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A study on the Floods in West Bengal and West Uttar Pradesh during September-October 1956*

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ABSTRACT. In connection with the study of extensive floods during September and October 1956 in West Bengal and parts of Uttar Pradesh, old records of rainfall dating from 1891 were examined. Several periods of heavy rainfall during the period, end of September to beginning of October, were found. Detailed examination of the district rainfall, with the help of standard deviation and coefficient of variation of daily rainfall during the chosen period revealed considerable variability within the district. One case (1922) has been studied further by considering the isohyets during the period of heavy rainfall. In the case of Jamuna Floods a few self-recording raingauges in the mountainous catchment were used to prepare the intensity-pattern. These on comparison with the hydrograph at Tajewala show striking characteristics. Delhi self-recording raingauge records and Jamuna Bridge river gauge records have also been examined. It is concluded from the above studies that the heavy rainfalls towards the end of September and early October 1956 were not absolutely unique. Cases of early occurrence of heavy rainfall during the same period are available, thus showing that heavy rainfalls have occurred in the past during the period, end of September and early October when there were no atomic or thermo-nuclear explosions polluting the atmosphere, contrary to a popular view which seems to have gained ground that the 1955-56 heavy rainfalls are unique and direct result of atomic explosions.

1. Introduction

Destructive floods were experienced in the central districts of West Bengal during the last week of September 1956. One of the primary causes attributed to these floods is the heavy and continuous rainfall experienced in West Bengal during this period. Also there were heavy rains in the northwest Uttar Pradesh and the Punjab on 8 and 9 October 1956 leading to considerable flooding. A popular view seems to have gained ground that these heavy rainfalls in the past two or three years are the direct results of atomic explosions that take place in the northern and the southern hemispheres from time to time.

The synoptic meteorological study of the situations that are associated with very heavy rainfall in West Bengal and also in other parts of northern India during the last part of September and early October comes under the purview of the general study of precipitation. It appears that the occurrence of the heavy rainfall can be attributed to three factors—(1) The axis of the extended seasonal trough of low pressure in the Bay of Bengal and the Arabian Sea lay in a more SE-NW orientation than is usual at such times, (2) The passage of a 'low' from the east Bay of Bengal along the above mentioned axis and the formation of a depression off Bombay and (3) The eastward passage across the Punjab and Kashmir of two active low pressure waves in close succession.

From the preliminary synoptic meteorological studies there appears to be a strong indication that very heavy rainfall of this year and similar cases in previous years, especially when it occurs at the end of or just after the southwest monsoon season, is caused by a combination of a number of *weather factors* a few of which are of definite tropical origin and the others are of extra-tropical origin. It appears that when these two different systems affect Indian areas simultaneously, the occurrences of very

* A portion of this investigation was undertaken as a result of one of the recommendations of the Fifth Meeting of the Ganga River Commission requesting the India Meteorological Department to prepare a note on the West Bengal (September 1956) floods for presentation before the Central Flood Control Board Meeting in early 1957.

heavy rainfall are experienced. And of course, the massive mountain ranges further modify the weather pattern, by exerting their perturbing influence. This hypothesis can be fully established only after much detailed examination and a great deal of work in synoptic analysis and related investigations in dynamical meteorology are completed.

2. Study

In order to answer the question whether such very heavy rainfall during the period late September and early October had been known in the past, all previous records of rainfall were examined and it is found that in previous years there had been occasions when very heavy rainfall occurred in West Bengal during the period in question. Table 1 gives the years when such heavy rainfalls occurred. It also gives the average daily rainfall of the districts for the periods of heavy rainfall, their standard deviation and the coefficient of variation. It is seen that there were eight such occasions and on half the occasions the heavy rainfall was confined to North Bengal only. The daily average rainfall of the districts concerned is also plotted in graphs (Fig. 1) to clearly indicate the nature of the time distribution of the storm rainfall. It should be mentioned that the standard deviation and the coefficient of variations of the daily rainfall show that there are considerable differences in the daily rainfall of different raingauges in the same district. The obvious conclusion would be that the very heavy rainfalls are more localised. Therefore, the ideal approach would be to study also isohyetal patterns obtained from the daily rainfall of individual stations or at least from the total rainfall of the period at these stations. The case of rainfall during 1922 is rather striking, as it was very extensive covering as many as nine districts in central parts of Bengal (25,000 sq. miles). The rainfall during the period 21 to 28 September 1922 was followed by another spell of slightly lesser intensity during the period 30 September to 7 October. A detailed examination of this situation has been carried out and the map (Fig. 2) shows the distribution of the isohyetals for this period.

Examination in such details for the case of floods in 1956 would be possible only after the State rainfall data are available. As occurrence of floods depends on factors other than rainfall, such as the antecedent and subsequent condition of the area, the precedent surface run-off in the different channels of all the rivers in the area concerned, it is necessary for the complete study of floods that these factors should also be studied in detail. In the mean time all available rainfall data mainly from departmental observatories for 25 and 26 September 1956 have been plotted and isohyetals have been drawn as shown in Fig. 3. The map shows that the heaviest rainfall was experienced on these two days in the central part of West Bengal with heavy falls extending into areas of southwest and south Bengal.

