

Cyclones and depressions over the north Indian Ocean during 2018*

1. Introduction

During 2018, in all 14 intense low pressure systems formed over the Indian Seas. These include; one extremely severe cyclonic storm (MEKUNU), 3 very Severe Cyclonic Storms (LUBAN, TITLI and GAJA), 1 Severe Cyclonic Storm (PHETHAI), 2 Cyclonic Storms (SAGAR and DAYE), 3 Deep Depressions and 4 Depressions. Out of these 14 systems, 10 systems formed over the Bay of Bengal and four over the Arabian Sea. One Depression, one Cyclonic Storm and one Extremely Severe Cyclonic Storm formed over Arabian Sea and one Deep Depression over Bay of Bengal in Pre-monsoon season. Monsoon Season witnessed two Deep Depressions, three Depressions and one Cyclonic Storm over Bay of Bengal. One Very Severe Cyclonic Storm over the Arabian Sea and two Very Severe Cyclonic Storms and one Severe Cyclonic Storm formed over Bay of Bengal in Post monsoon season.

The details of these systems are summarised below in Table 1 and the tracks are shown in Fig. 1.

2. Details of the systems

2.1. Depression over southeast Arabian Sea and adjoining equatorial Indian Ocean (13-15 March, 2018)

2.1.1. A low pressure area formed over southwest Bay of Bengal off Sri Lanka-south Tamil Nadu coasts on 10th and it lay over equatorial Indian Ocean and adjoining southwest Bay of Bengal and south Sri Lanka coast on 11th March. Associated cyclonic circulation extended upto 5.8 kms a.s.l. It lay as a well marked low pressure area over equatorial Indian Ocean and adjoining Comorin area, south Sri-Lanka and southwest Bay of Bengal on 11th evening. It persisted and lay over equatorial Indian Ocean and adjoining south Sri Lanka and Comorin-Maldives area on 12th. It concentrated into a Depression and lay centred over southeast Arabian Sea and adjoining equatorial Indian Ocean near Lat. 5.0° N/Long. 76.0° E, about 480 kms southeast of Minicoy, 390 kms south-southwest of Thiruvananthapuram and 290 kms east-northeast of Male (Maldives) at 0300 UTC of 13th. It moved north-northwestwards and lay centred over southeast Arabian sea near Lat. 6.5° N/Long. 75.0° E, about 280 kms southeast of Minicoy, 300 kms southwest of

Thiruvananthapuram and 330 kms north-northeast of Male (Maldives) at 1200 UTC of 13th. It further moved north westwards and lay centred over southeast Arabian Sea near Lat. 7.5° N/Long. 74.0° E, about 130 kms southeast of Minicoy, 340 kms west-southwest of Thiruvananthapuram and 380 kms north-northeast of Male (Maldives) at 0300 UTC of 14th. It moved northeastwards and lay centred over Southeast Arabian Sea near Lat. 8.7° N/Long. 72.8° E, about 70 kms north-northwest of Minicoy, 450 kms west-northwest of Thiruvananthapuram and 510 kms north-northwest of Male (Maldives) at 1200 UTC of 14th. It further moved north-northwestwards and weakened into a well marked low pressure area and lay over Lakshadweep and adjoining southeast Arabian Sea by 0000 UTC of 15th.

2.1.2. Other features observed

The lowest Estimated Central Pressure had been 1006 hPa and estimated Maximum Sustained surface Wind speed (MSW) was 25 knots during the depression.

(i) A ship near south Kerala coast reported 20 kt (37 kmph) at 0000 UTC of 14th March and 30 kt (55 kmph) at 1200 UTC of 14th March, (ii) Maximum wind of 20 kt (37 kmph) was reported by ship over Lakshadweep area and adjoining southeast Arabian Sea at 1200 UTC of 14th, (iii) Amini Divi reported 15 kt (28 kmph) at 1800 UTC of 14th March and (iv) A buoy in Comorin area reported 15 kt (27 kmph) at 0600 UTC of 14th.

2.1.3. Weather and damage caused

This system caused heavy to very heavy rainfall at isolated places in south Tamil Nadu and Kerala on 13th and heavy rainfall at isolated places over Kerala and Lakshadweep on 15th and over Tamil Nadu and interior Karnataka on 16th.

Chief amounts of (24 hrs) rainfall (≥ 7 cm) ending at 0300 UTC of date from 14-17 March, 2018 are given below:

14 March, 2018

Tamilnadu & Puducherry

Tuticorin 20, Papanasam (Tirunelveli) 19, Shenkottah 10, Srivaikuntam and Thenkasi 9 each, Tiruchendur 8, Manimutharu and Ambasamudram 7 each

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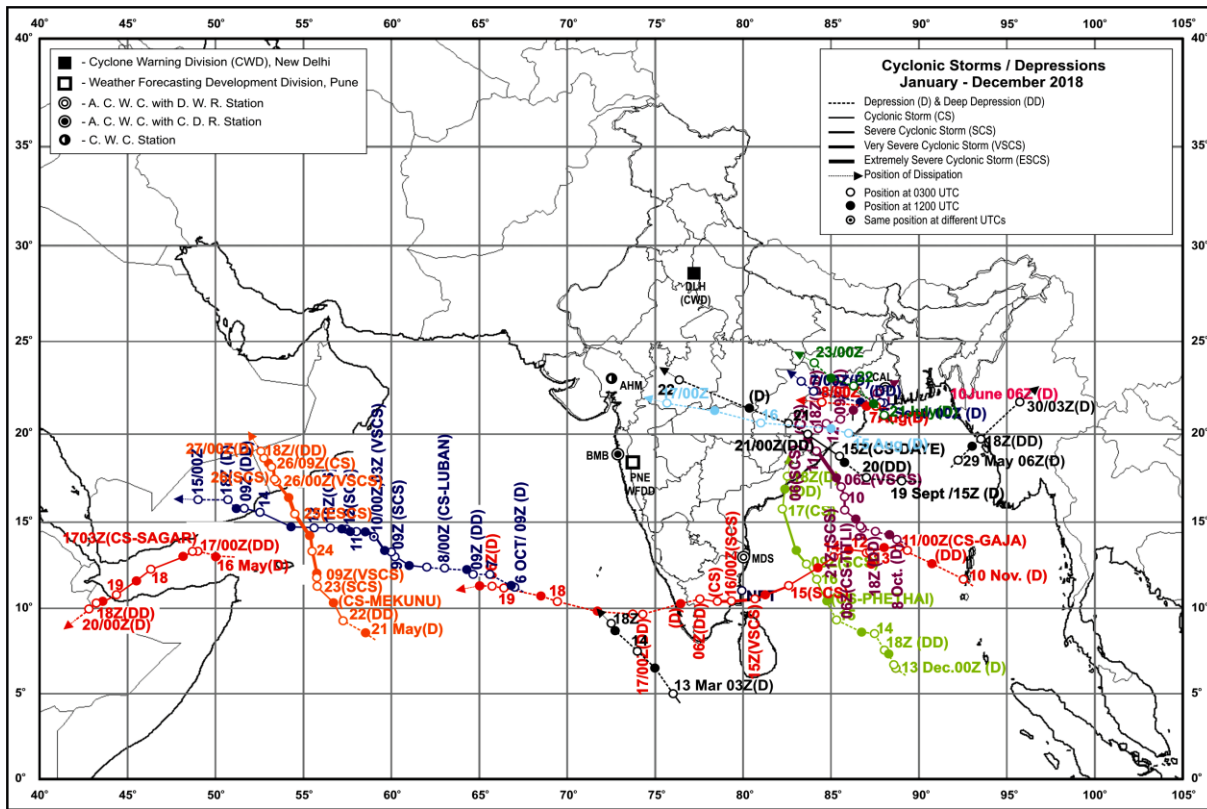


Fig. 1. Tracks of storms and depressions over during the year 2018

Kerala

Aryankavu 12

16 March, 2018

Kerala

Vyttiri 9

Lakshadweep

Agathi 11

17 March, 2018

Tamilnadu & Puducherry

Tirupattur 8, Omalur 7

North Interior Karnataka

Haveri 7

South Interior Karnataka

Chintamani 10

2.2. Cyclonic Storm (CS) 'SAGAR' over the Arabian Sea (16-20 May, 2018)

2.2.1. A low pressure area formed over southwest Arabian Sea and neighbourhood on 14th. It lay as a well marked low pressure area over the same region on 15th and over southwest Arabian Sea and adjoining westcentral Arabian Sea and Gulf of Aden on 16th. Associated cyclonic circulation extended upto upper tropospheric levels. It concentrated into a Depression and lay centred over Gulf of Aden near Lat. 13.0° N/Long. 50.0° E about 330 kms east-northeast of Aden (Yemen) and 500 kms west-northwest of Socotra Islands at 1200 UTC 16th. It moved westwards, intensified into a Deep Depression and lay centered over Gulf of Aden near Lat. 13.2° N/Long. 49.0° E, about 430 kms east-northeast of Aden (Yemen) and 530 kms west-northwest of Socotra Islands at 0000 UTC of 17th. It further moved westwards and intensified into a Cyclonic Storm 'SAGAR' and lay centered over Gulf of Aden near Lat. 13.2° N/Long. 48.7° E, about 400 kms east-northeast of Aden (Yemen) and 560 kms west-northwest of Socotra Islands at 0300 UTC of 17th. It moved further west-southwestwards and lay centered over Gulf of Aden near Lat. 12.2° N/Long. 46.3° E; about 140 km east-southeast of Aden (Yemen) and 820 km west-southwest of Socotra

TABLE 1

Brief Summary of cyclonic storms and depressions over the Indian Seas and neighbourhood during 2018

S. No.	Category	Life Period	Place/Time of landfall	Lowest Estimated central Pressure (hPa)	Max. wind Estimated (kts)	Highest "T" No.
1	Depression	13-15 March	Weakened into a well marked low pressure area over Lakshadweep and adjoining southeast Arabian sea at 0000 UTC of 15 th March	1006	25	1.5
2	Cyclonic storm 'SAGAR'	16-20 May	Crossed the Somalia coast near Lat. 10.6° N/Long. 44.0° E between 0800 and 0900 UTC of 19 th May. Weakened into well marked low pressure area over Ethiopia and adjoining Somalia in the morning 0300 UTC of 20 th May.	994	45	3.0
3	Extremely Severe Cyclonic Storm 'MEKUNU'	21-27 May	Crossed along the coast of Oman south of Salalah during mid night of 25 th May. Weakened into a Well Marked Low pressure area over Saudi Arabia and adjoining area of Oman and Yeman at 0300 UTC of 27 th May.	960	95	5.0
4	Deep Depression	29-30 May	Crossed Myanmar coast to the north of Kyakpyu between 1700-1800 UTC of 29 th May. Weakened into a well marked low pressure area and lay centered over Myanmar at 0600 UTC 30 th May.	992	30	2.0
5	Depression	9-11 June	Crossed Bangla Desh coast close to south of FENI around 1500 UTC of 10 th June. Weakened into a well marked low pressure area over Tripura and neighbourhood on 11 th June morning.	988	20	1.5
6	Deep Depression	21-23 July	Crossed north Odisha-West Bengal coasts close to south of Digha during 1100 to 1200 UTC of 21 st July. Weakened into a well marked low pressure area over northwest Jharkhand and neighbourhood at 0300 UTC of 23 rd July	989	25	1.5
7	Depression	7-8 August	Crossed north Odisha-West Bengal coasts close to Balasore during 1430-1630 UTC of 7 th August. Weakened into a well-marked low pressure area over north Chattisgarh and neighborhood at 0300 UTC of 8 th August	992	25	1.5
8	Depression	15-17 August	Weakened into a well-marked low pressure area over southwest Madhya Pradesh and adjoining Gujarat and north Madhya Maharashtra on 17 th August	993	25	-
9	Deep Depression	6-7 September	Crossed West Bengal coast close to the south of Digha (West Bengal) between 0430 and 0530 UTC of 6 th September. Weakened into a well marked low pressure area and lay over north Chhattisgarh and neighbourhood at 0600 UTC of 7 th September	994	30	1.5
10	Cyclonic Storm 'DAYE'	19-22 September	Crossed south Odisha and adjoining north Andhra Pradesh coast close to Gopalpur during 1900 to 2000 UTC of 20 th September. Weakened into a well marked low pressure area and lay over West Madhya Pradesh and adjoining East Rajasthan at 1200 UTC of 22 nd September	992	55	2.5
11	Very Severe Cyclonic Storm, 'LUBAN'	6-15 October	Crossed Yemen and adjoining Oman coasts near 15.8° N and 52.2° E during 0530 to 0600 UTC of 14 th October. Weakened into a well-marked low pressure area over Yemen and adjoining Saudi Arabia at 0300 UTC of 15 th October	978	75	4.5
12	Very Severe Cyclonic Storm 'TITLI'	8-13 October	Crossed north Andhra Pradesh-south Odisha coasts, near Lat. 18.8° N/Long. 84.5° E, during 2300 UTC of 10 th and 0000 UTC of 11 th October. Weakened into a well marked low pressure area over Gangetic West Bengal and neighbourhood at 0000 UTC of 13 th October	972	80	5.0
13	Very Severe Cyclonic Storm 'GAJA'	10-19 November	Crossed Tamil Nadu and Puducherry coasts between Nagapattinam and Vedaranniyam near 10.45° N and 79.8° E during 1900 to 2100 UTC on 15 th November. Weakened into a well marked low pressure area over southwest and adjoining southeast Arabian Sea on 1800 UTC of 19 th November	976	70	4.0
14	Severe Cyclonic Storm 'PHETHAI'	13-18 December	Crossed Andhra Pradesh coast near Lat. 16.5° N/ Long. 82.3° E between 0800 & 0900 UTC of 17 th December. Weakened into a well marked low pressure area over northwest and adjoining westcentral Bay of Bengal and Odisha at 0000 UTC of 18 th December	992	55	3.5

Islands at 0300 UTC 18th. It moved west-southwestwards and lay centered over Gulf of Aden near Lat. 11.6° N/ Long. 45.5° E; about 120 km south-southeast of Aden (Yemen) and 920 km westsouthwest of Socotra Islands at 1200 UTC of 18th. It continued to move west-south west-wards and lay centered over Gulf of Aden near Lat. 10.9° N/ Long. 44.4° E; about 80 km north-northeast of Berbera (Somalia) and 210 km south-southwest of Aden (Yemen) at 0300 UTC of 19th. It moved west-southwestwards and crossed the Somalia coast near Lat. 10.6° N/Long. 44.0° E about 110 kms west-northwest of Barbera between 0800 and 0900 UTC of 19th as a Cyclonic Storm. Moving further west-southwestwards, it weakened into Deep Depression in the night *i.e.*, by 1800 UTC on 19th, Depression in the early morning, 0000 UTC of 20th and lay as a well marked low pressure area over Ethiopia and adjoining Somalia in the morning of 20th.

2.2.2. Other features observed

The lowest ECP had been 994 hPa during 0300 UTC of 18th to 0300 UTC of 19th. The estimated MSW was 45 knots during the same period. At the time of landfall, the ECP was 996 hPa and MSW was 40 knots (Cyclonic Storm).

2.2.3. Weather and damage caused

Rainfall associated with this CS (SAGAR), was the maximum over Yemen coast on 16 and 17 and over north Somalia and Ethiopia on 18 and 19 May, 2018.

