

Letters to the Editor

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A DAY OF EXCEPTIONALLY HEAVY RAINFALL OVER BOMBAY

1. Bombay city and suburbs experienced exceptionally heavy rainfall on 16 June 1990 establishing a new record of a 24-hourly rainfall for the month of June. The rainfall recorded at 0830 hrs IST was 421.2 mm which exceeded the earlier record of 408.9 mm of 18 June 1886. The normal rainfall for the month of June and for the whole season (June-September) for Colaba is 494.6 and 1805.7 mm respectively. Thus, the 24-hourly rainfall of Colaba on 16 June 1990 was 85% of the month's normal rainfall and 23% of the season's rainfall. The torrential rains resulted in loss of life and property and affected transport and communication services. An attempt has been made to examine the characteristics of rainfall and meteorological situation causing the heavy down pour.

2. The exceptionally heavy rainfall under study was mostly localised within a strip of 100 km extending from Dharavi (Bombay) in the north to Alibag in the south. Dharavi and Alibag recorded 28 and 20 cm of rainfall at 0830 hrs IST. The spatial distribution of rainfall as recorded at 0830 hrs IST is shown in Fig. 1. The heavy rainfall over Colaba during 15th/16th night can be divided into seven spells according to the intensity of rainfall based on SRRG chart of 15/16 June 1990 (Table 1).

TABLE 1

S. No.	Period hours (IST)	Rainfall recorded (cm)	Intensity of rainfall (cm/hour)
1.	2215 to 2245	7	14
2.	2245 to 2300	1	4
3.	2300 to 2400	6	6
4.	0000 to 0100	11	11
5.	0100 to 0130	1	2
6.	0130 to 0200	6	12
7.	0200 to 0300	6	6

The rainfall amounts recorded at Santacruz airport located about 22-23 km to the north of Colaba Observatory, on 15th/16th night, though moderate to heavy, were considerably less as compared to rainfall amounts recorded at Colaba. It is also seen from the SRRG chart of Santacruz airport that there is a lag of about 2 hours between the spells of heavy rain at Colaba and Santacruz.

3. The southwest monsoon 1990 advanced into north Konkan on 31 May and as on 15 June, the northern limit of monsoon was passing through Dahanu, Indore, Bhopal, Umaria, Dehri, Chapra and Raxaul (IDWR 15 June 1990). Main features noticed on synoptic charts of 15th and 16th June are listed below:

- (a) A trough of low pressure on sea level chart lay over southeast Arabian Sea off Kerala coast at 0830 and 1730 hrs IST on 15 June [Figs. 2 (a & b)].
- (b) A depression lay over north Orissa and adjoining areas at 0830 hr IST on 15 June about 50 km southsoutheast of Jharsuguda [Fig. 2(a)]. The associated cyclonic circulation extended upto mid-tropospheric levels. It weakened into a well marked low pressure area and lay over east Madhya Pradesh and adjoining Orissa and Bihar Plateau in the evening of 15 June [Fig. 2 (b)]. The well marked low pressure area weakened into a low pressure area over central parts of east Madhya Pradesh on 16 June morning. An east-west trough in mid-tropospheric levels extended from this system upto north Konkan both on 15th evening and 16th morning. The system became less marked by 18th June.

3.1. Morning Radiosonde ascent of Santacruz airport of 15 June, shows that the atmospheric stratification is conditionally unstable in a deep layer with small negative area. Various stability indices for this ascent have been worked out and