It would be interesting to see whether the late heavy rains in west Uttar Pradesh and the Punjab in the year 1956 are something new or there have been instances of this in the past years. An examination of old records, starting from the year 1891, shows that in the past there have been occasions when very heavy rainfall amounting to 10″ or more in 24 hours occurred over several districts in Uttar Pradesh towards the end of September or in the beginning of October. The instances are shown in Table 2.

A few cases out of the above listed occasions are of particular interest in the present context. It is seen that in the year 1894 there was heavy rain in the districts of Banda and Azamgarh from 30 September to 5 October, followed by very heavy rain in Almorah district from 3 to 7 October and in Nainital district from 4 to 6 October.

In the year 1903, there was very hevy rainfall in Jaunpur district from 30 September to 4 October and then from 8 to 12 October there was very heavy rainfall over the districts of Hardoi, Furkhabad, Etah, Shahjahanpur and Budaon.

TABLE 1

	Name of districts	No. of rain-gauges of which data used	Total area (sq. miles)	Date	Average rainfall (inches)	Standard deviation	Coefficient of variation
September 1898	Jalpaiguri	5	8949	14	0·33	0·49	148·5
	Darjeeling	6		15	1·34	1·65	123·1
	Cooch Behar	5		16	4·37	3·18	72·8
	Rangpur	8		17	2·54	1·75	68·9
				18	0·10	0·21	210·0
September 1899	Darjeeling	7	1160	22	0·07	0·11	157·1
				23	0·57	1·08	189·5
				24	3·66	1·44	39·3
				25	8·87	6·82	76·9
				26	0·02	0·03	150·0
September 1899	24 Parganas	8	15,531	22	0·66	0·89	134·8
	Howrah	3		23	3·52	1·67	47·4
	Bankura	10		24	2·23	2·04	91·5
	Midnapore	8		25	0·01	0·01	100·0
	Birbhum	6		26	0	0	..
September 1902	Jalpaiguri	7	8949	24	0·04	0·10	250·0
	Darjeeling	6		25	1·04	0·74	71·1
	Cooch Behar	5		26	2·14	1·18	55·1
	Rangpur	8		27	5·96	3·42	57·4
				28	0·17	0·36	211·8
September 1922	Cooch Behar	5	25,076	21	0·46	0·82	178·3
	Rangpur	8		22	1·03	1·02	99·0
	Dinajpur	12		23	1·17	1·53	130·8
	Malda	4		24	3·67	2·54	69·2
	Rajshahi	2		25	4·55	3·08	67·7
	Bogra	7		26	4·42	4·38	99·1
	Mymensingh	9		27	2·15	2·32	107·9
	Pabna	4		28	0·48	1·34	279·2
	Faridpur	10					
September—October 1922	Dacca	8	9114	30	0·06	0·25	416·7
	Mymensingh	11		1	0·74	0·58	241·7
				2	0·68	1·19	175·0
				3	1·98	1·72	86·9
				4	1·31	1·01	77·1
				5	2·36	2·01	85·2
				6	0·43	0·81	188·4
				7	0·11	0·33	300·0
September—October 1922	Jalpaiguri	8	2962	30	0		
				1	0·03		
				2	0·01		
				3	0·33		
				4	1·13		
				5	0·61		
				6	0·14		
				7	0·53		
September—October 1922	24 Parganas	10	5293	30	0·08		
				1	0·37		
				2	1·36		
				3	1·00		
				4	0·30		
				5	0·41		
				6	0·07		
				7	0·20		

TABLE 1 (*contd*)

	Name of districts	No. of rain-gauges of which data used	Total area (sq. miles)	Date	Average rainfall (inches)	Standard deviation	Coefficient of variation
September—October 1937	Dinajpur	14	8438	27	0·18	0·30	166·6
	Malda	5		28	0·51	0·58	113·7
	Rajshahi	9		29	2·23	1·67	74·9
				30	4·23	2·77	65·5
				1	2·49	4·13	165·9
				2	0·53	0·94	177·3
September—October 1937	Faridpur	10	6823	27	0·64	0·70	109·4
	Bakarganj	8		28	3·16	3·14	99·4
				29	2·00	2·14	107·0
				30	0·17	0·31	182·3
				1	0·01	0·05	500·0
				2	0·12	0·32	266·7
September 1943	Jalpaiguri	6	8068	23	0·07	0·15	214·3
	Dinajpur	12		24	0·38	0·48	126·3
	Darjeeling	5		25	0·78	0·95	121·8
				26	2·02	1·55	76·7
				27	2·86	2·52	88·1
				28	2·66	2·19	82·3
				29	0·39	0·48	123·1
				30	0·12	0·25	208·3
September 1946	24 Parganas	8	26,914				
	Nadia	4					
	Murshidabad	12					
	Burdwan	7		14	0·07	0·25	351·1
	Birbhum	5		15	0·86	1·88	218·6
	Bankura	21		16	2·06	2·39	116·0
	Midnapore	15		17	1·94	2·63	135·6
	Hooghly	7		18	0·34	0·59	173·5
	Howrah	3					
	Dinajpur	13					
September 1952	Jalpaiguri	5	3538	13	0·64	1·14	178·1
	Darjeeling	6		14	1·09	1·28	117·4
				15	0·80	1·47	183·7
				16	0·86	0·99	115·1
				17	0·88	1·86	211·4
				18	2·63	3·01	114·4
				19	0·91	0·84	92·3
September 1952	Jalpaiguri	5	3538	19	0·91	0·84	92·3
	Darjeeling	6		20	1·79	2·39	133·5
				21	0·81	0·72	88·9
				22	1·47	0·83	56·5
				23	4·79	4·45	92·9
				24	2·82	1·66	58·9
				25	0·52	0·89	171·1

