

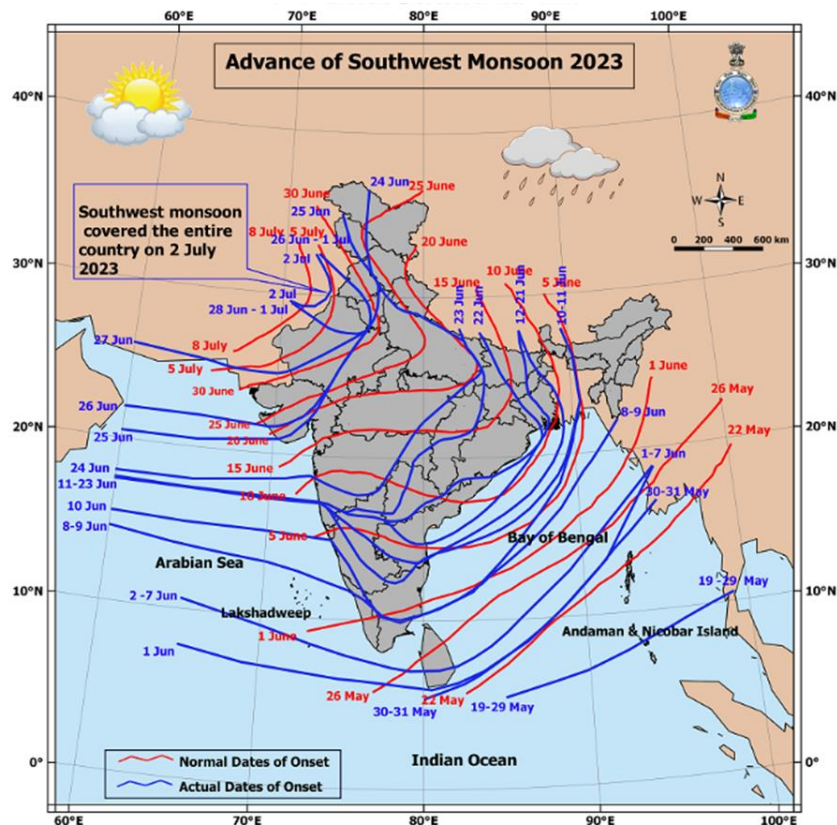
**MONSOON REPORT-2023**  
**RAJASTHAN**  
**HIGHLIGHTS**

- ❖ The rainfall recorded during monsoon season (June-September, 2023) over the Rajasthan state as a whole was 499.7 mm against its normal of 435.6 mm which is 115% of its long period average (LPA) based on data of 1971-2020. The rainfall received over the state was Normal (Departure +15% of long period average).
- ❖ Seasonal rainfall was 99 % of its LPA over East Rajasthan and 142 % of its LPA over West Rajasthan.
- ❖ Monthly rainfall received over the state was 285% of LPA in June, 142% of LPA in July, 20% of LPA in August and 131% of LPA in September.
- ❖ Southwest monsoon advanced over Kerala on 08th June, and over Rajasthan on 25th June (5 days behind the normal schedule of 20th June). Thereafter, monsoon covered the entire state by 2nd July against normal date of 8th July (about 6 days ahead of normal date).
- ❖ 30.9 mm rainfall recorded in the state in the month of August-2023 was the third lowest rainfall in the history of the month. The lowest rainfall in the month of August was 15.2 mm recorded in 1905.
- ❖ Out of total 33 districts, 02 districts received large excess rainfall (Departure +60% or more), 09 districts received excess rainfall (Departure +20% to +59%), 17 districts received normal rainfall (Departure -19% to +19%) and 05 districts received deficient rainfall (Departure -20% to -59%) during the season.
- ❖ In the month of June, an extremely severe cyclonic storm "Biparjoy" arose from the Arabian Sea, due to which very heavy to extremely heavy rainfall recorded in the South Rajasthan. During this, in the span of 24 hours record 536 mm of rainfall was recorded at Muthana station of the Pali district while 471 mm of rainfall was recorded in Ahore tehsil of the Jalore district.
- ❖ The rainfall in the state in the month of June-2023 was the highest ever in the history of the month of June.

### 1. Onset and Advance of Southwest Monsoon 2023

The advance of the Southwest Monsoon began on May 19th in the southeast Bay of Bengal, Nicobar Islands, and south Andaman Sea, due to persistent south-westerly winds and widespread rainfall. By 30th May, it had extended its reach to the southwest Bay of Bengal, more parts of the southeast Bay of Bengal, the Andaman Sea, Andaman and Nicobar Islands, and portions of the east-central Bay of Bengal. Continuing its advance, the monsoon covered areas such as the south Arabian Sea, Maldives, and the Comorin region on 1st June, followed by additional parts of the south Bay of Bengal and east-central Bay of Bengal on 2nd June 2023.

The monsoon reached Kerala on 8th June, 7 days after the normal date of onset over Kerala. From there, it progressed further, encompassing the central Arabian Sea, the remaining parts of Kerala, portions of Karnataka, most of the north-eastern states, Goa, Konkan, Tamil Nadu, Puducherry, many parts of Andhra Pradesh and many parts of Bay of Bengal by the second week of June. On 19th June, it extended to more areas, including parts of Karnataka, Andhra Pradesh, some more parts of the Bay of Bengal, and parts of Gangetic West Bengal and Jharkhand. During the last week of June, it covered a vast area, including Odisha, Telangana, Chhattisgarh, Jammu and Kashmir, Ladakh, Uttar Pradesh, Himachal Pradesh, Vidarbha, Haryana, north Arabian Sea, Gujarat and Rajasthan. On 2nd July, it covered the remaining parts of the country, a remarkable six days ahead of the usual date of 8th July. The onset dates of Monsoon 2023 are shown in **Fig.1**.

