

Report on Extreme Weather Events during June-December 2021

1. Introduction

As per the classification of the seasons, the months June to September (JJAS) constitute the monsoon season whereas October-December (OND) constitutes the post-monsoon season. The monsoon season during JJAS is associated with the formation of Low Pressure Areas (LPAs) and monsoon Depressions over the Bay of Bengal (BoB) which move inland over India giving rise to heavy rainfall over different parts of the country. Sometimes, a Depression intensifies into a Tropical Cyclone (TC) particularly during the onset phase (June) or the withdrawal phase of monsoon (September). The heavy rainfall leading to flooding is a very common phenomenon during the monsoon season. This season is also characterized by the formation of LPAs over the north Indian Ocean and occasionally their intensification into cyclones. The post-monsoon season from October to December (OND) is mainly associated with TCs over north Indian Ocean, easterly waves over the southern peninsula India leading to heavy rainfall over Tamil Nadu and adjoining regions. The northern part of India witnesses Western Disturbances (WDs) and Fog particularly in the months of November and December. In this report, an attempt has been made to bring out the details of the extreme weather phenomena and their impacts during the monsoon and post-monsoon seasons of 2021.

2. Low Pressure Systems during June-September 2021

During the southwest monsoon season 2021, fifteen low-pressure systems (1 cyclonic storm, 1 Deep Depression (DD), 4 well-marked low-pressure areas (WMLs), 7 LPAs, and 2 land LPAs) were formed. The frequency and place of origin of these low-pressure systems formed over the Indian region during the monsoon season are shown in Table 1.

The first intense low-pressure system in form of DD formed in September over BoB during the period 12- 15 September. The first cyclonic storm (CS) of the season, GULAB occurred during 24-28 September over BoB. The remaining thirteen

systems were WMLs/LPAs/land LPAs. Figure 1 shows the track of the intense low-pressure system formed during the season.

Table 1. Frequency of low pressure systems formed during Jun-Sep 2021 over North Indian Ocean.

Month /Systems	CS	DD	D	WML	LPA	LAND LPA
June	0	0	0	0	1(BOB)	1
July	0	0	0	2(BOB)	1(BOB),1(AS)	1
August	0	0	0	0	2(BOB)	0
September	1(BOB)	1(BOB)	0	2(BOB)	1(BOB),1(AS)	0
	(AS: Arabian Sea)		(BOB: Bay of Bengal)			

2.1 Cyclonic Storm GULAB over the Bay of Bengal (24-28 Sep, 2021)

A LPA formed over east-central BoB and neighborhood in the morning (0830 hours IST / 0300 UTC) of 24th September. It lay as a WML in the same afternoon (1430 hours IST) over east-central and adjoining northeast BoB. Under favourable environmental and marine conditions, it concentrated into a depression over east-central and adjoining northeast BoB in the same evening (1730 hours IST/ 1200 UTC) of 24th September. Moving nearly westwards, it further intensified into a deep depression over north & adjoining central BoB in the early morning (0530 hours IST/ 0000 UTC) of 25 September. Continuing to move further westwards, it intensified into the CS GULAB (pronounced as GUL-AAB) over northwest and adjoining west-central BoB in the same evening (1730 hours IST) of 25 September, 2021. Thereafter, it intensified gradually and reached its peak intensity of 75-85 kmph gusting to 95 kmph around noon (1130 hours IST/0600 UTC) of 26 September. Continuing to move further westwards, it crossed north Andhra Pradesh and adjoining south Odisha coasts near 18.4°N/84.2°E (20 km north of Kalingapatnam) with maximum sustained wind speed of 75-85, gusting to 95 kmph during 1930-2030 IST of 26 September. Thereafter, it weakened into a DD in the early hours (0230 hours IST) of 27th September over north Andhra Pradesh

