MAUSAM, **74**, 3 (July 2023), 881-910

MAUSAM

DOI : https://doi.org/10.54302/mausam.v74i3.6303
Homepage: https://mausamjournal.imd.gov.in/index.php/MAUSAM

Weather in India

MONSOON SEASON (June - September 2022)†

1. Introduction

The rainfall over the country as a whole during the monsoon season (June-September) 2022 was 106% of its long period average (LPA) thus categorized as *normal** monsoon rainfall. The monthly rainfall for the country for June was less than normal while for the other three monsoon months it was more than normal with July recording 117% of LPA rainfall. Total six intense low-pressure systems, five Depressions and one Deep Depression formed in the season over the north Indian ocean. Other than these systems, two Well Marked Low Pressure systems and 4 Low Pressure systems formed in the monsoon months over the north Indian Ocean. Southwest monsoon reached over the parts of Andaman Sea on 16 May (normal date 22 May), it set in over Kerala on 29 May, 2 days prior than its normal date and covered the entire country by 2 July, 6 days earlier to its normal date (8 July). The withdrawal of monsoon began on 20 September (normal 17 September) and the monsoon withdrew from the entire country on 23 October against its normal date of 15 October. The Northeast Monsoon rains commenced over coastal Tamil Nadu, Puducherry & Karaikal and adjoining areas of south Coastal Andhra Pradesh on 29 October, 2022. The *La Nina* conditions and negative Indian Ocean Dipole (IOD) were observed over the equatorial Pacific and Indian Ocean respectively.

2. Various aspects of southwest Monsoon - 2022

2.1. *Onset and advance*

Fig. 1 shows the isochrones for advance of monsoon over the country. In view of strengthening of south westerlies in the lower tropospheric levels, fairly widespread to widespread rainfall activity and persistent cloudiness over the area; Southwest Monsoon advanced into some parts of south Bay of Bengal, most part of Andaman Nicobar Islands and Andaman Sea on the 16 May, 2022. It advanced into Kerala on 29 May, 3 days earlier than normal, *i.e.*, 1 June. The further advance of the monsoon current was steady and it covered most of the country outside northwest India by 20 June. After a hiatus

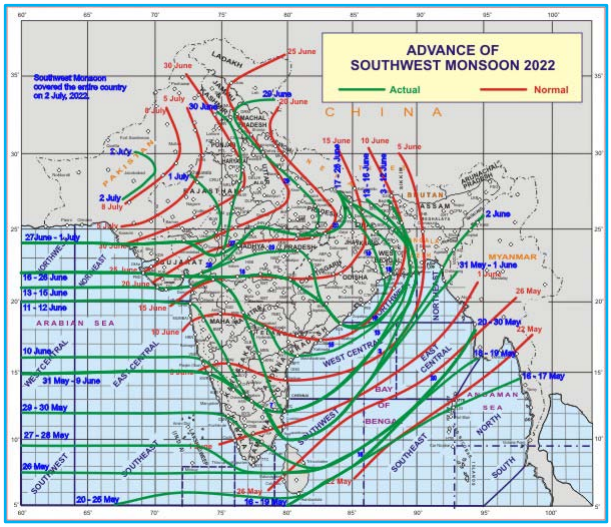

Fig. 1. Isochrones of advance of SW monsoon 2022

of 6 days southwest monsoon further advanced into most parts of Arabian Sea and Gujarat state on 27 June and progressed further covering the entire country on 2 July 2022, 6 days ahead of its normal date (8 July).

2.2. *Monthly rainfall distribution*

In the month of June, the precipitation over the country was *normal* but on the negative side with a departure of -8% of LPA. Rainfall over the homogenous region of East and Northeast India was above normal at 122% of LPA and over Assam & Meghalaya sub division, it was 177% of normal which was the highest since 1901 for the sub division.

Rainfall over Kerala & Mahe was fourth lowest (308.7 mm) since 1901. The other three lowest rainfall years were in 1976 (196.4 mm), 1962 (244.9 mm), 1974 (266.9 mm). During June 2022, only one low pressure area formed which lasted just for two days only against normal of 11 days. Irrespective of absence of any major LPS in June 2022, ISMR % dep from normal was -8% and it was mainly due to stronger cross equatorial flows and southwesterly winds over Arabian Sea causing higher rains over west coast of India. Similarly, there were persistent lower level stronger southerly/south-westerly

**Definitions of terms in italics other than sub-titles are given in Appendix*

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TABLE 1

Advance of southwest Monsoon 2022

S. No.	Date	Southwest monsoon advanced over	Northern limit of monsoon passed through
1.	16 May	Some parts of south Bay of Bengal, most part of Andaman Nicobar Islands and Andaman sea	Lat.5° N / Long.80° E, Lat.8° N / Long.85° E, Lat.11° N / Long.90° E, Long Islands and Lat.14.8° N / Long.97.5° E
2.	18 May	Some more parts of southeast Bay of Bengal, entire Andaman, Nicobar Islands, entire Andaman sea and some more parts of eastcentral Bay of Bengal	5° N/80° E, 8° N/85° E, 12.5° N/90° E and 16.0° N/ 94.5° E
3.	20 May	Some parts of south Arabian Sea, southern parts of Maldives, some more parts of south and eastcentral Bay of Bengal	Lat.5° N/67° E, Lat.6° N/ Long.72° E, Lat.5.5° N/ Long.80° E, Lat.8° N/Long.85° E, Lat.12.5° N/Long.90° E, Lat. 16.0° N/Long.93° E and Lat. 18.0° N/Long.94.5° E
4.	26 May	Some parts of southwest Arabian Sea, some more parts of southeast Arabian Sea, Maldives, Comorin area and south Bay of Bengal	Lat.7.5°N/Long.60°E, Lat.7.5°N/Long.70°E, Lat.7.5°N/ Long.79°E, Lat. 8°N/Long.83°E, Lat.11.5°N/Long.89°E, Lat.16.0°N/Long.93°E and Lat.18.0°N/Long.94.5°E
5.	27 May	Some more parts of South Arabian Sea, entire Maldives & adjoining areas of Lakshadweep and some more parts of Comorin area	Lat. 9.5° N/Long.60° E, Lat. 9.5° N/Long.70° E, Lat.9.5° N/Long.73° E, Lat. 7.5° N/Long.77° E, Lat. 8.0° N/Long.83° E, Lat. 12.5° N/Long.90° E, Lat. 16.0° N/Long.93° E and Lat. 18.0° N/Long.94.5° E
6.	29 May	Remaining parts of south Arabian Sea, Lakshadweep area, most parts of Kerala, some parts of south Tamil Nadu, some parts of Gulf of Mannar and some more parts of southwest Bay of Bengal Thus, Southwest Monsoon has set in over Kerala on today, the 29th May, 2022 against the normal date of 01st June (3 days ahead of the normal date)	Lat. 12° N/Long. 60° E, Lat. 12° N/ Long. 70° E, Kannur, Palakkad, Lat. 9° N/Long. 79° E, Lat. 8.0° N/Long. 83° E, Lat. 12.5° N/Long. 90° E, Lat.16.0° N/Long.93° E and Lat.18.0° N/Long.94.5 ° E
7.	31 May	Some more parts of central Arabian Sea, some parts of Karnataka, entire Kerala, some more parts of Tamil Nadu, entire southeast Bay of Bengal, some more parts of southwest Bay of Bengal, most parts of eastcentral Bay of Bengal, some parts of westcentral and northeast Bay of Bengal	Lat. 15° N/Long. 60° E, Lat. 15° N/Long. 70° E, Karwar, Chikmangaluru, Bengaluru, Dharmapuri, Lat. 10° N/ Long. 80° E, Lat. 11.0° N/Long. 83° E, Lat. 14.0° N/ Long. 86° E, Lat. 20.0° N/Long. 91° E and Lat. 22.0° N/ Long. 93° E
8.	2 Jun	Some parts of northwest Bay of Bengal, some more parts of northeast Bay of Bengal; some parts of Mizoram, Manipur and Nagaland	Lat. 15° N/Long. 60° E, Lat. 15° N/Long. 70° E, Karwar, Chikmagaluru, Bengaluru, Dharmapuri, Lat. 10° N/ Long. 80° E, Lat. 11.0° N/Long. 83° E, Lat. 14.0° N/ Long. 86° E, Lat. 21.0° N/Long. 91° E, Aizwal, Kohima and Lat. 26.5° N/Long. 95° E.
9.	3 Jun	Some more parts of northwest and west central Bay of Bengal, remaining parts of northeast & eastcentral Bay of Bengal, entire northeast India and some parts of Sub Himalayan West Bengal & Sikkim	Lat. 15° N/Long. 60° E, Lat. 15° N/Long. 70° E, Karwar, Chikmagaluru, Bengaluru, Dharmapuri, Lat. 10° N/Long. 80° E, Lat. 11.0° N/Long. 83° E, Lat.14.0° N/Long. 86° E, Lat. 22.0° N/Long. 90° E, Lat. 25.0° N/Long. 89° E, Siliguri and Lat. 27.5° N/Long. 88° E
10.	7 Jun	Some more parts of Tamil Nadu, Puducherry, Karaikal, southwest and westcentral Bay of Bengal	Lat. 15° N/Long. 60° E, Lat. 15° N/Long. 70° E, Karwar, Chikmagalur, Bengaluru, Puducherry, Lat. 14° N/ Long. 84° E, Lat. 17.0° N/Long. 87° E, Lat. 20.0° N/Long. 89.5° E, Lat. 22.0° N/Long. 90° E, Lat. 25.0° N/Long. 89° E, Siliguri and Lat. 27.50° N/Long. 88° E
11.	10 Jun	Some more parts of central Arabian Sea, entire Goa, some parts of Konkan and some more parts of Karnataka	Lat. 16° N/Long. 60° E, Lat. 16° N/Long. 70° E, Vengurla, Chikmagalur, Bengaluru, Puducherry, Lat. 14° N/Long. 84° E, Lat. 17.0° N/Long. 87° E, Lat. 20.0° N/Long. 89.5° E, Lat. 22.0° N/Long. 90° E, Lat.25.0° N/Long. 89° E, Siliguri and 27.50° N/Long. 88° E
12.	11 Jun	Remaining parts of central Arabian Sea, most parts of Konkan (including Mumbai), some parts of Madhya Maharashtra, some more parts of Karnataka	Lat. 20° N/Long. 60° E, Lat. 20° N/Long. 70° E, Dahanu, Pune, Gadag, Bengaluru, Puducherry, Lat. 14°N/ Long. 84° E, Lat. 17.0° N/Long. 87° E, Lat.20.0° N/ Long. 89.5° E, Lat.22.0° N/Long. 90° E, Lat. 25.0° N/ Long. 89° E, Siliguri and Lat. 27.50° N/Long. 88° E

TABLE 1 (*Contd.*)

S. No.	Date	Southwest monsoon advanced over	Northern limit of monsoon passed through
13.	13 Jun	Some more parts of Arabian Sea, some parts of Gujarat State, entire Konkan, most parts of Madhya Maharashtra, most parts of Marathwada and Karnataka, some parts of Telangana and Rayalaseema, some more parts of Tamil Nadu, most parts of Sub Himalayan West Bengal, some parts of Bihar	Lat. 21° N/Long. 60° E, Lat. 21° N/Long. 70° E, Diu, Nandurbar, Jalgaon, Parbhani, Bidar, Tirupati, Puducherry, Lat. 14° N/Long. 84° E, Lat. 17.0° N/Long. 87° E, Lat. 20.0° N/Long. 89.5° E, Lat.22.0° N/Long. 90° E, Lat. 25.0° N/ Long. 89° E, Balurghat, Supaul and Lat. 26.5° N/ Long. 86° E
14.	15 Jun	Some more parts of Marathwada, entire Karnataka, Rayalaseema and Tamil Nadu, some parts of coastal Andhra Pradesh, northwest and westcentral Bay of Bengal	Lat. 21° N/Long. 60° E, Lat. 21° N/Long. 70° E, Diu, Nandurbar, Jalgaon, Parbhani, Medak, Rentachintala, Machilipatnam, Lat. 17° N/ Long. 84° E, Lat. 18.5° N/Long. 87° E, Lat.22.0° N/Long. 90° E, Lat. 25.0° N/Long. 89° E, Balurghat, Supaul and Lat. 26.5° N/ Long. 86° E
15.	16 Jun	Some more parts of north Arabian Sea, Gujarat State, entire Madhya Maharashtra and Marathwada, some parts of south Madhya Pradesh, most parts of Vidarbha, entire Telangana, some parts of south Chhattisgarh and south Odisha, most parts of coastal Andhra Pradesh, some more parts of westcentral and northwest Bay of Bengal	Lat. 22° N/Long. 60° E, Lat. 22° N/Long. 65° E, Porbandar, Bhavnagar, Khandwa, Gondia, Durg, Bhawanipatna, Kalingapatnam, Lat. 22.0° N/Long. 89.5° E, Lat. 25.0° N/Long. 89° E, Balurghat, Supaul and Lat. 26.5° N/Long. 86° E
16.	17 Jun	Remaining parts of Sub-Himalayan West Bengal and some more parts of Bihar .	Lat. 22° N/Long. 60° E, Lat. 22° N/Long. 65° E, Porbandar, Bhavnagar, Khandwa, Gondia, Durg, Bhawanipatna, Kalingapatnam, Lat. 22.0°N/Long. 89.5° E, Lat.25.0° N/ Long. 89° E, Malda, Motihari and Lat. 27.0° N/Long. 84° E
17.	18 Jun	Entire westcentral Bay of Bengal, most parts of northwest Bay of Bengal, some parts of Gangetic West Bengal, Jharkhand and some more parts of Bihar	Lat. 22° N/Long. 60° E, Lat. 22° N/Long. 65° E, Porbandar, Bhavnagar, Khandwa, Gondia, Durg, Bhawanipatna, Kalingapatnam, Lat. 20.0° N/Long. 87.0° E, Haldia, Bardhaman, Dumka, Banka and Motihari, Lat. 27.0° N/Long. 84° E
18.	19 Jun	Some more parts of Gujarat region, Madhya Pradesh, remaining parts of Vidarbha, some more parts of Chhattisgarh, Gangetic West Bengal, Jharkhand and Bihar	Lat. 22° N/Long. 60° E, Lat. 22° N/Long. 65° E, Porbandar, Baroda, Indore, Umaria, Pendra Road, Bhawanipatna, Kalingapatnam, Lat. 20.0° N/Long.87.0° E, Digha, Giridih, Patna, 27.0° N/84° E
19.	20 Jun	Most parts of Madhya Pradesh, remaining parts of Chhattisgarh and coastal Andhra Pradesh, remaining parts of northwest Bay of Bengal, entire Odisha and Gangetic West Bengal, most parts of Jharkhand and Bihar, some parts of southeast Uttar Pradesh	Lat. 22° N/Long. 60° E, Lat. 22° N/Long. 65° E, Porbandar, Baroda, Shivpuri, Rewa, Churk, Lat. 27.0° N/Long. 84° E.
20.	27 Jun	Most parts of Arabian Sea and most parts of Gujarat State	Lat. 24° N/Long.60° E, Lat.24° N/Long.65° E, Disa, Ratlam, Shivpuri, Rewa, Churk, Lat.27.0° N/Long.84° E
21.	29 Jun	Remaining parts of Bihar, some more parts of Uttar Pradesh, entire Uttarakhand, most parts of Himachal Pradesh	Lat. 24° N/Long. 60° E, Lat. 24° N/Long. 65° E, Deesa, Ratlam, Shivpuri, Rewa, Mirzapur, Ayodhya, Haridwar, Una, Dharamshala, Lat. 33.5° N/Long. 79.0° E
22.	30 Jun	Entire Uttar Pradesh, Himachal Pradesh and Jammu-Kashmir and Ladakh, some parts of Rajasthan, entire Delhi, some parts of Punjab and Haryana, Chandigarh	Lat.24° N/Long.60° E, Lat.24° N/Long.65° E, Deesa, Ratlam, Jaipur, Rohtak, Pathankot and Jammu
23.	1 Jul	Entire Punjab, Haryana and more parts of Rajasthan 2	Lat. 24° N/Long. 60° E, Lat. 24° N/Long. 65° E, Deesa, Chittorgarh, Bikaner and Khajuwala
24.	2 Jul	The Southwest Monsoon has further advanced into remaining parts of north Arabian Sea, Gujarat and Rajasthan	The Southwest Monsoon has covered the entire country on 2 July 2022, against the normal date of 8th July (6 days before the normal date of covering the entire India)

