

Cyclones and depressions over the north Indian Ocean during 2016*

1. Introduction

During 2016, in all 10 intense low pressure systems formed over the Indian Seas. These include; one Very Severe Cyclonic Storm (VSCS) 'VARDAH', 3 Cyclonic Storms (ROANU, KYANT and NADA), 2 Deep Depressions and 4 Depressions. Out of these 10 systems, seven systems formed over the Bay of Bengal, two over the Arabian Sea and one over Land. One Cyclonic Storm over the Bay of Bengal formed in Pre monsoon season. Monsoon Season witnessed two Deep depressions over the Bay of Bengal and two Depressions, one over the Arabian Sea and one over land. Post-monsoon season was cyclogenically active with successive formations of Cyclonic Storms (KYANT and NADA) and VSCS 'VARDAH' over the Bay of Bengal.

The details of these systems are summarised in Tables 1, 2 & 3 and the tracks are shown in Fig. 1.

2. Details of the systems

2.1. Cyclonic Storm 'ROANU' over Bay of Bengal (17th -22nd May, 2016)

2.1.1. A cyclonic circulation extending in the lower tropospheric levels lay over southwest Bay of Bengal off Sri Lanka coast on 12th and over southwest Bay of Bengal off Sri Lanka coast and adjoining equatorial Indian Ocean on 13th. Under its influence, a trough of low formed over the same region with a cyclonic circulation aloft upto 4.5 kms a.s.l. on 14th. It organised into a low pressure area over the same region in the evening. It lay as a well marked low pressure area over southwest Bay of Bengal and adjoining Sri Lanka coast on 15th and over Sri Lanka and adjoining areas of Gulf of Mannar and southwest Bay of Bengal on 16th with associated cyclonic circulation extending upto mid tropospheric levels. It moved north-northwestwards and concentrated into a Depression (D) and lay over southwest Bay of Bengal off north Tamil Nadu coast centred near Lat. 11.0° N / Long. 81.0° E, about 240 kms south-southeast of Chennai at 0300 UTC of 17th. It moved slightly north-northeastwards and lay over southwest Bay of Bengal off north Tamil Nadu coast centred near Lat. 12.0° N / Long. 80.7° E, about 120 kms south-southeast of Chennai at 1200 UTC of 17th. It further moved north-northeastwards and intensified into a Deep

Depression (DD) and lay over southwest Bay of Bengal off north Tamil Nadu - south Andhra Pradesh coasts centered near Lat. 13.3° N / Long. 81.0° E, about 170 kms southeast of Nellore at 0300 UTC of 18th. It moved northwards and lay over west central and adjoining southwest Bay of Bengal centred near Lat. 14.4° N / Long. 81.0° E, about 200 kms south of Machilipatnam (Andhra Pradesh) and 160 kms east of Nellore (Andhra Pradesh) at 1200 UTC of the same day. It moved nearly north-northeastwards and intensified into Cyclonic Storm (CS) 'ROANU' and lay over west-central Bay of Bengal centered near Lat.15.1° N / Long. 81.4° E, about 125 kms south-southeast of Machilipatnam, 350 kms southwest of Vishakhapatnam and 225 kms southwest of Kakinada at 0000 UTC of 19th. It further moved north-northeastwards and lay over west-central Bay of Bengal centered near Lat. 15.6° N / Long.81.6° E about 80 kms south-southeast of Machilipatnam, 290 kms south-southwest of Vishakhapatnam and 160 kms south-southwest of Kakinada at 0300 UTC of 19th. It moved north-northeastwards and lay centred near Lat.16.0° N / Long. 81.9° E, about 240 kms south of Vishakhapatnam and 110 kms south-southwest of Kakinada at 1200 UTC of 19th. It then moved northeastwards and lay over west-central and adjoining northwest Bay of Bengal centered near Lat. 18.0° N / Long. 84.2° E, about 40 kms south-southeast of Kalingapatnam, 360 kms south-southwest of Paradip and 920 kms southwest of Chittagong (Bangla Desh) at 0300 UTC of 20th. It moved east-northeastwards and lay over northwest Bay of Bengal centred near Lat.19.7° N / Long. 86.5° E, about 70 kms south-southwest of Paradip, 70 kms southeast of Puri and 630 kms west-southwest of Chittagong (Bangla Desh) at 1200 UTC of 20th. It further moved east-northeastwards and lay over northwest Bay of Bengal centred near Lat. 21.5° N / Long. 90.3° E, about 270 kms east-southeast of Sagar Islands, 55 kms south of Khepupara (Bangla Desh) and 180 kms west-southwest of Chittagong (Bangla Desh) at 0300 UTC of 21st. It moved further east-northeastwards and crossed southeast coast of Bangladesh near Lat. 22.6° N / Long. 91.6° E around 1000 UTC of 21st, close to and to the north of Chittagong (Bangla Desh). It continued to move east-northeastwards and lay over Bangladesh centred near Lat. 22.8° N / Long. 92.0° E, about 130 Kms south-southwest of Aizwal (Tripura) at 1200 UTC of 21st. It further moved east-northeastwards and weakened into a DD over Mizoram