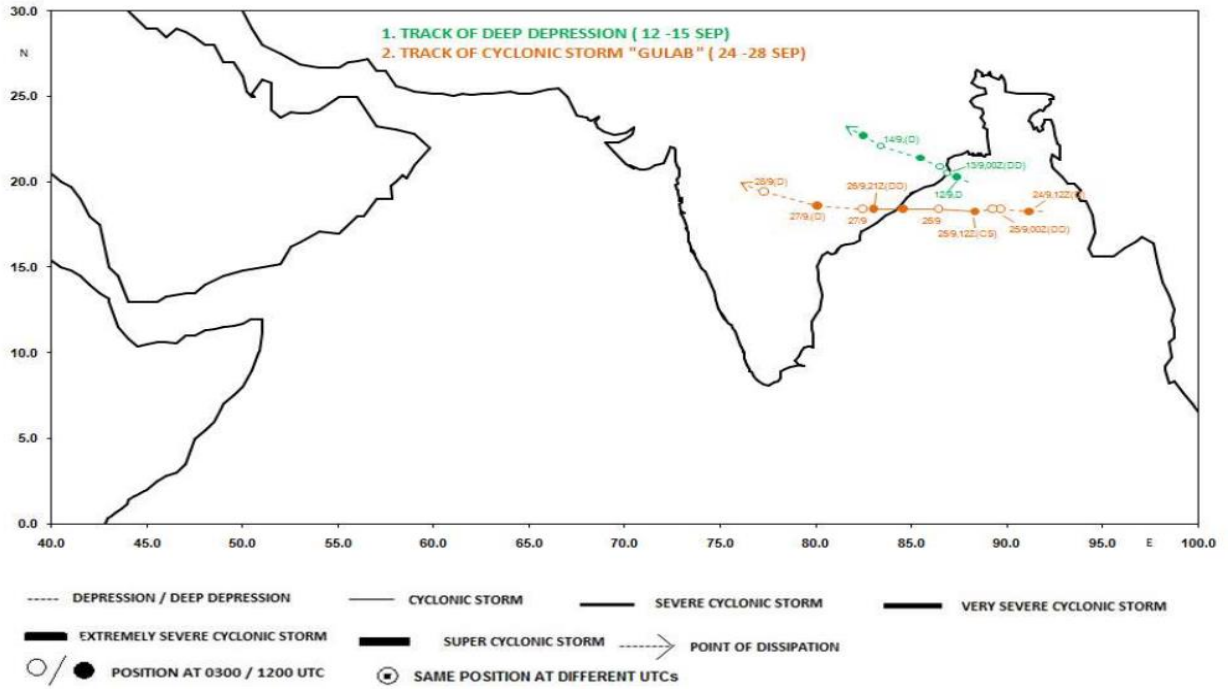


Figure 1: Tracks of intense low pressure system formed during southwest monsoon season 2021.