According to media report, along its rare trajectory through the Gulf of Aden, Cyclonic Storm 'SAGAR' caused rainfall in coastal Yemen, northern Somalia, Djibouti and Ethiopia. The storm first affected Yemen's Socotra Island. Later, strong winds damaged houses on Yemen's mainland. Heavy rainfall along the coast caused isolated flooding, which damaged roads and electric infrastructure. In Djibouti, flooding damaged about 10,000 houses with 2,000 of them severely damaged, which displaced 3,150 people. The rain flooded crops, streets and buildings. Three people are reported to be killed. In the Somalia Region of eastern Ethiopia, 'SAGAR' produced strong winds and heavy rainfall, resulting in flooding and landslides. Near the border of SNNPR and Oromia, a landslide killed 23 people. The storm damaged schools, health facilities and houses, displacing 1,94,000 people. The village of Dambal was almost entirely washed away, affecting 150 households. Beginning on May 17, it caused heavy rainfall in northern Somalia. A total of 53 deaths were reported in Somalia as a result of the cyclone.

2.3. Extremely Severe Cyclonic Storm 'MEKUNU' over Arabian Sea (21-27 May, 2018)

2.3.1. Under the influence of a cyclonic circulation over Lakshadweep and neighbourhood a low pressure area formed over southeast Arabian Sea on 20th. Associated cyclonic circulation extended upto 3.6 kms a.s.l. It lay as a well marked low pressure area over southwest Arabian Sea on 21st. Associated cyclonic circulation extends upto mid-tropospheric level. It concentrated into a Depression over the same region and lay centered over the southwest Arabian sea near Lat. 8.5° N/Long. 58.5° E about 680 km southeast of Socotra Island and 1060 km south-south east of Salalah (Oman) at 1200 UTC 21st May. It moved northwestwards and intensified into a Deep Depression and lay centred over southwest Arabian Sea near Lat. 9.2° N/Long. 57.2° E about 520 kms southeast of Socotra islands and 930 kms south-south east of Salalah (Oman) at 0300 UTC of 22nd May. It moved north-northwestwards and intensified into Cyclonic Storm 'MEKUNU' and lay centred over southwest Arabian Sea near Lat. 10.2° N/Long. 56.8° E, about 410 km southeast of Socotra islands and 810 km south southeast of Salalah (Oman) at 1200 UTC of 22nd May. It moved north-northwestwards, intensified into a Severe Cyclonic Storm and lay centered over southwest Arabian Sea near Lat. 11.2° N/Long. 55.9° E about 270 kms southeast of Socotra islands and 670 km south-southeast of Salalah (Oman) at 0300 UTC of 23rd May. It moved north-northwestwards and further intensified into a Very Severe Cyclonic Storm and lay centered over southwest and adjoining westcentral Arabian Sea near Lat. 11.8° N/ Long. 55.9° E, about 270 kms southeast of Socotra islands and 670 kms south-southeast of Salalah (Oman) at 0900 UTC of 23rd May, 2018. It further moved northwards and lay centred over west central and adjoining southwest Arabian sea near Lat. 12.0° N/Long. 55.9° E, about 220 kms east-southeast of Socotra islands and 590 kms south-southeast of Salalah (Oman) at 1200 UTC of 23rd May. It further moved north-northwestwards and lay centred over west central and adjoining southwest Arabian Sea near Lat. 13.3° N/Long. 55.4° E, about 180 kms east northeast of Socotra Islands and 440 kms south-southeast of Salalah (Oman) at 0300 UTC of 24th May. It then moved north-northwestwards and lay centred over westcentral and adjoining southwest Arabian Sea near Lat. 14.3° N/Long. 55.2° E, about 230 kms north-northeast of Socotra Islands and 320 kms south-southeast of Salalah (Oman) at 1200 UTC of 24th May. It continued to move further north-northwestwards and intensified into an Extremely Severe Cyclonic Storm and lay centered over westcentral Arabian Sea near Lat. 15.4° N/ Long. 54.5° E, about 310 kms north-northeast of Socotra Islands and 180 kms south-southeast of Salalah (Oman) at 0300 UTC of 25th May. It intensified slightly further and

TABLE 2
Storms/Depressions statistics 2018

Name of the system	Winter		Pre-monsoon			Monsoon				Post-monsoon			Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Over the Bay of Bengal													
Depressions/Deep Depressions	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyclonic Storms	-	-	-	-	-	-	-	-	-	-	-	-	-
Severe Cyclonic Storms	-	-	-	-	-	-	-	-	-	-	-	-	-
Very Severe Cyclonic Storms	-	-	-	-	-	-	-	-	-	1	-	-	1
Super Cyclonic Storms	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Depression													
Depressions/Deep Depressions	-	-	-	-	-	-	-	-	-	-	-	-	-
Over the Arabian Sea													
Depressions/Deep Depressions	-	-	1	-	1	1	1	2	1	-	-	-	7
Cyclonic Storms	-	-	-	-	1	-	-	-	1	-	-	-	2
Severe Cyclonic Storms	-	-	-	-	-	-	-	-	-	-	-	1	1
Very Severe Cyclonic Storms	-	-	-	-	-	-	-	-	-	1	1	-	2
Extremely Severe Cyclonic Storms	-	-	-	-	1	-	-	-	-	-	-	-	1
Super Cyclonic Storms	-	-	-	-	-	-	-	-	-	-	-	-	-
Grand Total	-	-	1		3	1	1	2	2	2	1	1	14

lay centered over westcentral Arabian Sea near Lat. 16.4° N/ Long. 54.1° E, about 420 kms nearly north of Socotra Islands and 70 kms south of Salalah (Oman) at 1200 UTC of 25th May. It moved further northwestwards and crossed along the coast of Oman south of Salalah during mid night of 25th May. It moved further northwestwards and weakened into Very Severe Cyclonic Storm and lay centred over Oman near Lat. 17.2° N/Long. 53.5° E, about 60 kms of west- southwest of Salalah at 0000 UTC of 26th May. It moved further northwestwards and weakened into a Severe Cyclonic Storm and lay centred over Oman near Lat. 17.4° N/Long. 53.4° E, about 100 kms west-northwest of Salalah at 0300 UTC of 26th May. It moved northwards, weakened into a Cyclonic Storm and lay centred over Oman near Lat. 18.1° N/Long. 53.1° E, about 160 kms northwest of Salalah at 0900 UTC of 26th May. It further moved north-northwestwards and lay centred over Oman near Lat. 18.3° N/Long. 53.0° E, about 180 kms northwest of Salalah at 1200 UTC of 26th May. It moved north-northwestwards and weakened into a Depression and lay centred over Oman near Lat. 19.0° N/Long. 52.6° E, about 250 kms northwest of Salalah at 0000 UTC of

27th May. It moved north-northwestwards and further weakened into a Well Marked Low pressure area over Saudi Arabia and adjoining area of Oman and Yeman by 0300 UTC of 27th May, 2018.

2.3.2. Other features observed

The ECP had been 960 hPa during 1200 to 1800 UTC of 25th. The ECP gradually decreased from 1004 hPa at 1200 UTC of 21st to 994 hPa at 0000 UTC of 23rd. Thereafter, there was a sudden fall in pressure from 994 hPa to 990 hPa (14 hPa) during 0000 UTC of 23rd to 0600 UTC of 23rd. It then gradually decreased becoming minimum 960 hPa during 1200 to 1800 UTC of 25th. Thereafter, there was sudden rise in ECP from 960 hPa (at 1800 UTC of 25th) to 976 hPa at 0000 UTC of 26th. Thereafter it increased gradually to 1000 hPa at 0000 UTC of 27th. Similarly, in the wind field it is seen that there was gradual increase in MSW during 1200 UTC of 21st (25kt) to 0000 UTC of 23rd (45 kt), sudden rise of 15 kt during 0000 to 0600 UTC of 23rd, gradual increase in intensity of system reaching maximum of 95 kt

TABLE 3
Ships' Observations during 1 January to 31 December, 2018

Call Sign	Date/Time (UTC)	Position of the Ship		Wind		Pressure
		Lat. (°N)	Long. (°E)	Dir. (°)	Speed (kts)	PPPP (hPa)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(A) Cyclonic storm "SAGAR" over Arabean Sea (16-20 May, 2018)						
NIL						
(B) Extremely Severe Cyclonic Storm "MEKUNU" over Arabian Sea (21-27 May, 2018)						
DCUJ2	240300	15.6	58.1	140	26	1003.2
TBWUK63	260300	20.3	63.8	260	17	1008.4
VRHM2	260300	8.6	63.5	210	10	1011.0
VRJT8	261200	13.2	53.3	220	36	1003.3
A8XD3	261200	14.2	55.8	210	32	1005.0
DIGY2	261200	10.2	59.5	190	24	1008.7
SHIP	270000	22.1	61.6	2300	23	1002.3
(C) Cyclonic Storm "DAYE" over eastcentral Bay of Bengal and adjoining Myanmar (19-22 September, 2018)						
AUCE*	191500	10.3	86.6	240	23	954.2
AUCE*	200000	10.7	86.1	210	27	966.8
AUCE*	200300	11.0	86.9	200	29	970.3
AUCE*	201200	11.8	84.3	200	27	967.3
AUCE	202100	11.8	83.1	180	27	962.8
AUCE	210000	12.2	82.2	190	29	963.5
AUCE	210300	12.2	82.1	190	27	969.6
(D) Very Severe Cyclonic Storm, "LUBAN" over the Arabian Sea (6-15 October, 2018)						
VRNF7*	060900	12.3	62.4	360	20	1010.5
TBWUK52*	070300	18.1	64.9	090	20	1009.9
TBWUK52*	070900	16.6	65.9	070	20	1007.6
A8BX6	080000	7.0	66.7	200	13	1009.5
VRKF2	081200	10.4	58.6	290	26	1007.0
A8UX4	081200	9.1	57.1	270	21	1007.3
A8BX6	090000	13.3	66.4	200	20	1009.5
A8UX4	090300	7.8	61.5	220	27	1008.5
A8YD3	090900	7.8	61.3	230	41	1007.0
A8UX4	090900	7.6	63.1	220	23	1007.0
VRMV8	091200	10.4	58.8	270	35	1001.0
VRKF2	091200	8.8	64.4	230	22	1008.0
WN TL	091200	17.6	61.8	110	20	1004.9
A8BX6	091200	16.6	66.5	100	10	1009.5
WN TL	100000	16.8	57.2	070	20	1007.9
VRKF2	100000	8.2	66.8	230	21	1010.0
A8UX4	100300	7.8	68.4	270	10	1011.7

TABLE 3 (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
C6AB6	101200	21.6	65.2	330	12	1010.0
VRMV8	101200	8.6	65.6	240	15	1005.0
DICY2	110000	9.0	64.9	220	19	1011.0
TBWUK69	110300	1.0	49.6	210	14	1011.4
VRBJ9	110300	3.5	70.0	300	12	1014.9
DCQP2	111800	11.1	57.4	240	38	1005.3
DICY2	120300	10.4	56.6	220	33	1008.0
DCQP2	121800	12.3	50.5	230	12	1007.5
(E) Very Severe Cyclonic Storm "TITLI" over eastcentral Bay of Bengal (8-13 October, 2018)						
VVFH	100000	10.3	83.0	320	11	1005.1
VRCQ2	100600	10.3	83.8	270	9	1010.0
VVFH	110000	14.9	82.9	270	16	1002.3
VRCQ2	110600	15.6	86.1	240	19	1010.0
(F) Very Severe Cyclonic Storm "GAJA" over Bay of Bengal (10-19 November, 2018)						
VIXB*	100300	12.6	85.1	140	17	1011.8
VIXB*	101200	12.6	82.6	120	16	1009.7
SHIP	110000	14.9	88.0	040	17	1008.4
VTFG	110300	9.4	93.0	320	10	-
SHIP	111200	12.5	87.5	290	12	1005.6
VRJT8	111200	5.6	85.0	250	10	1009.0
SHIP	121200	9.8	87.9	220	19	1005.4
MAZS3	121200	5.4	85.6	320	16	1010.0
MAZS3	121800	5.8	85.8	320	16	1010.0
SHIP	121800	9.8	88.0	250	16	1007.8
DDOR2	130300	5.7	86.8	290	16	1009.7
SHIP	131200	6.8	88.1	260	17	1005.9
DDOR2	140300	6.0	79.3	310	13	1011.1
VRKQ	141200	12.9	88.9	320	14	1013.3
SHIP	141200	4.9	89.8	260	14	1007.3
VRKQ	150000	14.6	87.1	120	14	1016.4
SHIP	151200	4.3	88.3	220	10	1008.7
AUYM	160000	13.9	84.8	130	19	1012.4
AUYM*	160600	13.1	84.3	130	18	1013.3
VTJR*	161200	8.3	73.3	300	14	1008.8
WDI3177*	161800	12.0	70.1	350	16	1015.3
VTSJ*	161800	14.1	73.3	360	12	1010.4
MAZS6*	170000	8.4	68.8	320	21	1011.3
2HDG3*	171200	9.2	68.6	330	12	1009.2
MAZS6*	180300	8.0	70.2	300	14	1013.6

TABLE 3 (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
3FMV6*	190000	13.6	72.5	010	17	1011.1
DCUJ2*	190000	9.1	70.0	160	15	1009.8
DCUJ2*	190300	9.3	69.5	160	12	1011.4
SHIP*	191200	11.5	62.7	040	25	1008.6
VRNS2*	191200	15.5	61.5	020	22	1014.0
(G) Severe Cyclonic Storm "PHETHAI" over southeast Bay of Bengal (13-18 December, 2018)						
AUZY*	130000	7.0	91.6	130	12	1006.0
AUZY*	130300	6.9	91.6	160	21	1008.6
CQFA*	140000	3.2	91.0	260	14	1010.0
DFGN2*	140000	5.6	83.2	310	18	1008.5
TBWUK77*	140300	5.8	90.2	110	15	1009.5
A8PX5*	141200	6.2	94.9	090	16	1010.0
CQFA*	141200	1.6	88.7	260	25	1010.0
SHIP*	151200	5.7	84.2	250	24	1008.0
3FQY9*	151200	6.1	78.0	010	22	-

* Observation during Depression/deep Depression

at 1200 UTC of 25th. The system maintained its intensity upto 1800 UTC of 25th, thereafter there was sudden fall in MSW to 75 kt at 0000 UTC of 26th. The system then weakened gradually. On all other occasions during the life cycle of system, there was gradual strengthening and weakening of system. There was rapid intensification during 1200 UTC of 22nd to 1800 UTC of 23rd, when the wind speed increased from 35 knots to 70 knots.

2.3.3. Realized weather and damage caused

Extremely heavy rainfall of the order of 30 cm was recorded on the day of landfall over Salalah.

Damage over India: No casualties were reported from any Indian state due to ESCS, Mekunu.

Damage over Socotra Islands: Socotra received widespread rainfall leading to flash flooding and downed power lines. About 20 persons lost their lives because of heavy rains and strong winds caused by cyclone Mekunu.

Damage over Oman: According to Oman's Public Authority for Civil Aviation (PACA), Salalah received 278.2 millimeters (10.95 inches) of rain in just 24 hours ending around 1030 am on May 26. This was over double the city's average yearly rainfall of about five inches in just 24 hours. In addition, Salalah reported 617 mm of

rainfall during 23-27 May. As per media reports (Times News Service), Taqah recorded 275 mm, Mirbat received 221 mm, Rakhoot had 214 mm, Thumrait recorded 196 mm and Sadah received 180 mm. Moreover, the Sahalnoot Dam collected 6.4 million cubic metres of water. As per official records six persons lost their lives in Oman.