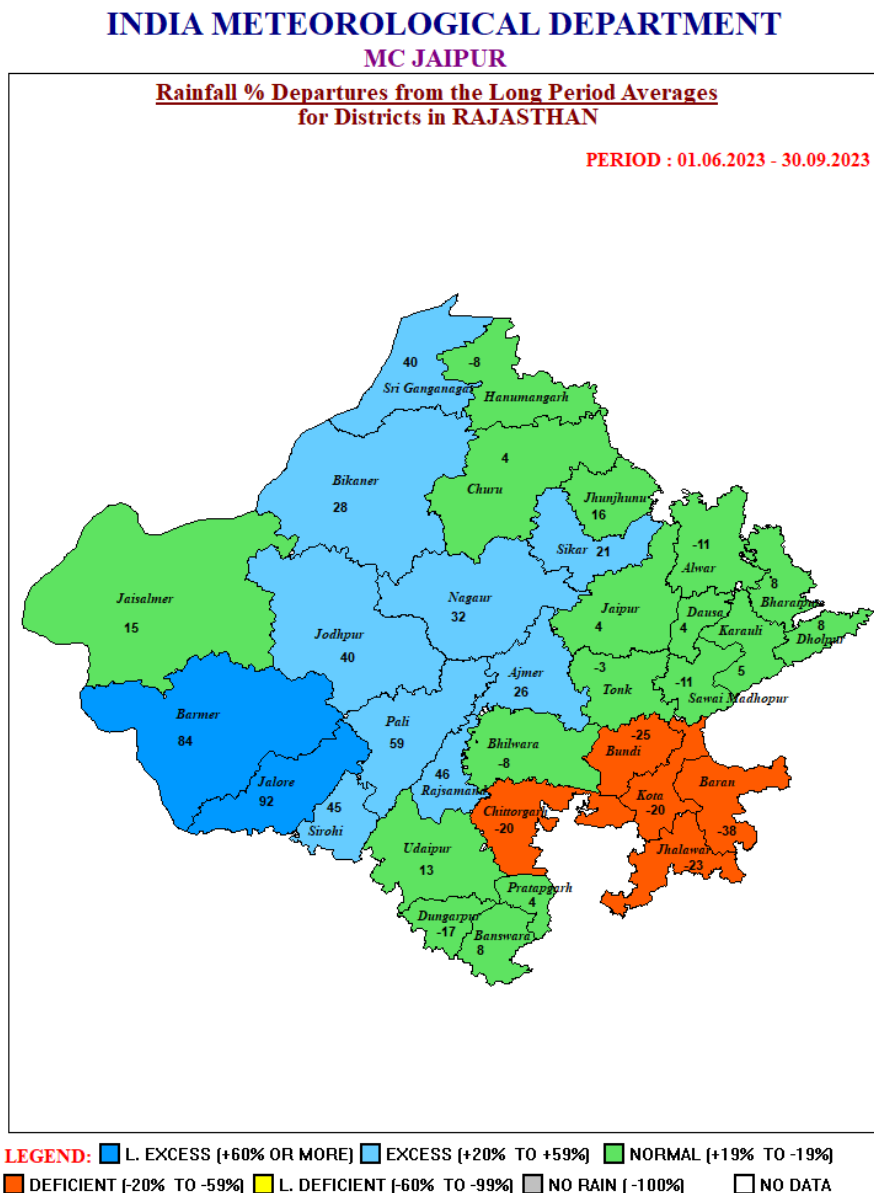


**Fig. 1:** Isochrones of advance of the Southwest monsoon during 2023

## 2. Rainfall Distribution

The districtwise, subdivisionwise and seasonal rainfall over the state during Southwest Monsoon 2023 are given in **Table 1** along with respective long period average (LPA) values and % departure from normal.

The seasonal rainfall over Rajasthan was 115% of its LPA during SW monsoon season 2023, East Rajasthan 99% of its LPA and West Rajasthan 142% of its LPA. Out of 33 districts, 2 districts received large excess rainfall, 9 districts received excess rainfall, 17 districts received normal rainfall, 5 of the districts received deficient and none of the districts received scanty rainfall during the season.



**Fig. 2:** Districtwise June-September 2023 Rainfall % Departures from the Long Period Averages

**Table 1: CUMULATIVE RAINFALL STATISTICS (01/06/2023 to 30/09/2023)**

SR NO.	NAME	ACTUAL RAINFALL (MM)	NORMAL RAINFALL (MM)	DEPARTURE FROM NORMAL (%)	CATEGORY
1	RAJASTHAN AS WHOLE	499.7	435.6	15	NORMAL
2	EAST RAJASTHAN	622.7	626.6	-1	NORMAL
3	WEST RAJASTHAN	401.7	283.6	42	EXCESS

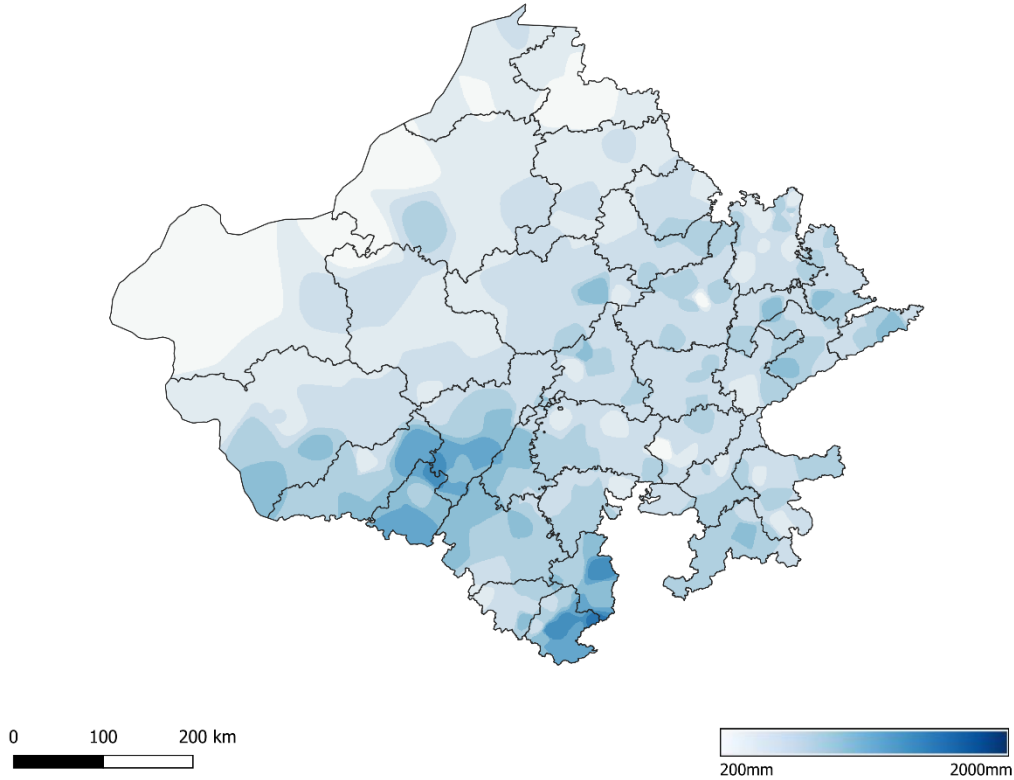
**EAST RAJASTHAN**

1	AJMER	579.1	458.3	26	EXCESS
2	ALWAR	488.2	545.9	-11	NORMAL
3	BANSWARA	957.9	886	8	NORMAL
4	BARAN	513.1	832	-38	DEFICIENT
5	BHARATPUR	589.1	543.3	8	NORMAL
6	BHILWARA	555.8	604.5	-8	NORMAL
7	BUNDI	482.7	644.4	-25	DEFICIENT
8	CHITTORGARH	578.5	727.2	-20	DEFICIENT
9	DAUSA	617.4	594.5	4	NORMAL
10	DHOLPUR	632.5	584.1	8	NORMAL
11	DUNGARPUR	585.2	706.5	-17	NORMAL
12	JAIPUR	542.8	524.3	4	NORMAL
13	JHALAWAR	683.9	884.3	-23	DEFICIENT
14	JHUNJHUNU	472.7	408.8	16	NORMAL
15	KARALI	625	595.8	5	NORMAL
16	KOTA	586.2	732.2	-20	DEFICIENT
17	PRATAPGARH	948	914.2	4	NORMAL
18	RAJSAMAND	786.9	538.1	46	EXCESS
19	SAWAI MADHOPUR	591.9	661.5	-11	NORMAL
20	SIKAR	494.2	407.1	21	EXCESS
21	SIROHI	1267.9	873	45	EXCESS
22	TONK	548.4	566.8	-3	NORMAL
23	UDAIPUR	695.6	617.7	13	NORMAL

**WEST RAJASTHAN**

24	BARMER	501.3	272.7	84	LARGE EXCESS
25	BIKANER	316.3	247	28	EXCESS
26	CHURU	348.2	334	4	NORMAL
27	HANUMANGARH	233.1	253.6	-8	NORMAL
28	JAISALMER	202.6	176.9	15	NORMAL
29	JALORE	804.3	417.8	92	LARGE EXCESS
30	JODHPUR	408.9	292.6	40	EXCESS
31	NAGPUR	488.6	369.5	32	EXCESS
32	PALI	782.4	491.6	59	EXCESS
33	SRI GANGANAGAR	285.6	204.7	40	EXCESS

### Stationwise Total Seasonal Rainfall



**Fig 3.:** Station wise Total Seasonal Rainfall

The rainfall recorded during monsoon season (June-September, 2023) over the Rajasthan state as a whole was 499.7mm against its normal of 435.6 mm which is 115% of its long period average (LPA) based on data of 1971-2020. The highest rainfall in June from 1901-2023 is shown in **Table 2**.