TABLE 2

Withdrawal of southwest Monsoon 2022

S. No.	Date	Southwest monsoon withdrew from	Withdrawal line passed through
1.	20 Sep	Parts of southwest Rajasthan and adjoining Kutch (normal date of withdrawal from southwest Rajasthan of 17th September)	Khajuwala, Bikaner, Jodhpur and Naliya
2.	29 Sep	Entire Punjab and Chandigarh; some parts of Jammu-Kashmir and Ladakh, Himachal Pradesh, west Uttar Pradesh and Haryana; entire Delhi; some more parts of Rajasthan	Jammu, Una, Chandigarh, Karnal, Baghpat, Delhi, Alwar, Jodhpur and Naliya
3.	3 Oct	Most parts of north Arabian Sea, most parts of Gujarat Region, some parts of west Madhya Pradesh and Uttarakhand; remaining parts of Saurashtra, Kutch, Rajasthan, Haryana, Himachal Pradesh, Jammu-Kashmir and Ladakh and some more parts of west Uttar Pradesh	Long. 79.0° E/Lat. 31.7° N, Uttarkashi, Nazibabad, Agra, Gwalior, Ratlam, Bharuch and Long. 71.0° E/Lat. 20.3° N
4.	14 Oct	Remaining parts of Uttarakhand, Uttar Pradesh and Gujarat; most parts of Madhya Pradesh and some parts of Bihar, Jharkhand, Chhattisgarh and Maharashtra	Raxaul, Daltonganj, Pendra Road, Chhindwara, Jalgaon, Dahanu, Long. 71.0 °E/Lat. 19.5 °N
5.	15 Oct	Entire Bihar, entire Sikkim, entire Meghalaya, entire Madhya Pradesh, some parts of Assam, Tripura and West Bengal, some more parts of Vidarbha, Chhattisgarh and Maharashtra	28.6° N, 93.6° E, Lumding, Kailashahar, Berhampore, Kanke, Bilaspur, Bramhapuri, Buldhana, Dahanu, Long. 71.0° E/Lat. 19.5° N
6	20 Oct	Some more parts of Vidarbha, Chhattisgarh; many parts of Odisha; remaining parts of Jharkhand, West Bengal, Assam, Tripura; entire Mizoram, Manipur, Nagaland, Arunachal Pradesh and many parts of North Bay of Bengal	Lat. 20.0° N/Long. 93.0° E, Puri, Kanker, Buldhana, Dahanu, Lat. 19.5° N/Long. 71.0° E
8	21 Oct	Some more parts of Vidarbha; remaining parts of Chhattisgarh,Odisha, north Bay of Bengal; some parts of Telangana, coastal Andhra Pradesh, central Bay of Bengal The withdrawal line of Southwest Monsoon now passes through 17.0°N, 94.5°E, Kakinada, Ramagundam, Buldana, Dahanu, Long. 71.0° E/Lat. 19.5° N	Lat. 18.5° N/Long. 94° E and Lat. 18.5° N/Long. 90° E, Kalingapatnam, Nandigama, Kurnool, Gadag, Majali, Lat. 15° N/Long. 65° E and Lat. 15° N/Long. 60° E
7	23 Oct	In view of significant reduction in rainfall activity over most parts of the country the Southwest Monsoon withdrew from the entire country on 23 October 2022	

wind and moisture convergence to northeast India at lower level in the absence of major system over Bay of Bengal in June 2022. As a result, it had consistently caused heavy to very heavy rains over northeast India in most dates of June 2022 with record breaking extreme spell during 11 June to 24 June which caused extreme floods for prolonged period.

Some of the stations received record 24-hour rainfall. A list of stations is given below with their previous record and date.

Station	24 Hour record rainfall in June 2022 (mm)#	Date	Previous rainfall record (mm)	Date
Mawsynram	1003.6	17	945.4	07-06-1966
Forbesganj	352.6	29	219	26-06-1964
Srinagar aero	62.4	22	47.2	21-06-1996
Batote	121.4	22	121	25-06-2015
Udgir	48	17	40.6	07-06-2017
Mahabali-puram	25.4	30	14.2	22-06-1979
K.Paramathi	65	18	57.6	01-06-2000
Tondi	68.0	7	63.7	11-06-1996
Bengaluru-kialobsy	66.0	19	55.5	29-06-2014
Chamaraja-nagar	51.4	17	44.8	02-06-2011
Mysuru	76	15	73	04-06-1972
Silchar	288.7	19	229.8	20-06-1972
Najibabad	121	30	93.5	12-06-1984

Source : IMD Climate Diagnostics Bulletin of India June 2022

TABLE 3

Rainfall figures (mm) for each month and season as a whole (June-September 2022)

S. No.	Meteorological Sub-divisions	June			July			August			September			Season		
		Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)
1.	Andaman & Nicobar Islands	285.3	417.5	-32%	523.7	387.1	35%	384.7	397.6	-3%	397.6	429.5	-7%	1591.3	1631.7	-2%
2.	Arunachal Pradesh	599.3	454.7	32%	322.3	529.2	-39%	177.9	343.2	-48%	330.7	348.0	-5%	1430.3	1675.1	-15%
3.	Assam & Meghalaya	861.9	486.6	77%	292.1	552.3	-47%	216.9	394.7	-45%	229.9	328.6	-30%	1600.7	1762.2	-9%
4.	Naga., Mani., Mizo. and Tri.	283.7	353.2	-20%	253.0	354.2	-29%	223.0	326.0	-32%	183.7	268.3	-32%	943.4	1301.7	-28%
5.	Sub-Himalayan West Bengal & Sikkim	735.2	455.9	61%	362.6	586.3	-38%	398.1	459.1	-13%	391.0	388.2	1%	1887.0	1889.5	0%
6.	Gangetic West Bengal	126.2	247.9	-49%	191.9	344.8	-44%	332.8	308.3	8%	234.8	265.8	-12%	885.7	1166.8	-24%
7.	Odisha	131.6	209.3	-37%	376.6	341.4	10%	479.9	363.8	32%	208.6	235.7	-12%	1196.6	1150.2	4%
8.	Jharkhand	97.4	189.5	-49%	161.8	318.7	-49%	329.0	290.7	13%	229.3	224.0	2%	817.6	1022.9	-20%
9.	Bihar	172.6	163.3	6%	134.7	340.5	-60%	170.1	271.9	-37%	206.2	216.5	-5%	683.7	992.2	-31%
10.	East Uttar Pradesh	53.4	108.3	-51%	145.9	276.9	-47%	151.1	240.6	-37%	205.8	173.4	19%	556.2	799.2	-30%
11.	West Uttar Pradesh	33.6	78.6	-57%	150.2	240.3	-38%	123.0	228.3	-46%	193.9	124.8	55%	500.8	672.0	-25%
12.	Uttaranchal	125.5	176.8	-29%	404.8	417.8	-3%	330.2	385.7	-14%	267.6	182.4	47%	1128.0	1162.7	-3%
13.	Haryana, Chandigarh & Delhi	35.6	55.3	-36%	221.0	150.5	47%	70.0	147.7	-53%	138.8	77.2	80%	465.4	430.7	8%
14.	Punjab	39.7	54.5	-27%	219.3	161.4	36%	58.4	146.2	-60%	96.5	77.7	24%	414.0	439.8	-6%
15.	Himachal Pradesh	66.1	101.1	-35%	263.1	255.9	3%	243.4	256.8	-5%	134.2	120.6	11%	706.9	734.4	-4%
16.	Jammu & Kashmir	116.4	75.9	53%	225.8	192.6	17%	157.4	184.9	-15%	80.9	95.7	-15%	580.5	549.1	6%
17.	West Rajasthan	46.4	39.4	18%	221.4	107.8	105%	162.5	95.5	70%	18.7	40.9	-54%	449.0	283.6	58%
18.	East Rajasthan	66.1	74.7	-12%	331.4	228.6	45%	284.5	231.5	23%	98.7	91.8	8%	780.7	626.6	25%
19.	West Madhya Pradesh	91.3	117.8	-23%	451.1	297.7	52%	434.5	312.8	39%	211.3	149.0	42%	1188.2	877.3	35%
20.	East Madhya Pradesh	128.6	148.4	-13%	351.8	342.7	3%	436.7	362.3	21%	228.1	190.0	20%	1145.2	1043.4	10%
21.	Gujarat region	60.9	133.3	-54%	592.5	340.3	74%	302.1	307.0	-2%	149.2	146.9	2%	1104.7	927.5	19%
22.	Saurashtra & Kutch	44.2	93.6	-53%	401.7	196.3	105%	180.3	156.8	15%	126.5	93.2	36%	752.7	539.9	39%
23.	Konkan & Goa	532.7	701.5	-24%	1327.0	1053.5	26%	748.5	741.7	1%	528.6	374.1	41%	3136.8	2870.8	9%
24.	Madhya Maharashtra	92.9	157.7	-41%	385.0	229.5	68%	230.9	201.2	15%	233.7	159.0	47%	942.5	747.4	26%
25.	Marathawada	140.3	134.7	4%	349.7	170.4	105%	86.7	176.8	-51%	217.6	160.9	35%	794.2	642.8	24%
26.	Vidarbha	106.8	175.4	-39%	564.8	309.3	83%	307.5	297.1	3%	248.7	155.5	60%	1227.8	937.3	31%
27.	Chattisgarh	137.3	188.0	-27%	441.9	369.0	20%	454.8	364.2	25%	242.3	211.0	15%	1276.3	1132.2	13%
28.	Coastal Andhra Pradesh & Yanam	105.1	109.5	-4%	210.7	158.6	33%	143.1	170.3	-16%	181.3	163.0	11%	640.2	601.4	6%
29.	Telangana	142.6	131.4	9%	535.3	218.5	145%	181.2	226.1	-20%	213.6	158.8	35%	1072.7	734.8	46%
30.	Rayalaseema	106.5	72.3	47%	82.8	92.1	-10%	182.5	107.3	70%	114.6	136.9	-16%	486.5	408.6	19%
31.	Tamil Nadu, Puducherry and Karaikal	79.0	50.7	56%	137.9	69.0	100%	173.7	90.1	93%	85.5	118.6	-28%	476.2	328.4	45%
32.	Coastal Karnataka	609.0	863.6	-29%	1495.7	1088.9	37%	744.9	821.3	-9%	385.8	320.1	21%	3235.4	3093.9	5%
33.	North interior Karnataka	90.7	105.3	-14%	211.1	116.5	81%	171.1	119.4	43%	174.3	139.6	25%	647.3	480.8	35%
34.	South interior Karnataka	134.0	149.7	-10%	347.4	200.6	73%	374.4	179.5	109%	152.3	148.6	3%	1008.1	678.4	49%
35.	Keralaand Mahe	308.8	648.3	-52%	652.7	653.5	0%	553.3	445.1	24%	221.8	271.8	-18%	1736.7	2018.7	-14%
36.	Lakshadweep	366.6	335.6	9%	295.2	289.3	2%	364.4	232.0	57%	365.0	169.7	115%	1391.2	1026.6	36%

TABLE 4

Details of the weather systems during June 2022

S. No.	System	Duration	Place of initial location	Direction of movement	Place of final location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(**A**) *Low pressure area*						
1.	Low pressure	27-28	Eastcentral and adjoining northeast Arabian Sea off north Konkan- south Gujarat coasts	Northeast	Northeast and adjoining eastcentral Arabian Sea	Initially it lay as a cycir over eastcentral Arabian Sea off Maharashtra coast The Low pressure became less marked on 28, the associated cyclonic circulation. merged with the trough from the cyclonic circulation over east Rajasthan and neighbourhood to westcentral Arabian Sea on 1st July
(**B**) *Western Disturbances/Eastward moving systems*						
(*i*) *Upper air cyclonic circulation*						
1	Between 4.5 and 5.8 km above m.s.l.	20-22	Jammu-Kashmir and Ladakh, adjoining Pakistan	East	Jammu-Kashmir and Ladakh	Initially it lay as a trough in mid tropospheric westerlies with its axis at 5.8 km above m.s.l. ran roughly along Long. 72° E to the north of Lat. 25° N on 18. The cycir became less marked on 23. However, the trough in mid and upper tropospheric westerlies with its axis at 7.6 km above m.s.l. ran roughly along Long. 70° E to the north of Lat. 26° N on 23 which moved away north-eastwards on 26
(*ii*) *As a trough*						
1.	At 5.8 km above m.s.l.	4-6	Roughly along Long. 62° E to north of Lat. 28° N	East	Roughly along Long. 67° E to north of Lat. 29° N	It lay as a cyclonic circulation over Himachal Pradesh and neighbourhood on 7 which became less marked on 8
2.	At 5.8 km above m.s.l.	8 eve-11	Roughly along Long. 70° E to the north of Lat. 30° N	Northeast	Roughly along Long. 80° E to the north of Lat. 28° N	Moved away northeastwards on 12
3.	At 5.8 km above m.s.l.	11-16	Roughly along Long. 64°E to the north of Lat. 35° N	Do	Roughly along Long. 80° E to the north of Lat. 30° N	Became less marked on 17
4.	At 5.8 km above m.s.l.	15-17	Roughly along Long. 63° E to the north of Lat. 30° N	Do	Roughly along Long. 75° E to the north of Lat. 30° N	Moved away northeastwards on 18
(*iii*) *Induced cyclonic circulations*						
1.	Up to 1.5 km above m.s.l. on	21-22	Northwest Rajasthan and neighbourhood	Stationary	*In situ*	Became less marked on 23
(**C**) *Other upper air cyclonic circulations*						
1.	Up to 0.9 km above m.s.l.	1-7	Southeast Uttar Pradesh and neighbourhood	Northwest	Central parts of Uttar Pradesh	Merged with the east-west trough from north Punjab to Manipur trough on 8
2.	At 3.1 kms a.s.l.	3	Sri Lanka and neighbourhood	Stationary	*In situ*	Became less marked on 4
3.	At 3.1 km above m.s.l.	5-6	West Rajasthan and adjoining Pakistan	East	East Rajasthan and neighbourhood	Became less marked on 7
4.	Between 5.8 and 7.6 km above m.s.l.	2-7	Southeast Bay of Bengal and adjoining Andaman Sea	West	Southeast Bay of Bengal	Became less marked on 8