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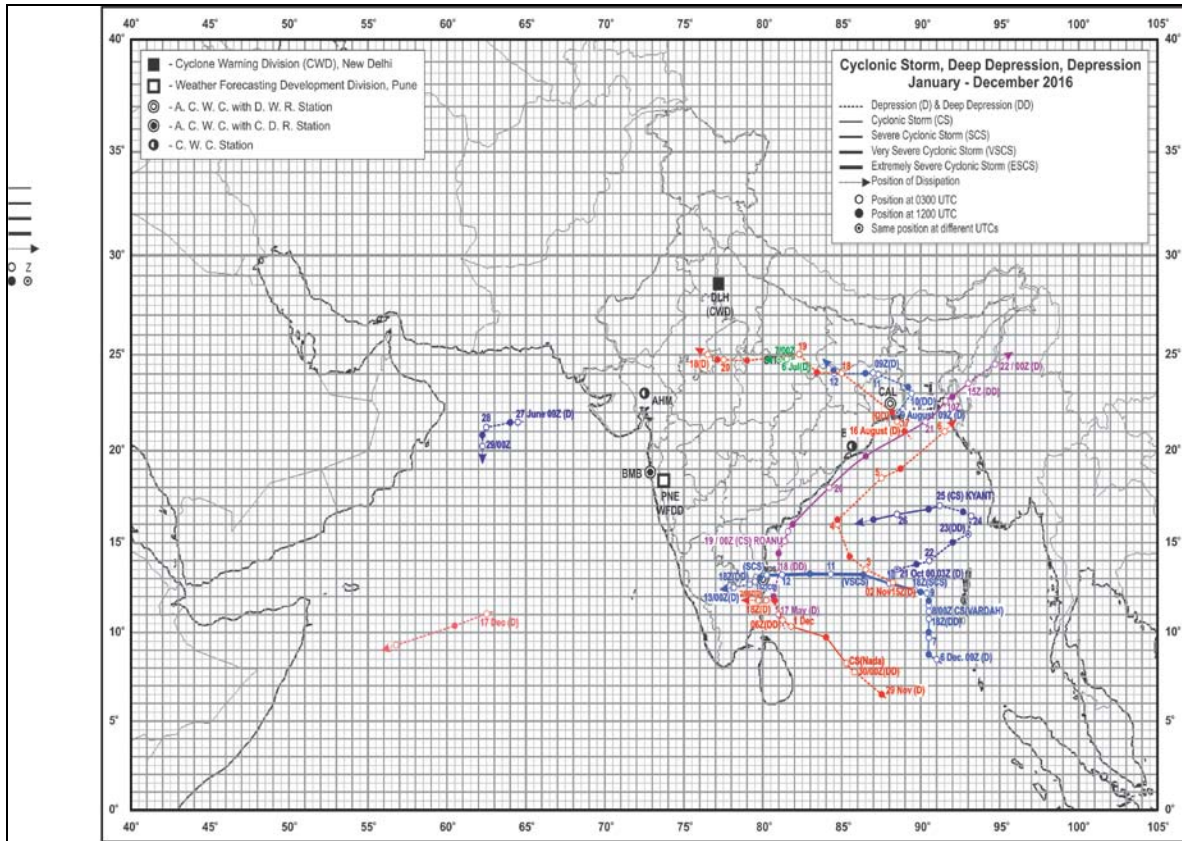


Fig. 1. Tracks of storms and depressions over during the year 2016

and lay centered near Lat. 23.5° N / Long. 93.0° E about 35 kms north-northeast of Aizwal at 1800 UTC of 21st. Further moving east-northeastwards, it weakened into a D and lay centered near Lat. 24.5° N / Long. 94.7° E, about 80 kms east-southeast of Imphal at 0000 UTC of 22nd. It weakened further and lay as a well marked low pressure area over Myanmar and adjoining Nagaland and Manipur with an associated cyclonic circulation extending upto 3.1 kms a.s.l. on 22nd morning and became un-important in the evening.

2.1.2. Other features observed

The lowest Estimated Central Pressure (ECP) was 983 hPa from 2100 UTC of 20th to 0900 UTC of 21st. The maximum estimated mean wind speed was 45 kts from 1800 UTC of 20th to 0900 UTC of 21st. The lowest observed pressure of 991.1 hPa was reported by Patuakhali (Bangla Desh) at 0300 UTC of 21st, when the system was very close to it towards the south. The maximum observed mean wind speed of 28 kts was reported by Patuakhali (Bangla Desh) at 0300 UTC of 21st. Bhubaneshwar recorded wind speed of 24 knots around midnight of 19th May.

Wind speed in knots recorded by following stations at the time of landfall is as follows- Cox'Bazar: 45, Sitakunda: 40, Comilla: 40, Sandwip: 38, Khepupara and Majidee Court: 35 each.

CS 'ROANU' moved nearly northwards till the midnight of 18th. It then moved north-northeastwards till the midnight of 19th and then northeast/ east-northeast for the remaining life period.

2.1.3. Weather and damage caused

Sri Lanka experienced heavy rainfall during 14th to 16th in association with the low pressure area over southwest Bay of Bengal and adjoining Sri Lanka coast. The heavy rainfall belt shifted gradually northwards and was limited to north Sri Lanka and coastal Tamil Nadu on 17th and rainfall more than 35 cm was observed over the region. It then shifted towards north Tamil Nadu and adjoining south coastal Andhra Pradesh on 18th. On 19th coastal Andhra Pradesh and adjoining areas of north coastal Tamil Nadu experienced rainfall more than 12 cm. On 20th north Andhra Pradesh, coastal Odisha and coastal West Bengal received rainfall more than 12 cm. On 21st

TABLE 1

Brief summary of cyclonic storms and depressions over the Indian Seas and neighbourhood during 2016

S. No.	Category	Life Period	Place / Time of landfall	Lowest Estimated/ observed central Pressure (hPa)	Max. wind (Estimated/ observed) (kts)	Highest "T" No.
1.	Cyclonic Storm (Roanu)	17-22 May	Crossed southeast coast of BanglaDesh near Lat. 22.6° N and Long. 91.6° E around 1000 UTC. It weakened into a well marked low pressure area over Myanmar and adjoining Nagaland and Manipur on 22 nd morning	983	45	3.0
2.	Depression	27-29 Jun	Weakened into a well marked low pressure area and lay over northwest and adjoining west central Arabian Sea	996	25	1.5
3.	Land Depression	6-7 Jul	Weakened into a well marked low pressure area over northeast Madhya Pradesh and neighbourhood on 7 th	992	25	-
4.	Deep Depression	9-12 Aug	Weakened into a well marked low pressure area over south Bihar and neighbourhood on 13 th	993	30	2.0
5.	Deep Depression	16-20 Aug	weakened into a well marked low pressure area over east Rajasthan & adjoining west Madhya Pradesh at 0000 hours UTC of 21 st	989	25	2.0
6.	Cyclonic Storm (Kyant)	21-27 Oct	weakened into well marked low pressure area over westcentral Bay of Bengal off Andhra Pradesh coast at 0530 hrs IST of 28 th	988	40	2.5
7.	Depression	2-6 Nov	Crossed southeast Bangla Desh coast near Long.92° E.Weakened into a well marked low pressure area over southeast Bangladesh & adjoining northeast Bay of Bengal on 0530 hrs IST of 7 th	996	25	1.5
8.	Cyclonic Storm (Nada)	29 Nov- 2 Dec	Crossed north Tamil Nadu coast near Nagapattinam between 2230 & 2330 UTC of 1 st Dec.weakened as a well marked low pressure area over interior Tamil Nadu & neighbourhood on 2 nd December	988	40	2.5
9.	VSCS (Vardah)	6-13 Dec	Crossed north Tamil Nadu coast close to Chennai Between 0930-1130 UTC of 12 th and weakened into a Well marked low pressure area over north interior Tamil Nadu and adjoining south interior Karnataka at 0300 hrs UTC of 13 th December	984	65	4.0
10.	Depression	17-18 Dec	weakened into a Well marked low pressure area over southwest Arabian Sea	994	25	1.5