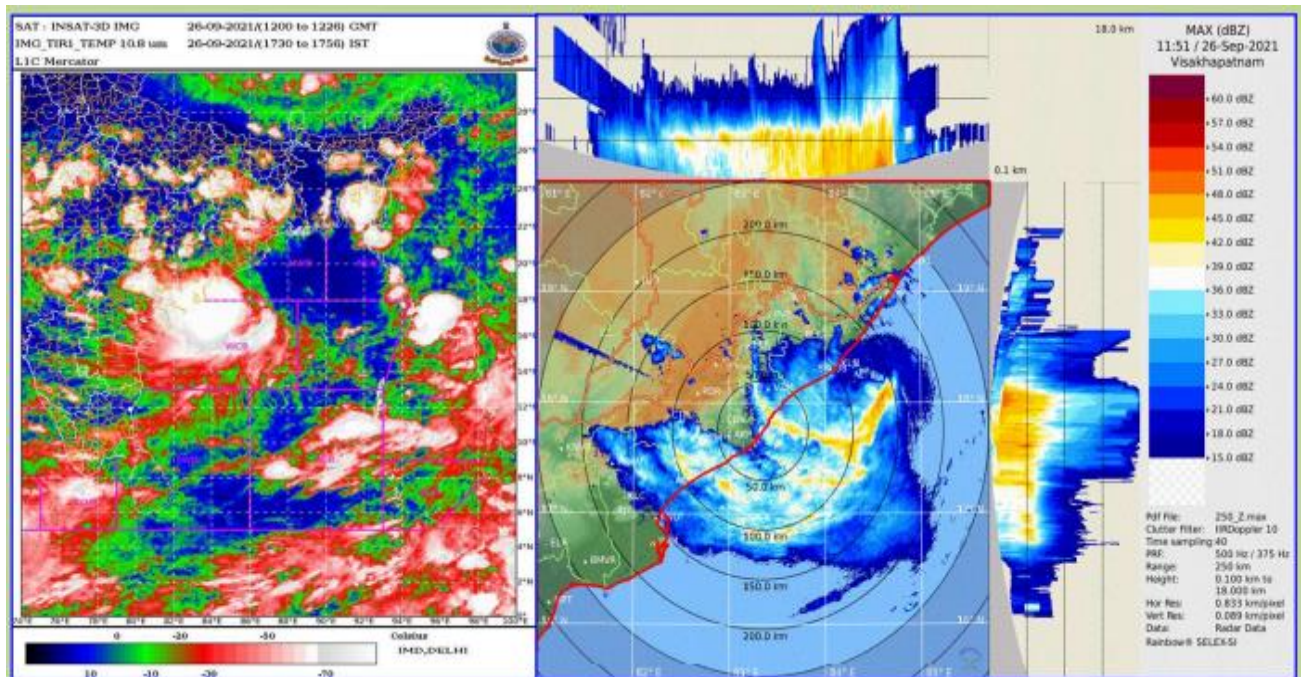


Figure 2: Cyclonic Storm GULAB over Bay of Bengal during 24th-28th September, 2021. Satellite imagery and Radar imagery from DWR Visakhapatnam at 1730 hrs IST of 26th September, 2022.

and adjoining south Odisha and into a depression over south Chhattisgarh in the evening (1730 hours IST) of 27th. It further weakened into a WML over western parts of Vidarbha and neighbourhood around noon of 28 September. The satellite imagery and DWR Radar imagery of CS GULAB over BoB during 26th September, 2021 is shown in Figure 2.

3. Significant Weather during June to September 2021

Figure 3 shows significant weather events during the southwest monsoon season 2021 (based on real-time media reports). During the season, a total of 801 persons were reportedly claimed dead, more