TABLE 4 (*Contd*.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
5.	At 1.5 km above m.s.l.	6	East Jharkhand and neighbourhood	Stationary	*In situ*	Became less marked on 7
6.	Upto 5.8 kms a.s.l.	9-10	Eastcentral Arabian Sea off south Konkan - Goa coasts	Do	Do	It lay as a trough from south Gujarat coast to central parts of Arabian Sea which extended between 3.1 and 4.5 km above m.s.l. on 11 and merged with the trough from the cyclonic circulation over eastcentral Arabian Sea to northeast Madhya Pradesh on 13
7.	At 3.1 km above m.s.l.	13	South coastal Odisha and neighbourhood	Do	Do	Became less marked on 14
8.	Between 3.1 km and 7.6 km above m.s.l.	13-15	Eastcentral Arabian Sea	West	Central parts of Arabian Sea	Became less marked on 16 morning
9.	At 3.1 km above m.s.l.	15	Southwest Rajasthan and neighbourhood	Stationary	*In situ*	Became less marked on 18
10.	Between 1.5 and 5.8 km above m.s.l.	16	Southeast Bay of Bengal which	Do	Do	Became less marked on 17
11.	At 1.5 km above m.s.l.	16	Central Pakistan and neighbourhood	Do	Do	Became less marked on 17
12.	At 3.1 km above m.s.l.	16-18	North Tamil Nadu and neighbourhood	East	Southwest Bay of Bengal off Tamil Nadu	Became less marked on 19
13.	At 0.9 km above m.s.l.	16-20	Haryana and neighbourhood	Do	West Uttar Pradesh and neighbourhood	Became less marked on 21
14.	Up to 1.5 km above m.s.l.	21	East Uttar Pradesh and neighbourhood	West	-	It merged with the east- west trough at mean sea level from northwest Rajasthan to northwest Bay of Bengal on 22
15.	Between 1.5 km and 5.8 km above m.s.l.	22-24	East Jharkhand and adjoining north Odisha	Do	Southeast Uttar Pradesh and neighbourhood	Became less marked on 25
16.	Between 1.5 km and 3.1 km above m.s.l.	25	North Andaman Sea and adjoining eastcentral Bay of Bengal	Stationary	*In situ*	Became less marked on 26
17.	At 0.9 km above m.s.l.	25-27	West Rajasthan and neighbourhood	South	Southwest Rajasthan and neighbourhood	Became less marked on 28
18.	Between 1.5 km & 2.1 km above m.s.l.	24-27	Jharkhand and neighbourhood	West	Central parts of Madhya Pradesh and neighbourhood	Became less marked on 28
19.	Between 3.1 km and 5.8 km above m.s.l.	29	Coastal Odisha and neighbourhood	Stationary	*In situ*	Became less marked on 30
(D)	*Other troughs/Wind discontinuity*					
1.	At 3.1 km above m.s.l.	2-3	Roughly along Long. 88° E to north of Lat. 20° N	Northeast	Roughly along Long. 90°E to north of Lat. 22°N	Became less marked on 4
2.	Upto 0.9 km above m.s.l.	2-4	From Gangetic West Bengal to north coastal Andhra Pradesh	Oscillatory	From Bihar to north coastal Andhra Pradesh	Became less marked on 5

TABLE 4 (*Contd*.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
3.	At 3.1 km above m.s.l.	4-9	From the cyclonic circulation over eastcentral and adjoining southeast Bay of Bengal to southwest Bay of Bengal	West	From northeast Bay of Bengal to Sri Lanka	Became less marked on 10
4.	At 3.1 km a.s.l.	5-8	Roughly along Long. 89° E to the north of Lat. 22° N	Southeast	Roughly along Long. 90° E to the north of Lat. 20° N	Became less marked on 9
5.	At 0.9 km a.s.l.	5-9	From the cyclonic circulation over east Uttar Pradesh and neighbourhood to south Chhattisgarh	East	From Sub-Himalayan West Bengal to interior Odisha	Became less marked on 10
6.	At 0.9 km above m.s.l.	10	From northeast Madhya Pradesh to westcentral Bay of Bengal	Stationary	*In situ*	Became less marked on 11
7.	Between 3.1 and 4.5 km above m.s.l.	11-12	From northeast Bay of Bengal to southwest Bay of Bengal	Oscillatory	From northeast Bay of Bengal to central parts of Bay of Bengal	Became less marked on 13
8.	Between 3.1 and 4.5 km above m.s.l.	13-14	From the cyclonic circulation over eastcentral Arabian Sea to northeast Madhya Pradesh	West	From the cyclonic circulation over central parts of north Arabian Sea to southwest Rajasthan	Became less marked on 15
9.	At 0.9 km above m.s.l.	14-15	From southeast Uttar Pradesh to south Chhattisgarh	East	From south Bihar to south coastal Andhra Pradesh	Became less marked on 16
10.	At 5.8 km above m.s.l.	15	Roughly along Long. 86° E to the north of Lat. 22° N	Stationary	*In situ*	Became less marked on 16
11.	At 1.5 km above m.s.l.	15	From south interior Karnataka to Comorin	Do	Do	Became less marked on 16
12.	At 3.1 km above m.s.l.	17	From northeast Bihar to interior Odisha	Do	Do	Became less marked on 18
13.	At 3.1 km above mean sea level	16-19	From cyclonic circulation over southwest Rajasthan and neighbourhood to northwest Arabian Sea	-	From the cyclonic circulation over southwest Haryana and neighbourhood to central parts of Arabian Sea	Became less marked on 20
14.	At 0.9 km above m.s.l.	16-20	From Rayalaseema to Comorin area	Oscillatory	From south Chhattisgarh to south coastal Andhra Pradesh	Became less marked on 21
15.	At 1.5 km above m.s.l.	24	From the cyclonic circulation over Jharkhand and neighbourhood to Vidarbha	Stationary	*In situ*	Became less marked on 25

TABLE 4 (*Contd*.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
16.	At 3.1 km above m.s.l.	26-27	From the cyclonic circulation over south Chhattisgarh and neighbourhood to cyclonic circulation over eastcentral and adjoining northeast Arabian Sea off north Konkan- south Gujarat coasts	West	From the cyclonic circulation over central parts of Madhya Pradesh and neighbourhood to the cyclonic circulation associated with low pressure area over northeast and adjoining eastcentral Arabian Sea	Became less marked on 28
(E)	*East-West shear zone*					
1.	Between 3.1 and 4.5 km above m.s.l.	1-2	Roughly along Lat. 10° N	Stationary	*In situ*	Became less marked on 3
2.	At 0.9 km a.s.l.	6-22	From the cyclonic circulation over east Uttar Pradesh to north Bangladesh	Oscillatory	Northwest Rajasthan to northwest Bay of Bengal	Became less marked on 23
3.	Between 4.5 and 7.6 km above m.s.l.	8	Roughly along Lat. 11° N across south peninsular India	Stationary	*In situ*	Became less marked on 9
4.	Between 3.1 and 5.8 km above m.s.l.	25	Roughly along Lat. 18° N	Do	Do	Became less marked on 26
5.	Between 4.5 and 5.8 km above m.s.l.	27-28	Roughly along Lat. 19° N	Do	Do	Became less marked on 29
6.	At 0.9 km above m.s.l.	25 Jun - 1 Jul	From the cyclonic circulation over west Rajasthan to Gangetic west Bengal	Oscillatory	From northwest Rajasthan to northeast Bay of Bengal	It lay as a monsoon trough on 2 July

In the month of July, the country recorded 117% of precipitation, with the homogeneous regions of Central India and South Peninsula receiving huge amounts of rainfall, *i.e.*, 142% and 160% of LPA respectively. The homogenous region of East & Northeast India logged 55% of LPA, the lowest recorded rainfall since 1901, while the precipitation over South Peninsular region was the second highest since 1901 after the year 1961.

The higher rainfall in July 2022 was mainly due to formation and movement of 4 low pressure systems (LPS), out of which, 2 LPS moved from South Odisha coasts to South Rajasthan and South Pakistan while two LPS formed over Gujarat and moved further westwards across north Arabian Sea. Monsoon Trough was also seen south of the normal position for most days of July.

Some of the stations received record 24-hour rainfall in this month. A list of stations is given below with their previous record and date.

Station	24-Hour Record rainfall in July 2022 (mm)#	Date	Previous rainfall Record (mm)	Date
Pauri	67	22	64.3	03-07-1983
Pathankot IAF	73	21	47	16-07-2017
Sriganganagar Tehsil	260	15	242.5	18-07-1978
Vidisha-Aws	200	11	129	22-07-1971
Arvi	123.2	5	36.6	03-07-1980
Champa	170	4	142	28-07-1952
Medak	192	23	168	23-07-1989
Hakimpet IAF	117.4	23	95	21-07-2012
Ramgundam	228.3	10	177.4	19-07-2013
Bhilwara	205	26	139.8	14-07-1975
Chamaraja-nagar	38.5	31	36.6	25-07-2007
Srinagar Aero	89	28	59.4	28-07-2003

Source : IMD Climate Diagnostics Bulletin of India July 2022

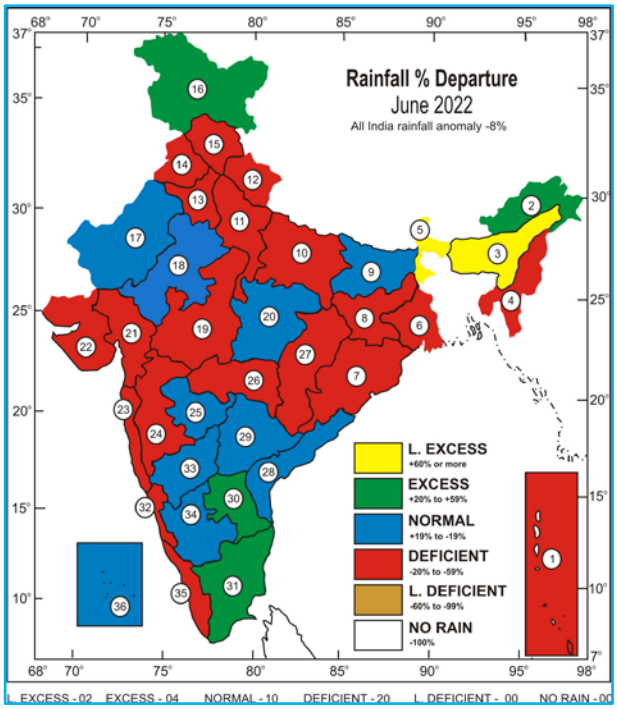


Fig. 2. Rainfall for the month of June 2022 as percentage departure from normal. 36 sub-divisions are indicated by numbers on the map & bold letters in legend below. The rainfall anomaly values for these sub-divisions are indicated below :

1	-32	**7**	-37	**13**	-36	**19**	-23	**25**	4	**31**	56
2	32	**8**	-49	**14**	-27	**20**	-13	**26**	-39	**32**	-29
3	77	**9**	6	**15**	-35	**21**	-54	**27**	-27	**33**	-14
4	-20	**10**	-51	**16**	53	**22**	-53	**28**	-4	**34**	-10
5	61	**11**	-57	**17**	18	**23**	-24	**29**	9	**35**	-52
6	-49	**12**	-29	**18**	-12	**24**	-41	**30**	47	**36**	9

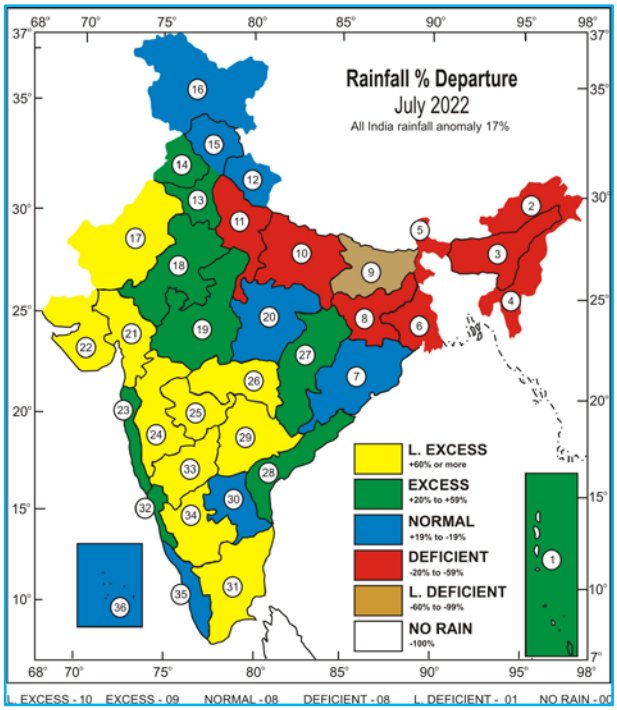


Fig. 3. Rainfall for the month of July 2022 as percentage departure from normal. 36 sub-divisions are indicated by numbers on the map & bold letters in legend below. The rainfall anomaly values for these sub-divisions are indicated below :

1	35	**7**	10	**13**	47	**19**	52	**25**	105	**31**	100
2	-39	**8**	-49	**14**	36	**20**	3	**26**	83	**32**	37
3	-47	**9**	-60	**15**	3	**21**	74	**27**	20	**33**	81
4	-29	**10**	-47	**16**	17	**22**	105	**28**	33	**34**	73
5	-38	**11**	-38	**17**	105	**23**	26	**29**	145	**35**	0
6	-44	**12**	-3	**18**	45	**24**	68	**30**	-10	**36**	2

The precipitation in the homogenous region of East and Northeast India in July was 55% of LPA, the subdued rainfall resulted in rise in day temperatures. Some stations equaled or broke the previous maximum temperature records a list of stations is given below with their previous record and date.

S. No.	Station name	New record (°C)#	Date (Jul 22)	Previous record (°C)	DD/MM/ YYYY
1.	Cherra-punji*	30.3@	15	30.3	20-07-2018
2.	North-Lakhimpur	39.4	15	38.5	08-07-2001
3.	Cooch-beharap	39	15	38.2	21-07-2018
4.	Sabour	39.2@	14	39.2	26-07-1972
5.	Palakkad	34.4@	28	34.4	15-07-1987

Source : IMD Climate Diagnostics Bulletin of India July 2022
@equals previous record

During the month of August, the rainfall over the country was 104% of LPA with the homogenous region of South Peninsula recording above normal rainfall at 127% of LPA, while East & Northeast region received precipitation only 74% of LPA, which was the third lowest since 1901. The rainfall over the sub division of south interior Karnataka (209% of LPA) was the highest since 1901 for the sub division.