**Table 2:** Highest rainfall in June (1901-2023) for Rajasthan

Sr. No.	Year	Actual rainfall	Normal (1971-2020)	% Departure
1	2023	156.9	55.0	185
2	1996	122.8	55.0	123
3	1933	118.7	55.0	116
4	1971	114.7	55.0	109
5	1917	108.9	55.0	98
6	1925	107.5	55.0	95
7	2008	102.4	55.0	86
8	1977	100.8	55.0	83
9	1920	99.7	55.0	81
10	1910	93.9	55.0	71

Central and northwestern parts of the state received excess rainfall. Whereas, Southeastern Rajasthan received deficient rainfall. In terms of percentage departure from normal, Baran district received least rainfall (62% of LPA) and Jalore district received highest rainfall (192% of LPA).

The monthly rainfall during monsoon season (June to September) for the State as a whole and its two meteorological sub divisions with respective LPA values and departure from normal is given in **Table 3-5**.

**Table 3:** Rainfall during southwest monsoon 2023 over Rajasthan

Month	Actual Rainfall (in mm)	Long Period Average (in mm)	Departure from Normal (in %)
June	156.9	55	185
July	228.4	161.4	42
August	30.9	155.8	-80
September	83.4	63.5	31

**Table 4:** Rainfall during southwest monsoon 2023 over East Rajasthan

Month	Actual Rainfall (in mm)	Long Period Average (in mm)	Departure from Normal (in %)
June	162.7	74.7	118
July	274.8	228.6	20
August	59.8	231.5	-74
September	125.4	91.8	37

**Table 5:** Rainfall during southwest monsoon 2023 over West Rajasthan

Month	Actual Rainfall (in mm)	Long Period Average (in mm)	Departure from Normal (in %)
June	152.4	39.4	287
July	191.5	107.8	78
August	7.9	95.5	-92
September	50	40.9	22

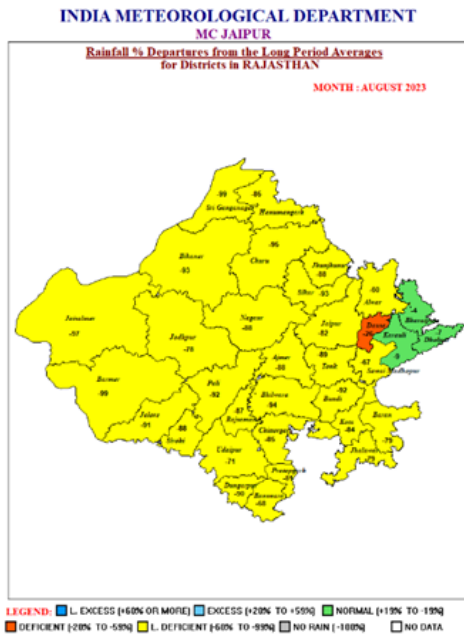
Both East Rajasthan and West Rajasthan received their highest rainfall during month of June which was 218 % of LPA (large excess) and 387 % of LPA (large excess) respectively.