north coastal Odisha, coastal West Bengal and Bangladesh received rainfall more than 12 cm. The region of heavy rainfall moved to Bangladesh & adjoining northeastern states of India on 22nd.

2.1.4. *Rainfall activities are summarized as follows*

18 May, 2016

Isolated extremely heavy rainfall and heavy to very heavy rainfall at a few places over Tamil Nadu. Heavy to

very heavy falls at a few places over coastal Andhra Pradesh. Isolated heavy to very heavy falls over Rayalaseema.

19 May, 2016

Isolated heavy to very heavy falls over Tamil Nadu. Isolated extremely heavy rainfall and heavy to very heavy rainfall at a few places over coastal Andhra Pradesh. Isolated heavy falls over Rayalaseema and south interior Karnataka.

TABLE 2
Storms / Depressions statistics 2016

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	-	-	-	-	1	1	2	-	-	1	-	5
Cyclonic Storms	-	-	-	1	-	-	-	-	-	1	-	2
Severe Cyclonic Storms	-	-	-	-	-	-	-	-	-	-	-	0
Very Severe Cyclonic Storms	-	-	-	-	-	-	-	-	-	-	1	1
Extremely Severe Cyclonic Storms	-	-	-	-	-	-	-	-	-	-	-	0
Super Cyclonic Storms	-	-	-	-	-	-	-	-	-	-	-	0
Total	-	-	-	-	-	-	-	-	-	-	-	8
Land Depression												
Depressions	-	-	-	-	-	1	-	-	-	-	-	1
Over the Arabian Sea												
Depressions/Deep Depressions	-	-	-	-	-	-	-	-	-	-	1	1
Cyclonic Storms	-	-	-	-	-	-	-	-	-	-	-	-
Severe Cyclonic Storms	-	-	-	-	-	-	-	-	-	-	-	0
Very Severe Cyclonic Storms	-	-	-	-	-	-	-	-	-	-	-	0
Extremely Severe Cyclonic Storms	-	-	-	-	-	-	-	-	-	-	-	0
Super Cyclonic Storms	-	-	-	-	-	-	-	-	-	-	-	0
Grand Total	0	0	0	1	1	2	2	0	0	2	2	10

20 May, 2016

Heavy to very heavy falls at a few places with isolated extremely heavy falls over Tamil Nadu. Heavy to very heavy falls at a few places over coastal Andhra Pradesh. Isolated heavy falls over Rayalaseema. Isolated heavy to very heavy falls over Odisha.

Isolated heavy falls over south interior Karnataka.

21 May, 2016

Heavy to very heavy falls at a few places with isolated extremely heavy falls over Odisha. Isolated heavy falls over Gangetic West Bengal and coastal Andhra Pradesh.

22 May, 2016

Heavy to very heavy falls at isolated places over Assam & Meghalaya. Heavy to very heavy falls at a few places over Nagaland-Manipur- Mizoram-Tripura.

2.1.5. Damages

Sri Lanka

As per media report, CS 'Roanu' in its genesis phase as a low pressure area/ depression over southwest Bay of Bengal caused mud-slide and severe flooding in Sri Lanka. It was responsible for 101 deaths and displacing over 1,34,000 people in Sri Lanka. Landslides buried three villages in Kegalle district of Sri Lanka.

India

Roanu also brought torrential rainfall to the Indian states of Tamil Nadu, Andhra Pradesh, Kerala and Odisha as it drifted in a generally northeastward direction, close to the coast. NDRF personnels were deployed in low lying areas of these states to handle any emergency situation. No death or damage was reported by these states.

TABLE 3
Ships' Observations during the system period

Call Sign	Date/Time	Position of the Ship		Wind		Pressure
	(UTC)	Lat. (°N)	Long. (°E)	Dir. (°)	Speed (Kts)	PPPP (hPa)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(A) Cyclonic Storm (Roanau) over the Bay of Bengal (17- 22 May, 2016)						
VTJR*	170300	9.9	88.5	190	23	1006.0
VTJR*	171200	9.9	88.4	190	16	1003.9
VTJR*	180000	9.4	88.6	200	19	1004.6
VTJR*	180300	9.2	88.6	200	17	1006.6
VTJR*	181200	8.3	88.9	220	21	1005.9
VTWS	190600	16.6	91.2	170	06	1006.4
AUXE	191200	12.6	81.4	320	25	1000.5
VTWS	200300	19.5	89.1	090	08	999.6
AUXE	200600	10.8	85.1	310	27	1004.6
(B) Cyclonic Storm (Kyant) over the Bay of Bengal (21 - 27 October, 2016)						
VTZJ*	210300	13.5	89.5	200	30	1004.6
AUXE*	211200	12.0	88.0	280	30	1004.6
VTJR*	211200	16.0	90.0	310	20	1003.5
AUXE*	220300	13.0	85.0	310	15	1010.9
VTJR*	221200	14.5	88.0	210	15	1006.5
VTJR*	230300	13.0	88.0	310	03	1010.8
VTJR*	231200	12.5	89.0	290	5	1007.5
VTJR*	240300	11.0	89.5	170	10	----
VTJR*	241200	11.0	89.5	---	---	1007.1
VTJR	250300	9.0	89.0	360	3	1009.8
VTJR	251200	8.5	89.0	140	10	1007.4
VTZJ	260300	12.5	91.0	210	10	1011.7
YJUP4	261200	14.0	83.0	160	10	1009.4
YJUP4	270300	14.5	82.0	160	20	1012.5
(C) Cyclonic Storm (Nada) over the Bay of Bengal (29 November - 2 December, 2016)						
VRGW3*	291200	5.7	84.2	320	22	1009.0
9V9132	300300	1.8	84.9	230	12	1014.0
YJUP4*	010600	---	---	030	16	1012.5
SJCD*	011800	---	---	180	06	1013.5
D) VSCS (Vardah) over the Bay of Bengal (6 - 13 Dec. 2016)						
BATFR10*	060900	6.2	88.0	310	18	---
SMGW*	061200	6.1	92.5	200	19	1006.3
9V7955*	070000	5.9	94.5	180	18	1007.0
SMGW*	070000	6.0	89.6	240	19	1007.9
BATFR10*	070300	6.0	85.3	320	13	--
TBWVK54*	070300	6.2	91.5	230	24	1009.5
9V9763*	070300	4.0	93.0	220	20	1009.5
SMCW*	071200	6.0	86.9	250	14	1008.0
A8UCS	091800	10.3	85.6	140	20	1008.0