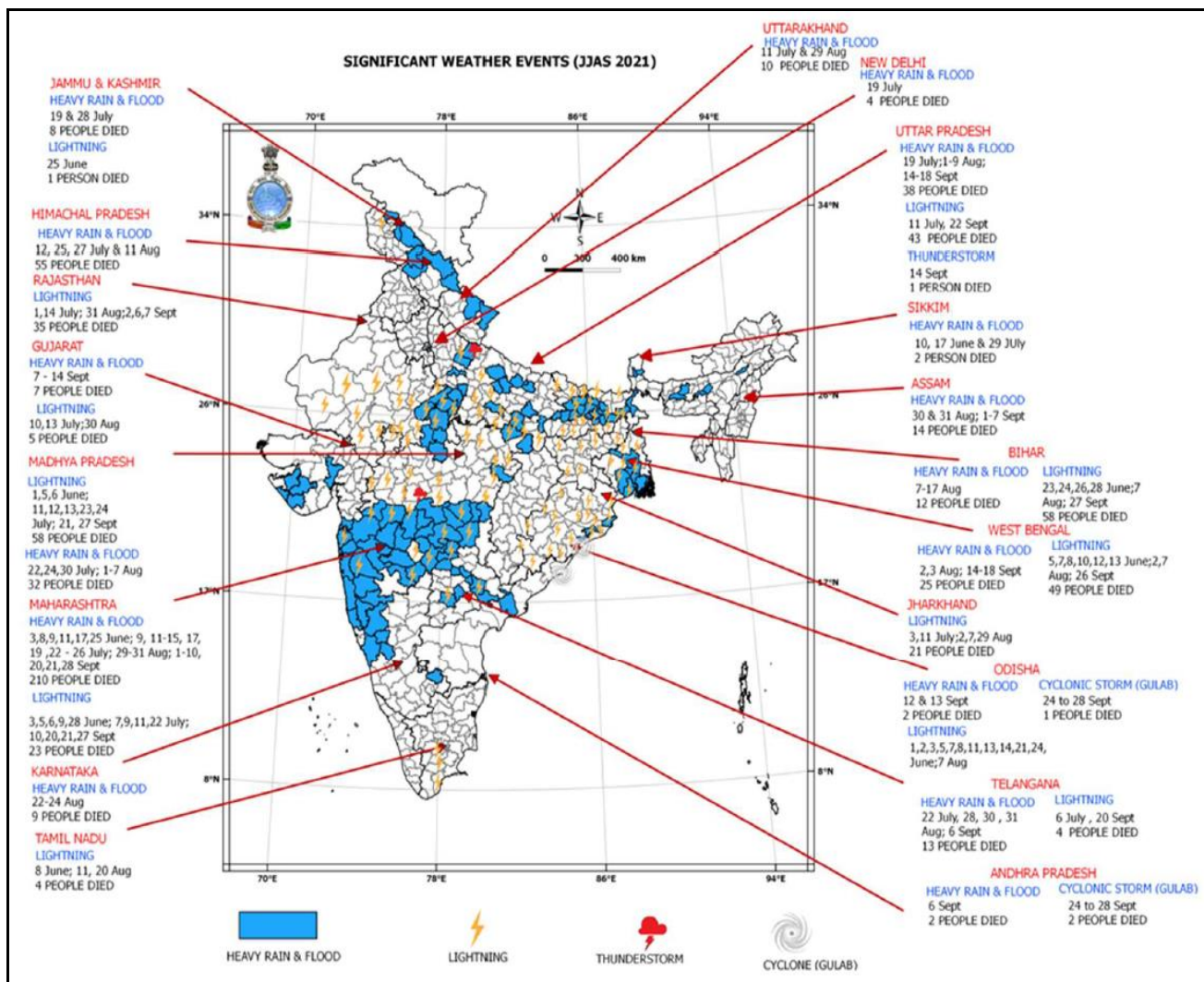


Figure 3: The significant weather events during the monsoon seasons (JJAS 2021). (CDBI, IMD Pune).

than 250 persons injured, more than 70 persons missing & more than 3100 livestock perished. The details of casualties given below which are based on real-time media reports.

Floods and Heavy Rain: In total, 444 persons were reportedly claimed dead, 96 persons got injured, 72 persons were missing and more than 2700 livestock perished because of heavy rains, floods and landslides during the season. Besides this damage to crops, the loss of public and private property was reported. The details of the area affected by the events are indicated in Figure 3. The details of the area affected by the events are also summarized and given in the Table 2.

Lightning: A total of 353 persons reportedly claimed dead, 165 injured and 383 livestock perished during the season because of lightning. The details of the area affected by the events are

indicated in Figure 3 and also in Table 3 given below.

Thunderstorms: One person was reportedly dead and 3 others were injured due to the thunderstorms in this season. The details of the area affected by the events are summarized and given in Figure 3.

Cyclonic Storms: A total of 3 persons were reportedly dead and one person was missing during the monsoon season 2021 because of CS GULAB.

4. Cyclonic Disturbances during October-December 2021.

During the post monsoon season from October-December, 2021, ten low-pressure systems (2 CS, 3 Depressions, 2 WML and 3 LPA) were formed. The frequency and place of origin of these low-pressure systems formed over the Indian region during the post-monsoon season are shown in Table 4.

Table 2. Areas affected and loss of life due to floods and Heavy Rain.

DATE	DEATH	INJURED	MISSING	LIVESTOCK	DISTRICT (STATE) AFFECTED
3, 8, 9, 11, 17, 25 Jun.; 9, 11 to 15, 17, 19, 22 to 26 Jul.; 29 to 31 Aug., 1 to 10, 20 & 21, Sep.28 Sep.	210	52	43	2699	Ahmednagar, Akola, Amravati, Aurangabad, Beed, Bhandara, Buldhana, Chandrapur, Dhule, Gondia, Hingoli, Jalgaon, Jalna, Kolhapur, Latur, Mumbai City, Mumbai Suburban, Nanded, Nagpur, Nashik, Osmanabad, Palghar, Parbhani, Pune, Raigad, Ratnagiri, Satara, Sangali, Sindhudurg, Thane, Wardha, Washim, Yavatmal (Maharashtra)
12, 25, 27 Jul. & 11 Aug.	55	13	7		Chamba, Kangra, Kinnaur, Lahaul-Spiti (Himachal Pradesh)
19 Jul.; 1 to 9 Aug.; 14 to 18 Sep.	38	12			Barabanki, Baghpat, Basti, Ballia, Bareilly, Budaun, Chitrakoot, Ghazipur, Gonda, Fatehpur, Etawah, Jaunpur, Kaushambi, Lucknow, Prayagraj (Allahabad), Sambhal, Sitapur (Uttar Pradesh)
22, 24, 30 Jul.; 1 to 7 Aug.	32				Ashoknagar, Bhind, Datia, Dindori, Gwalior, Guna, Morena, Rewa, Sheopur, Shivpuri, Singrauli, Vidisha (Madhya Pradesh)
2 & 3 Aug.; 14 to 18 Sep.	25				East Bardhaman, Howrah, Hooghly, North 24 Parganas, Purba Medinipur, Paschim Medinipur, South 24 Parganas, West Bardhaman (West Bengal)
30 & 31 Aug.; 1 to 7 Sep.	14			1	Barpeta, Goalpara, Kamrup, Majuli, Morigaon (Assam)
22 Jul.; 28, 30 & 31 Aug.; 6 Sep.	13				Asifabad, Bhadradi, Karimnagar, Khammam, Rajanna, Mahabubabad, Nirmal, Nizamabad, Rangareddi, Vikarabad, Warangal, Yadadri-Bhuvanagiri (Telangana)
7 to 17 Aug.	12				Begusarai, Bhagalpur, Bhojpur, Buxar, Darbhanga, Katihar, Khagaria, Lakhisarai, Munger, Muzaffarpur, Patna, Saharsa, Samastipur, Saran, Vaishali (Bihar)
11 Jul.; 29 Aug.	10	2			Chamoli, Pithoragarh (Uttarkhand)
22 to 24 Jul.;	9		3	78	Belgaum, Chikmagalur, Dharwad, Haveri, Uttara Kannada (Karnataka)
19 & 28 Jul.	8	17	19		Anantnag, Bandipora, Kishtwar (Jammu & Kashmir)
7 to 14 Sep.	7				Ahmedabad, Jamnagar, Junagadh, Porbandar, Rajkot, Valsad (Gujarat)
19 Jul.	4				Union Territory (New Delhi)
12 & 13 Sep.	3				Kendrapara, Khordha (Odisha)
10, 17 Jun. & 29 Jul.	2				East Sikkim, South Sikkim
6 Sep.	2				West Godavari (Andhra Pradesh)