Formation and west-northwestward movement of a total of four intense system (3 Depression and 1 Deep Depression) were the main reasons of higher rainfall in the month of August 2022. Out of these systems, 3 systems formed over North Bay of Bengal and moved along Monsoon trough to Central and further western parts of India and all latter systems caused severe flood situation reported over states like Odisha, Chhattisgarh, Madhya Pradesh, Rajasthan and Gujarat state in the month. The fourth system as Depression formed over Gujarat and moved to north Arabian Sea, causing huge moisture incursion from Arabian Sea to western and central India

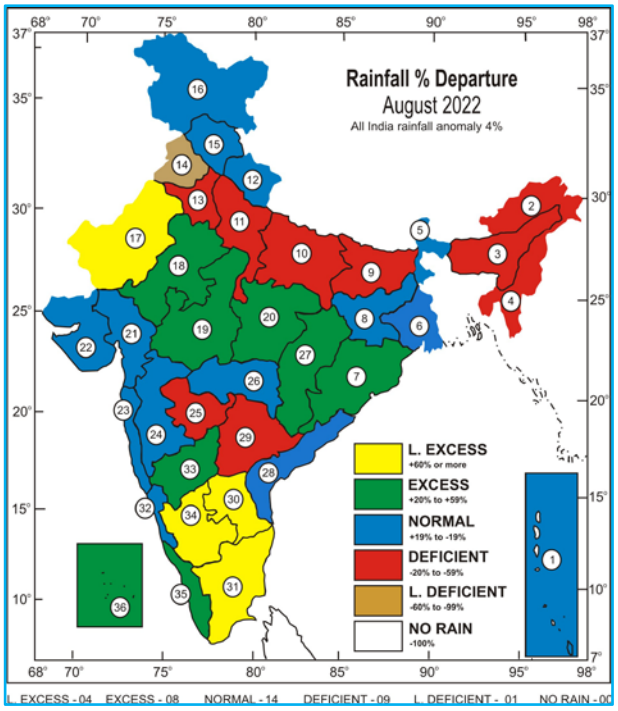


Fig. 4. Rainfall for the month of August 2022 as percentage departure from normal. 36 sub-divisions are indicated by numbers on the map & bold letters in legend below. The rainfall anomaly values for these sub-divisions are indicated below :

1	-3	**7**	32	**13**	-53	**19**	39	**25**	-51	**31**	93
2	-48	**8**	13	**14**	-60	**20**	21	**26**	3	**32**	-9
3	-45	**9**	-37	**15**	-5	**21**	-2	**27**	25	**33**	43
4	-32	**10**	-37	**16**	-15	**22**	15	**28**	-16	**34**	109
5	-13	**11**	-46	**17**	70	**23**	1	**29**	-20	**35**	24
6	8	**12**	-14	**18**	23	**24**	15	**30**	70	**36**	57

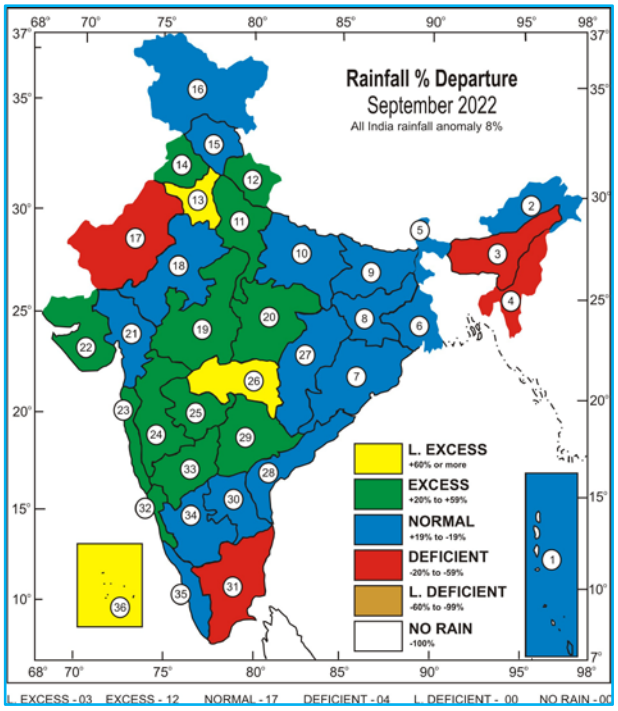


Fig. 5. Rainfall for the month of September 2022 as percentage departure from normal. 36 sub-divisions are indicated by numbers on the map & bold letters in legend below. The rainfall anomaly values for these sub-divisions are indicated below :

1	-7	**7**	-12	**13**	80	**19**	42	**25**	35	**31**	-28
2	-5	**8**	2	**14**	24	**20**	20	**26**	60	**32**	21
3	-30	**9**	-5	**15**	11	**21**	2	**27**	15	**33**	25
4	-32	**10**	19	**16**	-15	**22**	36	**28**	11	**34**	3
5	1	**11**	55	**17**	-54	**23**	41	**29**	35	**35**	-18
6	-12	**12**	47	**18**	8	**24**	47	**30**	-16	**36**	115

and thus also triggered heavy rainfall spell over latter areas during 10-14 August, 2022 over these areas. Because of these systems and their movement towards Pakistan one after other, monsoon trough was also seen south of the normal position for many days of August. Also, the presence of off shore trough and east-west shear zone insome dates helped monsoon to remain active in the month.

Some stations recorded highest one day rainfall in this month. A list of stations is given below with their previous record and date.

S. No.	Station	Rainfall (mm) In 24 Hrs.	Date Previous		DD/MM/ YYYY
		(New rec.)#	Aug-22	Record	
1.	Kota (A)	224.2	22	193.1	07-08-2016
2.	Bhind	100	20	80.4	04-08-1975
3.	Shivpuri	215	14	155	25-08-1991
4.	Rajnand-gaon	152	10	135	22-08-1990
5.	Mahabali-puram	53.4	22	4.2	02-08-1979
6.	Chamaraj-nagar	78.4	30	61.2	28-08-2008
7.	Shirali	287.8	2	240.4	03-08-1982
8.	Mandya	143	2	133.3	15-08-2017

Source : IMD Climate Diagnostics Bulletin of India August 2022

In September, the monthly rainfall for the country was 108% of LPA where the homogenous region of Central India was the main contributor with rainfall of 124% of LPA while East and Northeast (87% of LPA) homogenous region continued to receive less than normal rainfall, the other two regions recorded normal rainfall. Out of the total 36 meteorological sub divisions, 32 sub

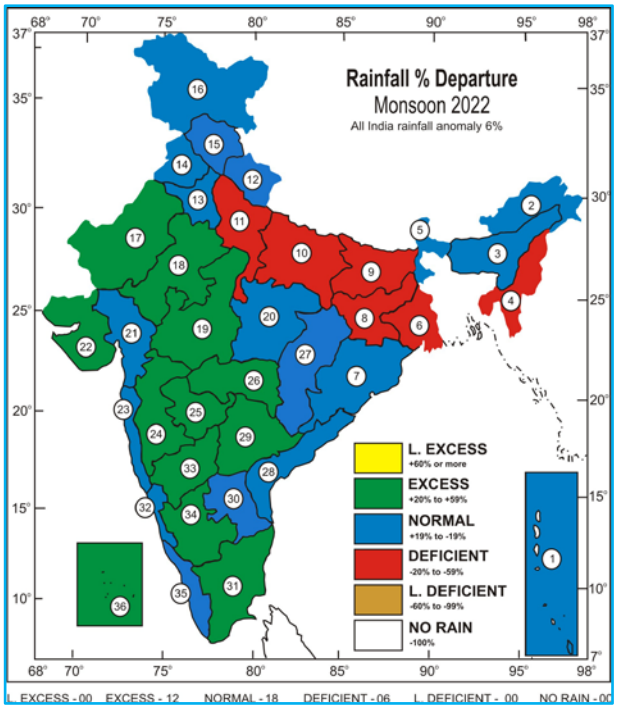


Fig. 6. Rainfall for the month of monsoon 2022 as percentage departure from normal. 36 sub-divisions are indicated by numbers on the map & bold letters in legend below. The rainfall anomaly values for these sub-divisions are indicated below :

1	-2	**7**	4	**13**	8	**19**	35	**25**	24	**31**	45
2	-15	**8**	-20	**14**	-6	**20**	10	**26**	31	**32**	5
3	-9	**9**	-31	**15**	-4	**21**	19	**27**	13	**33**	35
4	-28	**10**	-30	**16**	6	**22**	39	**28**	6	**34**	49
5	0	**11**	-25	**17**	58	**23**	9	**29**	29	**35**	-14
6	-24	**12**	-3	**18**	25	**24**	26	**30**	19	**36**	36

divisions, *i.e*., 85% of the country recorded normal or more precipitation in this month. Rainfall was higher in the second half of the September 2022. It was mainly due to formation of 1 Depression and 2 Low pressure systems which moved from Bay of Bengal to north India. The first system formed during the second week of September, as a Depression and moved from south coastal Odisha and neighborhood to south Chhattisgarh during 8-12 September and then further its remnant moved to central Uttar Pradesh which had longer period till 18 September while second system formed as a low pressure system over Bay of Bengal, and then moved in nearly west-northwestward direction causing strengthening of the monsoon flow across IGP region and kept the surface east-west trough south of the normal position in most dates during second half of the September. The third low pressure system formed from the remnant of the above low-pressure system. Further, a cyclonic circulation over eastcentral Arabian sea off south Maharashtra - Goa coasts in the lower/middle tropospheric levels and an east-

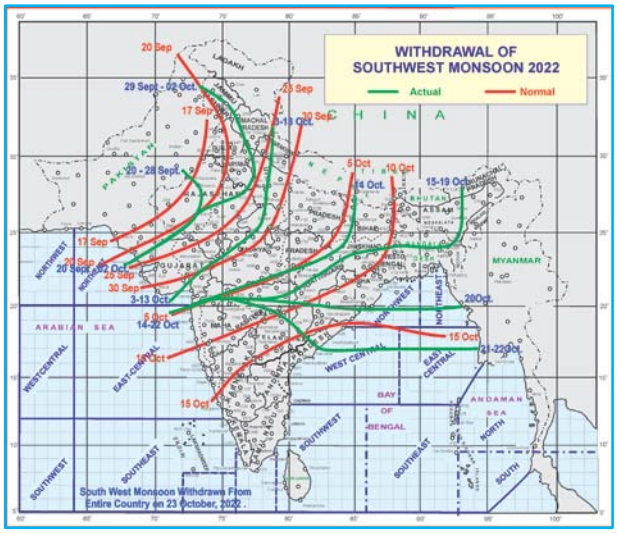


Fig. 7. Isochrones of withdrawal of SW monsoon 2022

west trough in the lower tropospheric levels across northern parts of peninsular India along with positioning of the monsoon trough to the south of its normal position all this culminated in the weekly rainfall to be a whopping 134% of LPA.

Some of the stations received record 24-hour rainfall. A list of these stations is given below with their previous record and date.

S. No.	Station	24-Hour record rainfall in Sep 2022 (mm)#	Date	Previous rainfall record (mm)	Date
1.	Tuensang	68.2	24	60	22-09-1972
2.	Pauri	75	16	50	18-09-2010
3.	Dharchula	132.2	10	122	16-09-1964
4.	Rohtak	165.4	25	158	11-09-2009
5.	Pathankotiaf	76.7	25	57	03-09-2017
6.	Delhiridge	88.8	21	82	17-09-2011
7.	Jaipurtehsilsr	67	24	54	25-09-1981
8.	Arvi	68.5	12	61	28-09-1988
9.	Nandurbar	148	14	140	29-09-1990
10.	Karipurap.	115.2	2	113	30-09-2001
11.	Palakkad	171.3	1	102.3	19-09-1989

Source : IMD Climate Diagnostics Bulletin of India September 2022

2.3. *Seasonal rainfall distribution*

Meteorological sub-divisionwise seasonal rainfall distribution in terms of percentage departures from *normal* is given in Fig. 6. Out of the total 36 meteorological sub

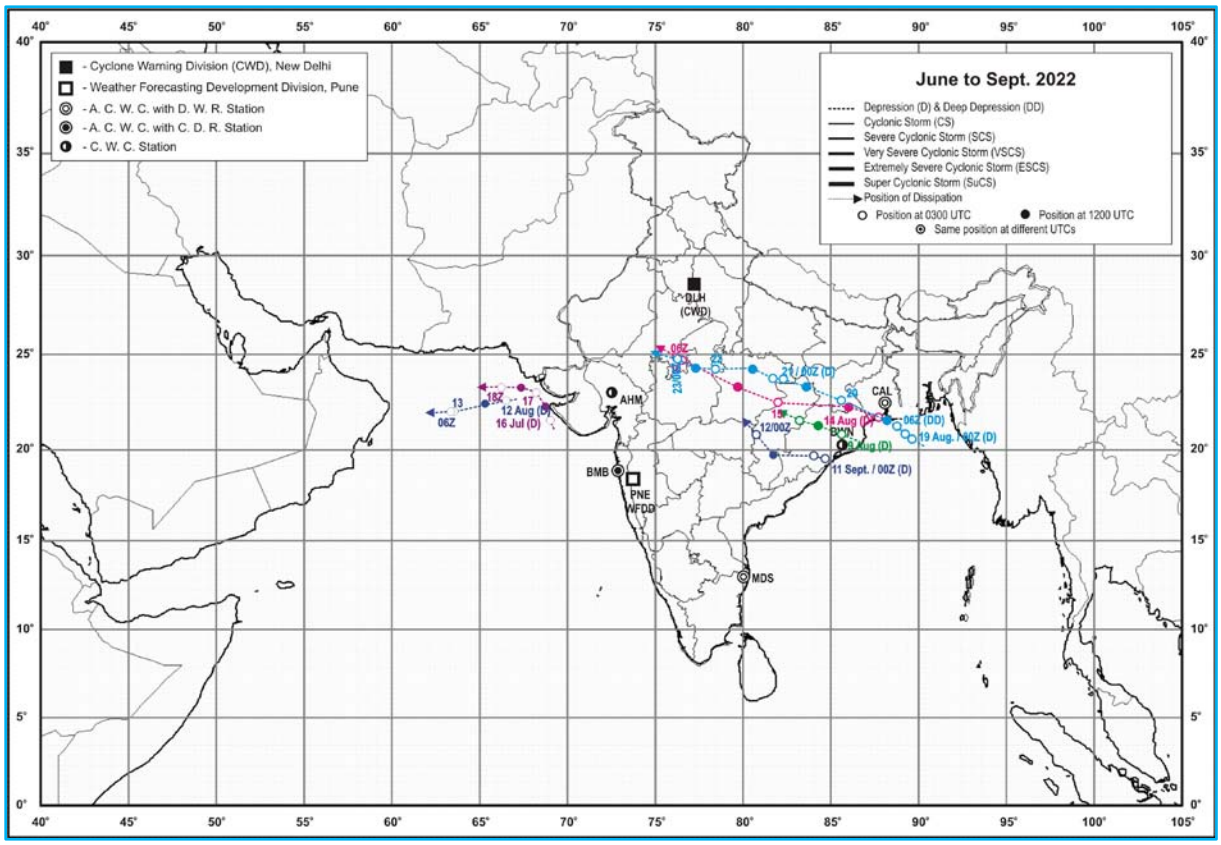


Fig. 8. Track of cyclonic storm and depression

divisions, 12 sub-divisions (40% area of the country) received *excess* rainfall, 18 *normal* (43% area of the country) and 6 sub-divisions (17% area of the country) *deficient* precipitation. No sub divisions recorded *large excess*, *large deficient* or zero rainfall in this season. The cumulative rainfall over the homogenous regions of South Peninsula and Central India were more than normal at 122% of LPA and 119% of LPA respectively.