2.4. Deep Depression over northeast and adjoining eastcentral Bay of Bengal (29-30 May, 2018)

2.4.1. A low pressure area formed over eastcentral Bay of Bengal and neighbourhood on 28th. It lay as a well marked low pressure area over eastcentral and adjoining northeast Bay of Bengal at 0000 UTC of 29th May. Associated cyclonic circulation extended upto 3.1 kms a.s.l. on 29th. It concentrated into a Depression and lay centred over northeast and adjoining eastcentral Bay of Bengal near Lat. 18.5° N/Long. 92.2° E, about 170 km west-southwest of Kyaukpyu (Myanmar) and 190 km south-southwest of Sittwe (Myanmar) at 0600 UTC 29th May. It moved northeastwards and intensified into a Deep Depression and lay centred over northeast and adjoining eastcentral Bay of Bengal near Lat. 19.2° N/Long. 93.0° E, about 60 kms west-southwest of Kyaukpyu (Myanmar) and 100 kms south-southwest of Sittwe (Myanmar) at 1200 UTC of 29th May. It further moved northeastwards and crossed Myanmar coast north of Kyaukpyu (Myanmar) near Lat. 19.87° N/

Long. 93.7° E between 1700 and 1800 UTC of 29th May. It moved northeastwards and weakened into a Depression and lay centred over Myanmar near Lat. 21.3° N/ Long. 95.2° E, about 30 kms east northeast of Nyaungu and 120 kms southwest of Mandalay (Myanmar) at 0000 UTC of 30th May. It further moved northeastwards and lay centered over Myanmar near Lat. 21.8° N/ Long. 95.8° E, about 30 kms southwest of Mandalay (Myanmar) at 0300 UTC 30th May. It further moved northeastwards and weakened into a well marked low pressure area and lay centered over Myanmar by 0600 UTC 30th May.

2.4.2. Other features observed

The ECP was 992 hPa at 1200 UTC of 29th and MSW was 35 knots during 1200 to 1800 UTC of 29th. The lowest observed Pressure of 991.1 hPa and maximum observed wind speed of 30 kts was recorded by Kyaukpyu at 1200 UTC of 29th, when the centre of system was very close to it.

2.4.3. Realized Weather

Under the influence of this system, heavy to very heavy rainfall occurred at isolated places in Andaman and Nicobar Islands on 29 and 30, Nagaland, Manipur, Mizoram & Tripura and Sub-Himalayan West Bengal & Sikkim on 1st June and Assam & Meghalaya on 2nd June.

Chief amounts of 24 hrs rainfall (≥ 7 cm) ending at 0300 UTC of from 29 May-2 June, 2018 are given below:

29 May, 2018

Andaman & Nicobar Islands

Hut Bay 10

30 May, 2018

Andaman & Nicobar Islands

Port Blair 23

1 June 2018

Nagaland, Manipur, Mizoram & Tripura

Dharma nagar/Panisagar 10

Sub-Himalayan West Bengal & Sikkim

Neora 10, Champasari 7

2 June, 2018

Assam & Meghalaya

Dillighat 7

2.5. Depression over northeast Bay of Bengal and adjoining Bangladesh (10-11 June, 2018)

2.5.1. Under the influence of a cyclonic circulation over north Bay of Bengal and neighbourhood, a low Pressure area formed over northeast Bay of Bengal and adjoining Bangla Desh coast on 9th. It lay as a well marked low pressure area over the same region on 10th. Associated cyclonic circulation extended upto upper tropospheric levels. It concentrated into a Depression over the same region near Lat. 22.3° N/Long. 91.5° E at 0600 UTC of 10th June and lay centred over the same region near 22.7° N/Long. 91.4° E, about 55 km south of Feni (Bangladesh) and 55 km south-southeast of Maijdicourt (Bangladesh). It crossed Bangla Desh coast near Lat. 23.1° N/Long. 91.2° E, close to south of Feni around 1500 UTC of 10th June and lay as a well marked low pressure area over Tripura and neighbourhood on 11th morning.

2.5.2. Other features observed

The ECP was 988 hPa at 1200 UTC of 10th and MSW was 25 knots during 0600 to 1200 UTC of 10th.

2.5.3. Realized Weather

Under the influence of this Depression, heavy rainfall occurred at isolated places over Gangetic West Bengal, Odisha and Jharkhand on 9th, over Gangetic West Bengal and Odisha on 10th and over Assam & Meghalaya on 11th. On 12th, the system caused heavy to very rainfall at isolated places over Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Odisha and Bihar. On 13th, it caused heavy to very rainfall at isolated places over Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura and Odisha.

Chief amounts of 24 hrs rainfall (≥ 7 cm) ending at 0300 UTC of from 9-13 June, 2018 are given below:

9 June, 2018

Gangetic West Bengal

Canning and Barrackpur (IAF) 7 each

Odisha

Nimpara 8, Chandanpur and Sorada 7 each

Jharkhand

Ghatsila 7

10 June, 2018

Gangetic West Bengal

Purihansa and Rampurhat (DRMS) 7 each

Odisha

Nawana 8

11 June, 2018

Assam & Meghalaya

Beki Mathungari 7

12 June, 2018

Assam & Meghalaya

Gharmura 11, Kampur, Matijuri and Cherrapunji (RKM) 8 each, B P Ghat, Lakhipur and Dholai 7 each

Nagaland, Manipur, Mizoram & Tripura

Sabroom 27, Serchip (Hydro) 24, Aizwal 15, Kailashahar Aero 14, Kolasib 11, Lengpui 10, Dharmanagar/Panisagar and Belonia 8 each

Odisha

Hemgiri, Burla and Hirakud 7 each

Bihar

Bihpur 8

13 June, 2018

Arunachal Pradesh

Bhalukpong 8, Itanagar 7

Assam & Meghalaya

Sohra 21, Sohra (RKM) 17, Kheronighat 15, Majbat 12, Silchar 11, Lumding 9, A P Ghat and Jia Bharali N T Xin 7 each

Nagaland, Manipur, Mizoram & Tripura

Sabroom 17, Bishalgarh 13, Sonamura 12, Serchip (Hydro) 10, Agartala Aero 9, Arundhutinagar 8

Odisha

Soro 10, Mahanga (ARG) 7

2.6. Deep Depression over the northwest Bay of Bengal (21-23 July, 2018)

2.6.1. A low pressure area formed over northwest Bay of Bengal and adjoining Gangetic West Bengal and Odisha on 19th. It became well marked low pressure area and lay over northwest Bay of Bengal and adjoining West Bengal and Odisha coasts on 20th. Associated cyclonic circulation extended upto 7.6 kms a.s.l. tilting southwestwards with height. It concentrated into a Depression and lay over northwest Bay of Bengal near Lat. 21.0° N/Long. 88.0° E, about 120 kms east-southeast of Balasore, 90 kms south-southeast of Digha and 130 kms east-northeast of Chandbali at 0300 UTC of 21st, intensified into a Deep Depression and lay centred close to Lat. 21.5° N/Long. 87.6° E at 0900 UTC of 21st. It moved northwestwards and crossed north Odisha-West Bengal coasts close to south of Digha during 1100 to 1200 UTC of 21st and lay centred over north coastal Odisha and adjoining coastal West Bengal and northwest Bay of Bengal near Lat. 21.7° N/Long. 87.4° E at 1200 UTC of 21st. It moved west-northwestwards, weakened into a Depression and lay over Gangetic West Bengal and adjoining Jharkhand and north Odisha near Lat. 22.2° N/ Long. 86.8° E, about 90 kms southeast of Jamshedpur at 0000 UTC of 22nd. It further moved west-northwestwards and lay over southeast Jharkhand and adjoining Gangetic West Bengal and north Odisha near Lat. 22.6° N/Long. 86.2° E, about 20 kms south of Jamshedpur at 0300 UTC of 22nd. It moved west-northwestwards and lay centred over south Jharkhand and neighbourhood near Lat. 23.0° N/Long. 85.0° E about 80 kms southeast of Ranchi and 150 kms southeast of Daltanganj at 1200 UTC of 22nd. It further moved slightly west-northwestwards and weakened into a well marked low pressure area over northwest Jharkhand and neighbourhood by 0300 UTC of 23rd.

2.6.2. Other features observed

The ECP was 989 hPa during 0300 to 1200 UTC of 27th. The estimated MSW was 25 kts during 21 and 22 July. The lowest observed Pressure was of 991.6 hPa at 1200 UTC of 21st and maximum observed wind speed of 31 kts was recorded by Ship VTWS (20.4/88.5)

at 0300 UTC of 21st, when the centre of system was very close to it.

2.6.3. Realized Weather

Under the influence of Depression, on 20th July, heavy to very heavy rainfall occurred at a few places with extremely heavy falls at isolated places over Odisha, heavy to very heavy rainfall at a few places over Jharkhand and at isolated places over north coastal Andhra Pradesh and heavy rainfall at isolated places over Telangana. On 21st, heavy to very heavy rainfall occurred at a few places with extremely heavy rainfall at isolated places over Odisha, heavy to very heavy rainfall at isolated places over Chattisgarh and heavy rainfall at isolated places over Jharkhand, Gangetic West Bengal and west Madhya Pradesh. On 22nd, heavy rainfall occurred at isolated places over Jharkhand, Chattisgarh, west Madhya Pradesh and east Rajasthan and at a few places over east Madhya Pradesh. On 23rd, heavy to very rainfall at isolated places occurred over west Madhya Pradesh and east Rajasthan, heavy rainfall at isolated places over east Madhya Pradesh and moderate rainfall at many places over Jharkhand. On 24th, heavy to very heavy rainfall occurred at isolated places over Bihar and east Rajasthan and heavy rainfall occurred at isolated places over Uttar Pradesh.

Chief amounts of 24 hrs rainfall (≥ 7 cm) ending at 0300 UTC of from 21-25 July, 2018 are given below:

21 July, 2018

Odisha

Brahmagiri 29, Puri 27, Junagarh 26, Tentulikhunti, Pipili and Kesinga 24 each, Kashipur 22, Narla, Cuttack and Jaipatna 21 each, Madanpur Rampur 20, Satyabadi, Bhubaneswar, Koraput and Similiguda 19 each, Mundali 17, Banki 16, Nuagada 15, Naraj and Jeypore 14 each, Bhawanipatna 13, Paralakhemundi, Nawarangpur and Salebhatta 12 each, Korei and Titlagarh 11 each, Balipatna, Tigiria, Krishnaprasad and Rajghat 10 each, Jajpur, Pottangi, R. Udaigiri, Akhuapada, Berhampur, Tangi, Gunupur, Kotagarh, Athgarh, Dhamnagar, Rayagada, Kantapada and Banpur 9 each, Lanjigarh, Malkangiri, Bolagarh, Paradeep, Gopalpur, Bonth, Astaranga, Kaptipada and Chandikhol 8 each, Dhenkanal, Danagadi, Dharmagarh, Kashinagar, Gop, Chhatrapur, Tarva, Kakatpur, Nayagarh, Kujanga, Kosagumda and Jaleswar 7 each

Coastal Andhra Pradesh

Palasa 15, Sompeta and Mandasa 12 each, Tekkali and Pathapatnam 11 each, Ichchapuram 10, Araku

Valley 9, Chintapalle 8, Palakonda, Paderu and Kalingapatnam 7 each

22 July, 2018

Chhattisgarh

Sarangarh 12, Saraipali 7

Gangetic West Bengal

Canning 7

Odisha

Burla 62, Sambalpur 57, Birmaharajpur 43, Hirakud 40, Atabira 35, Barh 31, Rairakhol 30, Ullunda 26, Jujumura 22, Binika, Khairamal and Athmalik 21 each, Rajkishorenagar, Barpalli, Jagannath Prasad and Batli 19 each, Tikabali, Satyabadi and Salebhatta 17 each, Odagaon, Phiringia, Brahmagiri AWS and Dunguripalli 16 each, Sonepur and Banki 15 each, Kuchinda 14, Ambabhona and Daspalla 13 each, Akhuapada, Puri, Kendrapara, G. Udayagiri, Agalpur, Krishnaprasad, Altuma, Jajpur and Tikarpara 12 each, Bijepur, Nawana, Laikera, Korei, Naktideul, Jamankira, Kirmira, Telkoi, Belaguntha, Bhanjagar, Derabis, Marsaghai, Kolabira and Kamakhyanager 11 each, Sohela, Kotagarh, Parjang, Nayagarh and Madanpur Rampur 10 each, Banarpal, Hindol, Keonjharh, Binjharpur, Chandbali, Batagaon, Reamal, Madhabarida, Talcher, Gurundia, Gaisilet, Banpur, Thakurmunda, Tarva, Jharsuguda, Kaptipada, Pallahara, Kashipur, Lahunipara, Gania, Dhenkanal, Danagadi, Soro, Bamra, Rajkanika, Barmul, Junagarh, Bari, Chandanpur and Jenapur 8 each, Astaranga, Phulbani, Deogaon, Baliguda, Tangi, Chandikhol, Rengali, Chendipada, Narsinghpur, Mohana, Jhumpura, Raikia, Purushottampur, Bolagarh, Jaipatna and Sorada 7 each

Jharkhand

Chaibasa 7

23 July, 2018

Odisha

Kuchinda and Gaisilet 9 each, Paikmal 8, Jharbandh, Joshipur and Hirakud 7 each

Gangetic West Bengal

Diamond Harbour 17, Alipore 8

Jharkhand

Rajmahal and Chakradharpur 10 each, Raidih and Jamshedpur 7 each

Chattisgarh

Bemetara 10, Kawardha and Saraipali 9 each, Simga 8, Ambagarh Chowki and Jashpurnagar 7 each

East Madhya Pradesh

Bichhia 11, Singrauli, Katni and Mandla 9 each, Patan, Sagar and Kotma 7 each

West Madhya Pradesh

Ratlam 11, Ashok Nagar 9, Khachrod 8

24 July, 2018

Bihar

Taibpur and Thakurganj 14 each, Kishanganj 7

East Rajasthan

Sawai Madhopur Tehsil 12, Sawai Madhopur 10, Kishanganj, Manohar Thana and Shahabad 9 each, Anta 8, Dug and Kota-Aero, Chabra, Baran, Asnawar, Atru and Bakani Sr 7 each

West Madhya Pradesh

Nalkheda 13, Kolaras 11, Sabalgarh 10, Pachmarhi 9, Shivpuri, Gandhwani, Biaoara and Kurwai 8 each, Dewas and Sarangpur 7 each

East Madhya Pradesh

Rehli and Deori 7 each

25 July, 2018

Bihar

Rajauli 17, Jhanjharpur 14, Palmerganj 11, Hisua 10, Madhwapur 8, Nawada and Bhabhua 7 Each

East Uttar Pradesh

Gyanpur 10, Pratapgarh 9

West Uttar Pradesh

Meerut 9, Budhana, Muzaffarnagar and Atrauli 7 each

East Rajasthan

Neemkathana 19, Shahabad and Srimadhpor 14 each, Sanganer Tehsil 10, Jaipur Aero 9, Nayanagar/Beawar 8

2.7. Depression over northwest Bay of Bengal and neighbourhood (7-8 August, 2018)

2.7.1. Under the influence of a cyclonic circulation over Bangladesh and adjoining West Bengal, a low pressure area formed over northwest Bay of Bengal and neighbourhood on 6th August. It lay as a well marked low pressure area over northwest Bay of Bengal and adjoining West Bengal and Odisha on 7th. Associated cyclonic circulation extended upto 7.6 kms a.s.l. tilting southwestwards with height. It concentrated into a Depression over the same region near Lat. 21.5° N/ Long. 87.5° E about 110 kms northeast of Chandbali and 55 kms southeast of Balasore at 0900 UTC of 7th August. It moved west-northwestwards and lay centred near Lat. 21.5° N/Long. 87.0° E, close to Balasore and 80 kms northeast of Chandbali at 1200 UTC of 7th August. It further moved west-northwestwards and crossed north Odisha-West Bengal coasts close to Balasore during 1430 to 1630 UTC of 7th August and lay centred over north Odisha near Lat. 21.6° N/Long. 86.0° E, 45 kms east-northeast of Keonjhar at 1800 UTC of 7th August and weakened into a well marked low pressure area over north Chhattisgarh and neighbourhood at 0300 UTC of 8th August.