Table 3. Area affected and death due to lightning.

DATE	DEATH	INJURED	MISSING	LIVESTOCK	DISTRICT (STATE) AFFECTED
1,5,6 Jun.; 11, 12, 13, 23, 24 Jul.; 21, 27 Sep.	58	48		16	Agar Malwa, Alirajpur, Betul, Burhanpur, Balaghat, Dewas, Dhar, Datia, Chhatarpur, Gwalior, Hoshangabad, Khandwa, Mandla, Morena, Panna, Rewa, Shahdol, Shivpuri, Sheopur, Umaria (Madhya Pradesh)
23, 24, 26, 28 Jun.; 7 Aug.; 2, 27 Sep.	58	7			Araria, Aurangabad, Begusarai, Banka, Bhagalpur, Darbhanga, East Champaran, Gaya, Jamui, Katihar, Khagaria, Lakhisarai, Madhepura, Madhubani, Muzaffarpur, Nalanda, Purnia, Patna Saharsa, Sheikhpura, Sitamarhi, West Champaran (Bihar)
1, 2, 3, 5, 7, 8, 11, 12, 13, 14, 21, 24, 26, 27, 30, Jun.; 7 Aug.	52	5			Angul, Bargarh, Balasore, Bhadrak, Boudh, Cuttack, Dhenkanal, Gajapati, Ganjam, Jagatsinghpur, Jharsuguda, Kandhamal, Kendrapara, Keonjhar, Khordha, Koraput, Nabarangpur, Naupada, Puri, Rayagada, Subranpur (Odisha)
5,7, 8, 10, 12, 13 Jun.; 2, 7 Aug.; 26 Sep.	49	12			Bankura, Birbhum, Bankura, East Burdwan, Hooghly, Howrah, Murshidabad, Nadia, Purba Medinipur, Paschim Medinipur (West Bengal)
11 Jul.; 22 Sep.	43	23		250	Allahabad (Prayagraj), Bareilly, Banda, Chitrakoot, Fatehpur, Firozabad, Hamirpur, Hardoi, Kanpur Dehat, Kaushambi, Mirzapur, Prayagraj, Sonbhadra, Unnao (Uttar Pradesh)
11, 14 Jul.; 31 Aug.; 2, 6, 7 Sep.	35	38		52	Baran, Barmer, Chittorgarh, Dhaulpur, Dholpur, Jaipur, Jhalawar, Jodhpur, Kota, Sawai Madhopur, Nagaur, Pali, Sawai Madhopur, Tonk, Udaipur (Rajasthan)

Table 4. Frequency of low pressure systems in Oct-Dec 2021 over North Indian Ocean.