2.4. *Withdrawal of southwest Monsoon*

Fig. 7 shows the isochrones of withdrawal of southwest monsoon 2022. With establishment of an anti-cyclonic circulation in the lower tropospheric levels over western parts of northwest India and substantial reduction in moisture content & rainfall, the monsoon started withdrawing from parts of southwest Rajasthan and adjoining Kutch on 20 September, 2022 with a delay of 3 days from its normal date, *i.e.*, 17 September. Thereafter, there was no further withdrawal till 28 September. West-northwestward Movement of remnant of a Depression and its cyclonic circulation in the lower tropospheric levels, a trough in the lower tropospheric levels, a low-pressure area over northwest and adjoining westcentral Bay of Bengal along with its associated cyclonic circulation extending up to mid-tropospheric levels tilting south-westwards with height caused further continuity of precipitation in parts of the northwest (but outside most parts of already withdrawal area of Kutch and southwest Rajasthan) and central India deterring any further withdrawal. It was only on 29 September after a hiatus of 9 days that further withdrawal from entire Punjab, Chandigarh; some parts of Jammu, Kashmir & Ladakh, Himachal Pradesh, west Uttar Pradesh, Haryana; entire Delhi and some more parts of Rajasthan on 29 September, from most parts of north Arabian Sea, Gujarat region, remaining parts of Saurashtra, Kutch, Rajasthan, Haryana, Himachal Pradesh, Jammu-Kashmir & Ladakh, some parts of west Madhya Pradesh, Uttarakhand and some more parts of west Uttar Pradesh on 3 October. After this there was an interruption in the withdrawal of the southwest monsoon for 11 days and then monsoon further withdrew from remaining parts of Uttarakhand, Uttar Pradesh and Gujarat; most parts of Madhya Pradesh and some parts of Bihar, Jharkhand, Chhattisgarh and Maharashtra. Continuing further withdrawal, southwest monsoon withdrew from the entire country on 23 October and the Northeast Monsoon rains commenced over coastal Tamil Nadu, Puducherry & Karaikal and adjoining areas of south Coastal Andhra Pradesh on the 29 October, 2022.

TABLE 5

Details of the weather systems during July 2022

S. No.	System	Duration	Place of initial location	Direction of movement	Place of final location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(**A**)	*Depression*					
1.	Depression	16 (0300 UTC) - 17 (0000 UTC)	Northeast Arabian Sea off Saurashtra coast	West	Northeast Arabian Sea off Saurashtra coast (Lat. 23.0°N/ Long. 68.2°E)	Initially it lay as a cyclonic circulation over northeast Arabian sea and adjoining coastal areas of Gujarat on 14 evening. It lay as a low pressure area on 15 morning & then WML on same day. Depression weakened into WML on 18 (morning) & low pressure on 18 (afternoon) and became less marked on 18 evening. The associated cyclonic circulation became unimportant for the Indian region on 19. Details are given in the article on, 'Cyclones & depression over north Indian ocean 2022'
(**B**)	*Well marked low/low pressure area*					
1.	Well marked low Pressure area	4-8	North Odisha and adjoining south Jharkhand, Gangetic West Bengal	North west	South Pakistan and adjoining Kutch	Initially it lay as a cyclonic circulation over Bangladesh and neighbourhood which extended up to 7.6 km above m.s.l. tilting southwestwards with height on 2. low-pressure became less marked on 8. The associated cyclonic circulation became less marked on 9
2.	Well marked low Pressure area	9-18	Odisha and neighbourhood	Oscillatory	Central parts of Madhya Pradesh and neighbourhood	Initially it lay as a cyclonic circulation over southwest and adjoining westcentral Bay of Bengal off south Odisha-north Andhra Pradesh coast which extended up to 7.6 km above m.s.l. tilting southwest ward with height on 7. The low pressure area became less marked on 19. The associated cyclonic circulation became less marked on 20
3.	Low Pressure area	24-26	Southwest Rajasthan and neighbourhood	Northwest	Northwest and adjoining northeast Arabian Sea	The associated cyclonic circulation extended up to 7.6 km. The LP moved away westward on 27
(**C**)	*Western Disturbances/Eastward moving Systems*					
(*i*)	*Upper air cyclonic circulation*					
1.	At 5.8 km above m.s.l.	20-21	North Pakistan and neighbourhood	Northeast	Himachal Pradesh and neighbourhood	It moved away northeastwards on 22
2.	At 3.1 km above m.s.l.	14-15	Afghanistan and adjoining north Pakistan	Stationary	*In situ*	With a trough aloft in mid and upper tropospheric westerlies with its axis at 5.8 km above m.s.l. the cycir became less marked on 16. The trough aloft moved away northeastward on 18
3.	At 5.8 km above m.s.l.	21-22	East Afghanistan and neighbourhood	East	Central Pakistan and neighbourhood	Became less marked on 23
4.	At 3.1 km above m.s.l.	31 Jul	Central parts of Afghanistan and neighbourhood	Northeast	-	A trough aloft with its axis at 5.8 km above m.s.l. ran roughly along Long. 65° E to the north of Lat. 25. Became less marked on 1 August. The trough above moved away northeastward on 2 August
(**D**)	*Other upper air cyclonic circulations*					
1.	Between 5.8 and 7.6 kms a.s.l.	2	Northeast Madhya Pradesh and neighbourhood	Stationary	*In situ*	Became less marked on 3
2.	Between 3.1 and 5.8 kms a.s.l.	1-2	East Rajasthan and neighbourhood	West	Central Rajasthan and neighbourhood	Became less marked on 3
3.	Up to 4.5 km above m.s.l.	5-6	Northwest Bay of Bengal and neighbourhood	Do	North Odisha and adjoining Chhattisgarh	Became less marked on 7

TABLE 5 (*Contd*.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
4.	At 1.5 kms a.s.l.	12	North Punjab and neighbourhood	Stationary	*In situ*	Became less marked on 13
5.	At 1.5 kms a.s.l.	13	South Pakistan and neighbourhood	Do	Do	Became less marked on 14
6.	At 3.1 kms a.s.l.	19-27	South Jharkhand and neighbourhood	Northwest	Central parts of Rajasthan and neighbourhood	Became less marked on 28
7.	At 1.5 km above m.s.l.	21	Haryana and neighbourhood	Stationary	*In situ*	Became less marked on 22
8.	Upto 1.5 kms a.s.l.	25-26	South Andaman Sea and neighbourhood	West	Southeast Bay of Bengal and adjoining south Andaman sea	Became less marked on 27
9.	Upto 3.1 kms a.s.l.	27	Westcentral Bay of Bengal off Andhra Pradesh coast	Stationary	*In situ*	Became less marked on 28
10.	At 1.5 km above m.s.l.	28-29	North interior Tamil Nadu and neighbourhood	Northwest	South interior Karnataka	Became less marked on 30
11.	Between 0.9 km and 1.5 km above m.s.l.	30	Northeast Uttar Pradesh and neighbourhood	Stationary	*In situ*	Became less marked on 31
12.	Between 1.5 and 3.1 km above m.s.l.	28-30	Southeast Bay of Bengal	Northwest	South central Bay of Bengal	Became less marked on 31
13.	Between 1.5 and 3.1 km above m.s.l.	31 July	Punjab and neighbourhood	Stationary	*In situ*	Became less marked on 1 August
(**E**)	*Other troughs*					
1.	Between 3.1 and 5.8 km above m.s.l.	1-4	From the cyclonic circulation over east Rajasthan and neighbourhood to westcentral Arabian Sea	Oscillatory	From northwest Rajasthan and neighbourhood to northcentral Arabian Sea	Became less marked on 5
2.	Up to 1.5 km above m.s.l.	20-23	South interior Karnataka to Comorin area	Stationary	*In situ*	Became less marked on 24
3.	At 0.9 kms a.s.l.	26	From Rayalaseema to Comorin area	Do	Do	Became less marked on 27
4.	At 0.9 kms a.s.l.	26 mor	From the cyclonic circulation over central parts of Madhya Pradesh to Rayalaseema	Northwest	From the cyclonic circulation over east Rajasthan and neighbourhood to westcentral Bay of Bengal	Became less marked on 27
5.	At 3.1 kms a.s.l.	31 Jul	From central parts of south Bay of Bengal to Comorin area	Stationary	*In situ*	Became less marked on 1 August
6.	At 0.9 km above m.s.l.	28 Jul - 2 Aug	From north interior Karnataka to Comorin area	Oscillatory	From south Chhattisgarh to Comorin area	Became less marked on 3 August
(**F**)	*East-West Shear Zone*					
1.	Between 3.1 & 5.8 kms a.s.l.	6-14	Roughly along Lat. 20° N	Oscillatory	Roughly along Lat. 19° N	Became less marked on 15
2.	Between 4.5 & 5.8 kms a.s.l.	19-20	Roughly along 20° N	Stationary	*In situ*	Became less marked on 21

TABLE 6

Details of the weather systems during August 2022

S. No.	System	Duration	Place of initial location	Direction of movement	Place of final location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(**A**)	*Depression*					
1.	Deep Depression	19 (0000 UTC) - 23 (0300 UTC)	Northwest and adjoining northeast Bay of Bengal	West northwest	Northwest Madhya Pradesh and adjoining east Rajasthan	Initially it lay as a cyclonic circulation over south Myanmar and neighbourhood which extended up to 5.8 km above m.s.l. on 17. It lay as a low pressure area on 18 & WML on 18 afternoon. Depression weakened into well marked low on 23 & low pressure on 25 evening & became less marked on 27. Details are given in the article on, 'Cyclones & depression over north Indian ocean 2022'
2.	Depression	9 (0300 UTC) - 10 (0000 UTC)	Coastal Odisha and neighbourhood	Northwest	Interior Odisha and adjoining Chhattisgarh	Initially it lay as a cyclonic circulation over Rayalaseema and neighbourhood at 1.5 km above m.s.l. on 31 July. It lay as a low pressure area on 6 and became WML on 7. Depression weakened into WML on 10 & lay as a low on 10 (1200 UTC) and became less marked on 11. Details are given in the article on, 'Cyclones & depression over north Indian ocean 2022'
3.	Depression	12 (0300 UTC) -13 (1200 UTC)	Northeast Arabian Sea	West	Northeast and adjoining northwest Arabian Sea	Initially it lay as a low pressure area over Saurashtra and adjoining northeast Arabian Sea on 10 & WML on 11. Depression weakened into WML on 13 &low pressure area on 14 morning which became less marked on 16 while the associated cycir became less marked on 17. Details are given in the article on, 'Cyclones & depression over north Indian ocean 2022'
4.	Depression	14 (0300 UTC) - 16 (1200 UTC)	Northwest Bay of Bengal and adjoining coastal areas of West Bengal and north Odisha	Northwest	East Rajasthan and adjoining west Madhya Pradesh	Initially it lay as a cyclonic circulation over west Myanmar and neighbourhood on 12. It lay as a low pressure area on 13 and WML on 13 evening. Depression weakened into WML on 16 &low pressure area on 20 which then merged with the well marked low pressure area over east Rajasthan and adjoining northwest Madhya Pradesh on 23. Details are given in the article on, 'Cyclones & depression over north Indian ocean 2022'
(**B**)	*Western Disturbances / Eastward moving Systems*					
(*i*)	*As a trough*					
1.	At 5.8 km above m.s.l.	11-13	Roughly along Long. 62°E to the north of Lat. 30°N	North	Roughly along Long. 66°E to the north of Lat. 32°N	Became less marked on 14
2.	At 5.8 km above m.s.l.	15-17	Roughly along Long. 60°E to the north of Lat. 32°N	Northeast	Roughly Long. 67°E to the north of Lat. 34°N	Moved away northeastwards on 18
3.	At 5.8 km above m.s.l.	20-25	Roughly along Long. 58°E to the north of Lat. 30°N	Northeast	Roughly along Long.65°E to the north of Lat. 30°N	Moved away north eastwards on 26
4.	At 3.1 km above m.s.l.	30	Roughly along Long. 87°E to the north of Lat. 22°N	Stationary	*In situ*	Became less marked on 31

TABLE 6 (*Contd*.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(*ii*)	*As a cyclonic circulation*					
1.	At 3.1 km above m.s.l.	27-28	West Afghanistan and adjoining Iran	East	East Afghanistan and neighbourhood	With the trough aloft with its axis at 5.8 km above m.s.l. ran roughly along Long. 63 E to the north of Lat.32 N. It then lay as a trough in mid tropospheric levels on 29 and then moved away northeastwards on 31
2.	At 3.1 km above m.s.l.	4-7	Central Pakistan & neighbourhood	Northeast	-	Initially, it lay as a trough along Long. 65°E to the north of Lat. 28°N Moved away northeast wards on 8
(**C**)	*Other upper air cyclonic circulations*					
1.	At 0.9 km above m.s.l.	2-8	Northeast Uttar Pradesh and neighbourhood	West	West Rajasthan and neighbourhood	Became less marked on 9
2.	Upto 3.1 kms a.s.l.	5	Jharkhand and adjoining Gangetic west Bengal	Stationary	*In situ*	Became less marked on 6
3.	Between 3.1 km and 7.6 km above m.s.l.	5-7	Central parts of Karnataka	West	Eastcentral & adjoining northeast Arabian Sea	Became less marked on 8
4.	At 1.5 km above m.s.l.	7	West Uttar Pradesh and neighbourhood	Stationary	*In situ*	Became less marked on 8
5.	Between 1.5 & 5.8 km above m.s.l.	10-12	Coastal areas of West Bengal and neighbourhood	West	Western parts of Gangetic west Bengal and neighbourhood	Became less marked on 13
6.	Between 4.5 & 5.8 km above m.s.l.	22-29	Eastcentral Bay of Bengal & adjoining Myanmar coast	Do	North Jharkhand & neighbourhood	Became less marked on 30
7.	Between 3.1 & 5.8 km above m.s.l.	24-25	North interior Tamil Nadu and neighbourhood	South	South interior Tamil Nadu and neighbourhood	Became less marked on 26
8.	At 3.1 km above m.s.l.	26	Southwest Bay of Bengal and neighbourhood	Stationary	*In situ*	Became less marked on 27
9.	Between 4.5 & 5.8 km above m.s.l.	27-28	Central parts of south Bay of Bengal	Do	Do	Became less marked on 29
10.	Between 3.1 & 7.6 km above m.s.l.	28	Kerala and neighbourhood	Do	Do	Became less marked on 29
11.	Upto 0.9 km above m.s.l.	28	East Uttar Pradesh and neighbourhood	Do	Do	Became less marked on 29
12.	Upto 5.8 km above m.s.l.	29 Aug-3 Sep	South coastal Andhra Pradesh and neighbourhood	Oscillatory	Lakshadweep Area and adjoining southeast Arabian Sea	Became less marked on 4 September
(**D**)	*North-South Trough/Other trough*					
1.	Between 3.1 & 4.5 km above m.s.l.	13-14	From the depression overnorthwest & adjoining northeast Arabian Sea to south Rajasthan	Oscillatory	From westcentral Arabian Sea to central Pakistan	Became less marked on 15
2.	At 1.5 km above m.s.l	15-16	From north interior Karnataka to Comorin area	Do	From Rayalaseema to Gulf of Mannar	Became less marked on 17

TABLE 6 (*Contd*.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
3.	At 0.9 km a.s.l.	17-18	From South interior Karnataka to Comorin area	Oscillatory	From Rayalaseema to Comorin area	Became less marked on 19
4.	At 0.9 km above m.s.l.	26-28	From north interior Karnataka to Comorin area	Do	From east Vidarbha to south coastal Andhra Pradesh	Became less marked on 29
5.	At 3.1 km above m.s.l.	26-28	From the cyclonic circulation over southwest Bay of Bengal & neighbourhood to interior Tamil Nadu	Oscillatory	From north Andaman sea to south Tamil Nadu	Merged with the trough from southeast Bay of Bengal to the cyclonic circulation over south coastal Andhra Pradesh on 29
6.	Upto 3.1 km above m.s.l.	29	From southeast Bay of Bengal to the cyclonic circulation over south coastal Andhra Pradesh and neighbourhood	Stationary	*In situ*	Became less marked on 30
(**E**)	*East-West shear zone*					
1.	Between 4.5 and 7.6 km above m.s.l.	1-4	Roughly along Lat. 10° N	North	Roughly along Lat. 11° N	Became less marked on 5
2.	Between 3.1 & 7.6 km above m.s.l.	8-12	Roughly along Lat. 19° N	Do	Roughly along Lat. 24° N	Became less marked on 13
(**F**)	*Trough in easterlies*					
1.	Upto1.5 km above m.s.l.	30 Aug - 2 Sep	From the cyclonic circulation over interior Tamil Nadu to west Vidarbha	Oscillatory	From the cyclonic circulation over Lakshadweep area & adjoining southeast Arabian Sea to north Madhya Maharashtra	Became less marked on 3 September

3. Chief synoptic features of southwest Monsoon 2022

The synoptic disturbances which affected the Indian monsoon region during June, July, August and September are given in Tables 4 to 7, respectively.