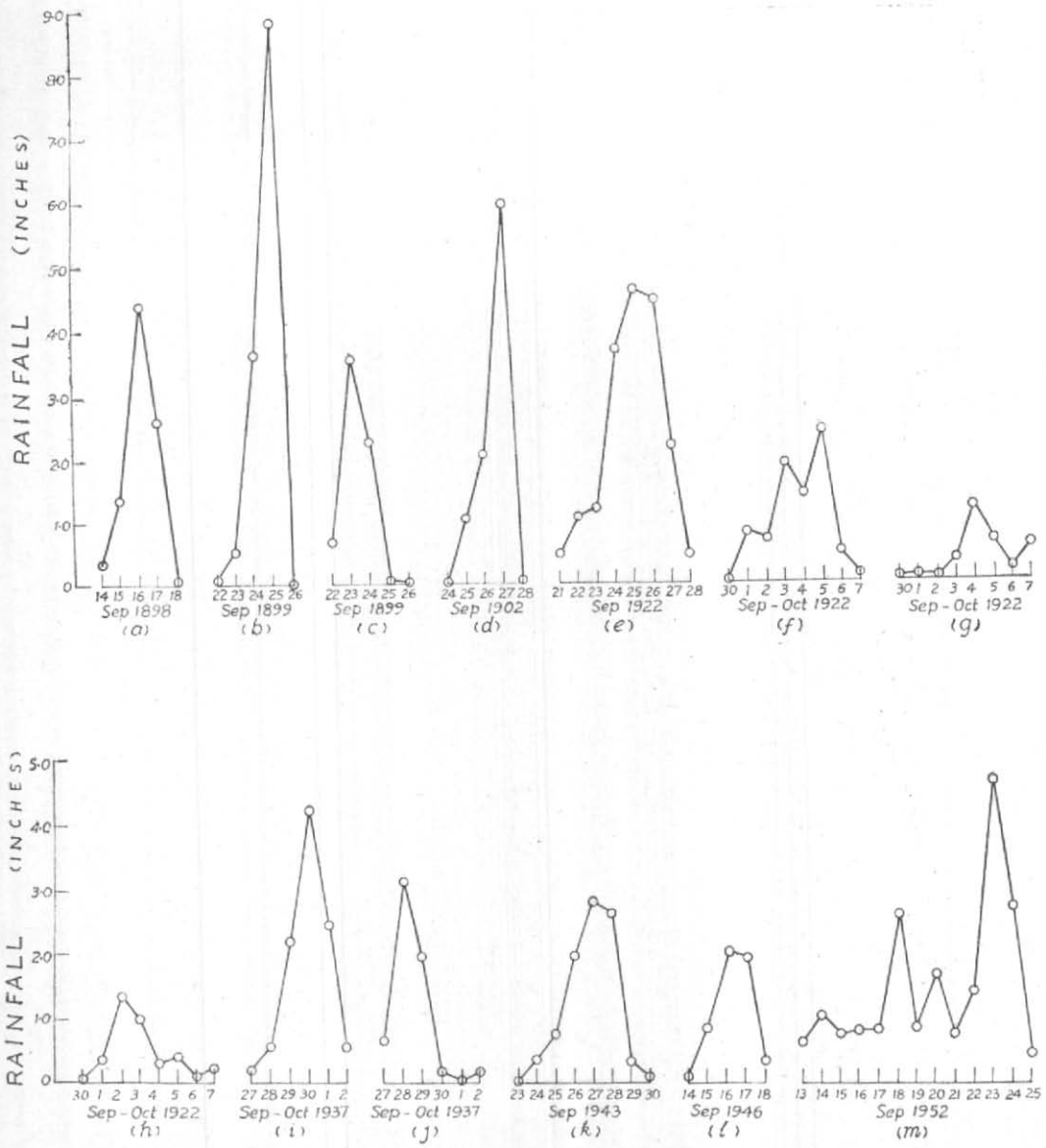


Fig. 1

The daily average rainfall of the following districts have been plotted in figures (a) to (m) (see also Table 1)—

(a) Jalpaiguri, Darjeeling, Cooch Behar and Rangpur; (b) Darjeeling; (c) 24 Parganas, Howrah, Bankura, Midnapur and Birbhum; (d) Jalpaiguri, Darjeeling, Cooch Behar and Rangpur; (e) Cooch Behar, Rangpur, Dinajpur, Malda, Bogra, Rajshahi, Mymensingh, Pabna and Faridpur; (f) Dacca and Mymensingh; (g) Jalpaiguri; (h) 24 Parganas; (i) Dinajpur, Rajshahi and Malda; (j) Faridpur and Bakarganj; (k) Jalpaiguri, Dinajpur and Darjeeling; (l) 24 Parganas, Nadia, Murshidabad, Burdwan, Birbhum, Bankura, Midnapur, Hooghly, Howrah and Dinajpur; (m) Darjeeling and Jalpaiguri.