2.7.2. Other features observed

The ECP was 992 hPa at 0900 UTC of 7th. The estimated MSW was 25 kts during 0900 to 1800 UTC of 7th.

2.7.3. Realized Weather

Under the influence of the Depression, widespread rainfall activity with isolated heavy to extremely heavy rainfall was observed over Gangetic West Bengal, Odisha, Chattisgarh, Madhya Pradesh and east Rajasthan during 6-10 August.

Chief amounts of 24 hrs rainfall (≥ 7 cm) ending at 0300 UTC of from 7-10 August, 2018 are given below:

7 August, 2018

Gangetic West Bengal

Kharidwar 11

Odisha

Puri 39, Satyabadi 18, Bhubaneswar and Brahmagiri 17 each, Pipili 16, Banki 15, Nimpara, Bolagarh and

Paradeep 13 each, Niali 12, Khandapara 11, Kakatpur and Athgarh 10 each

8 August, 2018

Odisha

Junagarh 19, Deogaon 15, Dharmagarh and Similiguda 13 each, Raigarh, Kuchinda and Anandpur 10 each, Jhorigam, Bijepur, Umakote, Boden, Malkangiri, Jharsuguda, Hiraakud, Lakhanpur and Kirmira 9 each, Sinapali, Laikera, Bhawanipatna and Jeypore 8 each, Kashipur, Marsaghai, Dabugan, Kankadahad, Kolabira, Tarva, Chandahandi, Ambabhona and Batli 7 each

Chattisgarh

Deobhog 15, Champa 9, Sukma 8, Dantewara, Raigarh, Narayanpur and Sakti 7 each

9 August, 2018

West Madhya Pradesh

Ashoknagar, Bhanpura and Neemuch 8 each, Kurwai 7

East Madhya Pradesh

Tendukheda 7

Chhattisgarh

Kawardha 9, Simga and Bemetara 8 each

East Rajasthan

Shahabad 11, Chhotisadri 9, Bari-Sadri 8

10 August, 2018

East Rajasthan

Pratapgarh and Dungla 8 each

West Madhya Pradesh

Isagarh 8, Jawad 7

East Madhya Pradesh

Garhakota 9, Panna 8

2.8. Depression over coastal Odisha (15-17 August, 2018)

2.8.1. Under the influence of a cyclonic circulation over north coastal Odisha and neighbourhood, a low

pressure area formed over northwest Bay of Bengal off West Bengal coast on 13th August. It lay as a well marked low pressure area over northwest Bay of Bengal off West Bengal-north Odisha coasts on 14th August. It concentrated into a Depression and lay over coastal Odisha and neighbourhood centred near Lat. 20° N/ Long. 86° E, about 30 kms east-southeast of Bhubaneswar at 0300 UTC on 15th August. It moved west-northwestwards and lay centred near Lat. 20.2° N/ Long. 85.0° E, about 30 kms southwest of Bhubaneswar at 1200 UTC of 15th August. It further moved westwards and lay over south Chhattisgarh and adjoining Vidarbha centred near Lat. 20.6° N/Long. 81.0° E, about 120 kms east-southeast of Bramhapuri (Vidarbha) at 0300 UTC of 16th August. It moved west-northwestwards and lay centered over Vidarbha and neighbourhood near Lat. 21.1° N/ Long. 78.3° E, about 210 km east-southeast of Khandwa (Madhya Pradesh) at 1200 UTC of 16th August. It further moved west-northwestwards and lay centred over southwest Madhya Pradesh and adjoining Gujarat and north Madhya Maharashtra near Lat. 21.8° N and Long. 75.8° E, about 270 kms east-southeast of Baroda (Gujarat) at 0000 UTC of 17th August. It weakened into a well marked low pressure area over southwest Madhya Pradesh and neighbourhood at 0300 UTC of 17th August.

2.8.2. Other features observed

The lowest ECP was 993 hPa during 0300 to 1800 UTC of 15th. The estimated MSW was 25 kts during 0300 UTC of 15th to 0000 UTC of 16th. The lowest observed Pressure of 993.3 hPa at 1200 UTC of 15th and maximum observed wind speed of 25 kts was recorded by Buoy 23093(16.4/88.0) at 0300 UTC of 15th.

2.8.3. Realized weather

Under the influence of the Depression, on 14th, heavy to very heavy rainfall occurred at a few places over Odisha and coastal Andhra Pradesh with extremely heavy falls at isolated places over Odisha. On 15th August, heavy rainfall occurred at a few places over Odisha, Vidarbha, Chattisgarh, Telangana and at isolated places over Madhya Pradesh, Madhya Maharashtra and Marathwada with very heavy rainfall at isolated places over Odisha, Vidarbha, Telangana and Chattisgarh and extremely heavy rainfall at isolated over Chattisgarh. On 16th, the system caused heavy to very heavy rainfall at many places over Vidarbha, Marathwada, Madhya Maharashtra, Gujarat, west Madhya Pradesh and Goa and at isolated places over Telangana with extremely heavy rainfall at isolated places over and west Madhya Pradesh. On 17th, it caused heavy to very heavy rainfall at isolated places over Gujarat, Saurashtra & Kutch, Vidarbha, Madhya Maharashtra and Marathwada. On 18th, it caused, heavy rainfall at isolated

places over Gujarat, Saurashtra & Kutch, Madhya Maharashtra, Konkan & Goa and at many places over Telangana with very heavy falls at isolated places. On 19th, it caused heavy rainfall at isolated places over Gujarat, Saurashtra & Kutch, Vidarbha, Konkan & Goa, Marathwada and east Rajasthan.

Chief amounts of 24 hrs rainfall (≥ 7 cm) ending at 0300 UTC from 15-20 August, 2018 are given below:

15 August, 2018

Odisha

Lanjigarh 28, Madanpur Rampur 25, Ambadola and Narla 24 each, Bhawanipatna 22, Kashipur 19, Koraput, Nuagada, Jaipatna and Tentulikhunti 15 each, Nawarangpur 13, Kashinagar, R. Udaigiri and Jeypore 12 each, Kesinga and Junagarh 10 each, Similiguda 7, Pottangi 9, Muniguda, Raghunathpur, Paralakhemundi and Dabugan 8 each, Niali, Chandanpur and Banki 7 each

Coastal Andhra Pradesh

Palakonda 13, Ranastalam 11, Vepada and Kalingapatnam 10 each, Mandasa 9, Garividi, Pathapatnam and Cheepurupalle 8 each, Gantayada and Palasa 7 each

16 August, 2018

Odisha

Malkangiri and Sinapali 15 each, Junagarh, Boden and Patnagarh 12 each, Nawapara 11, Narla, Raighar and Dharmagarh 10 each, Bhawanipatna, Saintala and Jharbandh 9 each, Ambadola, Dabugan, Hindol, Nischintakoili, Similiguda, Lanjigarh and Jeypore 8 each, Khaprakhol, Kesinga, Paikmal and Chandahandi 7 each

West Madhya Pradesh

Gwalior, Sonkatch and Isagarh 8 each, Kolaras 7

East Madhya Pradesh

Dindori 8, Tendukheda 7

Vidarbha

Lakhandur 13, Bhadravati and Ahiri 12 each, Korpana 11, Mohadi and Sadakarjuni 10 each, Bramhapuri, Chandrapur and Bhandara 9 each, Ballarpur, Lakhani,

Gondia, Nagbhir and Mulchera 8 each, Chimur, Deori, Umrer, Mul, Tumsar, Arjuni, Morgaon, Warora, Sindewahi and Desaignaj 7 each

Chhattisgarh

Bhopalpatnam 40, Bijapur 14, Kanker 11, Gariabund and Jagdalpur 9, Rajim, Mahasamund, Mana-Raipur and Simga 8 each, Arang and Deobhog 7 each

Telangana

Perur 19, Sirpur 17, Asifabad 13, Kaleswaram, Utnur and Chennur 11 each, Manthani, Ibrahimpatnam and Adilabad 9 each, Ramgundam, Venkatapuram, Metpalle, Bhupalpalle and Mudhole 8 each, Sarangapur, Eturnagaram, Bhiknur, Boath and Julapalle 7 each

Madhya Maharashtra

Mahabaleshwar 14

Marathwada

Mahur, Tuljapur, Bhum and Kinwat 7 each

17 August, 2018

Vidarbha

Barshitakli 16, Digras, Karanjlad and Arni 13 each, Manora and Buldana 12 each, Deolgaon Raja and Pusad 11 each, Patur, Malkapur and Sindkhed Raja 10 each, Murtajapur, Darwha, Jalgaon Jamod, Motala, Mangrulpir, Joiti and Umerkhed 9 each, Mahagaon, Malegaon, Lonar, Chikhli, Akola and Dharni 8 each, Washim, Mehkar, Korpana and Risod 7 each

Marathwada

Kinwat and Mahur 19 each, Kannad 17, Aurangabad 16, Phulambri and Jalna 15 each, Pathri, Jafrabad and Selu 14 each, Mantha, Manvat, Partur and Ghansawangi 13 each, Ardhapur 12, Himayatnagar, Badnapur, Vaijapur and Aundha Nagnath 11 each, Purna, Jintur, Nanded, Sillod, Hadgaon and Bhokardan 10 each, Sonpeth, Paithan, Manjlegaon, Kallamnuri and Osmanabad 9 each, Ambad and Parbhani 8 each, Kandhar, Vasmat, Soegaon, Gangapur, Kaij, Georai, Mudkhed and Hingoli 7 each

Madhya Maharashtra

Mahabaleshwar 16, Raver, Navapur and Jamner 14 each, Jalgaon 13, Lonavala 12, Dhadaon/Akrani 10, Peth, Dhule, Parola and Erandol 10 each, Shirpur,

Bodwad, Pachora, Surgana and Chalisgaon 9 each, Gidhade, Yaval, Dahigaon, Shrirampur, Girnadam and Igatpuri 7 each

Konkan & Goa

Valpoi 14, Bhira and Matheran 9 each, Dodamarg 8

Gujarat Region

Chhota Udepur 14, Tilakwada 13, Ukai, Quant and Valod 12 each, Godhra and Wanakbori 10 each, V. Vidyanagar 9, Vyara, Subir and Vadodara 8 each, Nizer, Vansda, Garudeshwar, Dhanpur, Garbada, Bodeli, Sagbara and Uchchhal 7 each

North Interior Karnataka

Londa 8

Telangana

Boath 19, Adilabad 10, Sarangapur 7

West Madhya Pradesh

Bhikangaon 23, Shegaon 21, Khandwa and Burhanpur 17 each, Khargone, Thikri and Sendhwa 13 each, Badwani 12, Jhabua 11, Manawar, Pandhana, Nepanagar, Sardarpur and Kasarwad 10 each, Maheshwar and Gandhwani 9 each, Kukshi, Khaknar and Barwaha 8 each

18 August, 2018

Gujarat Region

Kapadvanj 15, Godhra 13, Matar 12

Saurashtra & Kutch

Kandla New and Sayla 11 each, Muli and Chotila 9 each, Wadhvan, Dhrangadhra, Surendranagar and Limbdi 7 each

Vidarbha

Chandur Bazar 7

Madhya Maharashtra

Radhanagari 10, Mahabaleshwar 8

Marathwada

Jalna 16, Vasmat 7

2.9. Deep Depression over northwest Bay of Bengal and adjoining West Bengal and north coastal Odisha (6-7 September, 2018)

2.9.1. Under the influence of a cyclonic circulation over north Bay of Bengal and adjoining areas of Bangladesh and West Bengal, a low pressure area formed over northwest Bay of Bengal and neighbourhood. Associated cyclonic circulation extended upto 7.6 kms a.s.l. tilting southwestwards with height. The low pressure area over northwest Bay of Bengal and neighbourhood lay as a well marked low pressure area over the same region on 5th September evening. It concentrated into a Depression and lay centered over northwest Bay of Bengal and adjoining West Bengal and north coastal Odisha near Lat. 21.8° N/Long. 88.0° E, about 25 kms east-southeast of Digha (West Bengal) at 0000 UTC of 6th September. It moved slightly westwards and intensified into a Deep Depression and lay centred over the same region near Lat. 21.8° N/Long. 87.9° E about 20 east-southeast of Digha at 0300 UTC of 6th September. It moved westwards and crossed west Bengal coast close to the south of Digha (West Bengal) between 0430-0530 UTC and lay centred over coastal areas of West Bengal and north Odisha and neighbourhood, near Lat. 21.8° N/Long. 87.6° E, close to the south-southwest of Digha (West Bengal) and about 190 kms southeast of Jamshedpur (Jharkhand) at 0600 UTC of 6th September. It moved nearly westwards and lay centred over northeast Odisha and neighbourhood near Lat. 21.7° N/Long. 86.8° E, about 140 kms southeast of Jamshedpur (Jharkhand) and 130 kms east-northeast of Keonjhar (Odisha) at 1200 UTC of 6th September. It further moved nearly west-northwestwards and weakened into a Depression and lay centered over northwest Odisha and neighbourhood near Lat. 22.2° N/Long. 84.0° E, about 130 kms southeast of Ambikapur (Chhattisgarh) and 140 kms east-southeast of Pendra Road (Chhattisgarh) at 0000 UTC of 7th September. It further moved northwestwards and lay centered over north Chhattisgarh and neighbourhood near Lat. 22.9° N/Long. 83.3° E, about 30 kms south of Ambikapur (Chhattisgarh) and 140 kms east of Pendra Road (Chhattisgarh) at 0300 UTC of 7th September. Moving west northwestwards, it weakened into a well marked low pressure area and lay over north Chhattisgarh and neighbourhood at 0600 UTC of 7th September.

2.9.2. Other features observed

The lowest observed Pressure of 993.6 hPa recorded by Digha and maximum observed wind speed of 31 kts was recorded by Ship AUCE (18.7/88.0) at 0000 UTC of 6th.

2.9.3. Realized Weather

Under the influence of the system, on 5th September, isolated heavy rainfall occurred over Odisha and West Bengal. On 6th, heavy to very heavy rainfall occurred at isolated places over Gangetic West Bengal, heavy to very heavy rainfall at a few places with extremely heavy rainfall at isolated places occurred over Odisha and heavy rainfall at isolated places occurred over Jharkhand, Chhattisgarh and Madhya Pradesh. On 7th, heavy to very heavy rainfall at a few places over Odisha and at isolated places over Chhattisgarh and heavy rainfall at isolated places over Jharkhand and Madhya Pradesh was registered. On 8th, isolated heavy rainfall over West Madhya Pradesh, Chhattisgarh and Vidarbha and isolated heavy to very heavy rainfall over East Madhya Pradesh was recorded. On 9th, heavy to very heavy rainfall at isolated places over west Madhya Pradesh and East Rajasthan was observed.