* Observation during Depression / deep Depression

Bangladesh

As per the report received from Bangladesh Meteorological Department (BMD), overall 1,10,684 families were partially and 29,168 fully affected by CS Roanu. Twenty four people lost their lives and 2 were reported missing.

Landslides triggered by torrential rains claimed 11 lives and injuring seven in Assam and three lives in Aizawl, Mizoram

Chief amounts of 24 hrs rainfall (more than 7 cm) ending at 0300 UTC of 18 - 22 May, 2016 are given below:

18 May, 2016

Tamil Nadu

Kelambakkam 23, Ponneri 15, Mahabalipuram and Satyabama Uty ARG 14 each, Chembarabakkam and Chennai AP 12 each, Cholavaram, Kancheepuram and Chembarambakkam ARG 11 each, Anna Uty ARG and Tiruvallur 10 each, Chennai city, Cheyyur, Hvf Avadi ARG, Tambaram, Poondi, Red Hills, Thamaraipakkam and Puzhal ARG 9 each, Anna University, Poonamallee, Kvk Kattukuppam ARG and Sriperumbudur 8 each, Colachel and Tiruvallur ARG 7 each

Coastal Andhra Pradesh

Shar and Tada 15 each, Sullurpeta 14

Rayalseema:

Satyavedu 10, Tirupathi (ARG) 9

19 May, 2016

Tamil Nadu

Thamaraipakkam 9, Poonamallee, Pallipattu, Colachel and Cholavaram 8 each, Red Hills 7

Coastal Andhra Pradesh

Amalapuram 22, Kakinada 17, Anakapalle 14, Bapatla and Ambajipeta (Arg) 13 each, Avanigada, Atmakur and Chodavaram 12 each, Visakhapatnam and Narsapur 11 each, Gudivada 10, Vizianagaram, Palakoderu, Visakhapatnam AP, Peddapuram, Kaveli and Denkada 9 each, Machilipatnam, Gantyada, Pusapatirega and Tenali 8 each, Repalle, Vuyyuru AP, Ongole, Bheemavaram, Vepada, Garividi, Karamchedu,

Cheepurupalle, Srungavarapukota and Tanuku 7 each

Rayalseema

Palasamudram 7

South interior Karnataka

Thondebhavi 8

20 May, 2016

Tamil Nadu

Eraniel 24, Kuzhithurai and Colachel 19 each, Thuckalay and Krishnagiri 12 each, Thali and Kallakkurichchi 10 each, Muthupet, Grand Anaicut, Barur, Attur and Harur each 9, Hosur, Nagercoil, Nannilam and Thuvakudi Imti 8 each, Thanjavur, Thanjavur PTO, Thiruthuraipoondi and Ariyalur 7 each

Coastal Andhra Pradesh

Ichchapuram and Kalingapatnam 15 each, Ranastalam 14, Amalapuram, Palasa and Avanigada 11 each, Tekkali and Mandasa 10 each, Sompeta 9, Repalle and Visakhapatnam 8 each, Pusapatirega, Machilipatnam, Ambajipeta (ARG) and Tenali 7 each

Rayalseema

Arogyavaram and Mandapalle 7 each

Odisha

Kujanga ARG 12, Bhograi and Kakatpur 9 each, Marsaghai ARG and Gopalpur 8 each, Aska 7

South interior Karnataka

Rayalpadu 11, Devanahalli 7

21 May, 2016

Odisha

Balikuda ARG 21, Tirtol ARG 19, Astaranga ARG 18, Kujanga ARG 17, Paradip 16, Garadapur ARG and Marsaghai ARG 15 each, Bhograi and Nh5 Gobindpur 11 each, Derabis ARG and Alipingal 10 each, Rajghat, Kendrapara and Puri 9 each, Jaipur, Nilgiri, Binjharpur ARG and Chandbali 8 each, Kantapada ARG, Jagatsinghpur AWS, Bari ARG, Pattamundai, Rajkanika, Remuna ARG and Bonth 7 each

Gangetic West Bengal

Digha 10, Contai 9, Canning Town 7

Coastal Andhra Pradesh

Mandasa and Sompeta 7 each

22 May, 2016

Assam & Meghalaya

Haflong 20, Matijuri 12

Nagaland-Manipur-Mizoram-Tripura

Agartala AP 15, Arundhutinagar 14, Bishalgarh and Belonia 10 each, Aizawal, Imphal and Chottabekra 9 each, Khowai and Chandel AWS 8 each, Thoubal AWS, Kamalpur, Lengpui, Kohima and Khowai AWS 7 each