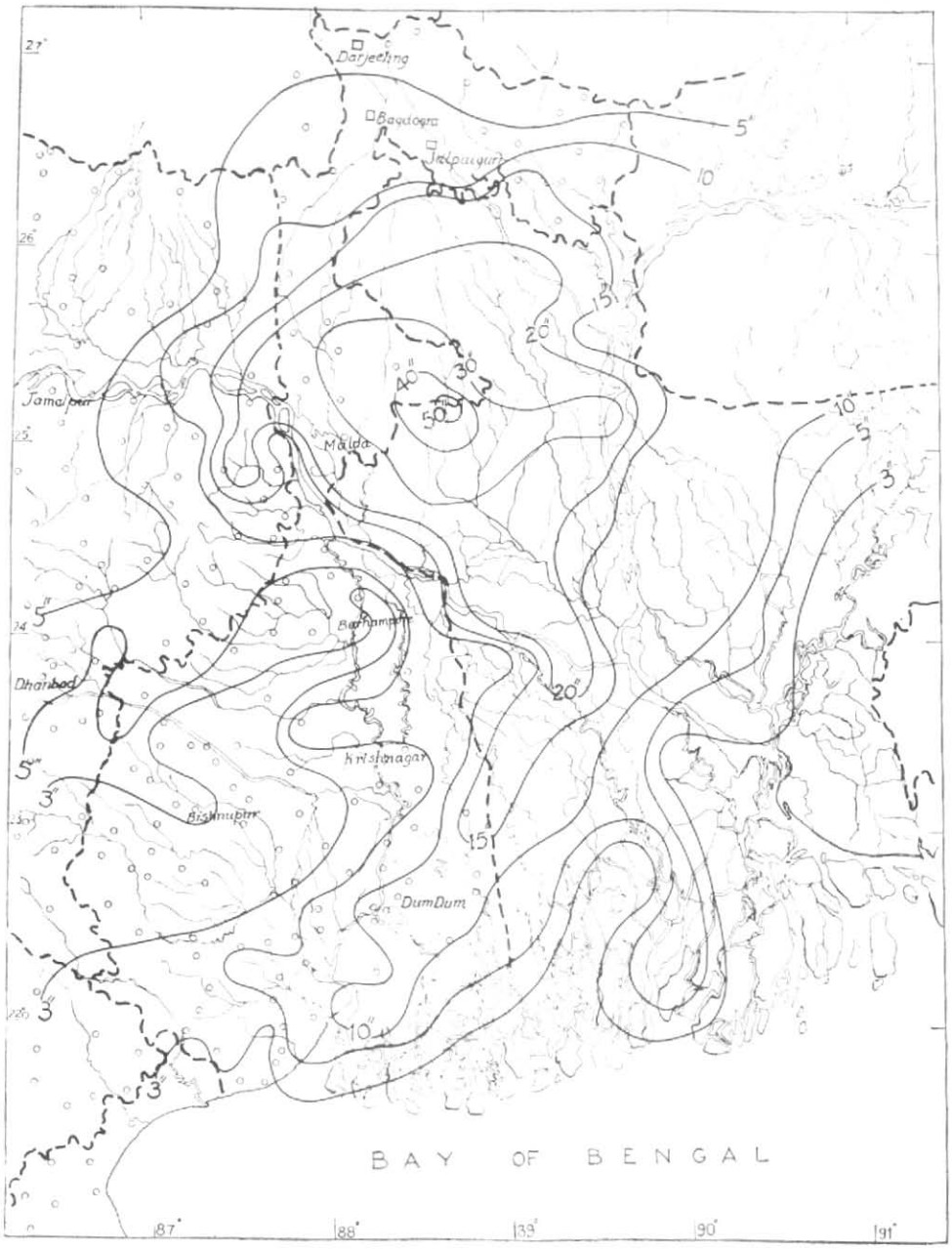


Fig. 2. Isohyets of rainfall for the period 21 to 28 September 1922
(based on district raingauge data)

Area enclosed by isohyets

Rainfall (in.)	4·0	7·5	12·5	17·5	25·0	35·0	45·0	50·0
Area (sq. miles)	12,416	11,571	11,162	4941	7731	2944	604	10