**Fig. 4:** Districtwise Monthly Distribution over Rajasthan – June



**Fig. 5:** Districtwise Monthly Distribution over Rajasthan – July

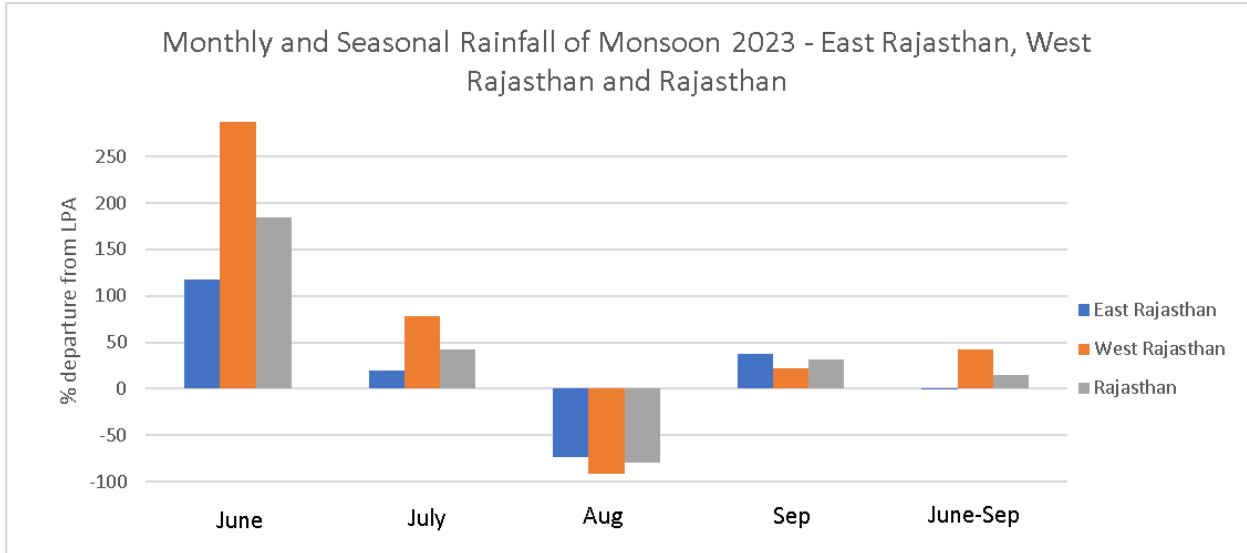


**Fig. 6:** Districtwise Monthly Distribution over Rajasthan – August

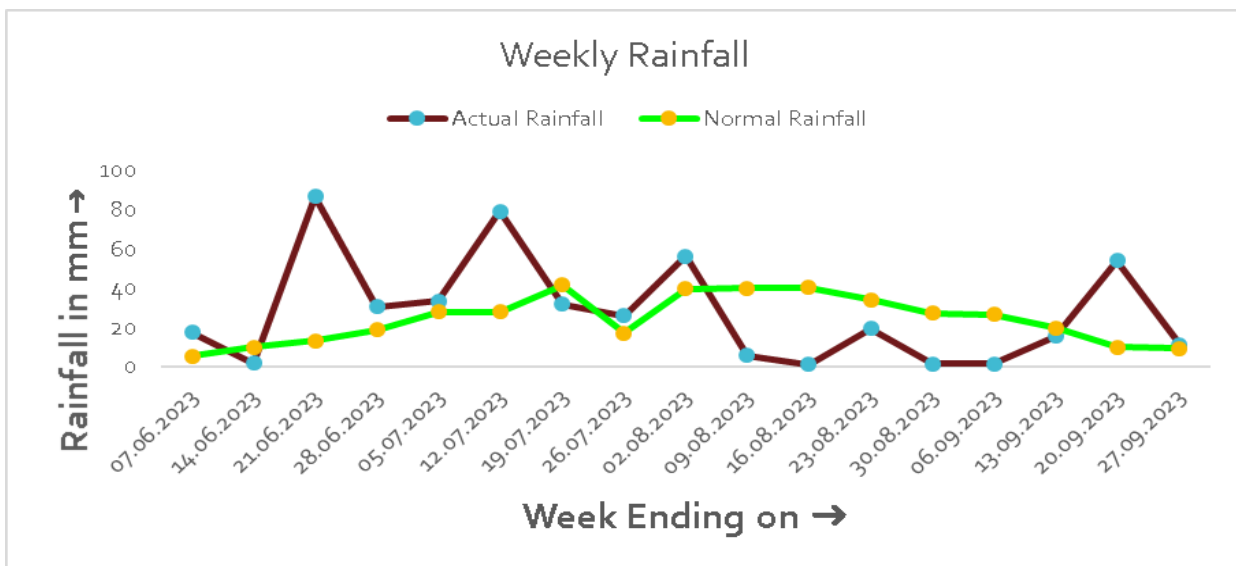


**Fig. 7:** Districtwise Monthly Distribution over Rajasthan – September

**Fig. 8** depicts the monthly variation for Rajasthan and two subdivisions during 2023 southwest monsoon season and **Fig. 9** depicts the weekly and cumulative weekly rainfall anomaly expressed as percentage departure from the LPA.



**Fig. 8:** Monthly and seasonal monsoon rainfall of 2023 over East Rajasthan, West Rajasthan and Rajasthan as whole in % departure.

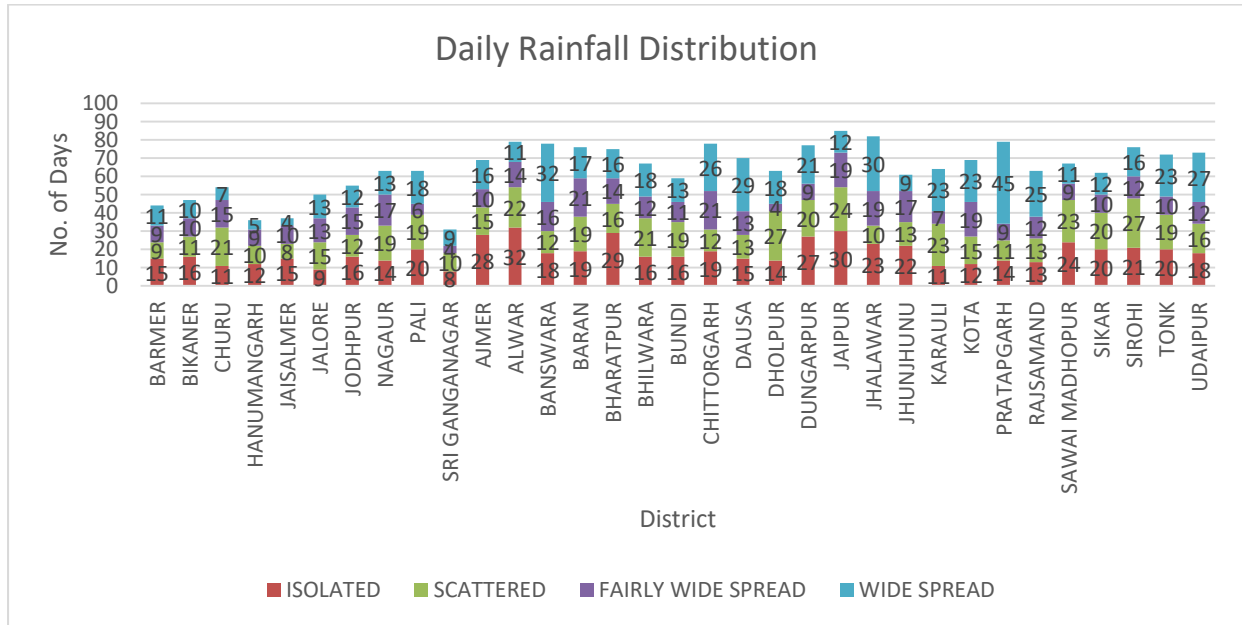


**Fig. 9:** Week by week progress and normal rainfall over Rajasthan as whole.

Out of the 9 positive rainfall anomaly weeks, 3 weeks were in June, 3 weeks were in July, 1 week was in August and 2 weeks were in September. The highest positive rainfall anomalies were recorded during the week ending on 21<sup>st</sup> June followed by the week ending on 12<sup>th</sup> July. Due to the Extremely Severe Cyclone Biparjoy, Rajasthan State received Extremely Heavy Rainfall during 16<sup>th</sup> -20<sup>th</sup> June.

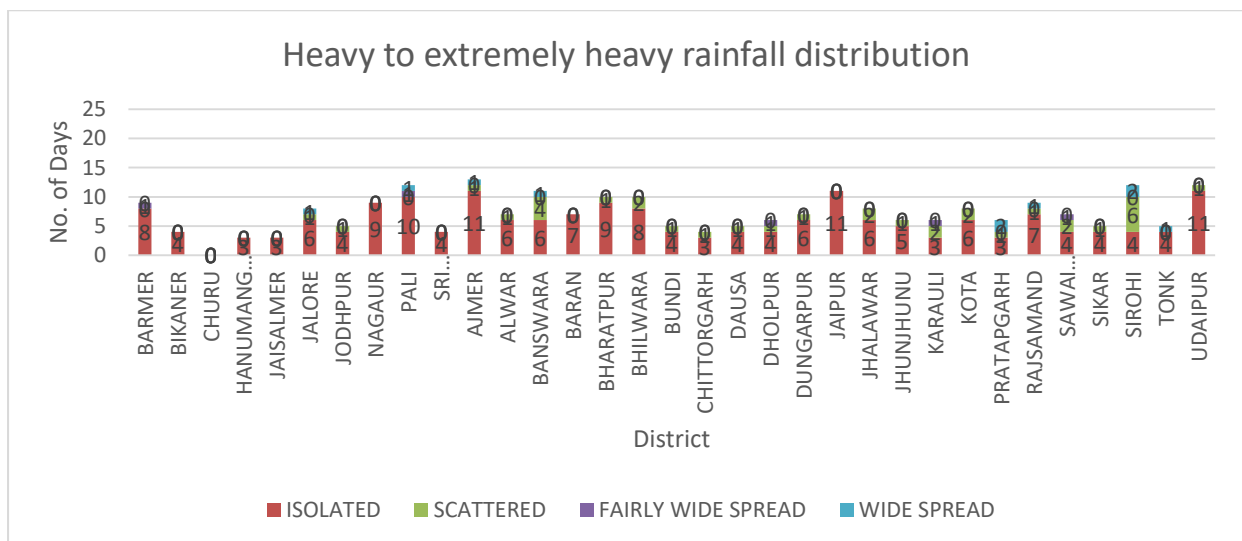


Fairly wide spread to wide spread rainfall occurred on 13 days (minimum) to 54 days (maximum) over different districts in Rajasthan during the whole monsoon season. Pratapgarh district got wide spread rainfall on 45 days (highest) during the whole season. The districtwise daily rainfall distribution of Monsoon 2023 is shown in **Fig.10**.



**Fig. 10:** Districtwise Daily Spatial Rainfall Distribution

Heavy to extremely heavy rainfall occurred at isolated to most places in all districts of the state on a few days. The districts namely Pratapgarh and Sirohi received heavy rainfall on a greater number of days at most places during the whole season. Pali, Barmer, Dholpur, Karauli and Sawai Madhopur districts experienced heavy rainfall at many places during the season. The districtwise daily heavy to extremely heavy rainfall distribution of Monsoon 2023 is shown in **Fig.11**. Extremely Heavy rainfall of the season is shown in **Table 6**.

