

L E T T E R S

551.579.4

A HYDROMETEOROLOGICAL STUDY OF A MOST DEVASTATING FLOOD IN GANGETIC WEST BENGAL IN SEPTEMBER 2000

1. Floods are most common in many basin areas of India causing colossal loss of lives and properties during monsoon seasons. The flood water sometimes stagnant for long duration due to want of adequate drainage system. Though the most responsible factor for flood is excessive rainfall, the drainage system for quick disposal of flood water need proper management.

A severe flood occurred over eight districts of gangetic West Bengal, *viz.*, Birbhum, Murshidabad, Nadia, Burdwan, Hooghly, Howrah, North 24 Parganas and Midnapore from 18 September 2000 and continued upto second week of October 2000. Heavy to very heavy rainfall occurred due to synoptic low pressure system over western part of Gangetic West Bengal (GWB) and adjoining Jharkhand in the basins of the rivers Bhagarathi, Rupnarayan, Mayurakshi, Ajay, Datnodar, Barakar, Jalangi and Brahmani during the period 18-22 September, 2000 resulting a most severe flood on record over the area except the highest severe flood in 1978 (Annual flood report, 2000).

Analysis of flood over different regions have been done by many scientists *e.g.*, Dhar and Changraney (1966) have studied floods over Assam with respect to the meteorological conditions during monsoon season. Chaudhury (1966) studied the meteorological conditions for heavy rain and flood over Ajay catchment. Basu (1989) presented a generalized mathematical model on relationship between rainfall and run-off over a basin area during a rainstorm period. Goldar and Basu (1996) studied an unprecedented flood in September 1992 over the Purulia district of West Bengal by depth-area-duration (DAD) analysis of the rainfall data during the rainstorm period. Mutreja (1986) analysed the DAD curves for the 34 years period (1915-48) for estimation of probable maximum precipitation over Yamuna catchment.

In the present paper an attempt has been made to investigate the aforesaid flood over GWB during September, 2000 by analysing the corresponding depth-area-duration (DAD) of the rainstorm. It is observed that the depth areas covered by the respective cumulative rainfall follow almost quasi-rectangular hyperbolic curves

associated with the movement of the synoptic weather system.

2. Rainfall data of all available stations (including a few from the neighbouring Jharkhand area) during the period 18-22 September, 2000 have been collected from Regional Meteorological Centre, Kolkata and Flood Meteorological office, Asansol.

The cumulative (1 day, 2 days, 3 days, 4 days and 5 days) rainfall data are plotted on the basin maps and isohyets are drawn to obtain the average depth of precipitation. The average depth (\bar{R}) is given by:

$$\bar{R} = \frac{\sum RdA}{\sum dA}$$

Where, R is the average isohyetal value between two successive isohyets covering the area dA , obtained by using planimeter and the summation indicates over the total area.

The danger level data of the rivers Rupnarayan, Damodar and Bhagarathi at five gauge stations at Ranichak (Midnapore), Bandar (Hooghly), Amta (Howrah), Kalna and Katwa (Burdwan), obtained from the Annual flood report 2000, are used to observe the duration of flood in different districts.

3. Initially an upper air cyclonic circulation (CYCIR) extending up to 3.1 km above mean sea level was observed over Jharkhand and adjoining GWB on 17th September 2000, which was actually the remnant of the low pressure area (LOPAR) formed over east-central Bay of-Bengal on 12th and subsequently moved northwestward towards GWB and Jharkhand. On 17th evening the system was over Jharkhand. It moved eastward on 18th morning, became well marked low pressure (WML) on 19th morning and remained practically stationary over the districts Birbhum and Burdwan and adjoining Purulia and Bankura of GWB and adjoining Jharkhand till 19th evening. The WML then moved westward and gradually weakened into a LOPAR on 20th evening over Jharkhand and adjoining GWB. It moved further northwestward and on 21st morning the LOPAR was over Jharkhand and adjoining east Uttar-Pradesh and Bihar (Fig. 1).