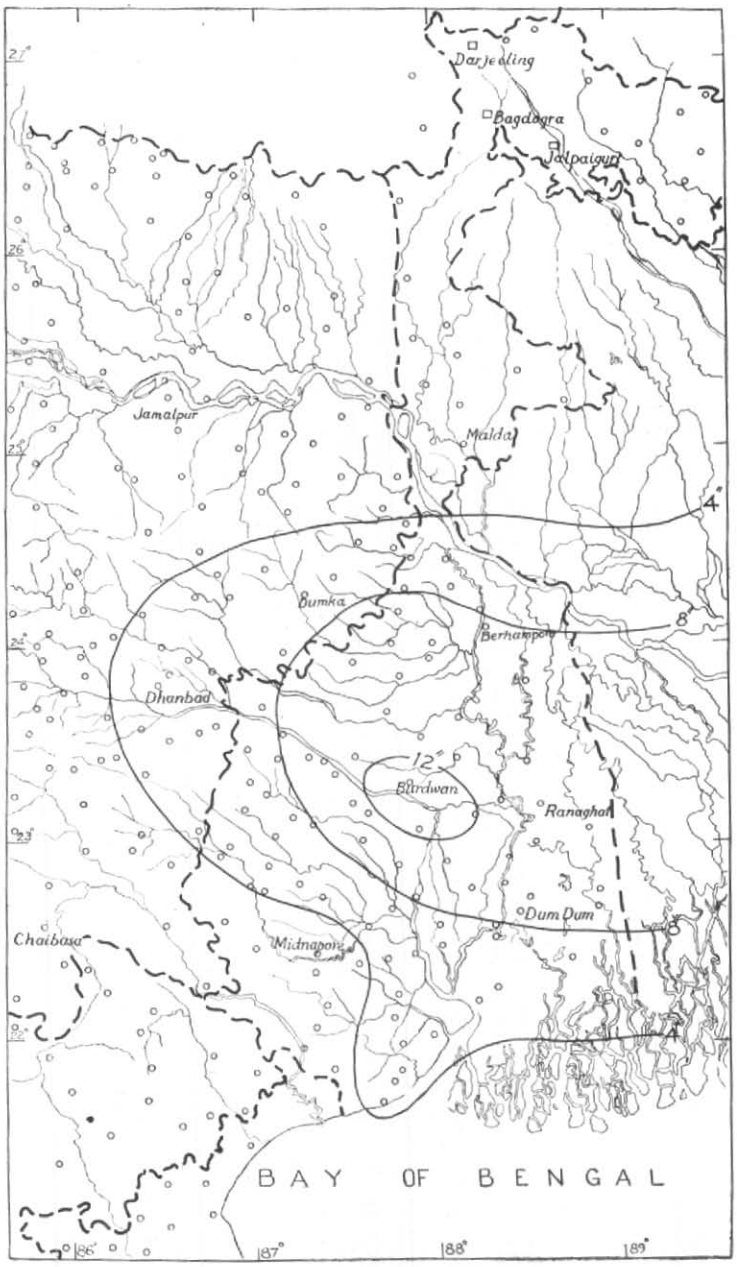


Fig. 3. Isohyets of rainfall for the period 25 to 26 September 1956
(based on rainfall data of I.M.D. observatories)

Area enclosed by isohyets

Rainfall (in.)	6·0	10·0	12·0
Area (sq. miles)	8192	9472	870

TABLE 2

Instances of heavy rain spells of 10 inches or more in late September and early October since 1891

Year	Date	District	Station
1894	Oct 1	Banda	Kirur
	2	Azamgarh	Mahul
	4	Mirzapur	Mirzapur
	5	Almorah	Champawat
	6	Nainital	Nainital
1897	Sep 26	Almorah	Tanakpur
	27	,,	Champawat
	27	Nainital	Nainital
1900	Sep 28	Gorakhpur	Maharajganj
1901	Sep 25	Fyzabad	Bikapur
		Gonda	Tarabganj
		Pilibhit	Pilibhit
		,,	Anaria
		Nainital	Kilpuri
1903	Oct 2	Jaunpur	Mariapu
	10	Hardoi	Shahabad
		Farrukhabad	Farrukhabad
		Etah	Aliganj
		Shahjahanpur	Shahjahanpur
		,,	Pawayan
		,,	Tilhar
		,,	Jalalabad
		Budaon	Dataganj
1905	Sep 29	Farrukhabad	Chibraman
1910	Oct 1	Mainpuri	Mustafabad
		,,	Shikohabad
		Badaun	Sahaswan
	2	Garhwal	Lansdowne
	5	Nainital	Kathgodam
1916	Sep 24	Banda	Khanna
1923	Sep 22	Shahjahanpur	Pawayan
		Rai Bareili	Salon
	23	Shahjahanpur	Khutar
		Pilibhit	Puranpur
1923	Sep 23	Kheri	Muhamdi
	Sep 30	Hamirpur	Mandaha
	Oct 2	Nainital	Nagla
	4	,,	Nagla
1924	Sep 28	Garhwal	Lansdowne
	29	,,	Lansdowne
		,,	Bironkhal
		Dehra Dun	Mussooree
		Saharanpur	Hardwar
		Bareilly	Faridpur
	30	Saharanpur	Kalsia
1927	Oct 7	Bareilly	Nawabganj
		,,	Kundhra
		Farrukhabad	Kananj
	8	Muradabad	Thakurdwara
		Nainital	Ramnagar
1930	Sep 27	Jaunpur	Kerakat
	28	Basti	Basti
		,,	Khalilabad
1931	Sep 25	Bareilly	Baheri
1943	Sep 26	Banaras	Banaras
		Jaunpur	Jaunpur
		,,	Kerakat
		,,	Shahganj
		Azamgarh	Mahul (Phulpur)
	27	Balia	Rasra
		Jaunpur	Kerakat
1944	Sep 23	Azamgarh	Muhammadabad
1945	Sep 26	Patiala	Barthala
		Ludhiana	Samrala
1947	Sep 26	Ambala	Dadnpur
		Hoshiarpur	Una
		Ludhiana	Ludhiana