Month /Systems	CS and above	DD	D	WML	LPA
October 2021	1 (AS)	0	0	0	1(BOB),1 (AS),1(LAND)
November 2021	0	0	2 (BOB),1 (AS)	1(AS)	0
December 2021	1 (BOB)	0	0	1(BOB)	0
	(AS: Arabian Sea)		(BOB: Bay of Bengal)		

In October, one Severe Cyclonic Storm (SCS) Shaheen (30 Sept-4 Oct) formed over the Arabian Sea and three LPAs (one over BoB, one over the Arabian Sea, and one over land) formed. In November, three depressions (two over BoB and one over the Arabian Sea) and one WML over the Arabian Sea formed. In December, CS Jawad (2 - 6 December) and one WML formed over BoB. Figure 4 shows the track of intense low pressure systems formed during the season.

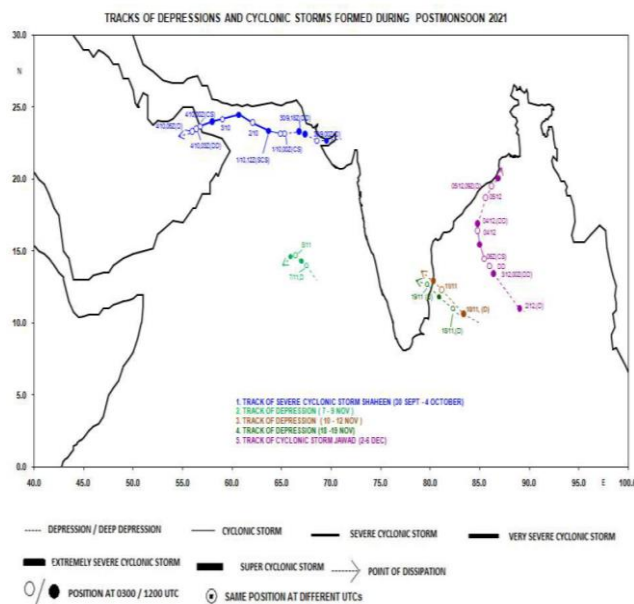


Figure 4: Tracks of intense low-pressure systems formed during post-monsoon season 2021.

Climatologically, no cyclone had crossed Odisha in the month of December in the recorded history. There had been landfall over north Andhra Pradesh and West Bengal. Even if there was no landfall, there had been impact of cyclones over Odisha during the past years in terms of heavy rainfall. Maximum genesis took place over south BoB and south Andaman Sea. Once the system crossed 15N over BoB, it changed its path and re-curved north-northeastwards. The same has been observed with CS Jawad. INSAT-3D enhanced colored imageries during life cycle of CS JAWAD during 2 Dec-5 Dec, 2021 is shown in Figure 5.

JAWAD had a recurving track. It moved north-northwestwards initially and started recurving from 4th morning (0530 hours IST/0000 UTC).

The peak maximum sustained wind (MSW) speed of the cyclone was 70-80 kmph (40 knots) gusting to 90 kmph during 3rd 1200 UTC to 4th 0000 UTC.

Dhamra Port reported south-southeasterly winds of intensity 32 knots gusting to 35 knots at 4th 0600 UTC. Thereafter, the system started weakening under unfavourable conditions (enhanced wind shear, dry air incursion into the core of system, lower ocean thermal energy, land interactions and unfavourable Madden Julian Oscillation index).

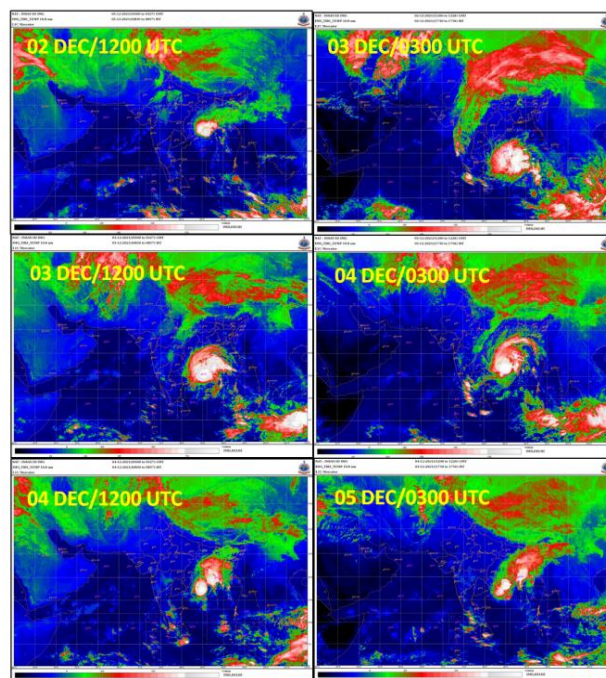


Figure 5 : INSAT-3D enhanced colored imageries during life cycle of CS JAWAD during 2 Dec-5 Dec, 2021.