Under the aforesaid synoptic situation four districts of GWB (Birbhum, Nadia, Burdwan & Murshidabad) and adjoining Jharkhand were affected by heavy to very heavy

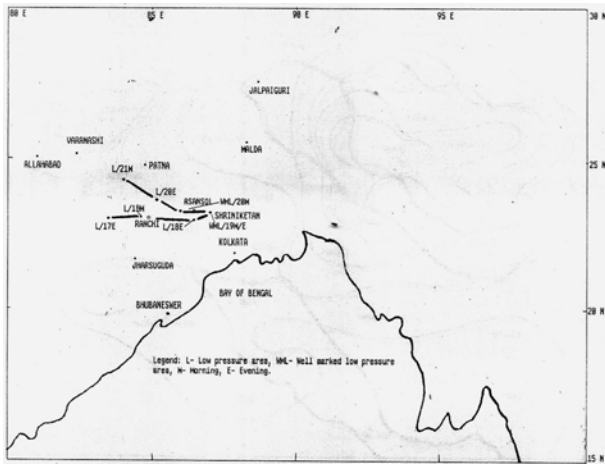


Fig. 1. Synoptic weather situation during 18-21 September, 2000 for heavy rainfall

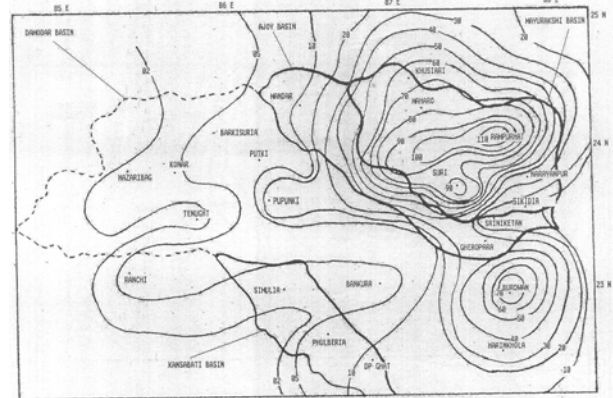


Fig. 4. Isohyets (cm) of watershed areas for the rainstorm from 18-28 September, 2000

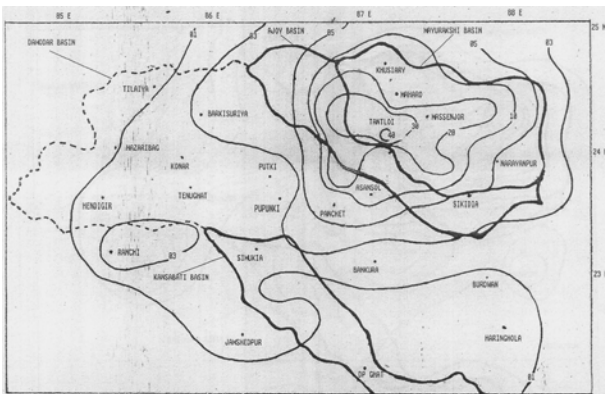


Fig. 2. Isohyets (cm) of watershed areas for the rainstorm on 18th September, 2000

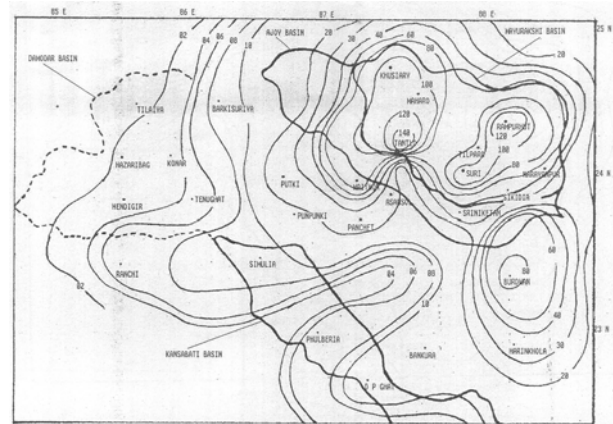


Fig. 5. Isohyets (cm) of watershed areas for the rainstorm from 18-21 September, 2000