In 1923, again there was very heavy rainfall from 20 to 24 September in the districts of Pilibhit, Shahjahanpur, Rai Barelli and Kheri which was followed by very heavy rainfall in the districts Hamirpur and Nainital from 30 September to 6 October. Again during 1924, there occurred very heavy rain in the districts of Bareilly, Garhwal and Dehra Dun from 26 to 30 September followed by very heavy rain in Saharanpur from 27 September to 1 October.

3. Conclusion

The tables and the figures mentioned above show that in the past there had been occasions when very heavy rainfall occurred in West Bengal, in Uttar Pradesh and in the Punjab towards the end of September and even in October. It will thus be seen that heavy rainfalls were experienced in the past towards or shortly after the end of southwest monsoon season when there were no atomic explosions to affect the atmosphere.

4. Intensity of rainfall pattern during the floods in river Jamuna in October 1956

In the course of further studies of the floods in the river Jamuna during October 1956 the self-recording raingauge records for the period 7 to 12 October from four stations, *i.e.*, Tehri, Simla, New Delhi and Roorkee were examined. Of the four self-recording raingauges only Delhi lies within the catchment of Jamuna (Fig. 4). The remaining three lie on the fringe of the catchment. Simla lies on the watershed of the catchment of Giri, Tehri is situated near the boundary of the catchment of Jamuna and Roorkee just outside the catchment in the upper reaches of the river after its debut into the plains.

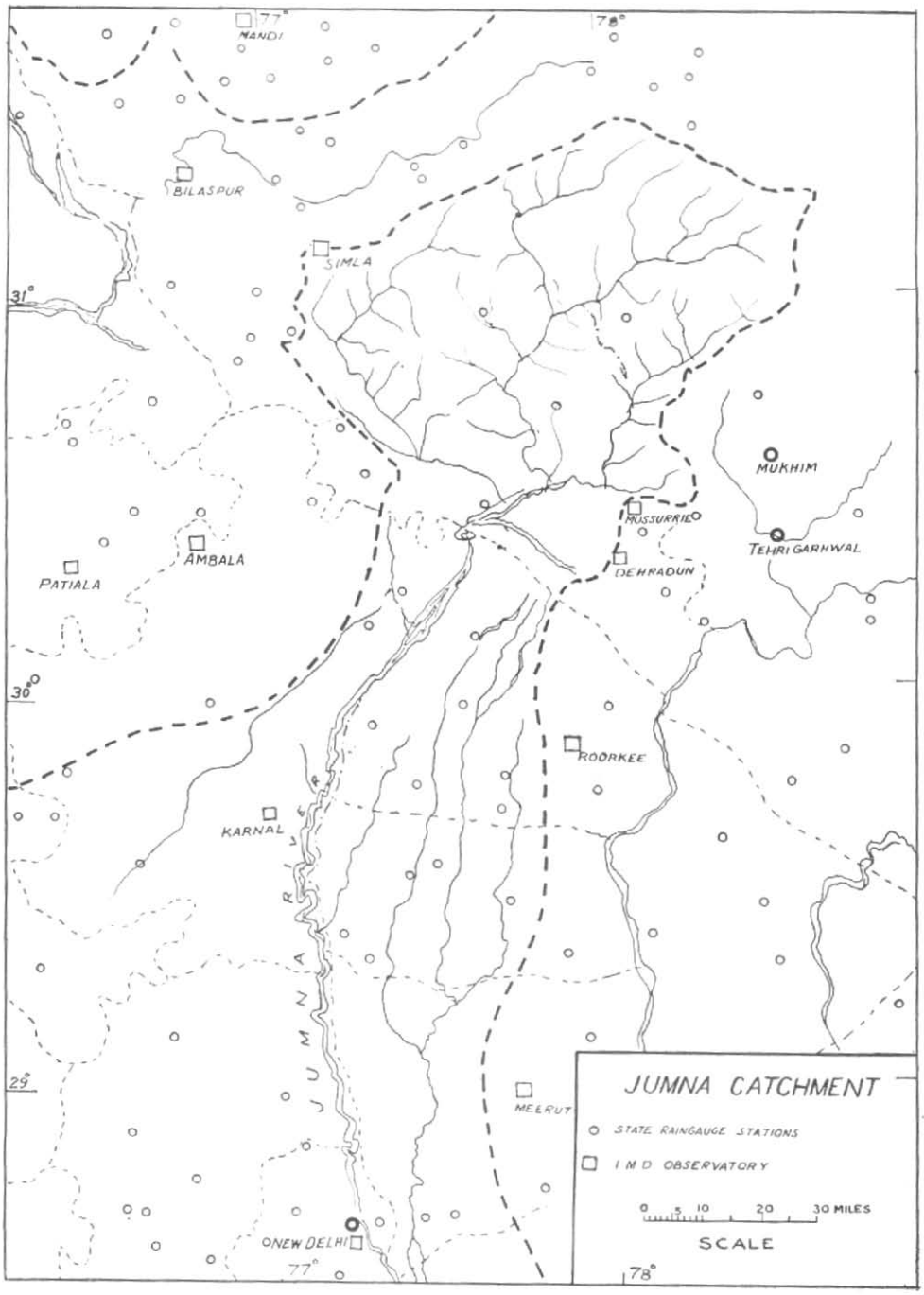
From the above-mentioned self-recording charts the rainfall amounts for periods at four-hour intervals were read off, and these values were plotted against a suitable time axis (Fig. 5). The resulting curve gave us the intensity-pattern of the rainfall occurring at these places.