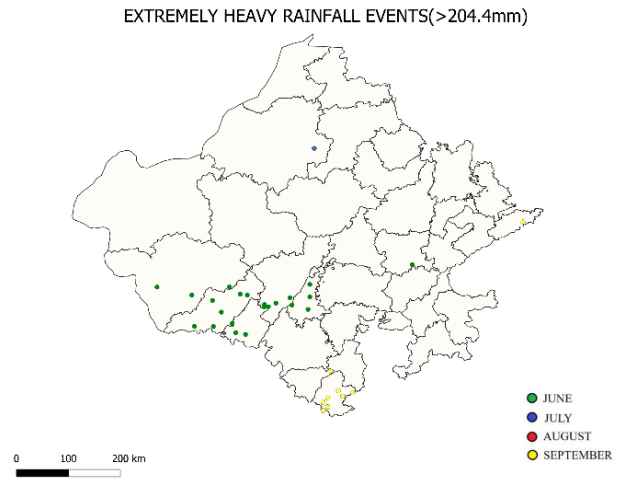
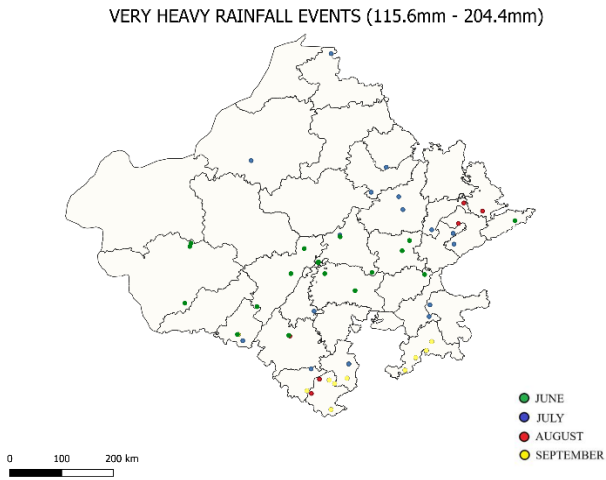


**Fig. 11:** Districtwise Daily Heavy to Extremely Heavy Rainfall Distribution

**Table 6:** Extremely Heavy Rainfall during Southwest Monsoon 2023

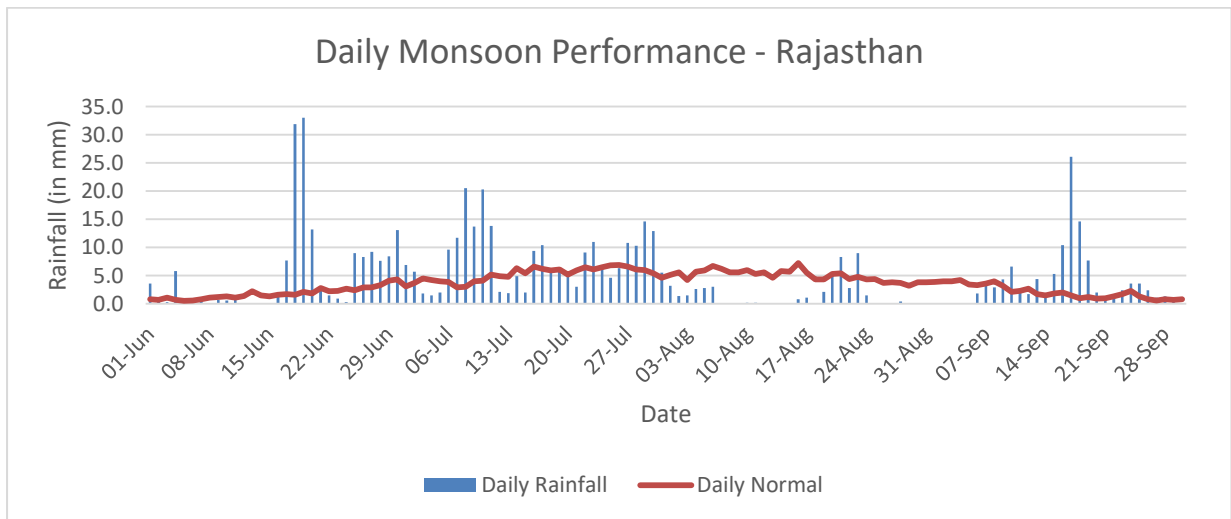
S.No.	Station	Date	Amount (in mm)	District
1	Ahore	18 June	471.0	Jalore
2	Jalore	18 June	456.0	Jalore
3	Desuri	19 June	379.0	Pali
4	Bagidora	17 September	365.0	Banswara
5	Mount Abu	18 June	360.0	Sirohi
6	Sheoganj	19 June	345.0	Sirohi
7	Bali	19 June	334.0	Pali
8	Jaswantpura	18 June	332.0	Jalore
9	Raniwada	18 June	322.0	Jalore
10	Sheoganj	18 June	315.0	Sirohi
11	Nagarfort	19 June	315.0	Tonk
12	Sanchole	18 June	296.0	Jalore
13	Sajjangarh	17 September	277.0	Banswara
14	Sumerpur	19 June	276.0	Pali
15	Sallopat	17 September	272.0	Banswara
16	Sumerpur	18 June	270.0	Pali
17	Shergarh	17 September	270.0	Banswara
18	Deogarh	19 June	269.0	Rajsamand
19	Chohtan	18 June	266.0	Barmer
20	Dorimanna	18 June	256.0	Barmer
21	Kesarpura	17 September	252.0	Banswara
22	Kumbhalgarh	19 June	245.0	Rajsamand
23	Reodar	18 June	243.0	Sirohi
24	Bali	18 June	240.0	Pali
25	Jawai Dam	19 June	239.0	Pali
26	Amet	19 June	237.0	Rajsamand
27	Siwana	18 June	236.0	Barmer
28	Mount Abu	10 July	231.0	Sirohi
29	Dholpur	10 September	230.0	Dholpur
30	Bagoda	18 June	228.0	Jalore
31	Jawai Dam	18 June	226.0	Pali
32	Banswara	17 September	223.0	Banswara
33	Rajsamand	19 June	218.0	Rajsamand
34	Bhinmal	18 June	217.0	Jalore
35	Dungargarh	27 July	208.0	Bikaner
36	Danpur	17 September	205.0	Banswara
37	Nithuwa	17 September	205.0	Dungarpur

Month wise very heavy and extremely heavy rainfall events are shown in **Fig.12** and **Fig. 13** respectively. Most number of very heavy to extremely heavy rainfall events occurred in the month of June. Highest rainfall of 471mm occurred in Ahore, Jalore on 18<sup>th</sup> June.