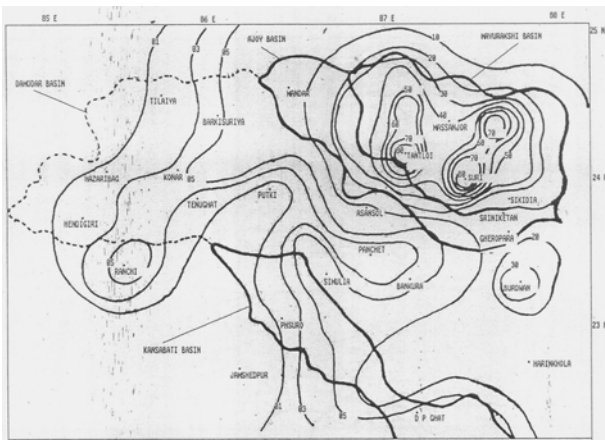


Fig. 3. Isohyets (cm) of watershed areas for the rainstorm from 18-19 September, 2000

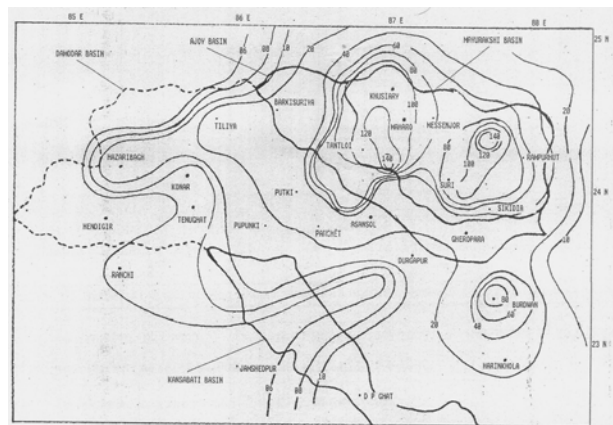


Fig. 6. Isohyets (cm) of watershed areas for the rainstorm from 18-22 September, 2000