In all, 12 Low Pressure areas formed, 1 of which intensified into a Deep Depression, 5 into Depressions, 2 into Well Marked Low pressure areas and 4 remained as Low-pressure areas. In the month of July, one Depression (16-17) formed over the Arabian Sea, one Deep Depression and two Depressions formed in August over the Bay of Bengal while one Depression formed over the Arabian Sea. The last intense low-pressure system formed over Bay of Bengal as a Depression (11-12) in the month of September.

In the first week of July, a weather system characterized by a low-pressure area and cyclonic circulation, extending from the lower to mid-levels of the atmosphere and tilting south-westwards with height, caused significant rainfall and thunderstorms over central India, northern parts of peninsular India and eastern regions. This weather pattern, coupled with an active monsoon trough positioned south of its usual location, helped alleviate the rainfall deficiency experienced in June.

Following this period, the weekly rainfall across the country remained above average for the rest of the monsoon season. Various factors contributed to this favourable weather pattern, including a Depression in the northeast Arabian Sea near the Gujarat coast, an off-shore trough stretching from Gujarat to Maharashtra coasts, an east-west shear zone in the lower and middle tropospheric levels across northern peninsular India, and an active monsoon trough passing through the region. These atmospheric features resulted in widespread rainfall and thunderstorms over Gujarat, Konkan, Goa, Madhya

TABLE 7

Details of the weather systems during September 2022

S. No.	System	Duration	Place of initial location	Direction of movement	Place of final location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(**A**)	*Depression*					
1.	Depression	11 (0000 UTC) - 12 (0300 UTC)	South coastal Odisha and neighbourhood	Northwest	South Chhattisgarh & adjoining southeast Madhya Pradesh and Vidarbha	It formed under the influence of cyclonic circulation over eastcentral and adjoining southeast Bay of Bengal on 7. It lay as a low pressure area on 9 evening and WML on 10. Depression weakened intoWML on 12 & weakened into low pressure on 17 morning and then became less marked. However, the associated cycir became less marked on 20. Details are given in the article on, 'Cyclones & depression over north Indian ocean 2022'
(**B**)	*Low Pressure Area*					
1.	Low pressure area	19-22 (mor)	Northwest and adjoining westcentral Bay of Bengal	Northwest	Northeast Madhya Pradesh and adjoining south Uttar Pradesh	It formed under the influence of cyclonic circulation over Northwest and adjoining westcentral Bay of Bengal. It became less marked on 22 (afternoon), However, the associated cyclonic circulation extending up to 5.8 km above m.s.l. lay over northwest Madhya Pradesh & neighbourhood and became less marked on 20
2.	Low pressure area	23-25	Northeast Rajasthan and adjoining areas of northwest Madhya Pradesh	West	Northeast Rajasthan and adjoining areas of southeast Haryana, Delhi & southwest Uttar Pradesh	This system formed from the remnant cycir of the above system. Became less marked on 25 evening. However, the associated cycir became less marked on 28
(**C**)	*Western Disturbances /Eastward moving Systems*					
(*i*)	*As a trough*					
1.	At 1.5 km above m.s.l.	5	Roughly along Long. 87° E to the north of Lat. 22° N	Stationary	*In situ*	Became less marked on 6
2.	At 5.8 km a.s.l.	5-6	Roughly along Long. 70° E to the north of Lat. 27° N	East	Roughly along Long. 73° E to the north of Lat. 27° N	Moved away northeastward on 7
3.	At 5.8 km a.s.l.	11-16	Roughly along Long. 62° E to the north of Lat. 32° N	Do	Roughly along Long. 70° E to the north of Lat. 27° N	It lay as a cycir on 13. Moved away northeastward on 17
4.	At 5.8 km a.s.l.	14-15	Roughly along Long. 89° E to the north of Lat. 21° N	Do	Roughly along Long. 90° E to the north of Lat. 18° N	It became less marked on 16
5.	Between 5.8 and 7.6 km above m.s.l.	17-18	Roughly along Long.70° E to the north of Lat. 30° N	Do	Roughly along Long. 74° E to the north of Lat. 30° N	It moved away northeastwards on 19
6.	At 5.8 km above m.s.l.	19-22	Roughly along Long.62° E to the north of Lat. 28° N	Do	Roughly along Long.70° E to the north of Lat. 28° N	It moved away northeastwards on 22 (evening)
7.	At 5.8 km above m.s.l.	23-26	Roughly along Long. 65° E to the north of Lat. 30° N	Do	Roughly along Long. 72° E to the north of Lat. 27° N	Moved away east-northeast ward on 27

TABLE 7 (*Contd*.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(D)	*Other upper air cyclonic circulations*					
1.	At 3.1 km above m.s.l.	1	Kutch and neighbourhood	Stationary	*In situ*	Became Less marked on 2
2.	Between 1.5 and 3.1 km above m.s.l.	4-7	Comorin area and neighbourhood	Oscillatory	Interior Karnataka and neighbourhood	It became less marked on 8
3.	Between 1.5 and 3.1 km above m.s.l.	8	Coastal Karnataka and neighbourhood	Stationary	*In situ*	Merged with the shear zone on 9
4.	Upto 3.1 km above m.s.l.	11-12	Eastcentral Arabian Sea off south Maharashtra-Goa coast	Stationary	*In situ*	It became Less marked on 13
5.	Between 3.1 and 5.8 km above m.s.l.	29-30 Sep	West Uttar Pradesh	Stationary	*In situ*	It became Less marked on 1 October
(E)	*North-South Trough/Other trough/trough in easterlies*					
1.	At 1.5 km a.s.l.	1	From Jammu to central Pakistan	Stationary	*In situ*	Became less marked on 2
2.	Between 1.5 & 5.8 km above m.s.l. (east-west trough)	2	From cyclonic circulation over Lakshadweep area and adjoining southeast Arabian Sea to southeast Bay of Bengal	Stationary	Do	Became less marked on 3
3.	At 0.9 km a.s.l.	4-6	From southeast Madhya Pradesh to Comorin area	Oscillatory	From Chhattisgarh to the cyclonic circulation over south interior Karnataka and neighbourhood	Became less marked on 7
4.	Between 3.1 & 5.8 km above m.s.l.	7	From the cyclonic circulation over eastcentral & adjoining southeast Bay of Bengal to north Kerala	Stationary	*In situ*	It lay as a shear zone roughly along 12° N on 8 and became less marked on 11
5.	At 0.9 km above m.s.l.	8-10	From south Konkan to the low-pressure area over westcentral & adjoining eastcentral Bay of Bengal	Stationary	Eastcentral Arabian Sea off Konkan coast to the well marked low pressure area over westcentral & adjoining northwest Bay of Bengal off north Andhra Pradesh –south Odisha coast	Became less marked on 11
6.	Upto 3.1 km above m.s.l.	12-17	From the cyclonic circulation over eastcentral Arabian Sea off south Maharashtra-Goa coasts to central parts of Bangladesh	West	From westcentral Arabian Sea to south Gujarat coasts	Became less marked on 18
7.	At 0.9 km above m.s.l.	17	From south interior Karnataka to Gulf of Mannar	Stationary	*In situ*	Became less marked on 18

TABLE 7 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
8.	Upto 1.5 km above m.s.l.	20	From the low pressure area over northwest Bay of Bengal & adjoining north Odisha-west Bengal coasts to southwest Uttar Pradesh	Stationary	*In situ*	Merged with the trough from north Punjab to northwest Bay of Bengal on 21
9.	Upto 3.1 km above m.s.l.	21-25	North Punjab to northwest Bay of Bengal	Oscillatory	From low pressure area over North Punjab and neighbourhood to southeast Bihar	Became less marked on 26
10.	Upto 3.1 km above m.s.l.	24	Roughly along Long. 87° E to the north of Lat. 20° N	Stationary	*In situ*	Became less marked on 25
(F)	*East-west shear zone/trough*					
1.	Between 4.5 & 5.8 km above m.s.l.	4	Roughly along 11° N	Stationary	*In situ*	Became less marked on 5
2.	At 3.1 km above m.s.l.	28-29	From north Andaman sea to Andhra Pradesh coast	Oscillatory	Eastcentral Bay of Bengal to south interior Karnataka	Merged with the trough from cyclonic circulation over westcentral Bay of Bengal off Andhra Pradesh coast to coastal Karnataka on 30
3.	Upto 4.5 km above m.s.l.	30 Sep	From cyclonic circulation over westcentral Bay of Bengal off Andhra Pradesh coast to coastal Karnataka	Stationary	*In situ*	Became less marked on 1 October

Maharashtra, Kerala, Mahe, Karnataka, and the Lakshadweep islands. Additionally, Tamil Nadu and Rayalaseema experienced isolated to scattered rainfall and thunderstorm activity.

During the third week of the month, some areas, including Gujarat, Konkan-Goa, Madhya Maharashtra, Tamil Nadu, and Karnataka, reported extremely heavy rainfall for a day or two. The occurrence of these heavy rainfall events was influenced by the movement of western disturbances and their interaction with the monsoon flow, aided by moisture incursion.

In July, 2022, there were 21 days with low-pressure systems, exceeding the normal average of 13.56 days. This increased frequency of low-pressure systems further contributed to the widespread rainfall and thunderstorm activity observed over northwest India.

During July, 4 low pressure areas formed over North Indian Ocean, out of this, one depression formed over Arabian Sea (16-17 July), One well marked low pressure area formed over Bay (9-19 July), one over land (4-8 July) and one low pressure area (24-27 July) formed over land.

The off-shore trough along different parts of the west coast persisted from 20 June-3 July, 5-12 July, 15-18 July, 29, 19-21 July and 6-18 August.

4. Extra Indian features

4.1. *Cross Equatorial Flow during June - September 2022*

(a) *Over the Arabian Sea*

	5° N - 5° S					North of 5° N				
		Weeks					Weeks			
Mon-th	Normal (in knots)	1	2	3	4	Normal (in knots)	1	2	3	4
Jun	10-12	+3	+5	+2	+4	15-20	- 4	-1	+3	+9
Jul	12-14	+4	N	+3	+4	20-25	+7	+3	+2	+2
Aug	12-14	N	N	-1	-1	20-25	+3	+5	-1	-7
Sep	08-10	+3	+4	+3	+2	05-10	+11	+13	+9	+6

TABLE 8

Representative amounts of extremely heavy rainfall during June-September 2022

Date	Some representative amounts of rainfall in cm for June, July, August and September 2022 (21 cm and above)
1 Jun	Nil
2 Jun	Nil
3 Jun	Nil
4 Jun	Mawsynram 21
5 Jun	Nil
6 Jun	Shella 26, Cherrapunji (rkm) 24, Cherrapunji and Mawsynram 23 each, Williamnagar 22
7 Jun	Nil
8 Jun	Nil
9 Jun	Bahadurganj 27
10 Jun	Nil
11 Jun	Nil
12 Jun	Cherrapunji (rkm) 37, Cherrapunji 35, Mawkyrwat ARG 32, Mawsynram 30, Williamnagar and Jowai AWS 21 each
13 Jun	Mawsynram 50, Cherrapunji (rkm), Shella and Mawkyrwat ARG 33 each, Mawkyrwat 32, Cherrapunji 29, Williamnagar 22
14 Jun	Nil
15 Jun	Cherrapunji (rkm) 91, Cherrapunji 81, Mawsynram 71, Mawkyrwat 30, Panbari 29, Mawkyrwat ARG 27, Tamulpur 26, Beky Rly.bridge, Aie Nh Xing and Khliehriat 25 each, Barpeta/Sarbhog AWS and Mawphlang 23 each, Manash Nh Xing and Shella 22 each, Barpeta and Hazuah 21 each
16 Jun	Cherrapunji (rkm) 68, Cherrapunji and Mawsynram 67, Mawkyrwat 36, Shella 34, Kokrajhar and Gossaigaon 32 each, Khliehriat 28, Aie Nh Xing 27, Hazuah 26, Mushalpur AWS and Dhemaji 25 each, Manash Nh Xing 24, Nalbari/Pagladia, Chepan, Goalpara CWC, Mawphlang, Panbari and Jowai AWS 23 each, Hasimara and Beki Mathungari 22 each
17 Jun	Mawsynram 100, Cherrapunji 97, Cherrapunji (rkm) 91, Mawkyrwat 54, Mawphlang 51, Shella 35, Kokrajhar 34, Williamnagar AWS 33, Khliehriat 30, Nalbari/Pagladia and Bhaghmara 26, Bhalukpong and Williamnagar 25 each
18 Jun	Beki Mathungari 41, Buxaduar 35, Shella 32, Hasimara 23
19 Jun	Silchar 29, Lakhipur 28, AP Ghat 27, Cherrapunji and Karimganj 25, Mawsynram 24, BP Ghat 22
20 Jun	Rongo 24
21 Jun	Neora 28, Umergam and Mawsynram 25, Murti 21
22 Jun	Nil
23 Jun	Nil
24 Jun	Nil
25 Jun	Nil
26 Jun	Lanja 27, Ratnagiri 22
27 Jun	Nil
28 Jun	Gossaigaon 29, Cherrapunji (rkm) 25, Cooch Behar23, Pasighat AP21
29 Jun	Forbesganj 35, Birpurand Amfu Pundibari 23, Kapkot 21
30 Jun	Nil
1 Jul	Borsad 28, Colaba and Bhalukpong 23 each
2 Jul	Nil
3 Jul	Maya Bandar, Porto Novo, Thrissur, Mangalore/P.bur, Madurai/T.south, Periakulum, Adiramapatnam, K. paramathi, Valparai, Puducherry AP, Tirupattur, Nungambakkam, Tiruthani, Arogyavaram, Sagar Island, Mahbubnagar, Nalgonda, Medak, Adilabad, Bapatla, Narsapur, Gannavaram AP, Tuni, Dhar, Datia, Motihari and Trivandrum AP 30 each
4 Jul	Nil
5 Jul	Lanja 34, Gaganbawada and Castle Rock 26 each, Tala 25, Mangaon, Malvan and Vaibhavwadi 23 each, Sanguem 22, Sangameshwar Devrukh 21
6 Jul	Castle Rock 25, Nilkund ARG 23, Harda and Dapoli ARG 22 each, Mahabaleshwar 21
7 Jul	Hosanagar 31
8 Jul	Karwar 26, Sanguem and Shirali 23 each, Mulki and Bhatkal 22 each, Matheran, Lanja and Canacona 21 each
9 Jul	Lakhpat 28, Navipet 23, Merakamudidam and Kaprada 22 each

TABLE 8 (*Contd*.)