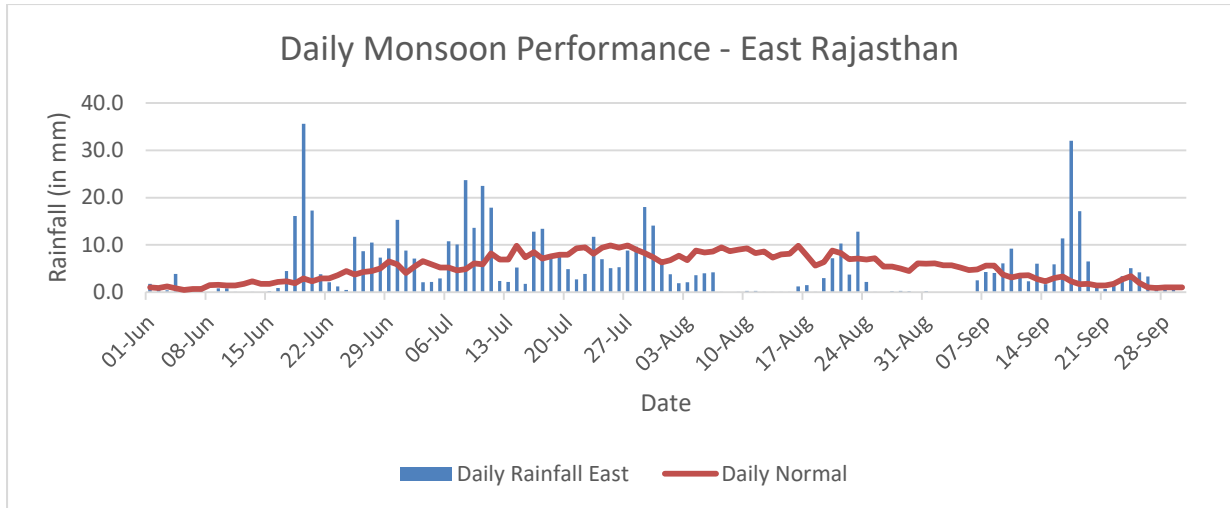


**Fig. 12:** The location of Very Heavy Rainfall (115.6 to 204.4 mm)

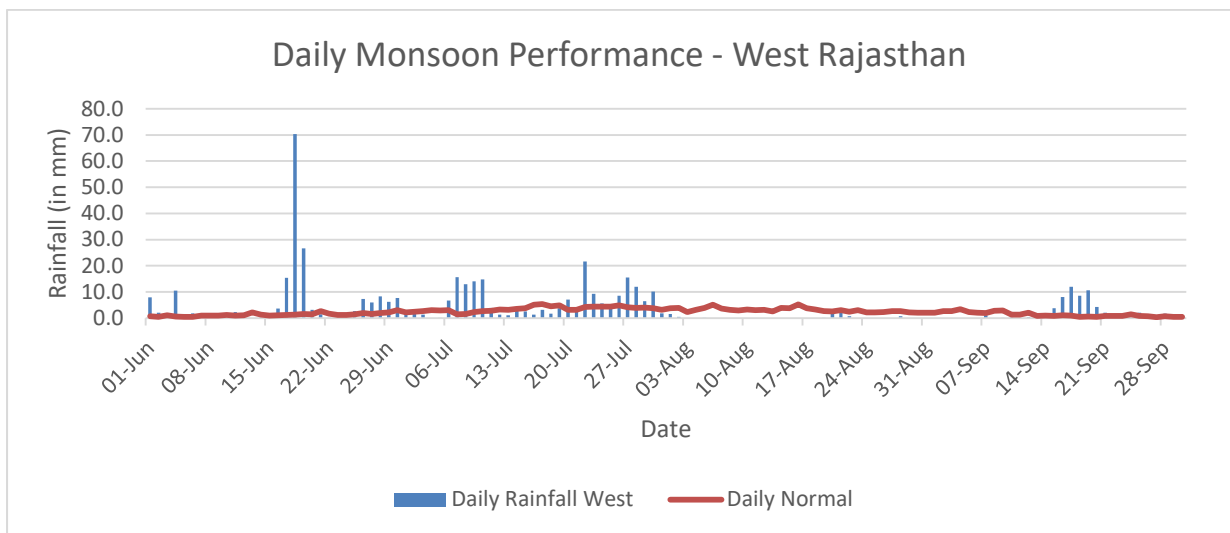
**Fig. 13:** The location of Extremely Heavy Rainfall (more than 204.4 mm)



**Fig. 14:** Daily Rainfall - Rajasthan



**Fig. 15: Daily Rainfall – East Rajasthan**

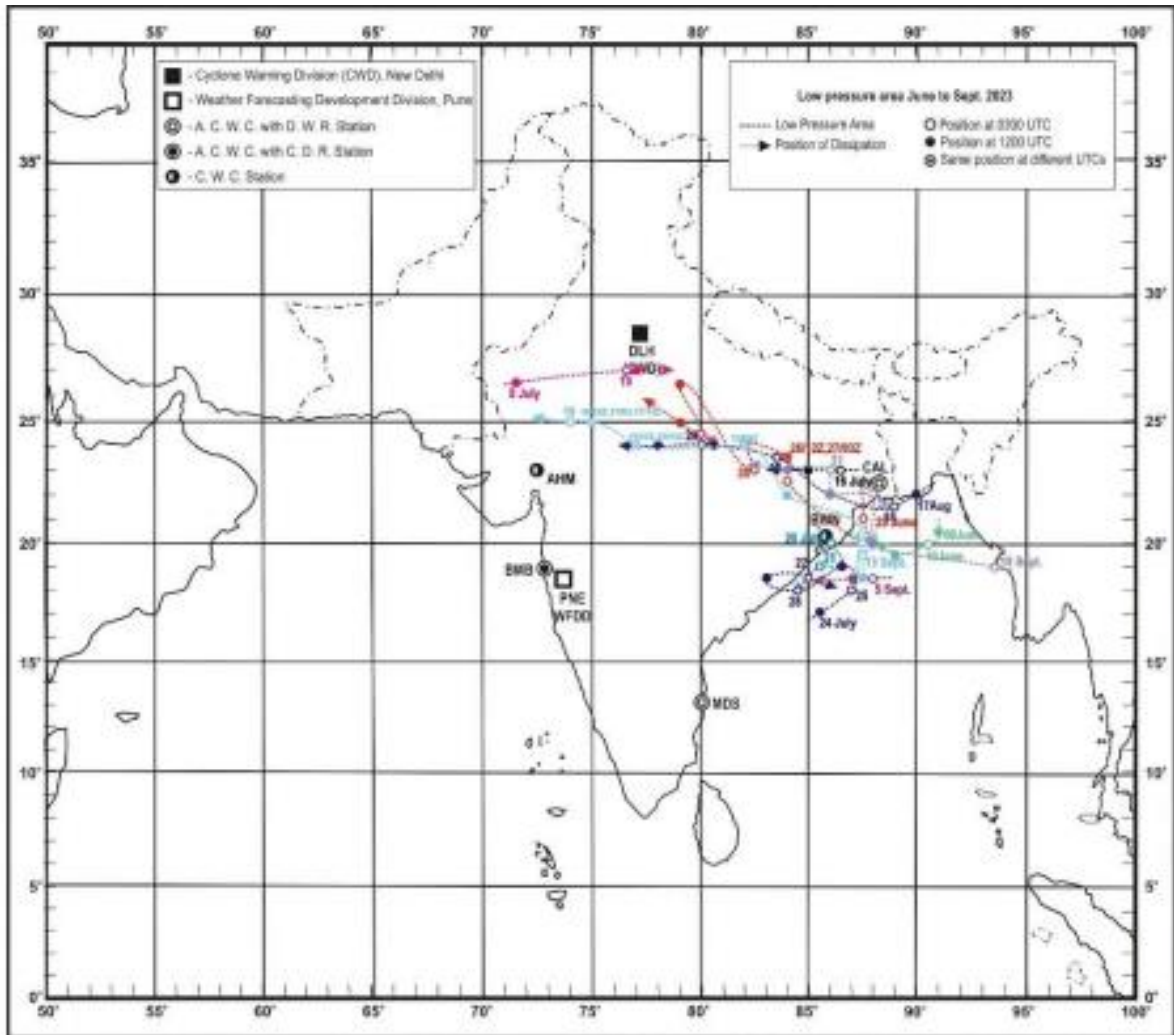


**Fig. 16: Daily Rainfall – West Rajasthan**

### 3. Chief Synoptic Features of Southwest Monsoon Season

During the season, there were 15 low pressure systems formed in the Indian region. The track of low pressure systems are given in **Fig.17**. Their month-wise frequency and intensity are given in the **Table 7**.