2.2. Depression over northeast Arabian Sea and neighbourhood (27-29 June, 2016)

2.2.1 A cyclonic circulation extending between lower & mid tropospheric levels lay over coastal Karnataka and neighbourhood on 21st; over north interior Karnataka & neighbourhood on 22nd; over south Konkan coast and neighbourhood on 23rd, over south Gujarat and adjoining areas of north Konkan on 24th & 25th and over Saurashtra and adjoining areas of northeast Arabian Sea on 26th. Under its influence, a low pressure area formed over northeast Arabian Sea and neighbourhood with the associated cyclonic circulation extending upto mid tropospheric level on 27th. It concentrated into a **D** over the same area and lay centred near Lat. 21.5° N / Long. 64.5° E, about 530 kms west of Porbandar (Gujarat) and 500 kms east-southeast of Ras Al Hadd (Oman) at 0900 UTC of 27th. It moved westwards and lay over north Arabian Sea centred near Lat. 21.5° N / Long. 64.0° E, about 580 kms west of Porbandar (Gujarat) and 440 kms east-southeast of Ras Al Hadd (Oman) at 1200 UTC of 27th. It further moved nearly westwards and lay over northwest Arabian Sea centred near Lat. 21.3° N / Long. 62.5° E, about 740 kms west-southwest of Porbandar (Gujarat) and 240 kms east-northeast of Masirah (Oman) at 0300 UTC 28th. It moved slowly south-southwestwards and lay over the same area centred near Lat. 20.8° N / Long. 62.3° E, about 770 kms west-southwest of Porbandar (Gujarat) and 350 kms east of Masirah (Oman) at 1200 UTC of 28th. It further moved southwards and lay over the same area centered near Lat. 20.3° N / Long. 62.3° E at 0000 UTC of 29th. It weakened into a well marked low pressure area and lay over northwest and adjoining west central Arabian Sea with the associated

cyclonic circulation extending upto mid tropospheric levels on 29th.

2.2.2. Other features observed

The lowest observed pressure of 994.1 hPa, was reported by Jiwani (along the Gulf of Oman) at 1200 UTC of 27th, when the system was to its northeast. The maximum mean wind speed of 40 kts was reported by Ship VTJR (12.4/58.9) at 1200 UTC of 28th when the system was to its north-northeast. The system initially moved in a westward direction and then south-southwest and southward direction.

2.2.3. Weather and damage caused

Active monsoon condition with very heavy to extremely heavy rainfall was observed over Konkan & Goa.

No damage has been reported due to this depression as it moved away from the coast.

Chief amounts of 24 hrs. Rainfall (more than 7 cm) ending at 0300 UTC from 27th to 29th June 2016 are given below:

27 June, 2016

Konkan & Goa

Ratnagiri 16, Murud 15, - Harnai 14, - Vengurla 12, Roha 11, Marmugoa, Mormugao and Kudal 10 each, Mulde Agri, Malvan, Quepem and Sanguem 9 each, Vaibhavwadi, Margao, Dabolim (Goa) and Dapoliagri 8 each, Sawantwadi, Rameshwaragri, Thane, Canacona, Sudhagad Pali and Kankavli 7 each

28 June, 2016

Saurashtra & Kutch

Tankara 7

Konkan & Goa

Harnai 18, Mhasla 14, Pernem 13, Sawantwadi 12, Shriwardhan, Dahanu, Rameshwar agri, Ratnagiri and Devgarh 11 each, Rajapur, Khed, Quepem, Tala and Dapoli agri 10 each, Mulde Agri, Guhagarh, Wakwaliagri, Ponda, Vengurla, Sanguem, Roha, Vaibhavwadi and Pen 9 each, Mangaon, Alibag, Kankavli, Margao, Lanja, Thane, Mumbai (SCZ), Kudal, Mapusa and Mandangad 8 each, Palghar agri, Ambernath, Dabolim (Goa), Malvan, Murud,

Bhiwandi and Panjim (Goa) 7 each

29 June, 2016

Gujarat Region

Choryasi 13, Umergam 8

Saurashtra & Kutch

Bhesan 7

Konkan & Goa

Murud 21, Harnai and Sanguem 18 each, Sawantwadi 17, Kudal 16, Valpoi, Dodamarg, Mulde Agri, Quepem, Mormugao 15 each, Guhagarh, Ratnagiri, Pernem, Rameshwar agri, Dabholim (Goa), Mapusa, Ponda, Malvan and Canacona 14 each; Vengurla, Mhasla, Lanja and Kankavli 13 each, Tala, Pen and Sangameshwar Devrukh 12 each, Panjim (Goa), Margao, Dapoli agri and Alibag 11 each, Mumbai (SCZ), Vaibhavwadi and Devgarh 10 each, Chiplun, Khed and Palghar agri 9 each, Mumbai (Colaba), Roha, Bhira and Dahanu 8 each, Mangaon, Sudhagad Pali and Shriwardhan 7 each

2.3 Land Depression over northeast Madhya Pradesh and neighbourhood (6-7 July, 2016)

2.3.1. A cyclonic circulation extending between 3.6 & 9.5 kms a. s. l. lay over west central Bay of Bengal off Andhra Pradesh-south Odisha coasts on 29th June. Under its influence, a low pressure area formed over westcentral and adjoining northwest Bay of Bengal and adjoining areas of north Andhra Pradesh-south Odisha coasts with an associated cyclonic circulation extending upto mid tropospheric levels on 30th June. It lay over northwest Bay of Bengal off Odisha coast on 1st July, over northwest Bay of Bengal and adjoining areas of Odisha and Gangetic West Bengal on 2nd, over Jharkhand and adjoining areas of Gangetic West Bengal & Odisha on 3rd and over southern parts of Bihar and neighbourhood on 4th with the associated cyclonic circulation extending upto mid & upper tropospheric levels. It lay as a well marked low pressure area over east Uttar Pradesh and adjoining Bihar with the associated cyclonic circulation extending upto 7.6 kms a.s.l. on 5th. It concentrated into a **D** and lay centred near Lat. 24.8° N / Long. 81.5° E over northeast Madhya Pradesh and neighbourhood centred nearly 30 kms to the east of Satna at 0300 UTC of 6th and persisted there and lay centred near Lat. 24.8° N / Long. 81.0° E at 1200 UTC. It persisted there and lay centred near Lat. 24.8° N / Long. 81.0° E nearly 30 kms to the east of Satna at 0000 UTC of 7th. It weakened subsequently and lay as a well

marked low pressure area over the same region on 7th. It lay as a low pressure area over the same region on 8th and became less marked on 9th.

