556.166 : 551.579.4 (282.253)

A CASE STUDY OF SEVERE FLOODS IN RIVER *BURHI GANDAK*

1. Floods of a severe magnitude occurred in river *Burhi Gandak* in September 1974 and July-August 1975. The river surpassed the highest flood levels at some gauging points. Extensive loss of life and property was reported from some northwestern districts of Bihar in both the years. This note gives a synoptic and hydrometeorological account of the floods.

The river *Burhi Gandak* has its source region in the western slopes of Someshwar range of hills in Nepal Himalayas. Major part of its catchment (about 12,500 sq. km) lies within India and a small portion in Nepal. The river flows southeast for 610 km in a highly meandering and tortuous course through the districts of Champaran, Muzaffarpur, Darbhanga and Samastipur to join *Ganga* opposite the town of Monghyr. During rains it rises very fast and floods a large area of land to a depth of 1 to 1·5 metres.

2. *Synoptic features and associated rainfall of September 1974 floods* — A low pressure area appeared over west central Burma on 7 September 1974. It moved to north Bay of Bengal and neighbourhood on 8th. Moving further west and north it was located over Bihar Plateau, adjoining Gangetic West Bengal and northwest Orissa on 9th (Fig. 1). Associated upper air cyclonic circulation was seen extending upto 5·8 km a.s.l.

The 24-hr rainfall ending at 0830 IST on 9 September are plotted in Fig. 1. A rainbelt delineated with peripheral isohyet of 5 cm can be seen to the northeast of the track of low pressure area from 8th to 9th.

The low pressure area continued moving northwest. It was located over southeast Uttar Pradesh and adjoining northeast Madhya Pradesh on 10th. Cyclonic circulation was now extending only upto 2·1 km a.s.l. with associated trough aloft upto 4·5 km a.s.l. A trough in the westerlies at 500 mb level can be located along 80°E (west of Lucknow). The low was thus positioned in the forward sector of the trough. Concurrently a well marked anticyclonic vortex in the upper troposphere lay over the area extending from east Uttar Pradesh to Assam through Bihar.

With the movement of the low northwestward the rainbelt shifted northwest resulting in the increased intensity of rainfall. Central isohyet of the rainbelt could be observed at a distance

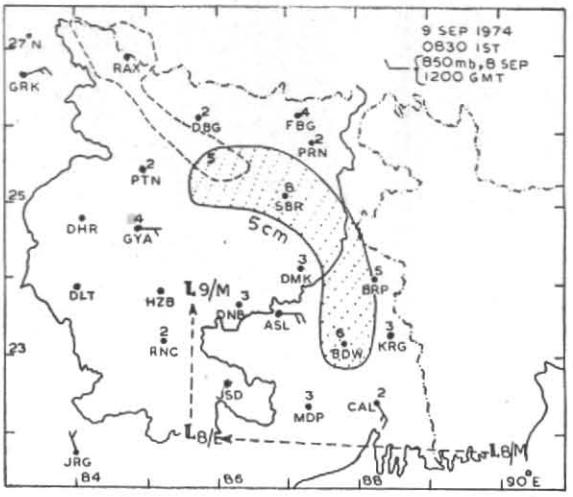

Fig. 1

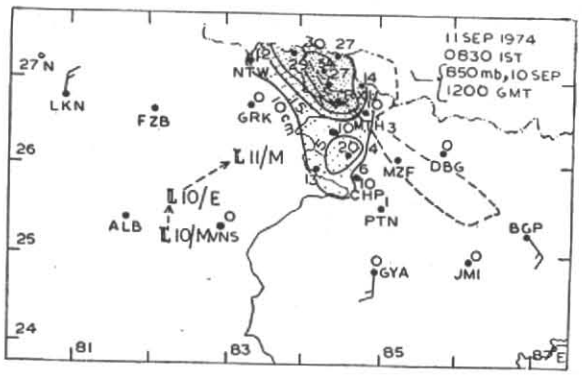

Fig. 2

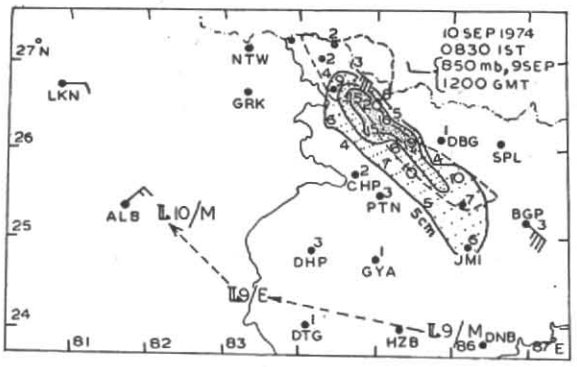

Fig. 3

of about 250-300 km to the northeast of the track of low from 9th to 10th. Rainbelt was concentrated and oriented along the length of the catchment at 0830 IST of 10 September 1974 (Fig. 2). This feature is peculiar to monsoon depressions of September (Rao 1976).