Chief amounts of 24 hrs rainfall (≥ 7 cm) ending at 0300 UTC from 5-9 September, 2018 are given below:

5 September, 2018

West Bengal

Alipore 7

Odisha

Chandanpur 7

6 September, 2018

Gangetic West Bengal

Tusuma 14, Kharidwar 13, D. P. Ghat 11, Kansabati Dam and Phulberia 8 each, Simula 7

Odisha

Paradeep 41, Kujanga 37, Kendrapara and Marsaghai 34 each, Pattamundai 31, Derabis 30, Bari 27, Tirtol 26, Salepur 25, Binjharpur and Garadapur 24 each, Raghunathpur and Alipingal 21 each, Jagatsinghpur, Chandbali and Jajpur 19 each, Rajkanika 18, Mahanga, Kantapada and Niali 15 each, Balikuda 14, Kakatpur, Chandikhol, Balipatna and Akhuapada 13 each, Joshipur, Nischintakoili and Dhamnagar 12 each, Nimpara, Phiringia, Astaranga and Cuttack 11 each, Pipili, Tihidi and Bhubaneswar 10 each, Gop, Banki, Naraj, Athmalik, Birmaharajpur and Danagadi 9 each, Kalinga 8, Boudhgarh, Mundali, Madanpur Rampur, G. Udayagiri, Baliguda, Tikabali, Bhadrak and Batlig 7 each

Jharkhand

Bokaro 8, Chandil 7

West Madhya Pradesh

Udaipura and Mehgaon 7 each

East Madhya Pradesh

Sagar and Panna 9 each, Gadarwara 8, Narsinghpur 7

Chhattisgarh

Ramanujganj and Manendragarh 9 each

7 September, 2018

Odisha

Phiringia and Ambabhona 19 each, K. Nuagaon 18, Binika 17, Batli 16, Baliguda and Nawana 15 each, Rajkanika and Narsinghpur 14 each, Birmaharajpur, Joda, Ullunda, Raikia, Chandbali and Binjharpur 13 each, Jhumpura and Dunguripalli 12 each, Tensa, Jajpur, Akhuapada, Tihidi and Sonapur 11 each, Khairamal, Korei, Danagadi, Salebhatta, Pattamundai, Gania, Athmalik and Rajkishorenagar 10 each, Deogarh, Daringibadi, Panposh, Boudhgarh, Barpalli, Rairakhol, Daspalla and Dhamnagar 9 each, Bonth, Bargarh, Barmul, Tikabali, Sukinda, Kantamal, Banki, Hindol and Joshipur 8 each, Bargaon, Daitari, Rajgangpur, Jamankira, Madanpur Rampur, Saintala and Mandira Dam 7 each

Jharkhand

Kurdeg 8

Chhattisgarh

Raigarh 13, Gharghoda and Janakpur 9 each

East Madhya Pradesh

Umaria and Dindori 8 each, Satna and Anuppur 7 each

8 September, 2018

West Madhya Pradesh

Guna and Sheopur 11 each, Biaora 8, Begumganj and Rajgarh 7 each

East Madhya Pradesh

Umaria 16, Panna, Chahtarpur and Khurai 9 each, Tikamgarh 8, Buxwaha and Katni 7 each

Chhattisgarh

Pathalgaon and Manendragarh 7 each

Vidarbha

Mul 7

9 September, 2018**East Rajasthan**

Pisagan 12, Mangrol 11, Bakani and Degod 10 each, Bijoliya, Hindoli, Patan, Bundi and Kotri 9 each, Jahazpur, Anta and Pachpahar 8 each, Talera, Sarwar, Mandalgarh, Banera, Arai and Kota 7 each

West Madhya Pradesh

Neemuch 11, Bhanpura 8

2.10. *Cyclonic Storm 'DAYE' over eastcentral Bay of Bengal and adjoining Myanmar (19-22 September, 2018)*

2.10.1. Under the influence of a cyclonic circulation over central Bay of Bengal and neighbourhood, a low pressure area formed over east central Bay of Bengal and adjoining Myanmar coast at 0900 UTC of 18th September. It persisted over the same region at 1200 UTC of same day. It lay as a well marked low pressure area over east central Bay of Bengal and neighbourhood on 19th September. Associated cyclonic circulation extended upto 7.6 kms a.s.l. tilting southwestwards with height. It concentrated into a Depression over eastcentral Bay of Bengal and lay centred near Lat. 17.2° N/Long. 89.0° E about 530 kms east-southeast of Kalingapatnam and about 440 kms east-southeast of Puri at 1500 UTC of 19th September. It moved nearly west-northwestwards and lay centred near Lat. 17.5° N/Long. 87.5° E over westcentral and adjoining eastcentral Bay of Bengal, about 360 kms east-southeast of Kalingapatnam and about 330 kms east-southeast of Gopalpur at 0000 UTC of 20th September. It further moved nearly westwards and intensified into a Deep Depression and lay centred near Lat. 17.5° N/Long. 87.0° E over westcentral Bay of Bengal, about 310 kms east-southeast of Kalingapatnam and about 300 kms east-southeast of Gopalpur at 0300 UTC of 20th September. It moved west-northwestwards and lay centred over westcentral and

adjoining northwest Bay of Bengal near Lat. 18.4° N/Long. 85.8° E, about 170 kms east of Kalingapatnam (coastal Andhra Pradesh) and about 130 kms southeast of Gopalpur (Odisha) at 1200 UTC of 20th September. It moved northwestwards, intensified into a Cyclonic Storm 'DAYE' and lay centred over northwest Bay of Bengal near Lat. 18.7° N/Long. 85.6° E at 1500 UTC of 20th September. It moved west-northwestwards and crossed south Odisha and adjoining north Andhra Pradesh coast close to Gopalpur during 1900 to 2000 UTC of 20th September and lay centred over south Odisha near Lat. 19.5° N/Long. 84.4° E about 40 kms west-northwest of Gopalpur (Odisha) and about 150 kms east-southeast of Bhavanipatna (Odisha) at 2100 UTC of 20th September. It further moved west-northwestwards and weakened into a Deep Depression and lay centred over south interior Odisha and neighbourhood near Lat. 20.0° N and Long. 83.7° E, about 65 kms east-southeast of Titlagarh at 0000 UTC of 21st September. It further moved west-northwestwards and lay centred over interior Odisha and adjoining Chhattisgarh near Lat. 20.5° N/Long. 82.5° E, about 120 kms east-southeast of Raipur (Chhattisgarh) and about 80 kms west of Titlagarh (Odisha) at 0300 UTC of 21st September. It further moved west-northwestwards and weakened into a Depression and lay centered over northeast Vidarbha and neighbourhood near Lat. 21.4° N/Long. 80.2° E close to south of Gondia at 1200 UTC of 21st September. It further moved west-northwestwards and lay centred over southwest Madhya Pradesh and neighborhood near Lat. 22.9° N/Long. 76.3° E about 60 kms south-southeast of Shajapur (Madhya Pradesh) at 0300 UTC of 22nd September. It moved nearly northwards and lay centred over west Madhya Pradesh and neighbourhood near latitude 23.3° N/long. 76.3° E, about 200 kms southeast of Kota (East Rajasthan) at 0900 UTC of 22nd September and further weakened into a well marked low pressure area and lay over West Madhya Pradesh and adjoining East Rajasthan at 1200 UTC of 22nd September.

2.10.2. *Other features observed*

The maximum wind speed of 74 kmph has been reported by high wind speed recorder at Puri during the time of landfall. The peak maximum sustained surface wind speed (MSW) of the cyclone was 60-70 kmph gusting to 80 kmph (35 knots gusting to 45 knots) during 1500 UTC of to 2100 UTC of 21st September. The lowest ECP was 992 hPa (from 1500 UTC to 1800 UTC of 21st September).

2.10.3. *Realized Weather*

Under the influence of this system, on 20th rainfall occurred at most places with heavy to extremely heavy

rainfall (20 cm or more in 24 hrs) at isolated places over Odisha with heavy to very heavy rainfall at isolated places over north Andhra Pradesh and Chhattisgarh. On 21st, rainfall occurred at most places with heavy to very heavy rainfall at a few places and extremely heavy falls at isolated places over Vidarbha. It caused rainfall at many places with heavy to very heavy rainfall at a few places over Telangana. Rainfall occurred at many places with isolated heavy falls over Marathwada, Madhya Maharashtra, East Rajasthan, Himachal Pradesh, Chattisgarh and moderate rainfall activity occurred over Uttar Pradesh, Uttrakhand, Haryana, Chandigarh and Delhi. On 22nd, rainfall occurred at most places with heavy to very heavy rainfall at a few places over west Madhya Pradesh; east Rajasthan, Punjab and Himachal Pradesh and heavy to very heavy falls at isolated places over Gujarat. On 23 and 24, it caused rainfall at many places with heavy rainfall at isolated places over west Uttar Pradesh, Uttrakhand and Haryana and Chandigarh and rainfall at a few places with heavy rainfall at isolated places over Jammu and Kashmir. Moderate rainfall activity was observed at a few places over west Rajasthan, east Uttar Pradesh, Madhya Maharashtra and at most places over Delhi. On 25th, isolated heavy to very heavy rainfall occurred over west Uttar Pradesh, Himachal Pradesh and Punjab and isolated heavy rainfall occurred over Uttrakhand.

Chief amounts of 24 hrs rainfall (≥ 7 cm) ending at 0300 UTC from 21-25 September, 2018 are given below:

21 September, 2018

Odisha

Jaypore 29, Malkangiri 28, Similiguda 21, Udala 19, Remuna 17, Balasore 14, Daitari 13, Kaptipada 12, Soro, Balimundali, NH5 Gobindpur, Talcher, Anandpur and Nilgiri 11 each, Narsinghpur, K. Nuagaon, Koraput, Tikabali, Rajghat, Bhograi, Hindol and Jaleswar 10 each, Komna, Harichandanpur, Gania, Pottangi, Berhampur, Jamsolaghat, Parjang, Baripada, Sukinda, Danagadi and Paikmal 9 each, Betanati, Daspalla, Khandapara, Nawapara, Bonth, Gopalpur and Binjharpur 8 each, Banki, Chandanpur, Nawarangpur, Satyabadi, Phulbani, Ghatagaon, Batagaon, Akhuapada, Jajpur, Athgarh, Dhamnagar, Ranpur, Raghunathpur, Tikarpara, Mundali, Tangi, Kosagumda, Kalinga, Tentulikhunti, Joshipur and Korei 7 each

Coastal Andhra Pradesh

Chintur 10, Bobbili 8, Pathapatnam and Kunavaram 7 each

Gangetic West Bengal

Contai 25, Barrackpur and Durgachack 9 each, Midnapore, Mohanpur and Digha 8 each, Midnapore and Diamond Harbour 7 each

Chattisgarh

Konta and Sukma 9 each, Jagdalpur 8

22 September, 2018

Himachal Pradesh

Renuka/Dadhau 7

East Rajasthan

Bakani 8

Madhya Maharashtra

Raver 7

Marathwada

Vasmat 7

Vidarbha

Hinganghat 23, Warora 13, Deoli, Wardha, Dharni and Chikhaldia 12 each, Chandur and Selu 9 each, Chandur Bazar 8, Samudrapur, Tiwsa, Ralegaon & Kharangha 7 each

Telangana

Utnur 13, Manthani 11, Shriramsag and Pocha 10 each, Adilabad, Karimnagar, Mallial and Karimnagar 9 each, Julapalle, Jagtial, Thimmapur, Metpalle, Mogullapalle and Bhupalpalle 8 each, Nirmal, Sultanabad, Khanpur, Mortad, Sirsilla, Kammar Palle, Sarangapur and Kaleswaram 7 each

23 September, 2018

West Uttar Pradesh

Shahjahapur and Shahjahanpur 7 each

Uttrakhand

Banbasa 9

Haryana, Chandigarh & Delhi

Chandigarh and Naraingarh 8 each, Guhla, Chandigarh and Chandigarh SASE 7 each

Punjab

Hoshiarpur 17, Adampur and Nangal 15 each, Halwara 14, Jalandhar 13, Anandpur Sahib 12, Hoshiarpur and Salern (District: Hoshiarpur) 11 each, Nawanshahr and Khanna 10 each, Balachaur 9, Patiala Rev, Sirhind, Pathankot, Mukerian and Ludhiana 8 each, Tibri, Fatehgarh Sahib, Sangrur, Derabassi (Basi), Gurudaspur, Kharar and Malakpur 7 each

Himachal Pradesh

Naina Davi 18, Sarkaghat 14, R L Bmb, Mehre (Barsar), Manali, Dharmshala and Aghar 13 each, Una and Barthin 12 each, Jogindarnagar, Sujanpur Tira, Kasauli and Bharari 11 each, Nadaun, Kangra and Baijnath 10 each, Palampur and Seo Bagh 9 each, Ghamroor, Dharampur, Gulern and Kahu 8 each, Nagrota Surian, Bhuntar and Sangraha 7 each

Jammu & Kashmir

Udhampur 10, Jammu and Katra 9 each, Samba 7

East Rajasthan

Bhungra 15, Pipalkhunt 14, Banswara, Khushalgarh and Sallopat 13 each, Pratapgarh 11, Arnod 10, Ghatol and Shergarh 9 each, Bhilwara Tehsil, Bhilwara, Garhi, Dug, Aspur, Jagpura, Salumber, Loharia, Gangdhar, Arthuna, Kherwara and Chhotisadri 7 each,

Gujarat Region

Godhra 10, Dahod 9, Morva Hadaf 8, Quant, Meghraj, Santrampur, Modasa, Chhota Udepur, Jhalod, Garbada and Fatepura 7 each

West Madhya Pradesh

Jhabua AWS 19, Badnagar 14, Jaora, Khachrod and Gandhwani 13 each, Sailana and Kasarwad 12 each, Depalpur 11, Manawar, Nalchha, Dhar-AWS, Sardarpur and Thandla 10 each, Neemuch AWS, Badnawar, Maheshwar, Mahidpur and Gautampura 9 each, Bhikangaon and Mandsaur AWS 8 each, Jabot, Jawad, Ratlam-AWS, Thikri and Petlawad 7 each

24 September, 2018**West Madhya Pradesh**

Jawad 9

Gujarat Region

Bhiloda 14, Vijaynagar 8, Idar 7

East Rajasthan

Deogarh and Jawaja 17 each, Nayanagar/Beawar 16, Tatgarh and Bhim 11 each, Amet, Pipalkhunt, Veja, Arnod, Kanva and Pratapgarh 9 each, Raipur, Nimarana and Chittorgarh 8 each, Gangrar, Rashmi, Aspur and Sahada 7 each

West Rajasthan

Raipur 7

Punjab

Pathankot 24, Gurudaspur 24, Kapurthala 23, Taran Taran 21, Amritsar 20, Tibri 18, Mukerian 17, Ranjit Sagar Dam Site, Malakpur and Madhopur 15 each, Shahpur Kandi and Phangota 14 each, Nakodar, Salern and Hoshiarpur 9 each, Rajpura and Patiala Rev 8 each, Adampur, Samana, Khanna, Raya, Patiala, Faridkot, Faridkot and Muktsar 7 each

Himachal Pradesh

Dalhousi Alha 17, Kheri 16, Dharmshala 14, Dehra Gopipur, Manali, Kangra, Naina Davi and Chamba 12 each, Guler and Palampur 11 each, Ghamroor 10, Nagrota Surian, Bangana and Amb 9 each, Tissa, Bharwain, Nadaun and Baijnath 8 each, Sujanpur Tira 7