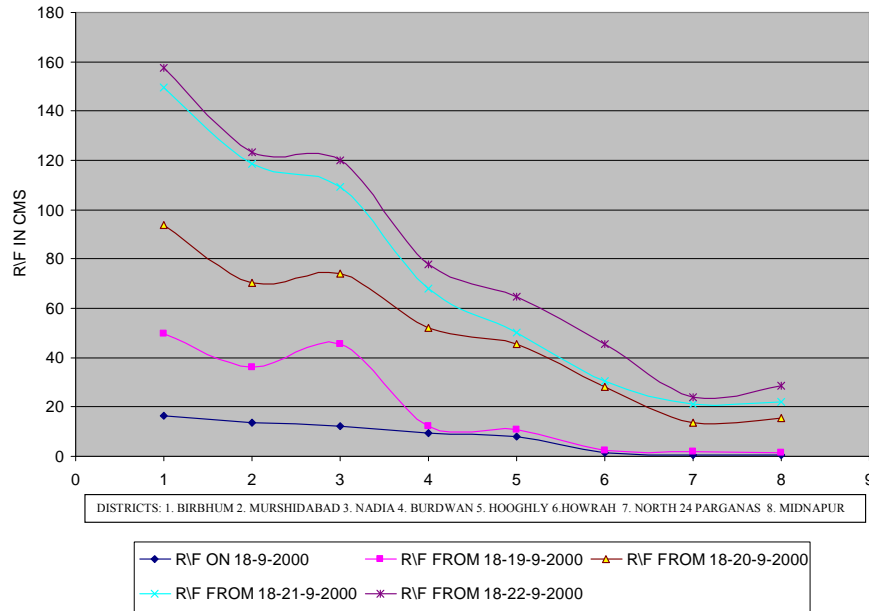


Fig. 7. District wise average rainfall for different durations

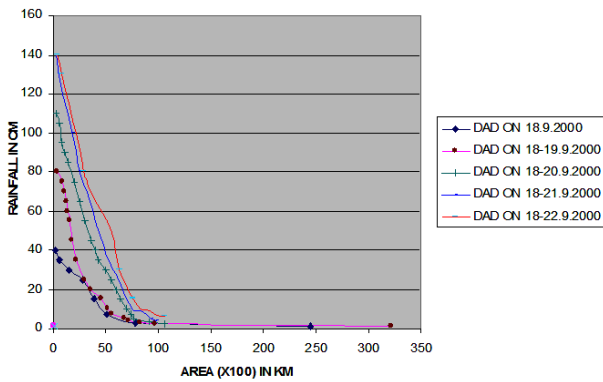


Fig. 8. Depth - Duration - Curve of different durations

rainfall from 18th to 22nd September 2000. The isohyetal maps with cumulative rainfall (1 day, 2 days, 3 days, 4 days & 5 days starting from 18th) over the districts of GWB and adjoining Jharkhand are shown in Figs. 2 to 6. The district wise average rainfall for 5 days obtained by computing the rainfall data of different districts using planimeter may also be seen from Table 1 and Fig. 7. It is observed that on 18th the concentration of rainfall maxima was of the order of 40 cm near Tantloi (Fig. 2) in the western part of the district Birbhum and adjoining eastern part of Jharkhand. Along with the movement of the synoptic system the rainfall maxima on 19th was near Suri (Fig. 3) in central Birbhum district. On 20th the maximum concentration was near Rampurhat (Fig. 4) in north



Fig. 9. Inundated area of West Bengal during September 2000 flood.

Birbhum as the movement of the weather system was very slow over the region. On 21st the maximum concentration of rainfall were near Tantloi and also near Rampurhat in Birbhum district (Fig. 5) when the system moved slowly

TABLE 1

District wise average depth of rainfall in cms

Name of districts	18 September 2000	18 to 19 September 2000	18 to 20 September 2000	18 to 21 September 2000	18 to 22 September 2000
Birbhum	16.46	49.59	93.83	149.53	157.49
Murshidabad	12.05	45.62	74.07	109.10	120.12
Nadia	13.50	36.20	70.20	118.60	123.2
Burdwan	9.49	12.13	51.84	68.09	77.94
Hooghly	8.12	10.56	45.62	50.09	64.76
Howrah	1.39	2.57	27.93	30.28	45.37
North 24-Parganas	0.61	1.73	13.59	21.15	23.79
Midnapur	0.67	1.59	15.60	22.07	28.65

TABLE 2

Gauge height over different rivers above danger level

Station / (district/ river)	Danger level in metre	Date of crossing danger level	Date of reaching below danger level	Maximum level reached in metre	No. of days above danger level
Ranichak / (Midnapur/ Rupnarayan)	5.33	21 September 2000	01 October 2000	7.81	11 Days
Bandar/ (Hooghly/ Rupnarayan)	6.85	21 September 2000	29 September 2000	8.36	9 Days
Amta / (Howrah / Damodar)	5.64	20 September 2000	01 October 2000	6.86	12 Days
Katwa / (Burdwan / Bhagirathi)	13.71	20 September.2000	28 September 2000	15.75	9 Days
Kalna / (Burdwan/ Bhagirathi)	7.63	20 September 2000	06 October 2000	10.31	17 Days

westward. On 22nd the rainfall maxima occurred near Rampurhat and Sikadia around east Jharkhand (Fig. 6), when the system moved further westward and weakened gradually.

4. On the basis of the isohyetal analysis (as in §3) for cumulative rainfall of different spells the depth-area-duration (DAD) curves are shown in Fig. 8. The DAD curves follow a quasi-hyperbolic nature and show the spatial distribution of rainfall with the associated system. Also it is observed from Table 1 and Fig. 7 that the maximum rainfall occurred over the Birbhum district followed by the districts Nadia and Murshidabad. But the

flood extended over a large area in other districts also. The inundated area in different districts of West Bengal due to this flood may be seen in Fig. 9. District wise the flood inundated areas were : 2016 sq km (49 %) in North 24 Parganas, 3731 sq km (95 %) in Nadia, 4525 sq km (85%) in Murshidabad, 3182 sq km (70 %) in Birbhum, 2458 sq km (35%) in Burdwan, 912 sq km (29%) in Hooghly, 293 sq km (20%) in Howrah and 226 sq km (5%) in (east) Midnapur. (Annual flood report 2000).