2.3.2. Other features observed

The lowest observed pressure of 992.1 hPa was reported by Satna at 1200 UTC of 6th. The maximum surface mean wind speed of 8 kts was reported by Varanasi at 1200 UTC of 7th.

2.3.3. Weather and damage caused

Vigorous monsoon conditions prevailed over east Madhya Pradesh with extremely heavy rainfall at isolated places and very Heavy rainfall at a few places over west Madhya Pradesh.

This system caused flood due to heavy rain in which 22 lives were lost in Madhya Pradesh.

Chief amounts of 24 hrs rainfall (more than 7 cm) ending at 0300 UTC of 6-7 July, 2016 are given below:

6 July, 2016

West Madhya Pradesh

Guna and Guna AWS 13 each, Begumganj 12, Vidisha AWS 11, Isagarh, Chicholi and Lateri 10 each, Udaipura, Shivpuri, Shivpuri - AWS, Salwani / Silvani and Bareli 9 each, Narsingarh, Sironj and Ichhawar 8 each, Ashoknagar - AWS, Raisen, Raisen - AWS, Nusrulgunj -Arg and Kurwai 7 each

East Madhya Pradesh

Narsingpur 31, Ajaigarh 19, Nagode 17, Sidhi and Sidhi - AWS 16 each, Khurai and Tendukheda 15 each, Lakhnadon, Satna - AWS, Satna and Kareli 13 each, Maihar 12, Panna - AWS, Rewa and Rewa - AWS 11 each, Deori, Umariya and Umariya - AWS 10 each, Chahtarpur - AWS 9, Gudh, Sagar and Sagar - AWS 8 each, Gadawara and Hanumana 7 each

7 July, 2016

West Madhya Pradesh

Pachmarhi 17, Udaipura 13, Salwani / Silvani and Mungaoli 10 each, Begumganj, Ganjbasoda and Bareli 9 each, Vidisha - AWS, Raisen, Raisen - AWS and Kurwai 8 each

East Madhya Pradesh

Maihar 34, Hatta 29, Satna and Satna - AWS 28 each, Nagode 21, Damoh, Damoh - AWS and Buxwaha 19 each, Panna - AWS; 11 - Ajaigarh and Khajurao 15 each, Sagar, Sagar - AWS and Deori 10 each, Khurai, Tendukheda, Rajnagar, Patan, Jabalpur, Katni - AWS and Garhakota 9 each, Rehli, Chahtarpur - AWS, Gotegaon and Tikamgarh - AWS 7 each

2.4. Deep Depression over coastal areas of West Bengal & neighborhood (9 -12 August, 2016)

2.4.1. A cyclonic circulation extending upto upper tropospheric levels lay over north Bay of Bengal and adjoining Gangetic West Bengal on 7th and over northwest Bay of Bengal and adjoining Gangetic West Bengal on 8th. Under its influence, a low pressure area formed over northwest Bay of Bengal and adjoining coastal areas of west Bengal in the early morning of 9th and lay as a well marked low pressure area over the same region at 0300 UTC of 9th. Associated cyclonic circulation extended upto 7.6 kms a.s.l. It concentrated into a D and lay over coastal areas of West Bengal & neighbourhood near Lat. 22.0° N/ Long. 88.5° E close to Canning Town at 0900 UTC of 9th. It remained practically stationary and lay over the same region near Lat. 22.0° N/ Long. 88.5° E close to Canning Town at 1200 UTC of 9th. It moved northeastwards and intensified into a D over south Bangla Desh & neighbourhood and lay centred near Lat. 23.0° N/ Long. 89.4° E about 100 kms east-northeast of Kolkata. at 0300 UTC of 10th. It moved north-northwestwards and lay centred over Bangla Desh and adjoining West Bengal near Lat. 23.4° N / Long. 89.1° E about 60 kms east of Krishnanagar at 1200 UTC of 10th. It moved west-northwestwards and lay over Gangetic West Bengal and adjoining Jharkhand, centred near Lat. 24.0° N / Long. 87.4° E about 240 kms northeast of Ranchi and 140 kms southeast of Bhagalpur at 0300 UTC of 11th. It moved west-northwestwards and weakened into a D and lay centred over Jharkhand and adjoining Gangetic West Bengal near Lat. 24.0° N / Long. 87.0° E about 200 kms northeast of Ranchi and 220 kms east-southeast of Gaya at 0600 UTC of 11th. It remained practically stationary and lay over the same region near Lat. 24.0° N / Long. 86.5° E at 1200 UTC of 11th. It moved nearly westwards and lay over Jharkhand & neighbourhood near Lat. 24.0° N / Long. 84.5° E, about 40 kms east of Daltonganj at 0300 UTC 12th. It remained practically stationary and lay centred over Jharkhand & neighbourhood near Lat. 24.2° N / Long. 84.5° E, about 40 kms east of Daltonganj at 1200 UTC of 12th. The system lay as a well marked low pressure area over south Bihar and neighbourhood on 13th.

2.4.2. Other features observed

The lowest observed Pressure of 992.5 hPa, and surface wind speed of 12 kts was recorded by Jessore (Bangla Desh) at 0300 UTC of 10th August, when the centre of system was very close to it. System initially moved northeastwards and then recurved northwestwards.

2.4.3. Weather and damage caused

Active to vigorous monsoon conditions prevailed over Gangetic West Bengal and Jharkhand. Scattered to widespread rainfall with heavy to very heavy rainfall at a few places occurred over Gangetic West Bengal and Bihar and extremely heavy rainfall at isolated places over Jharkhand.