As the cyclone moved very close to Odisha coast on 5th December, it caused heavy to extremely heavy rainfall activity affecting Odisha coast on 5-6 December and Gangetic West Bengal coast on 6 December. Very heavy rainfall (maximum 9 cm) was reported in Ganjam district on 5 December and extremely heavy rainfall (maximum 23 cm) was reported in Jagatsinghpur district of Odisha on 6 December. Very heavy rainfall (maximum 18 cm) was reported in Hooghly district of Gangetic West Bengal on 6 December. It also caused strong winds over Odisha coast. Meteorological Office at Puri reported MSW of 18 knots during 1030-1130 hrs IST (0500 to 0600 UTC) of 5 December; and high wind speed recorder at Paradeep reported MSW of 26 knots at 1530 hrs IST (0995 UTC) of 5 December. Dhamra Port reported south-southeasterly winds of intensity 32 knots gusting to 35 knots at 4th/0600 UTC (1130 IST).

Table 5. Areas affected and death due to floods and heavy rain.

DATE	DEATH	INJURED	MISSING	LIVESTOCK	DISTRICT (STATE) AFFECTED
16 to 19 Oct.	52	17	5		Almora, Bageshwar, Chamoli, Champawat, Nainital, Pauri Garhwal, Pithoragarh, Ranikhet, Udham Singh Nagar (Uttarakhand)
11 to 19 Oct.; 10 to 15 Nov.	49	2	6		Alappuzha, Idukki, Ernakulam, Kannur, Kottayam, Kollam, Kozhikode, Malappuram, Palakkad, Pathanamthitta, Thrissur, Thiruvananthapuram (Kerala)
8 to 21 Nov.	44		17	2400	Anantpur, Chittoor, Cuddapah, Kurnool, Nellore & Parts of Andhra Pradesh
3 to 6 Oct. 15 to 20 Nov.	23	1			Belgaum, Chikkaballapura, Chitradurga, Tumkur & parts of Karnataka
6 to 21 Nov.	20	9		157	Chennai, Kallakurichi, Krishnagiri, Madurai, Thanjavur, Teni, Tiruvannamalai, Tiruchirappalli, Tiruvannamalai, Thiruvarur, Vellore, Villupuram (Tamil Nadu)
6 & 9 Oct.	5			1	Ahmednagar, Aurangabad, Osmanabad (Maharashtra)
1, 23 Oct.	5	1			Pulwama, Rajouri (Jammu & Kashmir)
8 Oct.	2				Hyderabad (Telangana)

5. Other Significant Weather Events during October-December 2021.

Figure 6 shows the significant weather events during the post-monsoon season (based on real-time media reports). From 1st October to 31st December, a total of 272 persons were reportedly dead, 56 persons injured, 30 persons missed and 2567 livestock perished. The details of casualties are given below.

Floods and Heavy Rain: A total of 200 persons reportedly claimed dead, 30 persons got injured, 28 persons were missing and 2558 livestock perished because of heavy rains, floods and landslides from 1 October to 31 December, in addition to the damage to crops, public and private property reported. The details of the area affected by the events are summarized and given in Table 5.

Lightning: A total of 61 persons reportedly claimed dead, 24 got injured and 9 livestock

perished from 1 October to 31 December, because of lightning. The details of the areas affected by the events are summarized and given in Table 6.

Snowfall: 6 persons reportedly claimed dead and 2 others were missing during 1 October to 31 December because of snowfall. The details of the areas affected by the events are summarized and given in Figure 6.

Cold Wave: A total of 5 persons reportedly claimed dead from 1 October to 31 December because of cold wave. The details of the area affected by the event are summarized and given in Figure 6.

Thunderstorms: 2 persons were injured from 1 October to 31 December because of the thunderstorms.

The other events like Gale and Hailstorm also affected different parts of the country during post-monsoon season 2021.

Table 6. Areas affected and death due to lightning.