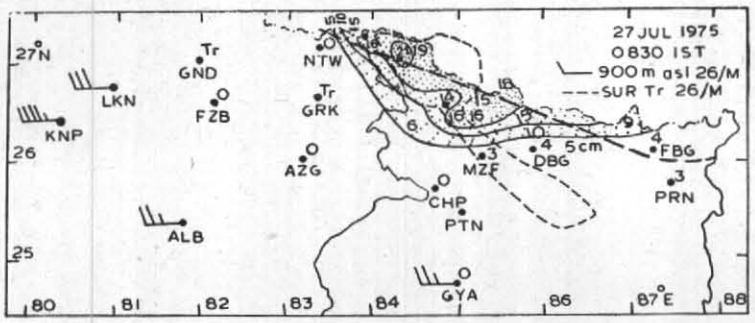

Fig. 4

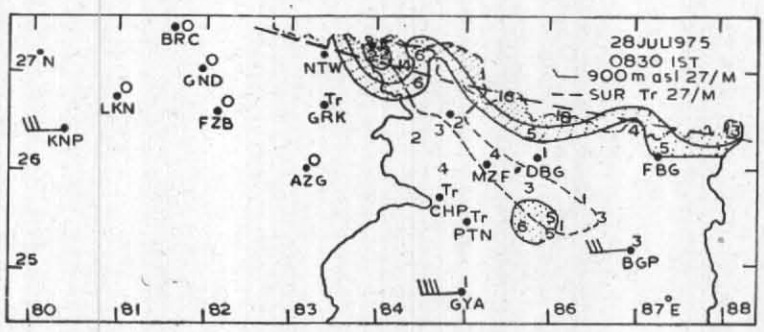

Fig. 5

During subsequent 24-hr the low initially took a slow northerly movement and later recurved northeast. Cyclonic circulation continued extending upto 2·1 km a.s.l. Middle and upper tropospheric features remained practically unchanged.

Rainbelt shifted further northwest and some stations recorded exceptionally heavy falls of the order of 35 cm. Distance of the central isohyet from the mean position of the low from 10th to 11th was about 250 km to the northeast (Fig. 3).

The low pressure persisted over the area till 11th evening. Heavy rainfall continued in some parts of the catchment till 12th.

3. *Synoptic features and associated rainfall of July-August 1975 floods* — Following the movement of a depression from central Bihar to northeast Pakistan, adjoining Punjab and Jammu & Kashmir across Uttar Pradesh and Rajasthan from 18 to 24 July 1975, the axis of seasonal monsoon trough shifted north close to the foothills of Himalayas on 25 July and persisted there till 27th. This resulted in 'Break' monsoon.

A trough in mid tropospheric westerlies over extreme north of the country on 25 July moved eastward to western Tibet on 26 and 27 July. Extending southward into Uttar Pradesh on 27th, it further moved away eastward across eastern Tibet on 28th. This situation was coupled with strengthening of winds in the lower troposphere due to steep pressure gradients prevailing over north India on 26 and 27 July. It is seen from Figs. 4 and 5 that the winds reached 30-40 kt at 900 m a.s.l.

Heavy to very heavy rains occurred along the trough in the submontane belt of Bihar from 26 to 28 July with heavier falls in the northwestern part.

The shifting of seasonal monsoon trough to foothills of Himalayas was brought about by northward movement of a Bay depression. The middle latitude westerly trough seems to have played a dominant role in producing heavy rainfall subsequently and holding the trough close to foothills. As can be seen from the rainfall chart of 27 July (Fig. 4), there was a noticeable southward extension of the belt of heavy rainfall, particularly in the catchment of *Burhi Gandak*, and a general increase in rainfall intensity when the trough was moving across

TABLE 1

Average (isohyetal) areal rainfall for major rainstorms in Burhi Gandak catchment

Period	Average rainfall (cm)		
	Max. one-day	Max. two-day	Three day (total)
12 Sep 1915	10·8	—	—
21-23 Jul 1940	10·4 (21)	20·1 (21+22)	25·8
16-17 Sep 1956	8·4 (16)	12·2	—
30 Jul 1965	14·1	—	—
10-11 Sep 1974	11·5 (11)	19·9	—
26-28 Jul 1975	8·7 (27)	14·5 (26+27)	20·2

western Tibet from 26 to 27 July, its southern end extending into Uttar Pradesh on 27th. As the trough moved further eastward from 27th to 28th, rainbelt also stretched eastward (Fig. 5). As soon as the mid-tropospheric trough moved away eastward, the monsoon trough started shifting south.

4. *Rainstorm of September 1974 and July 1975 vis-a-vis past major storms* — A comparison of the rainfall yields of September 1974 and July 1975 rainstorms was made with a few selected major storms which occurred in the upper catchment of *Burhi Gandak* since 1901 (by depth-area-duration analysis). The storms chosen for comparison were those in which the 24-hr maximum point rainfall occurred in the upper catchment (above Motihari) and which gave high values of average (arithmetic) areal rainfall.

Isohyetal averages for one-day, two-day and three-day duration are shown in Table 1.

It is seen that, as per the criterion adopted here for storm selection, the most severe rainstorm in the catchment occurred in July 1940. Next in order are the storms of July 1975 and September 1974. Amongst the September storms the one of 1974 gave the highest total storm precipitation yield.

5. The study has revealed that the low pressure areas even with not much vertical extension of their associated upper air cyclonic circulations may produce phenomenal rains under favourable middle and upper tropospheric conditions.

6. The author is grateful to Shri S. K. Ghose, Director, Regional Meteorological Centre, Calcutta and Shri A. K. Sen Sarma, Meteorologist-in-charge, Flood Meteorological Office, Patna for helpful guidance and suggestions.

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