Chief amounts of 24 hrs rainfall (more than 7 cm) ending at 0300 UTC from 9-12 August are given below:

9 August, 2016

Gangetic West Bengal

Canning Town 8, Amta and Contai 7 each

Odisha

Chandbali 11, Pattamumlai & Raj Kanika 9 each, Kendrapara 8, Derabis (ARG), Marsaghai (ARG) & Danagali (ARG) 7 each

Jharkhand

Hunterganj 7

Bihar

Bhabhua 11, Sherghati 7

10 August, 2016

Gangetic West Bengal

Deganga 16, Manmothnagar 13, Contai 9, Canning Town and Basirhat 7 each

Jharkhand

Jamshedpur AP 22, Jamshedpur 14, Rajdhanwar 11, Tundi 7

Bihar

Sherghati 9

11 August, 2016

Gangetic West Bengal

Krishnanagar 17, Bongaon and Mangalkote 16 each,

Krishnanagar 13, Gheropara and Ranaghat 11 each, Indus10, Kalna, Asansol CWC, Bolpur, Debagram, Manteswar, Deganga, Sonamukhi ARG, Rajnagar and Sriniketan 9 each, Kanksa BSF, Asansol and Durgapur 8 each, Mohanpur, Basirhat, Mankar, Amtala, Hetampur and Pingla 7 each

Jharkhand

Maithon 14, Maheshpur and Jamshedpur 11 each, Jamtara 10, Satgaon and Jamshedpur AP 9 each, Jarmindi 8, Pakuria, Panchet, Messenjore and Giridih 7 each

Bihar

Rafiganj 8

12 August, 2016

Jharkhand

Chatra 24, Panki and Bishrampur 17 each, Daltonganj and Manatu 14 each, Garhwa 13, Madhupur 12, Latehar 11, Bagodar I and Jamshedpur 10 each, Barkisuriya and Hunterganj 9 each, Jamshedpur AP, Tilaiya, Balumath, Tundi, Hazaribagh, Dumri and Giridih 8 each, Barhi, Rajdhanwar and Pathalgada 7 each

Bihar

Sono 7

2.5. Deep pepression over northwest Bay of Bengal & neighbourhood (16 -21 August, 2016)

2.5.1 A cyclonic circulation between 5.8 & 7.6 kms a.s.l. lay over northeast Bay of Bengal and neighbourhood on 14th. Under its influence, a low pressure area formed over north Bay of Bengal and neighbourhood on 15th. Associated cyclonic circulation extended upto 7.6 kms a.s.l. It became well marked and lay over northwest Bay of Bengal and neighbourhood on 16th. Associated cyclonic circulation extended upto 5.8 kms a.s.l. It concentrated into a D over the same region and lay centred near Lat. 21.0° N / Long 89.0° E about 160 kms southeast of Digha and 220 kms east-southeast of Balasore at 1200 UTC of 16th. It moved northwestwards and lay centred over northwest Bay of Bengal & neighbourhood near Lat. 21.5° N / Long. 88.5° E, about 75 kms east-southeast of Digha and 160 kms east of Balasore at 0300 UTC of 17th. It intensified into a D, lay centred over the same region near Lat. 21.6° N / Long. 88.4° E, about 70 kms east-southeast of Digha and 155 kms east of Balasore at 0900 UTC of 17th. It further moved northwestwards and crossed

west Bengal coast between Digha and Diamond harbour around 1130 UTC and lay centred over Gangetic west Bengal & neighbourhood, near lat. 22.0° N / Long. 88.2° E, close to Diamond harbour at 1200 UTC of 17th. It further moved northwestwards and lay centred over Jharkhand & adjoining areas of north Chhattisgarh and south Bihar, near Lat. 24.0° N / Long. 85.0° E, about 100 kms east of Daltonganj at 0300 UTC of 18th. It moved west-northwestwards and lay centred over southeast Uttar Pradesh and neighbourhood, near Lat. 24.1° N / Long. 83.4° E, about 80 kms west of Daltonganj and about 150 kms east-southeast of Sidhi at 1200 UTC of 18th. It further moved west-northwestwards and lay centred over south Uttar Pradesh & adjoining northeast Madhya Pradesh, near Lat. 25.0° N / Long. 82.3° E, about 160 kms east-northeast of Satna and 240 kms east of Khajuraho at 0300 UTC of 19th. It moved nearly westwards and lay centred over extreme north Madhya Pradesh and adjoining south Uttar Pradesh, near Lat. 24.7° N & Long. 79.0° E at 1200 UTC of 19th. It further moved nearly westwards and lay centred over west Madhya Pradesh and adjoining east Rajasthan close to Guna near Lat. Lat. 24.8° N / Long. 77.5° E at 0300 UTC of 20th. It moved slightly westwards and lay centred over same area, near Lat. 24.8° N / Long. 77.2° E, about 30 kms north-northwest of Guna at 1200 UTC of 20th. It further moved nearly westwards and weakened into a D and lay centred over east Rajasthan & adjoining northwest Madhya Pradesh, near Lat. 25.0° N / Long. 76.5° E, about 70 kms east of Kota at 1500 UTC of 20th. It further weakened into a well marked low pressure area and lay over east Rajasthan & adjoining west Madhya Pradesh at 0000 UTC of 21st.

2.5.2. Other features observed

The lowest observed pressure of 989.0 hPa was reported by Digha and Kolkata 0900 and 1200 UTC respectively of 17th and when the centre of system was very close to it. The maximum sustained wind speed of 23 kts was reported by Buoy 23092 (17.8/89.7) at 1200 UTC of 16th. The system initially moved in a north-west and west-northwestward direction and then westward and weakened into a well marked low pressure area over east Rajasthan and adjoining west Madhya Pradesh.

2.5.3. Weather and damage caused

Active to vigorous monsoon conditions prevailed over eastern parts of India and adjoining Central India. Fairly widespread to widespread rainfall occurred with heavy to very heavy & extremely heavy rainfall at isolated places around the track of the DD.

Flood affected more than one lakh people, many houses collapsed and water entered in many villages in districts of Bundelkhand.