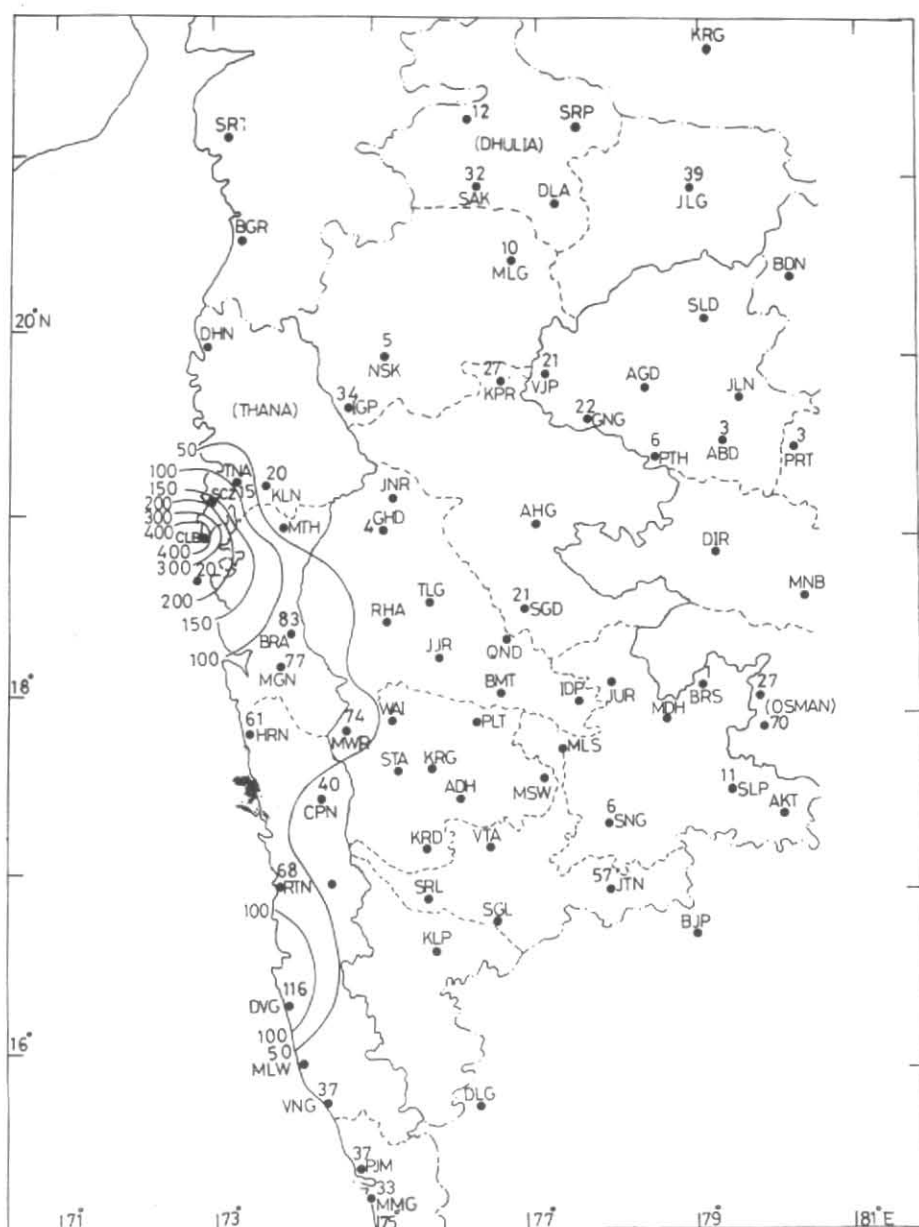


Fig. 1. Spatial distribution of rainfall as recorded at 0830 hrs IST on 16 June 1990

are shown in Table 2. These indices also show that the atmospheric stratification is favourable for thunderstorm development.

3.2 The synoptic situation prevailing on 15th and 16th June have been compared with synoptic situations prevailing on occasions of heavy rainfall over Bombay in the past. For this, all cases of very heavy rainfall (≥ 20 cms) over Colaba and Santa-cruz during 1981 to 1990 have been considered and synoptic situations prevailing on these occasions have been summarised in Table 3. It is seen that on 7 out of 9 occasions (excluding the case under study), the synoptic situations on occasions of very heavy

TABLE 2
Various stability indices for the Radiosonde
ascent of 15 June 1990

S. No.	Stability Index	Value
1.	K Index (K)	36.5
2.	Humidity Index (HI)	23.5
3.	Potential wet bulb Index (PI)	-5.0
4.	Showalter Index (SSI)	-1.0
5.	Total Totals Index (TTI)	42.5

TABLE 3

Occasions of heavy (> 20 cms) rainfall over Bombay during 1981-90

S. No.	Date	Amount of rainfall (cm)		Synoptic situation
		CLB	SCZ	
1.	23 Sep 1981	24.2	31.8	A well marked low pressure area over Marathwada on 22nd moved northwestwards and lay over north Madhya Maharashtra and adjoining southwest Madhya Pradesh on 23rd.
2.	19 Jul 1982	6.4	27.6	(i) Trough off the west coast during 18th to 21st. (ii) A depression over northwest Bay of Bengal (centre 300 km east-southeast of Puri) on 18th. Intensified into deep depression on 19th with centre about 100 km southeast of Puri. Crossed coast and lay over west Orissa and southeast Madhya Pradesh near Bolangir on 20th.
3.	21 Jul 1982	13.5	20.9	System weakened into low pressure area which lay over northwest Madhya Pradesh and adjoining southeast Uttar Pradesh on 21st. (iii) Eastwest trough at 3.1 km asl roughly along 20°N during 18th to 21st.
4.	17 Jul 1983	13.0	25.3	(i) Trough off the west coast on 16th and 17th. (ii) Eastwest trough at 3.1 km asl extended from coastal Andhra Pradesh to north Konkan on 16th. On 17th it extended roughly along 20°N.
5.	2 Jul 1984	54.4	24.0	(i) Trough off the west coast on 1st and 2nd. (ii) A low pressure area over east Madhya Pradesh and adjoining Bihar Plateau on 1st. Moved west north westwards and lay over north Madhya Pradesh and adjoining Uttar Pradesh on 2nd. (iii) Eastwest trough at 3.1 km asl extended along 15°N on 1st evening and from Saurashtra-Kutch to Gangetic West Bengal on 2nd.
6.	13 Sep 1984	14.8	21.6	(i) Trough off the west coast on 12th and 13th. (ii) A well marked low pressure area over Vidarbha and neighbourhood on 12th. Moved north westwards and lay over Gujarat state and adjoining Gulf of Cambay on 13th. (iii) Eastwest trough at 3.1 km asl extended from Sub-Himalayan West Bengal and Sikkim to East central Arabian Sea off south Maharashtra coast on 12th. It extended from Bihar plains to northeast Arabian Sea on 13th.
7.	17 Jun 1985	34.5	22.4	(i) Trough off the west coast on 16th. (ii) Mid-tropospheric cyclone over east Central Arabian Sea off Maharashtra coast on 16th. Lay over east-central Arabian Sea and adjoining Maharashtra on 17th. (iii) East-west trough at 3.1 km asl roughly along 18°N on 17th. (iv) Upper air trough in westerlies at 500 hPa, axis extending from Himachal Pradesh to east-central Arabian Sea off south Maharashtra coast.
8.	25 Jun 1985	30.9	16.2	(i) A low pressure area over northwest and adjoining west central Bay on 24th moved inland and lay over interior Orissa on 25th. (ii) East-west trough at 3.1 km asl roughly along 19°N on 24th and 25th.

