*) stated above. On 13th morning, the low pressure area diffused and merged with the seasonal trough and was running close to foot-hills of the Himalayas. The seasonal trough continued to be close to foot-hills of the Himalayas for the subsequent two days, *i.e.*, 14th and 15th. During the period from 10th to 12th, a trough in westerlies also passed over the area.

The significant amounts of rainfall (10 cm or more) recorded at the stations, in and around the basin, on individual days during the 5-day storm period are given in Table 4.

The highest 1,2,3,6,12 & 24-hr rainfall (mm) recorded at the S.R. stations in Jaldhaka basin have been worked out for the period under study and are shown in Table 5. It is seen that the highest observed 1-hour rainfall is of the order 85 mm while the highest 24-hour rainfall is 396 mm.

6. Conclusions

Rainstorms of one-day are most frequent and occur during the months of June and July. Rainstorms generally do not exceed 5-day duration. The presence of seasonal trough to the north of Lat. 24° N is fairly a sufficient condition to yield heavy rainfall over the catchment.

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