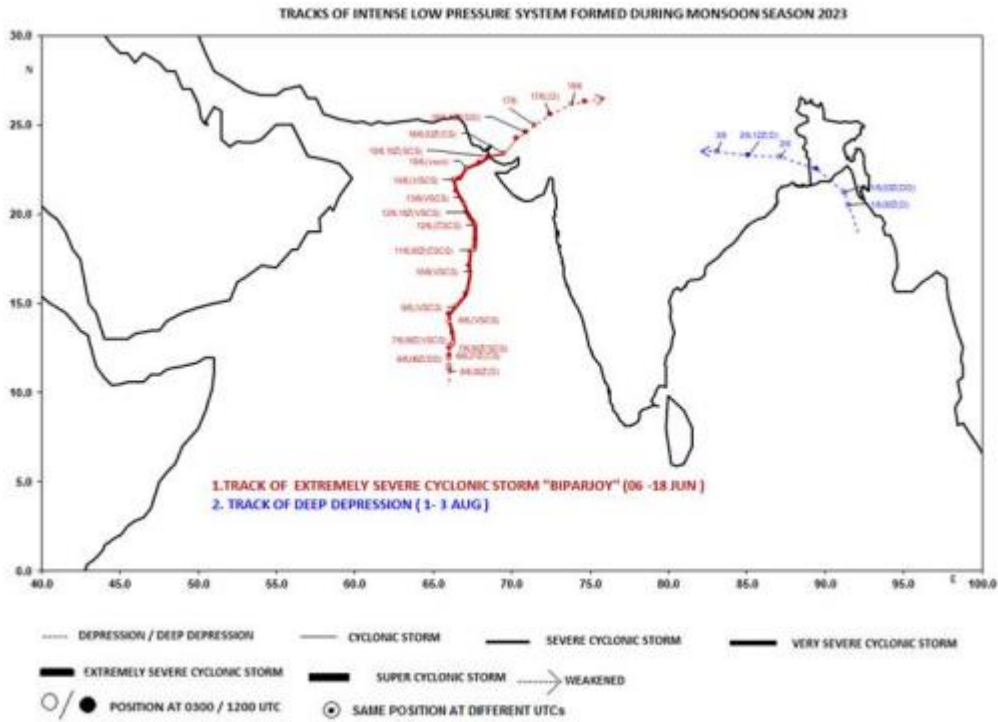
These low pressure systems helped to get a good amount of rainfall in July and September. Out of these low pressure systems one intensified into an extremely severe Cyclonic storm (“BIPORJOY”) that formed over the Northeast Arabian Sea during 6th to 19th June. There were two monsoon depressions during the season, one in August(1-3 August) and another on 30th September against the normal frequency of 6. The tacks of the cyclone and depression formed during the 2023 southwest monsoon season are given in **Fig.18**.



**Fig. 17:** Tracks of the Low Pressure Systems formed during Monsoon 2023

**Table 7:** Number of Low-pressure System (LPS) including Low (L), Well Marked Low (WML), Depression (D), Deep Depression (DD), Extremely Severe Cyclonic Storm (ESCS) and number of LPS days in monsoon 2023.

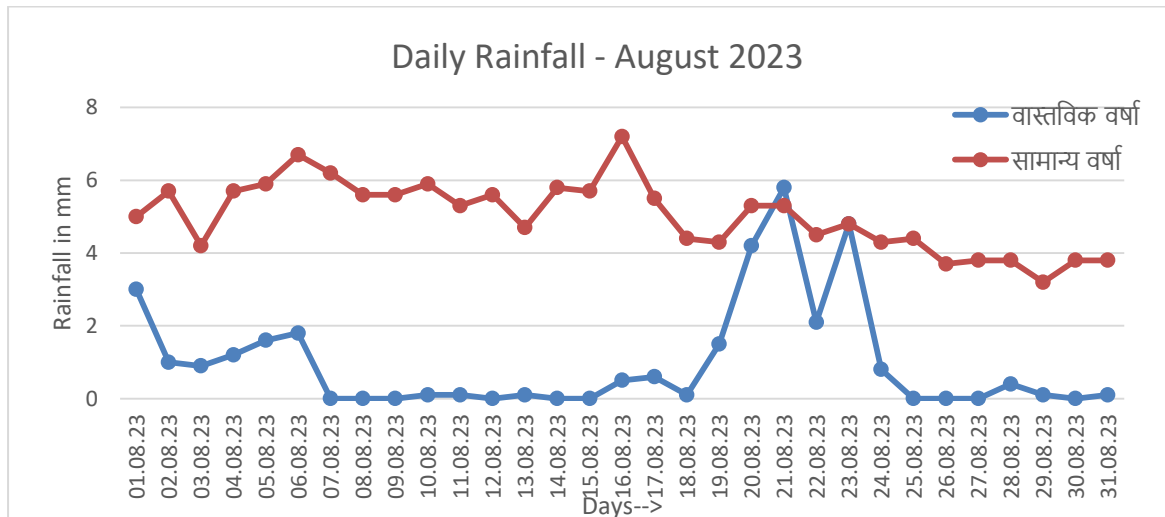
Systems/ Month	ESCS	DD	D	WML	L	Total Systems
<b>June</b>	1	0	0	2	0	3
<b>July</b>	0	0	0	2	3	5
<b>August</b>	0	1	0	0	1	2
<b>September</b>	0	0	1	3	1	5



**Fig. 18:** Tracks of the Cyclonic Storms and Depressions formed during Monsoon 2023

**3.1 Extreme Scanty during monsoon season:-**

In the month of August, a scanty spell arose from 07<sup>th</sup> -18<sup>th</sup> August. In this span, Rajasthan received 99% less Rainfall.



**Fig. 19:** Daily Rainfall during August - 2023

### 3.2 Extreme Rainfall during “Biparjoy cyclone” :-

In the month of June, Extremely Severe Cyclonic Storm “Biparjoy” arose from Arabian Sea. Due to which, Rajasthan State received Extremely Heavy Rainfall during 16<sup>th</sup> -20<sup>th</sup> June. In the span of 96 hrs, Rajasthan state received 86.6 mm of rainfall which was 20% of its seasonal. Jalore district received 96% of its LPA in just four days.