In the absence of self-recording raingauges actually within the catchment we shall assume that the intensity-pattern exhibited by the recorder at Simla would approximately represent the rainfall that occurred in the Giri catchment. Similarly that shown by the Tehri recorder would represent the rainfall in the Jamuna catchment (above the confluence with Tons and Giri) and the record at Roorkee as representative of the rainfall in the upper catchment of Jamuna. An examination of the rainfall curves thus drawn along with the hydrograph of Tajewala plotted on the same time base shows a very striking feature (Fig. 6).

Just as the rainfall intensity curves of Simla, Tehri and Roorkee show a number of sharp increase in rainfall which can be divided into two distinct groups each constituting a peak, the hydrograph shows a similar feature consisting of two humps separated by a trough. This may perhaps be understood from the facts that the intensity-patterns in both Giri and Jamuna catchments have been similar and the inlet time is also comparatively small in these mountainous reaches of the rivers. Therefore, the intensity-pattern shown by the rainfall recorders is clearly reflected in the discharge observations recorded at Tajewala.

An examination of the curve obtained by plotting the gauge readings recorded at Delhi on the same time base however does not show the double peak feature inspite of the fact that Delhi self-recording raingauge shows a marked double peak nature.

Of course, the gauge curve at Delhi shows a marked flattening at the time corresponding to the trough of the intensity curves. This may perhaps be taken to indicate that the discharge has not been passed on unmodified from the Tajewala headworks to Delhi, but has been modified considerably in the intervening portion of the river. Nevertheless slight traces of the original double peak is still to be detected at Delhi. The isohyetal map of this area (Fig. 7) shows that during the period 8 to 11 October 1956, 5″ of rainfall occurred over quite wide areas of Uttar Pradesh and adjoining hills and plains of the Punjab.


77°
MANDI
78°
BILASPUR
SIMLA
31°
MUKHIM
MUSSURRIE
TEHRI GARHWAL
AMBALA
PATIALA
DEHRADUN
30°
ROORKEE
KARNAL
JUMNA RIVER
29°
MEERUT
NEW DELHI
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JUMNA CATCHMENT
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0 5 10 20 30 MILES
SCALE

Fig. 4

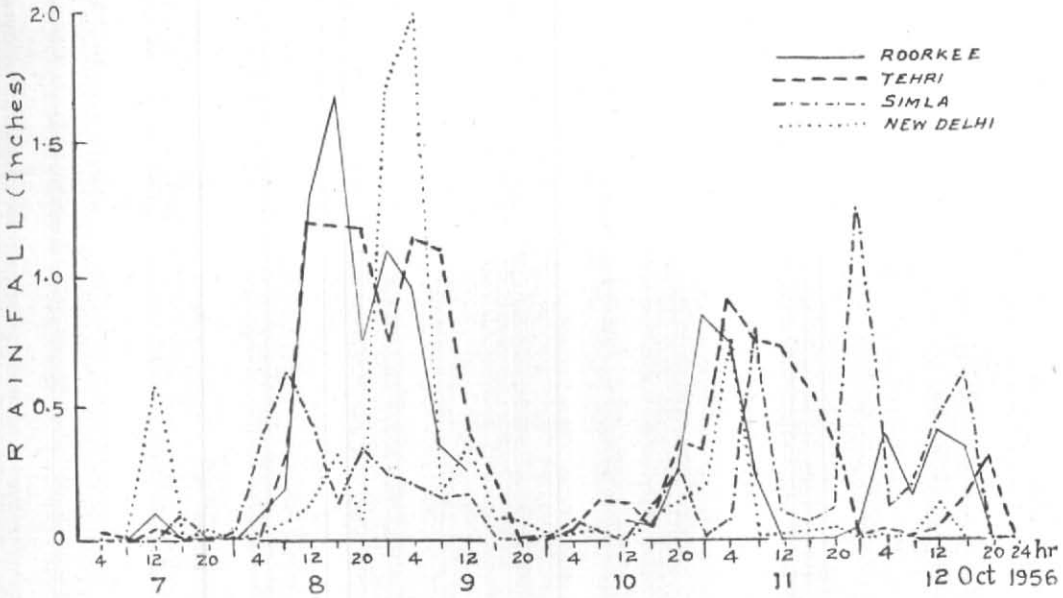
RAINFALL (Inches)
2·0
1·5
1·0
0·5
0
ROORKEE
TEHRI
SIMLA
NEW DELHI
4 12 20 4 12 20 4 12 20 4 12 20 4 12 20 4 12 20 24 hr
7 8 9 10 11 12 Oct 1956