TABLE 3 (Contd.)

S. No.	Date	Amount of rainfall (cm)		Synoptic situation
		CLB	SCZ	
				(iii) A cyclonic circulation between 2.1 and 3.1 km asl lay over east-central Arabian Sea off north Maharashtra coast on 24th and 25th.
9.	16 Jun 1990	42.1	15.0	Discussed in detail in the present case study.
10.	15 Aug 1990	25.9	7.4	A well marked low pressure area over west central Bay off north Andhra-south Orissa coast on 14th, concentrated into depression over northwest and adjoining west central Bay on 15th (centre 100 km southwest of Puri).

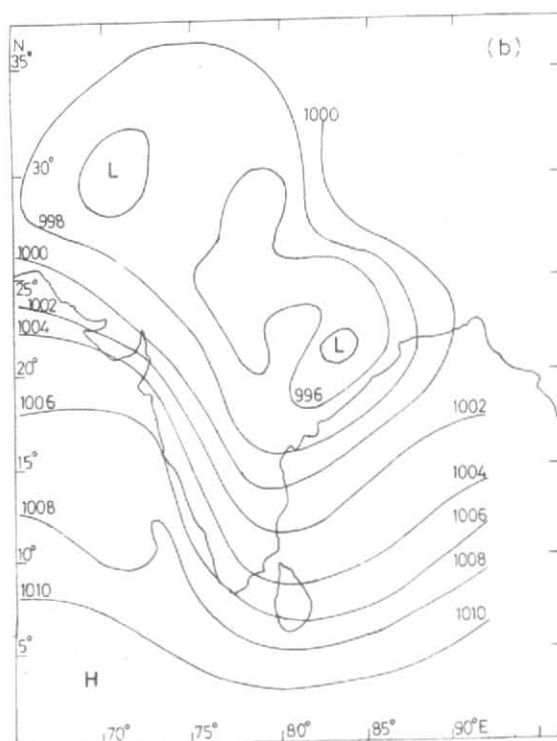
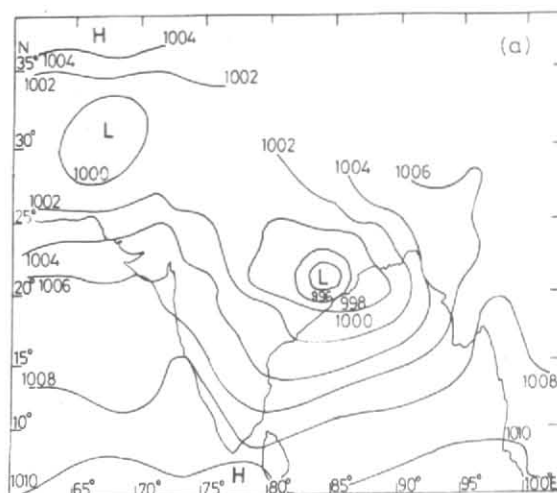


Fig. 2 (a & b). Sea level weather chart at 0830 & 1730 hr IST of 15 June 1990

rainfall over Bombay are almost similar to the conditions prevailing on 15/16 June that is a combination of (i) a trough off west coast at sea level, (ii) a low pressure system either in the northwest Bay or moving westnorthwest/northwestward across Orissa/Madhya Pradesh and (iii) an east-west trough line in mid-tropospheric levels extending roughly between 18° and 21°N upto north Konkan/south Gujarat region are present on almost all occasions of heavy rainfall situations over Bombay. A study of spells of heavy rainfall over Bombay by Apte (1979) based on heavy rainfall situations experienced during 1965 to 1975 confirms the above findings that a combination of the synoptic situations discussed above is the most favourable synoptic situation to cause heavy rainfall over Bombay. In the present case, the very heavy rainfall was confined to a narrow north-south belt around Bombay. So, it is inferred that a localised meso-scale system, which could not be detected by the synoptic scale network, might have developed over Bombay and neighbourhood and caused the record rainfall.

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Reference

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