Haryana, Chandigarh and Delhi

Assandh 16, Karnal 14, Thanesar and Kurukshetra 12 each, Nilokheri 11, Jagadhari and Radaur 9 each, Safidon 8, Bilaspur, Karnal Rev, Indri, Gurgaon Rev, Chhachhrauli, Panipat, Bhiwani, Bhiwani Rev and Guhla 7 each

West Uttar Pradesh

Gautam Buddha Nagar 12, Moradabad and Gunnaur 7 each

Uttarakhand

Banbasa 8, Purola and Roorkee 7 each

25 September, 2018**West Uttar Pradesh**

Muzaffarnagar 16, Thakurdwara 13, Budhana, Dhampur and Bijnor 10 each, Meerut and Mawana 8 each, Moradabad and Gautam Buddha Nagar 7 each

Uttarakhand

Banbasa 11, Pantnagar and Haldwani 7 each

Haryana, Chandigarh & Delhi

Guhla 11, Sonapat 9, Pilukhera 8, Chandigarh 7

Punjab

Hoshiarpur 15, Nangal and Hoshiarpur 14 each, Khanna 13, Fatehgarh Sahib 10, Patiala 9, Anandpur Sahib and Ludhiana 8 each, Samrala, Ropar and Patiala Rev 7 each

Himachal Pradesh

Jhandutta 19, Naina Davi 18, Una and Mehre (Barsar) 14 each, Una Rampur 13, R. L. BBMB and Dharampur 10 each, Banjar and Sarkaghat 9 each, Gohar, Barthin and Bharari 8 each, Aghar, Ghumarwin and Bangana 7 each

2.11. *Very Severe Cyclonic Storm, 'LUBAN' over the Arabian Sea (6-15 October, 2018)*

2.11.1. Under the influence of a cyclonic circulation over southeast Arabian Sea and adjoining Lakshadweep-Maldives area, a low pressure area formed over southeast Arabian Sea and neighbourhood on 5th October. Associated cyclonic circulation extended upto 7.6 kms a.s.l. It lay as a well marked low pressure area over the same region at 0000 UTC of 6th October and over southeast and adjoining eastcentral Arabian Sea at 0300 UTC of 6th October. It concentrated into a Depression and lay centred over southeast and adjoining eastcentral Arabian Sea near Lat. 11.2° N/Long. 67.0° E about 730 kms west-northwest of Minicoy (Lakshadweep Islands), 1400 kms east-southeast of Socotra Island and 1500 kms southeast of Salalah (Oman) at 0900 UTC of 6th October. It moved slightly northwestwards and lay centred over southeast and adjoining eastcentral Arabian Sea near Lat. 11.3° N/Long. 66.9° E about 750 kms west-northwest of Minicoy (Lakshadweep Islands), 1400 kms east-southeast of Socotra Island and 1500 kms southeast of Salalah (Oman) at 1200 UTC of 6th October. It further moved west-northwestward and lay centred near Lat. 12.0° N/Long. 65.6° E, about 1360 kms east-southeast of Salalah (Oman), 1270 kms east-southeast of Socotra Island (Yemen) and 920 kms west-northwest of Minicoy (Lakshadweep Islands) at 0300 UTC of 7th October. Moving westwards, it intensified into a Deep Depression over eastcentral and adjoining southeast Arabian Sea near Lat. 12.0° N/Long. 64.8° E, about 1280 kms east-southeast of Salalah (Oman), 1180 kms

east-southeast of Socotra Island (Yemen) and 980 kms west-northwest of Minicoy (Lakshadweep Islands) at 0900 UTC 7th October. It further moved west-northwestwards and lay centred over eastcentral and adjoining southeast Arabian Sea, near Lat. 12.1° N/Long. 64.3° E, about 1230 kms east-southeast of Salalah (Oman), 1130 kms east-southeast of Socotra Island (Yemen) and 1050 kms west-northwest of Minicoy (Lakshadweep Islands) at 1200 UTC of 7th October. It moved west-northwestwards and intensified into Cyclonic Storm 'LUBAN' and lay centred over westcentral and adjoining southwest Arabian Sea near Lat. 12.3° N/Long. 62.4° E, about 1040 kms east-southeast of Salalah (Oman), 920 kms east-southeast of Socotra Island (Yemen) and 1260 kms west-northwest of Minicoy (Lakshadweep Islands) at 0000 UTC of 8th October. It moved west-northwestwards and lay centred over west central and adjoining southwest Arabian Sea, near Lat. 12.4° N/Long. 62.0° E, about 990 kms east-southeast of Salalah (Oman), 880 kms east of Socotra Island (Yemen) and 1300 kms west-northwest of Minicoy (Lakshadweep Islands) at 0300 UTC of 8th October. It then moved west-northwestwards and lay centred over west central and adjoining southwest Arabian Sea, near Lat. 12.5° N/Long. 61.0° E, about 900 kms east-southeast of Salalah (Oman), 770 kms east of Socotra Island (Yemen) at 1200 UTC of 8th October. It lay centred over west central and adjoining southwest Arabian Sea, near Lat. 12.9° N/Long. 60.2° E, about 800 kms east-southeast of Salalah (Oman), 680 kms east of Socotra Island (Yemen) and 940 kms east-southeast of Al-Ghaidah (Yemen) at 0000 UTC of 9th October. It remained practically stationary and lay centred over west central and adjoining southwest Arabian Sea, near Lat. 13.0° N/Long. 60.1° E at 0300 UTC of 9th October. It moved northwestwards and intensified into a Severe Cyclonic Storm and lay centred over west central Arabian Sea, near Lat. 13.2° N/Long. 60.0° E, about 760 kms east-southeast of Salalah (Oman), 660 kms east of Socotra Island (Yemen) and 900 kms east-southeast of Al-Ghaidah (Yemen) at 0900 UTC of 9th October. It moved west-northwestwards and lay centered over westcentral Arabian Sea, near Lat. 13.3° N/Long. 59.7° E, about 730 kms east-southeast of Salalah (Oman), 630 kms east-northeast of Socotra Islands (Yemen) at 1200 UTC of 9th October. It further moved north-northwestwards, intensified into a Very Severe Cyclonic Storm and lay centred over westcentral Arabian Sea, near Lat. 14.1° N/Long. 59.0° E, about 610 kms east-southeast of Salalah (Oman), 570 kms east-northeast of Socotra Islands (Yemen) at 0000 UTC of 10th October. It remained practically stationary and lay centred over westcentral Arabian Sea, near Lat. 14.1° N/Long. 59.0° E, about 610 kms east-southeast of Salalah (Oman), 570 kms east-northeast of Socotra Islands (Yemen) at 0300 UTC of

10th October. It moved west-northwestwards and lay centred over westcentral Arabian Sea, near Lat. 14.4° N/ Long. 58.6° E, about 560 kms east-southeast of Salalah (Oman), 540 kms east-northeast of Socotra Islands (Yemen) and 720 kms east-southeast of Al-Ghaidah (Yemen) at 1200 UTC of 10th October. It moved west-northwestwards and lay centred over westcentral Arabian Sea, near Lat. 14.7° N/Long. 58.1° E, about 500 kms east-southeast of Salalah (Oman), 510 kms east-northeast of Socotra Islands (Yemen) and 660 kms east-southeast of Al-Ghaidah (Yemen) at 0000 UTC of 11th October. It further moved west-southwestwards and lay centred over westcentral Arabian Sea, near Lat. 14.5° N/Long. 58.0° E, about 500 kms east-southeast of Salalah (Oman), 490 kms east-northeast of Socotra Islands (Yemen) and 670 kms east-southeast of Al-Ghaidah (Yemen) at 0300 UTC of 11th October. It then moved westwards and lay centred over westcentral Arabian Sea, near Lat. 14.5° N/ Long. 57.7° E, about 480 kms east-southeast of Salalah (Oman), 460 kms east-northeast of Socotra Islands (Yemen) and 620 kms east-southeast of Al-Ghaidah (Yemen) at 1200 UTC of 11th October. It further moved westwards and weakened into a Severe Cyclonic Storm and lay centred over westcentral Arabian Sea, near Lat. 14.7° N/Long. 57.4° E, about 440 kms east-southeast of Salalah (Oman), 440 kms east-northeast of Socotra Islands (Yemen), 590 kms east-southeast of Al-Ghaidah (Yemen) and 860 kms east of Riyan (Mukalla) at 0300 UTC of 12th October. It moved further westwards and lay centred over westcentral Arabian Sea near Lat. 14.7° N/Long. 57.2° E, about 430 kms east-southeast of Salalah (Oman), 420 kms east-northeast of Socotra Islands (Yemen), 570 kms east-southeast of Al-Ghaidah (Yemen) and 850 kms east of Riyan (Mukalla) at 0900 UTC 12th October. It further moved westwards and lay centred over westcentral Arabian Sea near Lat. 14.7° N/ Long. 57.1° E, about 410 kms east-southeast of Salalah (Oman), 410 kms east-northeast of Socotra Islands (Yemen), 550 kms east-southeast of Al-Ghaidah (Yemen) and 840 kms east of Riyan (Mukalla) at 1200 UTC of 12th October. It moved further west-northwestwards and weakened into a Cyclonic Storm and lay centred over westcentral Arabian Sea, near Lat. 14.8° N/Long. 56.6° E, about 360 km east-southeast of Salalah (Oman), 370 km, east-northeast of Socotra Islands (Yemen), 500 km east-southeast of Al-Ghaidah (Yemen) and 790 km east-northeast of Riyan (Mukalla) at 1800 UTC of 12th October 2018. It moved westwards and lay centered over westcentral Arabian Sea, near lat. 14.8° N/long. 55.6° E, about 290 km south-southeast of Salalah (Oman), 300 km northeast of Socotra Islands (Yemen), 400 km east-southeast of Al-Ghaidah (Yemen) and 680 km east-northeast of Riyan (Mukalla) at 0300 UTC of 13th October. Continuing the westward movement, it lay centred over westcentral Arabian Sea near Lat. 14.9° N/

Long. 54.4° E, about 240 kms south-southeast of Salalah (Oman), 260 kms northeast of Socotra Islands (Yemen), 280 kms east-southeast of Al-Ghaidah (Yemen) and 550 kms east-northeast of Riyan (Mukalla) at 1200 UTC of 13th October. It further weakened into Deep Depression over Yeman and near Lat. 15.9° N/ Long. 51.7° E at 0900 UTC of 14th October. Further moving westwards, it lay centered over Yeman, near Lat. 15.9° N/Long. 51.2° E, about 90 kms west-southwest of Al-Ghaidah (Yemen) at 1200 UTC of 14th October. It moved west-northwestwards and weakened into a Depression and lay centered over Yemen near Lat. 16.2° N/ Long. 50.7° E, about 140 kms west of Al-Ghaidah (Yemen) at 1800 UTC of 14th October. It further moved west-northwestwards and lay centered over Yemen near Lat. 16.2° N/ Long. 49.0° E, about 320 kms west of Al-Ghaidah (Yemen) at 0000 UTC of 15th October. It moved west-northwestwards and weakened into a well marked low pressure area over Yemen and adjoining Saudi Arabia subsequently.

2.11.2. *Other features observed*

The lowest ECP had been 978 hPa during 0600 UTC of 10th to 0000 UTC of 11th. The ECP gradually decreased from 1003 hPa at 0900 UTC of 6th to 994 hPa at 0600 UTC of 9th. Thereafter, there was a rapid decrease from 994 hPa to 978 hPa (16 hPa) during 0600 UTC of 9th to 0600 UTC of 10th (within 24 hrs). There was rise in ECP from 978 hPa (at 0300 UTC of 11th) to 994 hPa at 1800 UTC of 12th. Thereafter it increased gradually to 1003 hPa at 0000 UTC of 15th. Similarly, in the wind field it is seen that there was gradual increase in MSW till 0600 UTC of 9th. There was rapid intensification by 30 knots as it increased from 45 knots at 0600 UTC of 9th to 0600 UTC of 10th. The system maintained its peak intensity of 75 knots during 0600 UTC of 10th to 0000 UTC of 11th. The system then weakened gradually.

2.11.3. *Realized Weather*

The system caused heavy to very rainfall (8-16 cm) over coastal areas of south Oman at a few places on 13th, 4-8 cm rainfall over coastal areas of Yemen on 14th and over interior parts of Yemen and Saudi Arabia on 15th.

(i) *Realised Weather over Yemen*

Al- Ghaidah (41398): Rainfall (290 mm), Wind 50 kt (45 gusting to 55kt)

Muklla (41443): Rainfall (56.5 mm), Wind 20 kt.

Socotra (41494): Rainfall (40 mm), Wind 26 kt.

(ii) Realised Weather over Oman

The highest amount of rainfall in Dhofar during 4 pm on October 13th to 8 am on October 14th was recorded in Dalkout (14.5 cm) followed by Salalah (13.8 cm), Rakhout (13.3 cm), Mirbat (3.8 cm), Shaleem and Al Halaniyat Island (3.2 cm), Sadah (2.4 cm), Taqah (1.3 cm), Thumrait (1.1 cm) and Al Mazyouna (1.0 cm). The highest amount of rainfall recorded in Al Wusta was 1.1 cm in the Wilayat of Al Jaser, 9.0 cm in Mahout and 6.0 cm in Haima.

2.11.4. *Damage due to VSCS Luban**(i) Damage over India*

No casualties were reported from any Indian state due to VSCS, LUBAN.

(ii) Damage over Oman and Yemen

14 persons lost their lives in Yemen due to floods in association with VSCS LUBAN.