Fig. 5

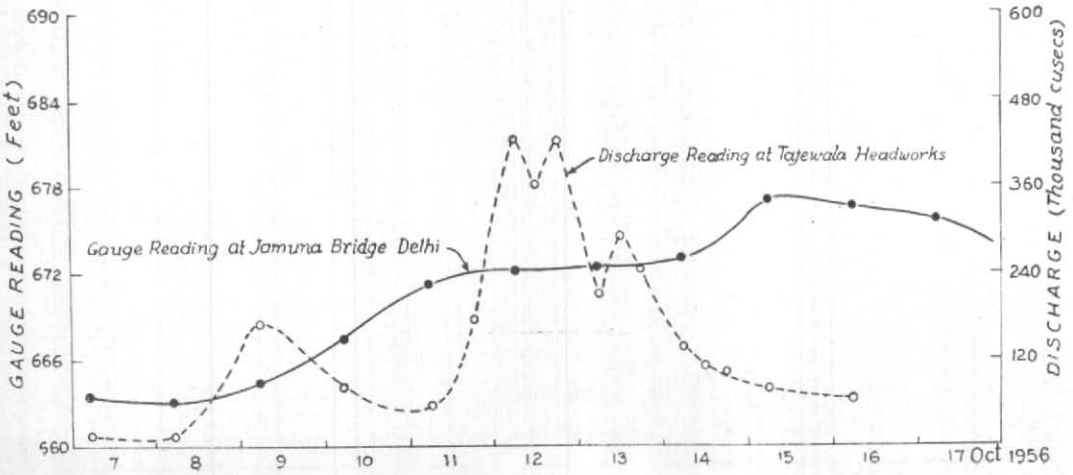
GAUGE READING (Feet)
690
684
678
672
666
660
DISCHARGE (Thousand cusecs)
600
480
360
240
120
Discharge Reading at Tajewala Headworks
Gauge Reading at Jamuna Bridge Delhi
7 8 9 10 11 12 13 14 15 16 17 Oct 1956

Fig. 6

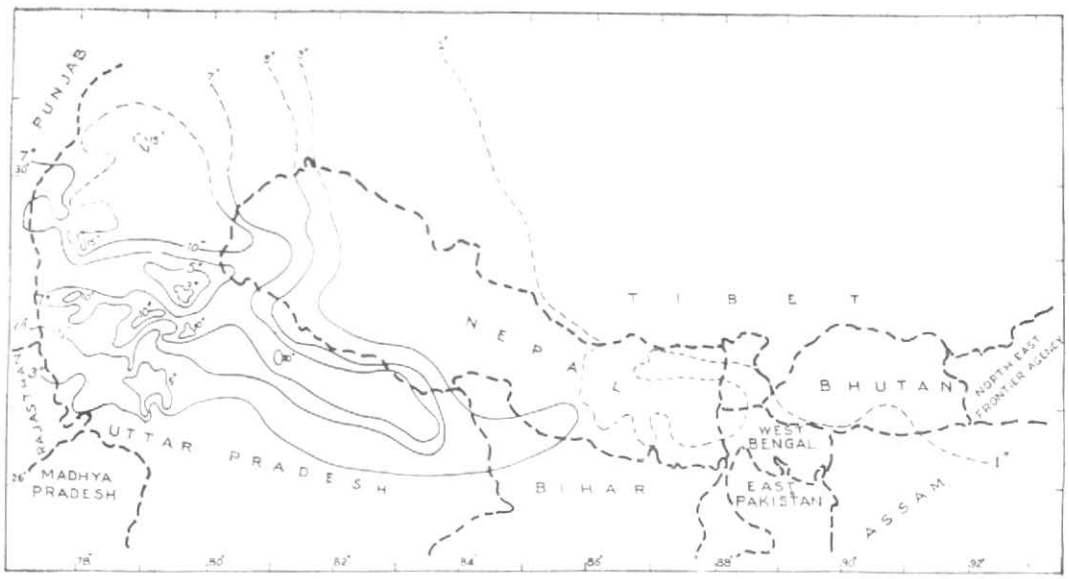

Fig. 7. Isohyets for the period 8 to 11 October 1956

The correspondences of the three distinct minor peaks on the rainfall intensity record shown by Simla with the minor peaks shown in the record of Tajewala discharge curve may not be taken to be specially significant unless it is substantiated by many more examples.

From the above, it will be seen that study of intensity-pattern looks rather promising. It is possible that the phasing of the intensity in the Giri catchment and the Jamuna catchment above Tajewala may not be the same as was in the present case and therefore, the resulting correspondence between the intensity-pattern and the hydrograph may not always be as striking as in this case.

6. Acknowledgement

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