The heavy rainstorm compelled the different dam/ barrage authorities to release water. Inundation was caused by discharge of water from the Massanjore dam

and Tilpara barrage over Mayurakshi river and also from Damodar Vally corporation reservoirs at Maithon over Barakar river and Panchet over Damodar river. These ultimately raised the river levels over Rupnarayan, Ajay and Damodar rivers enhancing the flood situation. This may be observed from the river-gauge levels of Rupnarayan river at Ranichak and Bandar, Damodar river at Amta and Bhagirathi river at Kalna and Katwa (Annual flood report 2000), where the river levels remained above the danger levels for long time, as shown in Table 2.

It is interesting to note that the flood situation started at the districts Nadia and North 24 Parganas from 23rd September, 2000 when the rainfall was almost nil there. This indicates that the inflow of surface discharge was responsible for flood over these districts. Further, though the rainfall over the district North 24 Parganas was significantly less in comparison to other flood affected districts, the flood water stagnated there for about a month. This was mainly due to overflow from the river Bhagirathi as the siltation in river beds possibly reduced the carrying capacity of the river. Also the poor drainage system in the region resulted longer stagnation of the flood water.

5. The heavy to very heavy rain associated with different synoptic weather situations leading to floods particularly during the monsoon months are not uncommon. The only speciality of this September, 2000 flood was its long duration in areas with lesser rainfall.

This study reveals that the heavy rainfall over different areas was associated with the shifting of the synoptic weather situation. In spite of very heavy rainfall the flood water receded from the districts Birbhum and Murshidabad in less than two weeks. But in the district Nadia and also in the district with lesser rainfall *i.e.*, North 24 parganas the flood water persisted for more than a month. The longer duration of stagnant flood water in these two districts (Nadia and North 24 parganas) was possibly due to lack of proper drainage system. Also the sudden release of water from different dams and reservoirs together with low capacity of the river system

due to siltation possibly enhanced the devastating condition. The overall picture reveals that planning for quick and proper drainage system (during rainstorm period) is very important for flood management.

6. The authors are grateful to Shri S. N. Roy, DDGM, R.M.C. Kolkata for encouragement and Dr. G. C. Basu, co-ordinator, Dept. of Atmospheric Science, University of Calcutta and Ex-Director of IMD for inspiration and valuable discussion. Thanks are also due to Shri S. Debnath, S.A. for typing the manuscript and Shri D. Roy, D' man of R.M.C. Kolkata for drawing the figures.

References

- Annual Flood Report 2000, "Irrigation and Waterways Directorate 2001, Govt. of West Bengal".
- Basu, G. C., 1989, "A mathematical model of relationship between rainfall and runoff during rainstorm period over a basin area", *Vayu Mandal*, **19**, 1&2, 33-35.
- Chaudhury, A. K., 1966, "On the meteorological conditions responsible for heavy rainfall in Ajay catchment area", *India J. Met. & Geophys.*, **17**, 127-132.
- Dhar, O. N. and Changraney, T.G., 1966, "A study of meteorological situations associated with major floods in Assam during the monsoon months", *India J. Met. & Geophys.*, **17**, 111-118.
- Goldar, R. N. and Basu, G. C., 1996, "A study of unprecedented flood in September, 1992 in Purulia district (West Bengal)", *Vayu Mandal*, **26**, 1 &2, 32-38.
- Mutreja, K. N., 1986, "Applied Hydrology", Tata McGraw-Hill Publishing co. Ltd. Chap., **5**, p226.

P. K. CHAKRABORTY
S. CHATTOPADHYAY

Regional Meteorological Centre, Alipore, Kolkata, India
(11 March 2011, Modified 16 August 2011)
e mail :pk.chakraborty@imd.gov.in