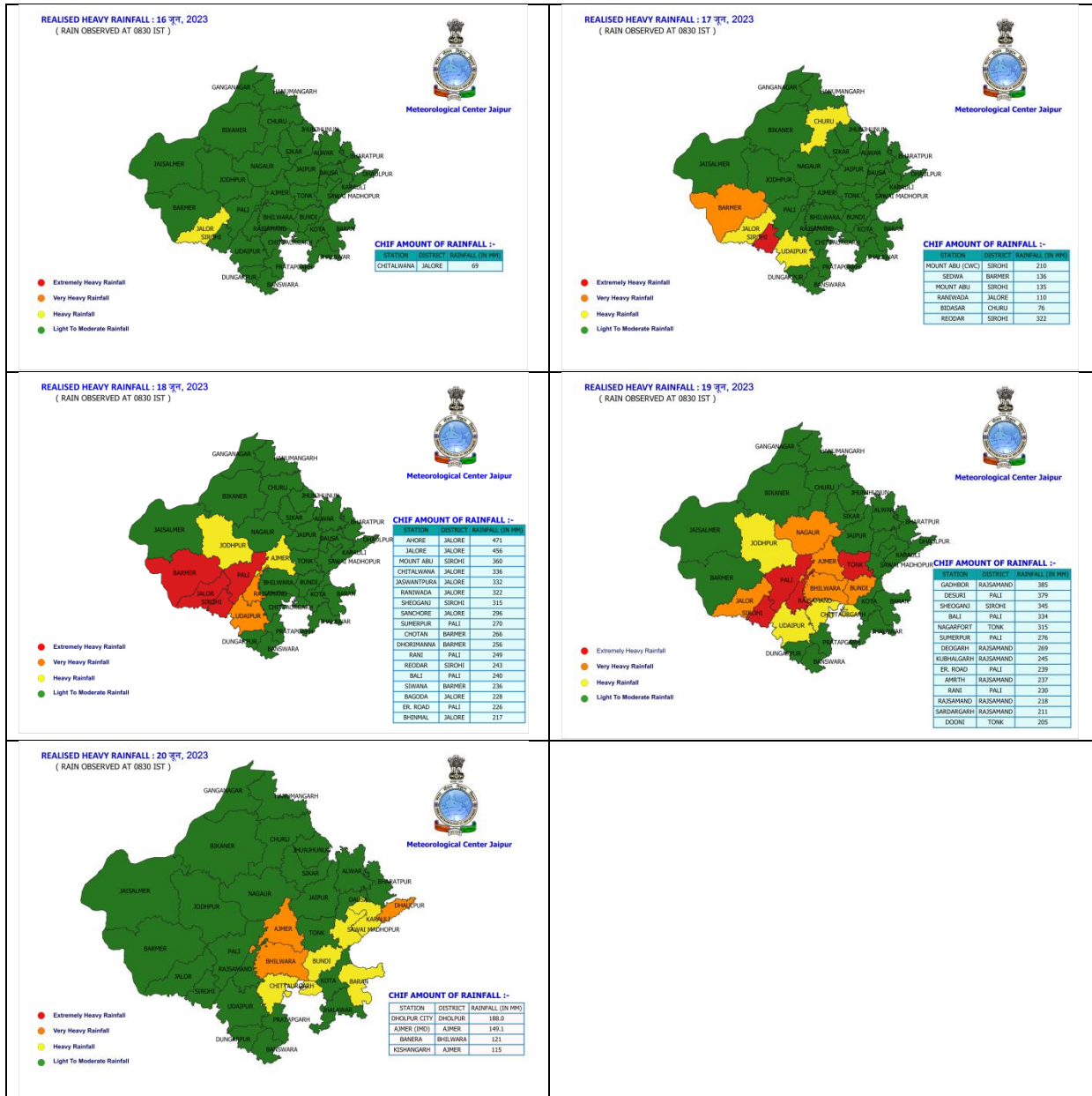
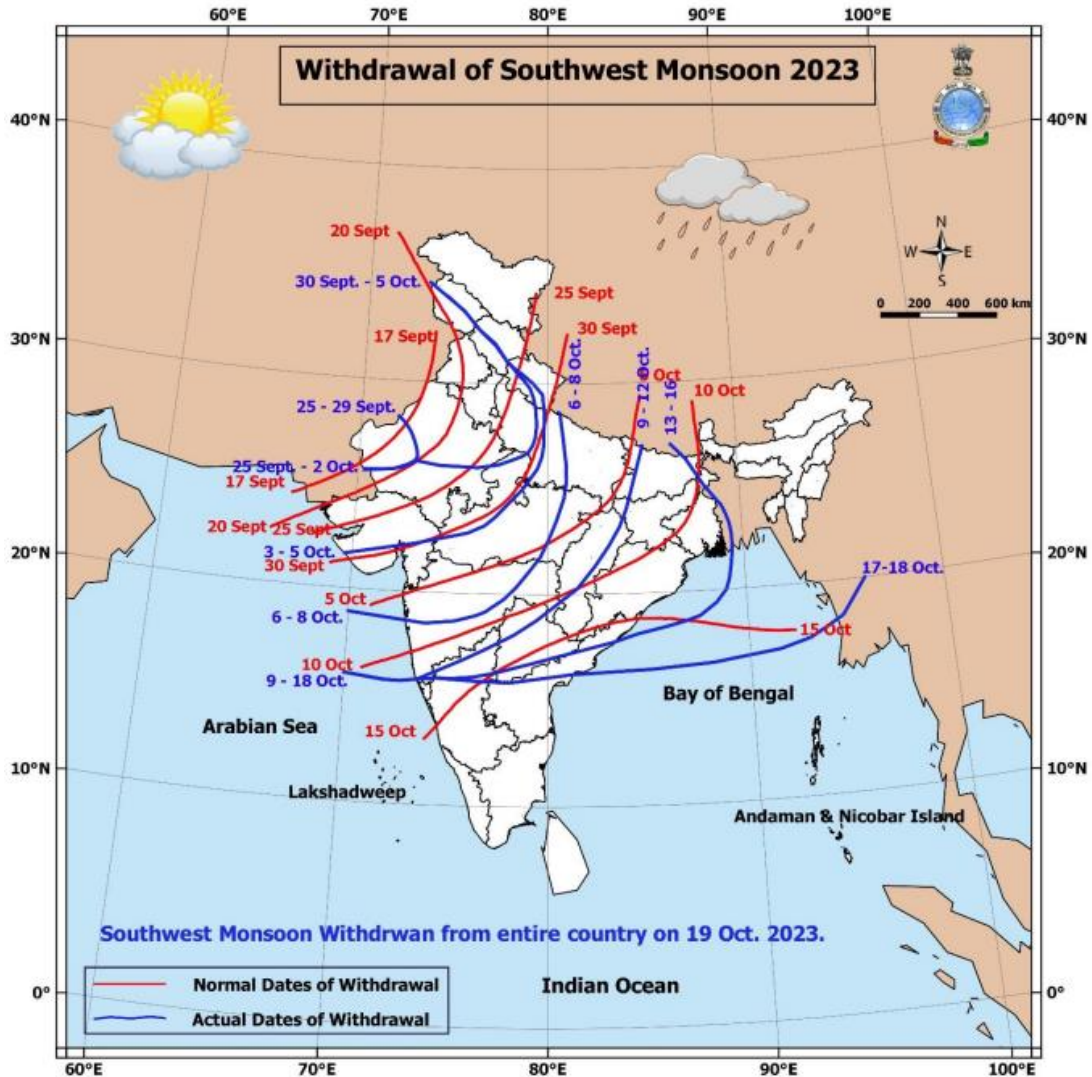


Fig. 20: Rainfall during Extremely Severe Cyclonic Storm “Biparjoy”

#### 4. Withdrawal of Southwest Monsoon 2023

With the reduction in the rainfall and formation of the anti-cyclonic circulation in lower troposphere, withdrawal of the SW-monsoon 2023 began on 25th September against the normal date of 17th September. Southwest monsoon 2023 withdrew from the entire country on October 19. The withdrawal dates of the 2023 Southwest Monsoon are illustrated in **Fig.18**.



**Fig. 21:** Isochrones of withdrawal of the Southwest monsoon during 2023

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