2.12. *Very Severe Cyclonic Storm 'TITLI' over eastcentral Bay of Bengal (8-13 October, 2018)*

2.12.1. Under the influence of a cyclonic circulation over north Andaman Sea and adjoining southeast Bay of Bengal, a low pressure area formed over the same region on 7th October. Associated cyclonic circulation extended upto 5.8 kms a.s.l. It became a well marked low pressure area over the same region on 7th evening. It lay over southeast and adjoining eastcentral Bay of Bengal and concentrated into a Depression and lay centred over eastcentral Bay of Bengal near Lat. 14.0° N/Long. 88.8° E, about 720 kms south-southeast of Gopalpur (Odisha), 690 kms southeast of Kalingapatnam (Andhra Pradesh) at 0300 UTC of 8th October. It moved west-northwestwards and lay centred over eastcentral Bay of Bengal near Lat. 14.3° N/Long. 88.2° E, about 650 kms southeast of Gopalpur (Odisha), 620 kms southeast of Kalingapatnam (Andhra Pradesh) at 1200 UTC of 8th October. It moved west-northwestwards and intensified into a Deep Depression and lay centred near Lat. 14.5° N/Long. 87.6° E, about 600 kms southeast of Gopalpur (Odisha) and 560 kms southeast of Kalingapatnam (Andhra Pradesh) at 1800 UTC of 8th October. It moved further west-northwestwards and lay centred over west central Bay of Bengal near Lat. 14.7° N/Long. 87.1° E, about 560 kms southeast of Gopalpur (Odisha), 510 kms southeast of Kalingapatnam (Andhra Pradesh) at 0000 UTC of 9th October. It remained practically stationary and lay centred, over west central Bay of Bengal near Lat. 14.7° N/Long. 86.9° E at 0300 UTC of 9th October. It continued to

move west-northwestwards, intensified into Cyclonic Storm 'TITLI' and lay centred over west central Bay of Bengal near Lat. 14.8° N/Long. 86.7° E, about 530 kms southeast of Gopalpur (Odisha) and 480 kms east-southeast of Kalingapatnam (Andhra Pradesh) at 0600 UTC of 9th October. It moved northwestwards and lay centred over Westcentral Bay of Bengal near Lat. 15.1° N/Long. 86.4° E, about 490 kms south-southeast of Gopalpur (Odisha) and 430 kms southeast of Kalingapatnam (Andhra Pradesh) at 1200 UTC of 9th October. It further moved north-northwestwards, intensified into a Severe Cyclonic Storm and lay centred over Westcentral Bay of Bengal near Lat. 15.7° N/Long. 85.8° E, about 370 kms south-southeast of Gopalpur (Odisha) and 310 kms southeast of Kalingapatnam (Andhra Pradesh) at 2100 UTC of 9th October. It further moved northwards and lay centred over Westcentral Bay of Bengal near Lat. 16.5° N/Long. 85.8° E, about 320 kms south-southeast of Gopalpur (Odisha) and 270 kms southeast of Kalingapatnam (Andhra Pradesh) at 0300 UTC of 10th October. It then moved north westwards and intensified into a Very Severe Cyclonic Storm and lay centred over West central Bay of Bengal near Lat. 17.0° N/Long. 85.6° E, about 280 kms south-southeast of Gopalpur (Odisha) and 230 kms southeast of Kalingapatnam (Andhra Pradesh) at 0600 UTC of 10th October. It moved north-northwestwards and lay centred over westcentral Bay of Bengal near Lat. 17.5° N/Long. 85.3° E, about 200 kms south-southeast of Gopalpur (Odisha) and 150 kms southeast of Kalingapatnam (Andhra Pradesh) at 1200 UTC of 10th October. It moved northwestwards and crossed north Andhra Pradesh-south Odisha coasts, near Lat. 18.8° N/Long. 84.5° E, (near Palasa, Srikakulam district) to the southwest of Gopalpur, as a Very Severe Cyclonic Storm between 2300 UTC of 10th and 0000 UTC of 11th October. It lay centred over north coastal Andhra Pradesh and adjoining south Odisha near Lat. 18.8° N/Long. 84.4° E, about 70 kms southwest of Gopalpur (Odisha) and 160 kms north-northeast of Kalingapatnam (Andhra Pradesh) at 0000 UTC of 11th October. It further moved westnorth-westwards and lay centred over south Odisha near Lat. 19.0° N/Long. 84.1° E, about 90 kms west southwest of Gopalpur and 60 kms south-southeast of Phulbani at 0300 UTC of 11th October. It then moved northwestwards and weakened into a Severe Cyclonic Storm and lay centred over south Odisha near Lat. 19.3° N/Long. 83.8° E, about 110 kms west of Gopalpur and 140 kms southwest of Phulbani at 0600 UTC of 11th October. It further moved north-northwestwards and weakened into a Cyclonic Storm lay centred over south Odisha near Lat. 19.9° N/Long. 83.7° E, about 50 kms east-northeast of Bhavanipatana and 80 kms west-southwest of Phulbani 1200 UTC 11th October. It further

moved eastwards, weakened into a Deep Depression and lay centred over south Odisha near Lat. 20.3° N/ Long. 84.3° E, 100 kms east-northeast of Bhawanipatna and 50 kms north-northwest of Phulbani at 1800 UTC of 11th October. Further moving east-northeastwards, it lay centred over Odisha near Lat. 20.6° N/Long. 84.9° E, 60 kms east-north-east of Phulbani and 30 kms southwest of Angul at 0300 UTC of 12th October. It moved east-northeastwards and weakened into a Depression over the same region and lay centred over Odisha near Lat. 20.9° N/Long. 85.5° E, 80 kms south of Keonjhar (Odisha) at 0900 UTC of 12th October. It moved further east-northeastwards and lay centred over Odisha near Lat. 21.2° N/Long. 86.1° E, 70 kms south of Keonjhar (Odisha) at 1200 UTC of 12th October. It moved east-northeastwards and lay centred over north Odisha and adjoining West Bengal near Lat. 21.9° N/ Long. 87.2° E about 50 km west-northwest of Digha at 1800 UTC of 12th October. It moved northeastwards and weakened into a well marked low pressure area over Gangetic West Bengal & neighbourhood at 0000 UTC of 13th October.

2.12.2. Other features observed

The peak MSW of the cyclone was 140-150 kmph gusting to 165 kmph (80 knots) during 1200 UTC of 10th to 0000 UTC of 11th October. The lowest ECP was 972 hPa during 1200 UTC of 10th to 0000 UTC of 11th October. Gopalpur reported maximum wind speed of 126 kmph at 0430 hrs IST of 11th, 55 kmph wind speed at 1730 IST of 11th and 45 kmph at 0830 IST of 12th October. Bhawanipatna (Kalahandi district) reported 52 kmph at 1730 IST of 11th. Puri reported 59 kmph at 0530 IST of 12th. Paradip reported 35 kmph on 10th and 12th and 27 kmph on 11th. Estimated wind speed at the time of landfall was 140-150 kmph gusting to 165 kmph.

2.12.3. Realized Weather

This system caused rainfall at most places with heavy to very heavy rainfall at many places over coastal Odisha, Gangetic west Bengal and adjoining north Bay of Bengal upto Assam with extremely heavy falls at isolated places over coastal Odisha on 11th, heavy to very falls at a few places with extremely heavy falls over coastal Odisha and heavy to very falls at most places over Assam on 12th and heavy to very falls at many places over Gangetic West Bengal upto Assam, Meghalaya, Manipur, Mizoram on 13th. The rainfall was higher in the right forward sector of the cyclone during and after the landfall.

Chief amounts of 24 hrs rainfall (≥ 7 cm) ending at 0300 UTC of from 11-14 October, 2018 are given below:

11 October, 2018

Odisha

Mahendragarh 23, R. Udaigiri and Mohana 22 each, Purushottampur 21, Rajghat 17, Nuagada 16, Aska 15, Bhograi, Digapahandi and Balikuda 14 each, Chhatrapur, Ranpur, Raghunathpur and Sorada 13 each, Kendrapara, Nilgiri, NH5 Gobindpur, Balasore and Kantapada 12 each, Kaptipada, Soro, Marsaghai, Chandikhol, Paradeep and Binjharpur 11 each, Alipingal, Jagatsinghpur AWS, Basudevpur, Gop, Korei and Gopalpur 10 each, Tikabali, Bhanjnar, Jaipur, Kujanga, Madhabarida, Odagaon, Betanati, Remuna, Belaguntha, Tirtol, Pattamundai, Bhadrak and Niali 9 each, Raikia, Kakatpur, Nimpara, G. Udayagiri, Puri, Nischintakoili, Pipili, Astaranga, Tangi and Jaleswar 8 each, Banpur, Jagannath Prasad, Krishnaprasad, Narsinghpur, Balimundali, Derabis, Banki, Akhuapada, Salepur, Bari, Balipatna, Jajpur, Bhubaneswar, Nayagarh, Jenapur and Garadapur 7 each

Gangetic West Bengal

Digha 14, Contai 10

Coastal Andhra Pradesh

Itchpuram 24, Tekkali 23, Palasa 20, Kalingapatnam 9

12 October, 2018

Gangetic West Bengal

Murari 7

Assam, Meghalaya, Mizoram and Tripura

Moderate rainfall upto 5 cm at many places

13 October, 2018

Assam & Meghalaya

Karimganj and B P Ghat 8 each

Nagaland, Manipur, Mizoram & Tripura

Serchip 8

Gangetic West Bengal

Digha 15, Contai 13, Kalaikunda 10

Odisha

Betanati ARG 16, Kaptipada, Rajghat and Bhograi 13 each, Danagadi, Dhamnagar, Balimundali, Tihidi and Bonth 11 each, Jaleswar and Remuna 10 each, Thakurmunda and Karanjia 9 each, Jajpur, Samakhunta, Bangiriposi, Mahanga, Anandpur, Bari and Balasore, NH5 Gobindpur and Chandanpur 8 each, Baripada, Nilgiri, Udala, Sukinda, Ghatagaon and Jamsolaghat 7 each

14 October, 2018**Assam & Meghalaya**

Sohra 9, Sohra (RKM) 8

2.13. *Very Severe Cyclonic Storm 'GAJA' over Bay of Bengal (10-19 November, 2018)*

2.13.1. Under the influence of a cyclonic circulation over south China Sea and adjoining gulf of Thailand, a low pressure area formed over Gulf of Thailand and adjoining Malay peninsula on 8th November. It lay over central parts of Andaman Sea and neighbourhood on 9th November. The associated cyclonic circulation extended upto mid-tropospheric levels. It lay as a well marked low pressure area over north Andaman Sea and neighbourhood on 9th evening. It lay over southeast Bay of Bengal and adjoining north Andaman Sea at 0000 UTC of 10th. It concentrated into a Depression and lay over southeast Bay of Bengal near Lat. 11.7° N/Long. 92.5° E, about 20 kms northwest of Portblair (Andaman Islands) 1340 kms east-southeast of Chennai (Tamil Nadu) and 1390 kms eastsoutheast of Nellore (Andhra Pradesh) at 0300 UTC of 10th. It moved west-northwestwards, intensified into a Deep Depression and lay centered over southeast and adjoining central Bay of Bengal near Lat. 12.6° N/Long. 90.8° E, about 230 kms west-northwest of Port Blair (Andaman Islands) and 1140 kms east-southeast of Chennai (Tamil Nadu) and 1180 kms eastsoutheast of Nellore (Andhra Pradesh) at 1200 UTC of 10th. It further moved west-northwestwards and intensified into Cyclonic Storm 'GAJA' and lay centred over eastcentral and adjoining westcentral and southeast Bay of Bengal near Lat. 13.4° N/Long. 89.3° E, about 400 kms west-northwest of Port Blair (Andaman Islands), 990 kms east of Chennai (Tamil Nadu) and 1050 kms east-southeast of Nellore (Andhra Pradesh) at 0000 UTC of 11th. It continued to move west-northwestwards and lay centered over eastcentral and adjoining westcentral and southeast Bay of Bengal near Lat. 13.5° N/Long. 88.9° E, about 460 kms northwest of Port Blair (Andaman Islands), 930 kms east-northeast of Chennai (Tamil Nadu) and 980 kms east-southeast of Sri Harikota (Andhra Pradesh) at 0300 UTC of 11th. It moved westwards and lay centred

over west central and adjoining east central and southeast Bay of Bengal near Lat. 13.5° N/Long. 88.0° E, about 840 kms east-northeast of Chennai (Tamil Nadu) and 880 kms east-northeast of Nagapattanam (Chennai) at 1200 UTC of 11th. Further it moved south-southwestwards and lay centred over westcentral and adjoining eastcentral and southeast Bay of Bengal near Lat. 13.1° N/Long. 87.0° E, about 730 kms east-northeast of Chennai (Tamil Nadu) and 820 kms east-northeast of Nagapattanam (Tamil Nadu) at 0300 UTC of 12th. It moved southeastwards and lay centred over southeast and adjoining central and southwest Bay of Bengal near Lat. 12.6° N/Long. 87.3° E, about 760 kms east-northeast of Chennai (Tamil Nadu) and 830 kms east-northeast of Nagapattanam (Tamil Nadu) at 1200 UTC of 12th. It further moved north-northeastwards and lay centred over westcentral and adjoining eastcentral and south Bay of Bengal near Lat. 13.2° N/Long. 87.5° E, about 780 km east of Chennai (Tamil Nadu) and 870 km east-northeast of Nagapattanam (Tamil Nadu) at 1800 UTC of 12th. It further moved west-northwestwards and lay centered over westcentral and adjoining eastcentral and south Bay of Bengal near Lat. 13.3° N/Long. 87.1° E, about 740 kms east-northeast of Chennai (Tamil Nadu) and 830 kms east-northeast of Nagapattanam (Tamil Nadu) at 0300 UTC of 13th. It then moved west-southwestwards and lay centered over west central and adjoining east central and south Bay of Bengal near Lat. 13.4° N/Long. 86.0° E, about 600 kms east-northeast of Chennai (Tamil Nadu) and 720 kms northeast of Nagapattanam (Tamil Nadu) at 1200 UTC of 13th. It continued to move west-southwestwards and lay centered over westcentral and adjoining south Bay of Bengal near Lat. 13.0° N/Long. 85.1° E, about 520 kms east of Chennai (Tamil Nadu) and 620 kms east-northeast of Nagapattanam (Tamil Nadu) at 0300 UTC of 14th. Further moving west-southwestwards, it lay centred over southwest and adjoining westcentral Bay of Bengal near Lat. 12.4° N/Long 84.2° E, about 430 kms east-southeast of Chennai (Tamil Nadu) and 510 kms east-northeast of Nagapattanam (Tamil Nadu) at 1200 UTC of 14th. It moved west-southwestwards and lay centred over southwest Bay of Bengal near Lat. 11.5° N/Long. 83.2° E, about 370 kms east-southeast of Chennai (Tamil Nadu) and 370 kms east-northeast of Nagapattanam (Tamil Nadu) at 0000 UTC of 15th. It further moved west-southwestwards, intensified into a Severe Cyclonic Storm and lay centered over southwest Bay of Bengal near Lat. 11.3° N/Long. 82.6° E, about 320 kms eastsoutheast of Chennai (Tamil Nadu) and 300 kms east-northeast of Nagapattanam (Tamil Nadu) at 0300 UTC of 15th. It moved further west-southwestwards and lay centred over southwest Bay of Bengal near Lat. 10.8° N/Long. 81.2° E, about 150 kms east of Nagapattanam (Tamil Nadu) at 1200 UTC of 15th. Moving further west-southwestwards,

it further intensified into a Very Severe Cyclonic Storm and lay centred at 1500 UTC of 15th, near Lat. 10.6° N/ Long. 80.7° E.