Date	Some representative amounts of rainfall in cm for June, July, August and September 2022 (21 cm and above)
10 Jul	Hosanagar 47, Kaleswaram 35, Kotapalle 25, Navipet and Igatpuri 24 each, Chennur, Armur and Ramgundam 23 each, Sausar, Bijapur and Dharampur 22 each, Mudhole, Vansda and Subramanya 21 each
11 Jul	Bodeli 60, Quant and Jambughoda 43 each, Jetpur Pavi 40, Chhota Udepur 33, Waghai 29, Dangs (ahwa) 27, Dharmsala and Dharampur 23 each, Subir 21
12 Jul	Dediapada 53, Tilakwada 51, Umerpada 43, Sagbara 42, Kaprada 40, Jambughoda 39, Garudeshwar 37, Nandod 35, Peth 33, Dangs (ahwa) 32, Narmada Kvk AWS 31, Subir and Jawhar 29 each, Mokheda - Fmo and Khategaon 27 each, Ukai and Talasari 26 each, Mahabaleshwar and Dharampur 25 each, Godhra and Khanvel 24 each, Uchchhal 23, Madhbun and Songadh 22 each
13 Jul	Jainoor 39, Kerameri 38, Utnoor (ARG) and Sirpuru 35 each, Shriramsag.pocha 31, Bijapur 30, Laxmanchanda 29, Godadongri, Elagaid, Sultanabad and Dharmaram 25 each, Luxettipet, Utnur and Peddapalle 24 each, Chicholi, Dilawarpur, Nirmal, Vagra and Dharmapuri 23 each, Matheran, Sarangapurnrl, Khanpur and Venkatapuram 22 each, Kinwat, Choppadandi, Nirmal (ARG) and Anjar 21 each
14 Jul	Vansda 39, Kaprada 38, Dharampur and Silvassa 34 each, Valsad Kvk AWS and Madhbun 31 each, Pardi, Mahabaleshwar, Khanpur and Khanvel 29 each, Subir, Dang Kvk AWS and Talasari 27 each, Waghai, Vapi and Vikramgad 25 each, Matheran, Wada, Jawhar and Nanipalson 24 each, G Bazar, Lonavala ARG, Khergam, Dolvan, Dahanu and Shriramsag pocha 23 each, Palghar ARG 22, Bheemgal, Umergam and Gangadhara 21 each
15 Jul	Matheran 35, Avalanche and Upper Bhavani 32 each, Sriganganagar Tehsil SR 26, Kaprada 25, Chikhli, Sutrapada and Kottigehara 24 each, Khanvel, Silvassa and Gandevi 23 each, Jawhar and Ganganagar 22 each, Navsari and Dharampur 21 each
16 Jul	Nil
17 Jul	Nuagada 24, R. udaigiri and Castle Rock 23, Tangi 21
18 Jul	Nil
19 Jul	Nil
20 Jul	Nil
21 Jul	Dhaurahara 22
22 Jul	Nil
23 Jul	Devaruppal and Deomali 24 each, Chegunta and Venkatapuram 23 each
24 Jul	Rehti 27
25 Jul	Nil
26 Jul	Nil
27 Jul	Nil
28 Jul	Nil
29 Jul	Nil
30 Jul	Nil
31 Jul	Nil
1 Aug	Beki Mathungari 25, Usilampatti 23
2 Aug	Shirali PTO 29, Enamakkal 23, Subramanya 22, Kochi C.i.a.l., Chalakudi and Kodungallur 21 each
3 Aug	Nil
4 Aug	Nil
5 Aug	Pargi 22
6 Aug	Avalanche 32
7 Aug	Vaibhavwadi 27, Barmul 23, Kankavli 22
8 Aug	Katekalyan 36, Lanja 29, Shriwardhan 25, Dabugan 23, Dapoli ARG 22, Mhasla 21
9 Aug	Lanja 33, Upper Bhavani and Bramhapuri 22 each, Tala 21
10 Aug	Mahabaleshwar and Tirora 22 each
11 Aug	Haripur 30, Bhainsdehi and Kottigehara 24 each, Mahabaleshwar 23, Harinkhola 22
12 Aug	Biaora 22
13 Aug	Nil
14 Aug	Shivpuri 21
15 Aug	Th Rampur 37, Kotpad 29, Pipariya 25, Salekasa 24, K Nuagaon 23, Amgaon and Kalampur 22 each, Dharmsala, Baliguda, Dabugan and Batagaon 21 each

TABLE 8 (*Contd*.)

Date	Some representative amounts of rainfall in cm for June, July, August and September 2022 (21 cm and above)
16 Aug	Palsana 22
17 Aug	Nil
18 Aug	Nil
19 Aug	Kangra AP 22
20 Aug	Kangra AP 35, Dharmsala 33, Rishikesh 29, Bhograi 23, Jogindarnagar and Phiringia 21 each
21 Aug	Nil
22 Aug	Biaora 35, Chachoda and Raghogarh 29 each, Dug 23, Nainwa, Degod SR and Kota-aero 22 each
23 Aug	Zirapur and Dug 29 each, A lot 28, Arnod SR 26, Nalkheda and Narsingarh 25 each, Shamgarh, Biaora and Khilchipur 24 each, Jaora, Sehore-aws, Bakani SR and Pirawa 23 each, Susner, Chachoda and Goharganj 21 each
24 Aug	Nil
25 Aug	Nil
26 Aug	Nil
27 Aug	Nil
28 Aug	Nil
29 Aug	Bhagamandala 21
30 Aug	Nil
31 Aug	Nil
1 Sep	Sevoke 24, Bagrakote 23, Gajoldoba 22
2 Sep	Nil
3 Sep	Nil
4 Sep	Williamnagar AWS 22, Pasighat AP 21
5 Sep	Nil
6 Sep	Nil
7 Sep	Nil
8 Sep	Nil
9 Sep	Nil
10 Sep	Nil
11 Sep	Bijapur 25
12 Sep	Nil
13 Sep	Nil
14 Sep	Nil
15 Sep	Orchha 25, Isagarh and Jaunpur 23 each
16 Sep	Fatehpur Tehsil 29, Ramnagar 27, Haidargarh and Dhaurahara 21 each
17 Sep	Nighasan 27, Sardanagar 23, Chanderdeepghat 22
18 Sep	Nil
19 Sep	Nil
20 Sep	Baliguda 30
21 Sep	Nil
22 Sep	Auraiya (CWC) 27, Kalpi CWC 24, Etawah (CWC) 23
23 Sep	Nil
24 Sep	Nil
25 Sep	Baheri 23
26 Sep	Nil
27 Sep	Nil
28 Sep	Nil
29 Sep	Nil
30 Sep	Nil

The Cross-Equatorial flow along the equatorial belt (equator to 5° N/ 5° S) over Arabian Sea was :

(*i*) In June 2022, it was above normal in all week.

(*ii*) In July 2022, it was normal in 2nd week while it was above normal in 1st week, in 3rd week and in 4th week.

(*iii*) In August 2022, it was normal in 1st and 2nd week while it was below normal in 3rd and 4th week.

(*iv*) In September 2022, it was above normal in all week.

The surface winds over Arabian Sea to the north of 5°N were:

(*i*) In June 2022, it was below normal in 1st and 2nd week while it was above normal in 3rd week and in 4th week.

(*ii*) In July 2022, it was above normal in all week.

(*iii*) In August 2022, it was above normal in 1st and 2nd week while it was below normal in 3rd and 4th week.

(*iv*) In September 2022, it was above normal in all week.

Over the Bay of Bengal

	5° N - 5° S					North of 5° N				
		Weeks					Weeks			
Mon-th	Normal (in knots)	1	2	3	4	Normal (in knots)	1	2	3	4
Jun	08-10	-4	+6	-2	+3	10-15	-1	-1	-2	+1
Jul	08-10	+6	+10	+4	+5	10-15	+5	+3	-2	-1
Aug	08-10	+6	+6	+4	+8	10-15	+5	+2	-3	-3
Sep	08-10	+8	+4	+6	+6	05-10	+5	+6	+10	+3

The Cross Equatorial flow along the equatorial belt (equator to 5° N/5° S) over Bay of Bengal was:

(*i*) In June 2022, it was below normal 1st and 3rd week while above normal in 2nd and 4th week.

(*ii*) In July 2022, it was above normal in all week.

(*iii*) In August 2022, it was above normal in all week.

(*iv*) In September 2022, it was above normal in all week.

The surface winds over the Bay of Bengal to the north of 5° N were :

(*i*) In June 2022, it was below normal in, 1st, 2nd, 3rd week while it was above normal in 4th week.

(*ii*) In July 2022, it was above normal in 1st and 2nd and below normal in 3rd and 4th week.

(*iii*) In August 2022, it was above normal in 1st, 2nd week and below normal in 3rd and 4th week.

(*iv*) In September 2022, it was above normal in all week.

4.2. *Position of Equatorial Trough was*

June 2022 : South of its normal position by 2°–4°, to the East of 50° E in the first week. South of its normal position by 1°–3° from 60° E to 100° E and North of its normal position by 1°–2°, from 40° E to 60° E in the 2nd week. South of its normal position by 2°–3° from 40°E to 110°E in the 3rd week. South of its normal position by 1°–5° from 75° E to 110° E and North of its normal position by 1°–2°, from 40°E to 70° E in the 4th week.

July 2022 : South of its normal position by 2°–4°, from 40° E to 110° E in the first week. South of its normal position by 1°–4° from 40° E to 110° E in the 2nd week. South of its normal position by 1°–3° from 40° E to 110° E in the 3rd week. It was South of its normal position by 1°-3° near to normal from 70° E to 110° E and near to normal in the 4th week.

August 2022 : It was South of its normal position by 1°–5° from 80° E to 110° E and North of its normal position by 1°-2° from 40° E to 75° E in the first week. North of its normal position by 1°-2° from 40° E to 110° E in the 2nd week. South of its normal position by 1°-2° from 40° E to 110° in the 3rd week. South of its normal position by 1°-8° from 40° E to 110° in the 4th week.

September 2022 : South of its normal position by 2°– 5° from 40° E to 110° E in first week. South of its normal position by 1°-2° from 40° E to 110° E in the 2nd week. South of its normal position by 1°-2° from South of its normal position and normal position from 40° E to 75° E in the 3rd week. South of its normal position by 1°-3° from 40° E to 110° E in the 4th week.

4.3.a *Low Pressure Systems during June to September 2022 in Bay of Bengal*

Low Pressure Systems	Jun	Jul	Aug	Sep	Total
Low Pressure Area / WML	00	02	00	01	03
Depression	00	00	02	01	03

Deep Depression	00	00	01	00	01
Tropical Storm (T.S.)	00	00	00	00	00
Total	00	02	03	02	07

4.3.b *Low Pressure systems during June to September 2022 in Arabian Sea*

Low Pressure Systems	Jun	Jul	Aug	Sep	Total
Low Pressure Area / WML	01	02	00	00	03
Depression	00	01	01	00	02
Deep Depression	00	00	00	00	00
Tropical Storm (T.S.)	00	00	00	00	00
Total	01	03	01	00	05

4.3.c *In the West Pacific Ocean/South China sea*

There were in all, 16 low pressure systems (reaching the intensity of Tropical depression and above) in the northwest Pacific Ocean/South China Sea during Jun-Sep, 2022. The month wise break-up is given below:

Low Pressure Systems	Jun	Jul	Aug	Sep	Total
Tropical Depression (T.D.)	00	01	02	01	04
Tropical Storm (T.S.)	00	01	02	02	05
Typhoon/Super Typhoon	01	00	02	04	07
Total	01	02	06	07	16

4.3.d *In South Indian Ocean*

One Tropical Cyclone 02 S formed during 27 Sep-28 Sep 2022, in Southern Hemisphere during Jun-Sep, 2022.

(*i*) *The Upper air troughs in mid and upper tropospheric Westerly* : Indian region

Troughs in Westerlies affecting the Indian region to the south of 30 Deg. N and to the north of 30° N during June to September 2022.

(*ii*) *The Upper air troughs in mid and upper tropospheric Westerly* : Indian region

The number of troughs in westerlies moved across Indian region from west to east penetrated to the south of 30° N was as follows :

The month wise break-up is given below:

Atmospheric Level	Jun	Jul	Aug	Sep	Total
500 hPa	07	03	10	10	30
300 hPa	06	02	06	05	19

(*Source* : INOSHAC/CONSTANT PRESSURE MAPS, USA)

The troughs in upper air westerlies which moved across the South Indian Ocean from west to east, penetrated to the north of Lat. 30° S, in the Southern Hemisphere, during June to September 2022.

The month wise break-up is as follows:

Atmospheric Level	Jun	Jul	Aug	Sep	Total
500 hPa	06	06	10	11	33
300 hPa	04	06	07	02	19

(*Source*: Climatic Atlas of The Indian Ocean)

4.4. *Normal position of Mascarene HIGH (centered at 30° S/50° E) and Australian HIGH (centered at 30° S/140° E) during June to September*

(*i*) Intensity of Mascarene High during June to September 2022 with its mean position at Lat. 31.1° S and Long. 54.6° E.

Month	*Normal Pressure (hPa) (approx.)	Actual Pressure (hPa)	Departure from normal hPa (approx.)
Jun	1023.0	1025.2	+2.2
Jul	1025.5	1027.9	+2.4
Aug	1026.0	1025.8	-0.2
Sep	1023.5	1025.3	+1.8

(**Source*: ACMAD, NOAA)

The Mascarene HIGH with its mean position at 31.6 S / 54.5° E was strengthened by 2.4 hPa in the month of July 2022. It was above normal by 2.2, 2.4, 1.8 hPa during the months of Jun, Jul, Sep and below normal in the month of August 2022.

(*ii*) Intensity of Australian High during June to September 2022 with its Mean position at Lat. 33.1° S and Long. 137.0° E.

Month	*Normal Pressure (hPa) (approx.)	Actual Pressure (hPa)	Departure from normal hPa (approx.)
Jun	1022.0	1026.8	+4.8
Jul	1022.0	1029.4	+7.4
Aug	1020.5	1026.4	+5.9
Sep	1018.0	1026.8	+8.8

(**Source*: NOAA)

The Australian HIGH centered at 33.2° S / 137.0° E was strengthened by an average of about 8.8 hPa during the month of September 2022. It was above normal by 4.8, 7.4, 5.9 & 8.8 hPa in the month of June, July, August and September 2022, respectively.