DATE	DEATH	INJURED	MISSING	LIVESTOCK	DISTRICT (STATE) AFFECTED
1, 2, 17, 19 Oct.	15				Darbhanga, Gaya, Gopalganj, Kaimur, Nalanda, Nawada, Saharsa, Rohtas, Samastipur, Saran, Siwan, Vaishali (Bihar)
1, 5, 6, 7, 9 Oct. 28 Dec.	14	1		6	Amravati, Beed, Jalna, Latur, Nanded, Nashik, Parbhani, Pune, Raigad (Maharashtra)
1, 2, 3, 17, 18 Oct.	10	8		3	Betul, Dewas, Guna, Khandwa, Rajgarh, Neemuch, Ujjain, Vidisha (Madhya Pradesh)
3, 4, 5, 7, 19, 21 Oct.; 1, 14 Nov.	10				Bargarh, Deogarh, Dhenkanal, Jagatsinghpur, Kandhamal, Kalahandi, Keonjhar, Koraput (Odisha)
5, 22 Oct.; 1 Nov.; 5 Dec.	6	1			Ariyalur, Chennai, Tirunelveli, Tuticorin (Tamil Nadu)
10 Oct.; 1 Nov.	3	3			Bangalore Urban, Dakshina Kannada (Karnataka)
4 Oct.	1	9			Bilaspur (Chhattisgarh)
6 Oct.	1	1			Ahmedabad (Gujarat)
18 Oct.	1	1			Jaipur (Rajasthan)

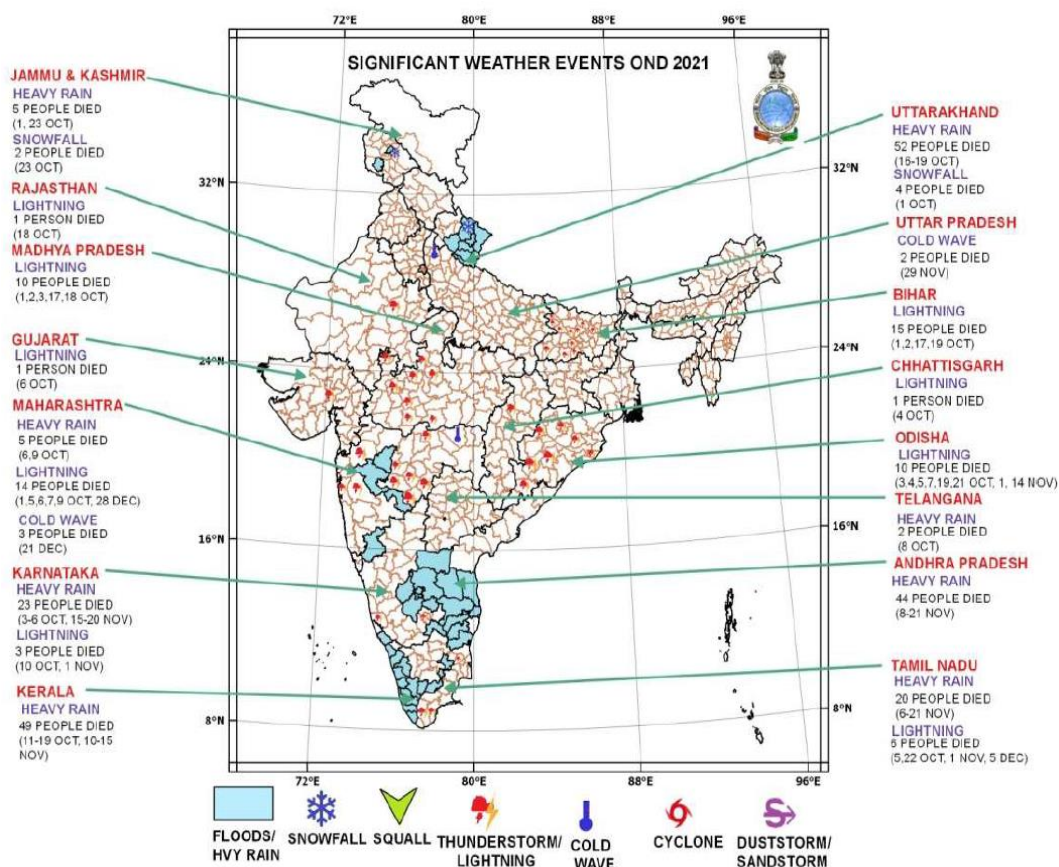


Figure 6: The significant weather events during the post-monsoon seasons (OND 2021). (CDBI, IMD Pune).

Acknowledgements

This report has been compiled by Dr. D. R. Pattanaik by referring to the various inputs from

IMD Pune, RSMC New Delhi and the monsoon and post monsoon reports of 2021.