It crossed Tamilnadu and Puducherry coasts between Nagapattinam and Vedaranniyam near Lat. 10.5° N/ Long. 79.8° E during 1900 to 2100 UTC of 15th. It moved nearly westwards, weakened into a Severe Cyclonic Storm by 0000 UTC of 16th and further into a Cyclonic Storm and lay centred over coastal Tamilnadu near Lat. 10.4° N/ Long. 79.2° E about 20 kms west-northwest of Adirampattinam at 0000 UTC of 16th. It moved nearly westwards and lay centred over interior Tamil Nadu near Lat. 10.4° N/Long. 78.5° E about 95 kms west of Adirampattinam and 110 kms east-northeast of Kodaikanal at 0300 UTC of 16th. It then moved nearly westwards and weakened into a Deep Depression and lay centred over interior Tamilnadu near Lat. 10.5° N/ Long. 77.6° E, about 80 kms northwest of Madurai at 0600 UTC of 16th. It further moved westwards and lay centered over Kerala and adjoining interior Tamil Nadu near Lat. 10.4° N/Long. 76.7° E, about 170 kms east-northeast of Kodaikanal and 70 kms northeast of Kochi (Kerala) at 0900 UTC of 16th. It further moved west-southwestwards and weakened into a Depression and lay centered over central parts of Kerala near Lat. 10.1° N/ Long. 76.4° E about 20 kms east-northeast of Kochi at 1200 UTC of 16th. It moved nearly westwards and lay over southeast Arabian Sea near Lat. 9.9° N/Long 75.3° E, about 100 kms west of Kochi and 310 kms east-southeast of Amini Divi at 1800 UTC of 16th. It moved nearly westwards and intensified into a Deep Depression and lay centered over southeast Arabian Sea near Lat. 9.8° N/ Long. 74.3° E, about 210 kms west of Kochi and 220 kms east-southeast of Amini Divi at 0000 UTC of 17th. It moved nearly westwards and lay centered over southeast Arabian sea near Lat. 9.8° N/Long. 73.7° E, about 40 kms east-southeast of Kalpeni, 150 kms east-southeast of Kavaratti and 180 kms east-southeast of Amini Divi at 0300 UTC of 17th. Then it moved nearly westwards, crossed Lakshadweep Islands during 0300 UTC to 0600 UTC and lay centred over southeast Arabian Sea near Lat. 9.9° N and Long. 71.7° E, about 200 km west-southwest of Kalpeni, 120 km west-southwest of Kavaratti and 130 km south-southwest of Agathi at 1200 UTC of 17th. It moved west-northwestwards and lay centered over southeast Arabian Sea near Lat. 10.4° N and Long. 69.4° E, about 350 km west-southwest of Kavaratti, 340 km west-southwest of Agathi and about 1700 km east-southeast of Socotra at 0300 UTC of 18th. It further moved west-northwestwards and lay centered over southeast Arabian Sea near Lat. 10.7° N/Long. 68.5° E, about 440 kms west of Agathi and about 1590 kms east-southeast of Socotra at 1200 UTC of 18th. It moved nearly westwards and

lay centered over southeast Arabian Sea near Lat. 11.0° N/Long. 66.6° E, about 600 kms west-northwest of Agathi and 1430 kms east-southeast of Socotra at 0000 UTC of 19th. It further moved westwards and lay centered over southeast Arabian Sea near Lat. 11.1° N/Long. 66.3° E, about 670 kms west-northwest of Agathi and 1360 kms east-southeast of Socotra at 0300 UTC of 19th. It moved westwards, weakened into a Depression and lay centered over southeast Arabian Sea near Lat. 11.2° N/ Long. 65.8° E, about 730 kms west-northwest of Agathi and 1300 kms east-southeast of Socotra at 0600 UTC of 19th. It further moved westwards and lay centered over southeast Arabian Sea near Lat. 11.2° N/Long. 65.0° E, about 850 kms west-northwest of Agathi and 1170 kms east-southeast of Socotra at 1200 UTC of 19th. It continued to move westwards and weakened into a well marked low pressure area over southwest and adjoining southeast Arabian Sea at 1800 UTC of 19th.

2.13.2. *Other features observed*

VSCS Gaja was the sixth cyclone over north Indian Ocean during 2018 against the normal frequency of about 4.5 cyclones per year during the satellite era (1961 onwards). It was the first ever looping track cyclone over the Bay of Bengal after 1996. The system had one of the longest track length equal to 3418 km. Despite unfavourable environmental conditions, the system intensified into a VSCS just prior to landfall near to coast. The very severe cyclonic storm intensity of the system was short lived (about 3 hrs). The MSW of the cyclone was 130 kmph gusting to 145 kmph during 1800 to 2100 UTC of 15th. The lowest ECP was 975 hPa with pressure drop of about 31 hPa. Adirampattinam reported maximum wind speed of 117 kmph at 0330 hrs IST, Nagapattinam reported 100 kmph during 0230-0330 hrs IST and Karaikal reported 92 kmph at 0130 hrs IST of 16th. Estimated maximum wind speed at the time of landfall was 130 kmph gusting to 145 kmph.

2.13.3. *Realized Weather*

Under the influence of the system, on 16th November, rainfall occurred at most places with heavy falls at a few places and very heavy falls at isolated places over Tamil Nadu. Moderate rainfall occurred over Kerala, south coastal Andhra Pradesh, Rayalaseema and south interior Karnataka. On 17th, rainfall occurred at most places with isolated heavy to very heavy rainfall over Kerala and Tamilnadu. Isolated extremely heavy rainfall also occurred over Kerala and isolated heavy rainfall over coastal Andhra Pradesh.

Chief amounts of 24 hrs rainfall (≥ 7 cm) ending at 0300 UTC of 10, 11, 16 and 17 November, 2018 are given below:

10 November, 2018

Andaman & Nicobar Islands

Long Islands 14, Maya Bandar 10, Port Blair 9

11 November, 2018

Andaman & Nicobar Islands

Maya Bandar 7

16 November, 2018

Tamilnadu & Puducherry

Thiruthuraiipoondi and Muthupet 17 each, Adirampattinam 16, Peravurani, Pattukottai and Neyveli 14 each, Virudachalam 12, Chengalpattu 11, Cuddalore 9, Madukkur, Arantangi and Vandavasi 8 each, Srimushnam, Valinokkam, Nagercoil, Uthiramerur, Orthanad, Needamangalam, Thuckalay, Sethiathope, Puducherry and Tozhudur 7 each.

17 November, 2018

Coastal Andhra Pradesh

Kandukur and Gudivada 7 each

Telangana

Aswaraopeta 7

Tamilnadu & Puducherry

Sivaganga 17, Kodaikanal 14, Thammampatty 10, Nilakottai, Illuppur, Periyakulam and Bodinaickanur 9 each, Tirupathur 8, Chinnakallar and Vadipatti 7 each

Kerala

Kozha 28, Piravam 19, Thodupuzha 15, Cherthala and Munnar KSEB 12 each, Kumarakam 11, Idukki 10, Vaikom & Myladumpara 9 each, Kottayam 8, Peermade 7

2.14. Severe Cyclonic Storm 'PHETHAI' over south east Bay of Bengal (13-18 December 2018)

2.14.1. Under the influence of a trough of low at mean sea level over equatorial Indian Ocean and adjoining

southeast Bay of Bengal, a low pressure area formed over equatorial Indian Ocean and adjoining central parts of south Bay of Bengal on 9th December evening. It persisted over the same region on 10th. It lay as a well marked low pressure area over central parts of south Bay of Bengal and adjoining equatorial Indian Ocean on 11th and over southeast Bay of Bengal and adjoining equatorial Indian Ocean on 12th. Associated cyclonic circulation extended upto 5.8 kms above m.s.l. It concentrated into a Depression and lay centered near Lat. 6.5° N/Long. 88.7° E about 850 kms east southeast of Trincomalee, 1170 kms southeast of Chennai and 1350 kms south southeast of Machilipatnam at 0000 UTC of 13th December. It further moved north-northwestwards and lay centered over southeast Bay of Bengal near Lat. 6.7° N/Long. 88.6° E about 830 kms east-southeast of Trincomalee (Sri Lanka), 1150 kms southeast of Chennai (Tamil Nadu) and 1330 kms south-southeast of Machilipatnam (Andhra Pradesh) at 0300 UTC of 13th December. It moved north-northwestwards and lay centered over southeast Bay of Bengal near Lat. 7.3° N/Long. 88.2° E about 780 kms southeast of Trincomalee (Sri Lanka), 1080 kms south-southeast of Chennai (Tamilnadu) and 1250 kms south-southeast of Machilipatnam (Andhra Pradesh) at 1200 UTC of 13th. It intensified into a Deep Depression and lay centred over southeast Bay of Bengal near Lat. 7.6° N/Long. 88.0° E about 750 kms east-southeast of Trincomalee (Sri Lanka), 1040 kms south-southeast of Chennai (Tamil Nadu) and 1210 kms south-southeast of Machilipatnam (Andhra Pradesh) at 1800 UTC of 13th. It further moved north-northwestwards and lay centered over southeast Bay of Bengal near Lat. 8.2° N/Long. 87.6° E, about 700 kms east-southeast of Trincomalee (Sri Lanka), 960 kms east-southeast of Chennai (Tamil Nadu) and 1130 kms south-southeast of Machilipatnam (Andhra Pradesh) at 0000 UTC of 14th December. It moved further north-northwestwards and lay centered over southeast Bay of Bengal near Lat. 8.5° N/Long. 87.4° E, about 670 kms east of Trincomalee (Sri Lanka), 930 kms eastsoutheast of Chennai (Tamilnadu) and 1090 kms southeast of Machilipatnam (Andhra Pradesh) at 0300 UTC of 14th December. It then moved west-northwestwards and lay centered over southeast and adjoining southwest Bay of Bengal near Lat. 8.6° N/Long. 86.8° E about 610 kms east of Trincomalee (Sri Lanka), 870 kms east-southeast of Chennai (Tamil Nadu) and 1040 kms southeast of Machilipatnam (Andhra Pradesh) at 1200 UTC of 14th December. It moved west-northwestwards and lay centered over southwest and adjoining southeast Bay of Bengal near latitude Lat. 9.0° N/Long. 85.5° E, about 470 km eastnortheast of Trincomalee (Sri Lanka), 730 km eastsoutheast of Chennai (Tamilnadu) and 930 km southsoutheast of Machilipatnam (Andhra Pradesh) at 0000 UTC of 15th December. It moved further west-

northwestwards and lay centered over southwest and adjoining southeast Bay of Bengal near Lat. 9.2° N/ Long. 85.2° E, about 440 km east-northeast of Trincomalee (Sri Lanka), 690 km southeast of Chennai (Tamil Nadu) and 890 kms south-southeast of Machilipatnam (Andhra Pradesh) at 0300 UTC of 15th December. Moving north-northwestwards, it intensified into cyclonic storm 'PHETHAI' (pronounced as Pay-ti) and lay centred over southwest Bay of Bengal near Lat. 10.3° N/Long. 84.9° E, about 440 kms east-north east of Trincomalee (Sri Lanka), 590 kms east-southeast of Chennai (Tamil Nadu) and 770 kms south-southeast of Machilipatnam (Andhra Pradesh) at 1200 UTC of 15th December. It moved further north-northwestwards and lay centred over southwest Bay of Bengal near Lat. 11.3° N/Long. 84.3° E, about 460 kms east-northeast of Trincomalee (Sri Lanka), 490 kms east-southeast of Chennai (Tamil Nadu), 640 kms south-southeast of Machilipatnam (Andhra Pradesh) and 670 kms south-southeast Kakinada (Andhra Pradesh) at 0000 UTC of 16th December. It further moved north-northwestwards and lay centered at over southwest and adjoining west central Bay of Bengal near Lat. 11.8° N/Long. 84.1° E, about 460 kms northeast of Trincomalee (Sri Lanka), 430 kms east-southeast of Chennai (Tamilnadu), 560 kms south-southeast of Machilipatnam (Andhra Pradesh) and 600 kms south-southeast of Kakinada (Andhra Pradesh) 0300 UTC of 16th December. It moved further north-north westwards, intensified into a Severe Cyclonic Storm and lay centred over west central and adjoining southwest Bay of Bengal near Lat. 13.3° N/Long. 83.0° E, about 560 kms north-northeast of Trincomalee (Sri Lanka), 300 kms east-northeast of Chennai (Tamil Nadu), 380 kms south-south east of Machilipatnam (Andhra Pradesh) and 410 kms south-southeast Kakinada (Andhra Pradesh) at 1200 UTC of 16th December. It further moved northwards, weakened into a Cyclonic Storm and lay centred over westcentral Bay of Bengal near Lat. 15.8° N/Long. 82.2° E, 370 kms north-northeast of Chennai (Tamil Nadu), 120 kms east-southeast of Machilipatnam (Andhra Pradesh) and 130 kms south of Kakinada (Andhra Pradesh) at 0300 UTC of 17th December. It then moved northwards, crossed Andhra Pradesh coast near Lat. 16.5° N/Long. 82.3° E, 25 kms south of Yanam and 40 kms south of Kakinada between 0800 and 0900 UTC of 17th December and lay centred over coastal Andhra Pradesh, near Lat. 16.7° N/ Long. 82.3° E, close to Yanam and 25 kms south of Kakinada at 0900 UTC of 17th December. It further moved north-northeastwards, weakened into a Deep Depression and lay centred over westcentral Bay of Bengal near Lat. 16.9° N/Long. 82.4° E, close to Kakinada, north coastal Andhra Pradesh at 1200 UTC of 17th December. It further weakened into a Depression near Lat. 17.5° N/Long. 82.5° E at 1800 UTC of 17th December and into a well marked low pressure area over northwest

and adjoining west central Bay of Bengal and Odisha at 0000 UTC of 18th December and lay as a low pressure area over northwest Bay of Bengal and adjoining coastal Odisha in the morning of 18th.

2.14.2. *Other features observed*

Maximum sustained winds of 70-80 kmph gusting to 90 kmph were reported at the time of landfall. The MSW of the cyclone was 100-110 kmph gusting to 120 kmph (55 knots) during 1200 to 2100 UTC of 16th. The lowest ECP was 992 hPa during the same period with pressure drop of 15 hPa.

2.14.3. *Realized Weather*

The system caused rainfall at most places with heavy to very heavy rainfall at isolated places over coastal Andhra Pradesh on 17th. On 18th, light to moderate rainfall activity was observed over coastal Andhra Pradesh and adjoining Odisha.

Heavy to very heavy rainfall occurred at isolated places over north coastal Andhra Pradesh and heavy rainfall at isolated places over Telangana in past 24 hours ending at 0830 hours IST of 17th December. Heavy to very heavy rainfall occurred at a few places over north coastal Andhra Pradesh and heavy rainfall at a few places over Odisha and isolated places over Jharkhand in past 24 hours ending at 0830 hours IST of 18th December.

Chief amounts of 24 hrs rainfall (≥ 7 cm) ending at 0300 UTC of from 17-18 December, 2018 are given below:

17 December, 2018

Coastal Andhra Pradesh

Vijayawada 13, Gudivada 10, Nuzvid, Avanigada and Vijayawada 9 each, Eluru 8, Kaikalur, Chintalapudi, Repalle, Amalapuram and Tenali 7 each

Telangana

Sathupalle and Aswaraopet 9 each, Mulakalapalle, Chandrugonda and Enkuru 8 each, Kothagudem, Julurpad, Manuguru, Palawanacha and Burgampadu 7 each

18 December, 2018

Coastal Andhra Pradesh

Ninnimamidivalasa 19, Pachipenta 18, Kantakapalle and Ananthagiri 14 each, Araku Valley and Salur 13 each,

Amalapuram & Bheemunipatnam 12 each, Visakhapatnam, Mentada, Bondapalle and Ranastalam 11 each, Gajapathinagaram and Kalingapatnam 10 each, Cheepurupalle, Merakamudidam, Therlam, Nellimarla, Garividi and Bobbili 9 each, Vizianagram and Chodavaram 8 each, Pusapatirega, Seethanagaram, Kakinada, Gantyada, Chintapalle, Parvathipuram, Balajipeta, Paderu, Tuni, Garugubilli and Srungavarapukota 7 each

Odisha

Gurundia, Padampur and Kirmira 10 each, Bolangir, Lahunipara, Tensa, Nuagada, Banaigarh,

Bamra, Rajgangpur and Jamankira 9 each, Deogaon, Kuchinda, Burla, Hirakud, Jhumpura, Joda, G. Udayagiri, Reamal, Ambabhona, Pottangi, Lakhanpur, Binika, Bargarh, Panposh, Barpalli, Jharsuguda, Paikmal, Batli and Champua 8 each, Laikera, Sambalpur, Gaisilet, Ullunda, Paralakhemundi, Dunguripalli, Deogarh, Keonjhar, Rairakhol, Sonepur, Hemgiri, Bijepur, Atabira and Lanjigarh 7 each

Jharkhand

Jamshedpur 9, Chakradharpur and Chaibasa 7 each