5. Semi-permanent systems

5.1. *Heat Low*

The lowest and the second lowest values of the Heat Low were:

June : 992 hPa (on 22 and 30) and 994 hPa (on 10, 11, 21, 23, 26, 28 and 29)
July : 992 hPa (on 4) and 994 hPa (on 1, 2, 10, 14, 23 and 24)
Aug : 994 hPa (on 10 and 12) (on 9, 13 and 14)
Sep : 1000 hPa (4, 12 and 17) and 1002 (5, 7, 13, 15, 18, 24 and 25).

5.2. *Monsoon Trough*

During the month of June, a shallow Heat trough was observed over the Indo-Gangetic plains starting from the first week. By 2nd July, 2022, this trough had fully established itself.

In July, the Monsoon Trough was mainly positioned south of its normal location for the majority of the days, except for two periods : 20-21 July and 29-31 July, when it shifted to its normal and northward positions, respectively.

Moving into August, the Monsoon Trough remained primarily situated to the south of its usual position for a significant portion of the month, spanning a total of 20 days. However, there were a few exceptions: on 1-2 August, it resided in its normal and northward positions, while on 19-21 August, the western end of the trough was located at the foothills. Furthermore, from 27-31 August, the entire trough shifted to the foothills of the Himalayas.

In September, the Monsoon Trough continued to lie south of its typical position for several days between 9-18 September 2022. However, during 1-8 September, it exhibited weakness or resided north of its normal position.

5.3. *Tibetan Anticyclone/High*

This year, the Tibetan anticyclone was seen to south of its normal position in the month of June, it shifted to the north of its normal position in the last week of the month. Then it shifted to the north of its normal position and remained there till the end of August, mostly to the northeast of the normal. In September, it remained to South or southeast on most of the days.

5.4. *Tropical Easterly Jet (TEJ)*

The TEJ got established over the southern peninsular India by 2 June with Mangalore reporting easterlies of 77 knots at 115 hPa level. A latitudinal spread of the easterly jet speed winds was observed between 8° N to 14° N during June, July and August, while during September jet speed winds were reported further north upto 18° N. The highest wind speed of 109 knots was recorded over Thiruvananthapuram on 26 August at 112 hPa.

5.5. *Sub-Tropical Westerly Jet (STWJ)*

Shifted northwards from the last week of May, Patiala reported 70 knots wind (at 152 hPa) at 0000 UTC of 10 June. Subsequently, the core of STWJ shifted to the north of the Himalayas. It once again shifted southwards as evident by the 72 knots westerly wind reported over Patiala at 250 hPa on 13 October (0000 UTC).

6. Other features

6.1. *Monthly wind anomalies during Southwest Monsoon 2022*

The circulation anomaly features at lower, middle and upper tropospheric levels, 850, 700, 500 and 200 hPa during the southwest monsoon season are discussed below:

6.1.1. *June wind anomaly features*

In the monthly wind pattern, anomalous ridge was seen, from 850 hPa, over 23° N latitude. An anomalous ridge at 200 hPa extended along 28° N.

In the week ending 8 June, ridge was seen from 850 hPa, over central India extending upto 100 hPa.

In the week ending 15 June, anomalous anticyclone was seen at 850 hPa at latitude 17° N. Two anomalous cyclonic circulations one over head Bay of Bengal and the other at Northeast Arabian Sea at 700 hPa.

In the week ending 22 June, anomalous ridge was seen from 850 hPa extending upto 200 hPa, over Peninsula at approximate 16° N.

In the week ending 29 June, an anomalous trough was seen at 850 hPa extending upto 700 hPa, along longitude 77° E.

6.1.2. *July wind anomaly features*

In the monthly wind pattern anomalous trough was observed from east Sri Lanka to central Arabian Sea over the peninsulafrom 850 hPa to 500 hPa, tilting southwards with height an anomalous cycir over coastal Tamil Nadu at 300 hPa and an anomalous cycir over central India at 200 hPa. A ridge at 200 hPa extended along 34° N.

Consecutive In the week ending 6 July, an anomalous trough was seen from 850 hPa to 500 hPa, from northeast Arabian Sea to westcentral Bay of Bengal coast near Masulitipatinum. A ridge at 200 hPa extended along 33° N.

In the week ending 13 July, an anomalous trough was seen from 850 hPa to 300 hPa, at approximate 15° N. A ridge at 200 hPa extended along 32° N.

In the week ending 20 July, one anomalous cyclonic circulation was seen from 850 hPa to 700 hPa over central India with a trough passing approximately at latitude 20° N upto 300 hPa. A ridge at 200 hPa extended along 26° N.

In the week ending 27 July, two anomalous cyclonic circulations were seen at 500 hPa, one over northeast Arabian Sea and another over Madhya Pradesh. One anomalous cyclonic circulation was observed at 300 hPa over south Peninsula. A ridge at 200 hPa extended along 30° N.

6.1.3. *August wind anomaly features*

In the monthly wind pattern, one anomalous cyclonic circulation was seen over Madhya Pradesh Gujrat border from 850 hPa to700 hPa. A ridge at 200 hPa extended along 28° N.

In the week ending 3 August, anomalous anticyclone was observed over Jharkhand and adjoining Chhattisgarh from 850 hPa to 300 hPa. A ridge at 200 hPa extended along 31° N.

In the week ending 10 August, two anomalous cyclonic circulations were seen from 850 hPa to 200 hPa, one over east central Arabian Sea, adjoining Konkan and the second over west central Bay of Bengal adjoining coastal Odisha.

In the week ending 17 August, two anomalous cyclonic circulations were seen one over head Bay of Bengal and the other over north Madhya Pradesh and adjoining east Rajasthan extending from 850 hPa to 200 hPa. An anomalous ridge at 200 hPa extended along 33° N.

In the week ending 24 August, three anomalous cyclonic circulations were observed one over head Bay of Bengal, second over west Bengal and adjoining Bangladesh and the third over north Madhya Pradesh and adjoining east Rajasthan extending from 850 hPa to 200 hPa.

In the week ending 31 August, two anomalous anticyclonic circulations were seen from 850 hPa, over west Rajasthan and adjoining Pakistan and the other over Bangladesh and adjoining Bay of Bengal. A ridge at 200 hPa extended along 29° N.

6.1.4. *September wind anomaly features*

In the monthly wind pattern, at 850 hPa level, an anomalous cyclonic circulation was seen over central India. A ridge at 200 hPa extended along 29° N.

In the week ending 7 September, one anomalous cyclonic circulation was seen at 850 hPa over south peninsula extending upto 700 hPa. A ridge at 200 hPa extended along 30° N.

In the week ending 14 September, two anomalous cyclonic circulations were seen at 850 hPa one over Telangana which extended upto 500 hPa and the other over west Bengal extending upto 700 hPa. A ridge at 200 hPa extended along 28° N.

In the week ending 21 September, two anomalous cyclonic circulations were seen extending from 850 hPa to 500 hPa, one over north Madhya Pradesh and adjoining Uttar Pradesh, the second cyclonic circulation was observed over head Bay of Bengal. A ridge at 200 hPa extended along 28° N.

In the week ending 28 September, two anomalous cyclonic circulations were seen at 850 hPa extending upto 700 hPa, one over north Madhya Pradesh andthe second over northwest Bay of Bengal adjoining Odisha. A ridge at 200 hPa extended along 30° N.

7. Disastrous weather events and damage during Monsoon months

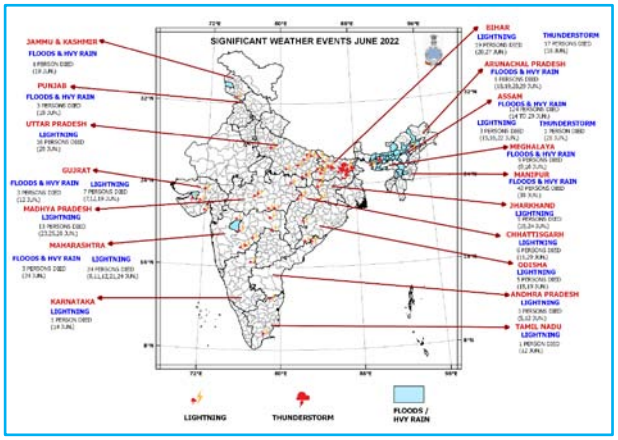
7.1. *June*

During this month, total 313 persons reportedly claimed dead, 72 persons injured, 50 persons missing & more than 72,000 livestock perished. The details of causalities given below, which are based on real time media reports and other state government agencies.

Figure below shows significant weather events during June. (Based on real time media reports.)

Floods, Heavy Rains & Landslide : Total 191 persons reportedly claimed dead, 8 persons injured, 50 persons missing & 72672 livestock perished, during 1st to 30th June, due to Floods, Heavy Rains & Landslide.

Lightning : Total 104 persons reportedly claimed dead, 64 persons injured & 61 livestock perished, during this month, because of Lightning.



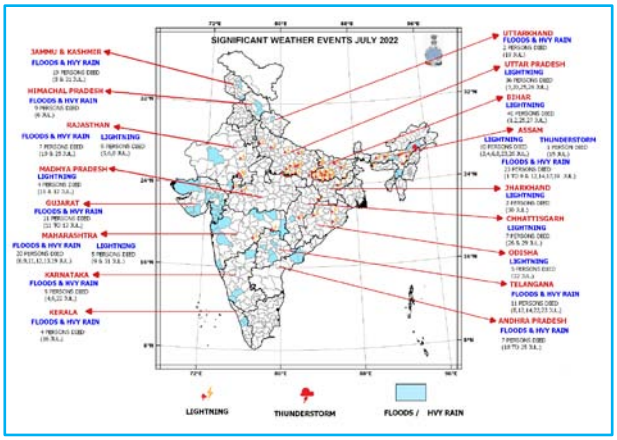
Thunderstorm : Total 18 persons reportedly claimed dead & 4 live stock perished during 1st to 30th June, because of Thunderstorm.

7.2. *July*

During the month, total 245 persons reportedly claimed dead, 129 persons injured, 56 persons missing & more than 39,000 livestock perished. The details of causalities given below, which are based on real time media reports and other state government agencies. Figure below shows significant weather events during the month of July. (Based on real time media reports.)

Floods, Heavy Rains & Landslide : Total 128 persons reportedly claimed dead, 55 persons injured, 56 persons missing & 39089 livestock perished, during July 2022, due to Floods, Heavy Rains & Landslide.

Lightning : Total 116 persons reportedly claimed dead, 74 persons injured & 43 livestock perished, in this month, because of Lightning.



Thunderstorm : One person reportedly claimed dead on 15th July in Sivasagar district of Assam due to Thunderstorm.

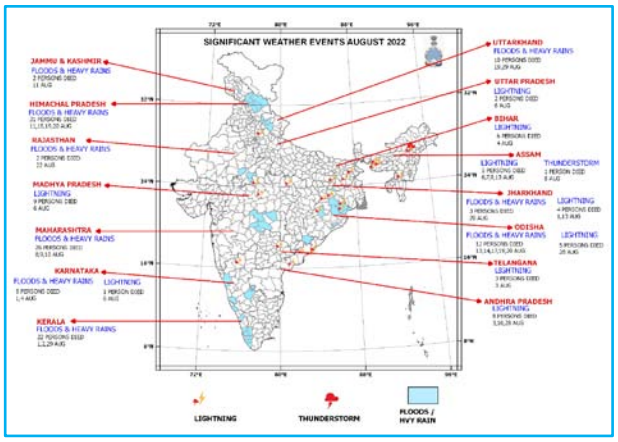
7.3. *August*

During August, total 160 persons reportedly claimed dead, more than 60 persons injured, 15 persons missing & more than 100 livestock perished. The details of causalities given below, which are based on real time media reports and other state government agencies.

Figurebelow shows significant weather events during the month of August. (Based on real time media reports). There were many districts which affected by flood due to heavy rainfall events.

Floods, Heavy Rains & Landslide : Total 116 persons reportedly claimed dead, 27 persons injured, 15 persons missing & 50 livestock perished, during August, because of Floods, Heavy Rains & Landslide.

Lightning : Total 43 persons reportedly claimed dead, more than 35 persons injured & 68 livestock perished, during August, because of Lightning.



Thunderstorm : One person reportedly claimed dead on 8th August in Lakhimpur district of Assam because of Thunderstorm.

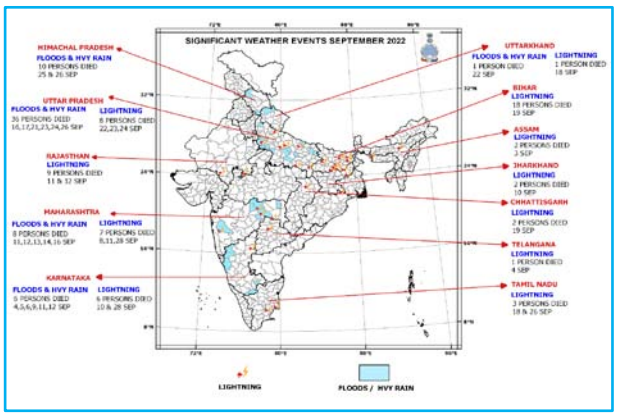
7.4. *September*

During September, total 120 persons reportedly claimed dead, more than 35 persons injured & more than 800 livestock perished. The details of causalities given below, which are based on real time media reports and other state government agencies. Figure below shows significant weather events during the month of September. (Based on real time media reports.)

Floods, Heavy Rains & Landslide : Total 61 persons reportedly claimed dead, 21 persons injured & 804

livestock perished, during September, due to Floods, Heavy Rains & Landslide.

Lightning : Total 59 persons reportedly claimed dead, 17 persons injured & one livestock perished, during September, because of Lightning.



The inputs from the offices of India Meteorological Department, *viz.*, (*i*) Director General of Meteorology (Hydromet), New Delhi and (*ii*) Climate Monitoring and Analysis Group, Climate Research Division, Pune are gratefully acknowledged. Thanks are due to Smt. P. P. Kulkarni for her assistance in preparation of the manuscript.

Appendix

Definitions of the terms given in '*Italics*'

Rainfall

Very light	- 0.1 to 2.4mm
Light	- 2.5 to 15.5mm
Moderate	- 15.6 to 64.4mm
Heavy	- 64.5 to 115.5 mm
Very heavy	- 115.6 to 204.4mm
Extremely Heavy	- ≥204.5mm

Monthly/seasonal rainfall distribution on sub-division scale

Large Excess	- percentage departure from normal rainfall is +60% or more
Excess	- percentage departure from normal rainfall is +20% to +59%
Normal	- percentage departure from normal rainfall is from +19 % to –19 %
Deficient	- percentage departure from normal rainfall is from –20 % to –59%
Large Deficient	- percentage departure from normal rainfall is from –60 % or less
No rain	- –100%

Rainfall distribution on All India scale

Below Normal	- percentage departure from normal rainfall is from <10 %
Normal	- percentage departure from normal rainfall is from +10 % to –10 %
Above Normal	- percentage departure from normal rainfall is from >10 %

Monsoon activity

Active	- Average rainfall of a sub-division is more than 1½ to 4 times the normal with minimum 5 cms along the west coast and 3 cms elsewhere in at least two stations in the sub-division
Vigorous	- Average rainfall of a sub-division is more than 4 times or more than the normal with minimum 7 cms along the west coast and 5 cms elsewhere in at least two stations in the sub-division