Chief amounts of 24 hrs. rainfall (more than 7 cm) ending at 0300 UTC from 16th August to 20th August are given below:

16 August, 2016

Jharkhand

Chaibasa 10, Deoghar 7

East Madhya Pradesh

Ajaigarh 14, Nagode 12, Rajnagar and Panna - AWS 9 each, Hanumana 8, Chahtarpur - AWS, Jabalpur, Rewa, Rewa - AWS and Maihar 7 each

17 August, 2016

Jharkhand

Manatu 7

East Madhya Pradesh

Maihar 18, Nagode, Satna and Satna - AWS 17 each, Ajaigarh and Khajurao 14 each, Rajnagar and Kotma 13 each, Rewa, Rewa - AWS, Umaria and Umaria - AWS 12 each, Panna - AWS 11, Sohagpur - AWS 10, Gudh 7

18 August, 2016

Gangetic West Bengal

Purihansa 13, Kharidwar 12, Asansol CWC and Tusuma 10 each, Asansol and Phulberia 9 each, Harinkhola, Kolkata, Hatwara and Purulia 8 each, Kashipur, Jhalda and Diamond Harbour 7 each

Jharkhand

Jamshedpur AP 27, Jamshedpur 24, Latehar 14, Chandil, Nimdih and Dhanbad 13 each, Putki and Tenughat 12 each, Chakradharpur, Kharsema and Bokaro 11 each, Kuru, Chaibasa and Papunki 10 each, Bagodar I, Jaridih, Mandar, Panchet, Simdega, Lohar - Daga and Gobindpur 9 each, Torpa, Tundi, Manatu and Topchanchi 8 each, Kolebira, Hazaribagh, Chatra, Sarath, Jarmindi, Giridih, Panki, Maithon, Daltonganj and Madhupur 7 each

East Madhya Pradesh

Katni - AWS and Panna - AWS 7 each

19 August, 2016

Gangetic West Bengal

Simula 9, Purulia 8

Jharkhand

Lohar - Daga 7

East Madhya Pradesh

Maihar 28, Nagaon and Nagode 21 each, Panna - AWS 19, Ajaigarh 18, Rajnagar and Chahtarpur - AWS 17 each, Gudh 15, Rewa, Rewa - AWS and Khajurao 14 each, Satna - AWS and Satna 13 each, Buxwaha, Sidhi and Sidhi - AWS 10 each, Hanumana 9, Katni - AWS 8, Tikamgarh and Tikamgarh - AWS 7 each

20 August, 2016

West Madhya Pradesh

Biaora 25, Kurwai 21, Rajgarh and Ganjbasoda 16 each, Lateri and Begumganj 15 each, Raisen, Raisen - AWS and Narsingarh 14 each, Isagarh 12, Mungaoli, Bhopal, Bhopal - AWS - Arg, Khilchipur and Vidisha - AWS 11 each, Salwani / Silvani 10, Chanderi, Chachoda and Sironj 9 each, Guna, Udaipura, Guna - AWS, Sarangpur and Agar 8 each, Ashoknagar - AWS, Tarana, Shajapur, Shajapur - AWS and Pichhore 7 each

East Madhya Pradesh

Khurai and Buxwaha 19 each, Sagar and Sagar - AWS 16 each, Hattal 14, Damoh, Damoh - AWS and Garhakota 13 each, Rehli 11, Deori 10, Tikamgarh and Tikamgarh - AWS 9 each, Tendukheda and Maihar 8 each

2.6. Cyclonic Storm 'KYANT' over east-central Bay of Bengal (21 - 28 October, 2016)

2.6.1. A cyclonic circulation extending upto mid tropospheric levels lay over Arakan coast and neighbourhood on 17th and over eastcentral Bay of Bengal and neighbourhood on 18th. Under its influence, a low pressure area formed over the same region. Associated cyclonic circulation extended upto 4.5 kms a. s. l. on 19th. It lay as a well marked low pressure area over eastcentral and adjoining southeast Bay of Bengal. Associated cyclonic circulation extended upto mid tropospheric levels on 20th. It concentrated into a D and lay centred over eastcentral and adjoining southeast Bay of Bengal near Lat. 13.5° N/Long. 88.5° E about 500 kms west-northwest

of Port Blair and 900 kms west-southwest of Yangon (Myanmar) at 0000 UTC of 21st. It remained practically stationary and lay centred over the same region near Lat. 13.5° N/ Long. 88.5° E at 0300 UTC of 21st. It moved east-northeastwards and lay centred over eastcentral Bay of Bengal near Lat. 13.9° N/Long. 89.8° E about 400 kms west-northwest of Port Blair and 750 kms west-southwest of Yangon (Myanmar) at 1200 UTC of 21st. It further moved east-northeastwards and lay centred over the same region near Lat. 14.0° N/Long. 90.5° E about, 350 kms northwest of Port Blair and 680 kms southwest of Yangon (Myanmar) at 0300 UTC of 22nd. It further moved east-northeastwards and lay centred over the same region near Lat. 14.9° N/Long. 92.0° E about 370 kms north-northwest of Port Blair and 490 kms southwest of Yangon (Myanmar) at 1200 UTC of 22nd. It continued to move east-northeastwards and intensified into a D D over Arakan coast and adjoining eastcentral Bay of Bengal and lay centred near Lat. 15.5° N/Long. 93.0° E about, 420 kms north of Port Blair and 360 kms west-southwest of Yangon (Myanmar) at 0300 UTC of 23rd. It remained practically stationary and lay centred near Lat. 15.5° N/ Long. 93.0° E about, 420 kms north of Port Blair and 360 kms west-southwest of Yangon (Myanmar) at 1200 UTC of 23rd. It moved nearly northwards and lay centred over the same region near Lat. 16.4° N/Long. 93.2° E about, 520 kms north-northeast of Port Blair and 310 kms west-southwest of Yangon (Myanmar) at 0300 UTC of 24th. It moved west-northwestwards and lay centred over the same region, near Lat. 16.7° N/Long. 92.7° E, about 560 kms north-northwest of Port Blair and 360 kms west-southwest of Yangon (Myanmar) at 1200 UTC of 24th. It further moved west-northwestwards and intensified into C S 'KYANT' and lay centred over eastcentral Bay of Bengal, near Lat. 17.0° N/Long. 91.2° E, about 620 kms north-northwest of Port Blair, 710 kms south-southeast of Gopalpur and 850 kms east of Vishakhapatnam at 0300 UTC of 25th. It moved west-southwestwards and lay centred near Lat. 16.9° N/Long. 90.5° E, about 650 kms east-southeast of Gopalpur, 770 kms east-southeast of Vishakhapatnam and 1000 kms east-northeast of Machilipatnam at 1200 UTC of 25th. It further moved west-southwestwards and lay centred over central Bay of Bengal near Lat. 16.6° N/Long. 88.5° E, about 480 kms southeast of Gopalpur, 570 kms east-southeast of Vishakhapatnam and 780 kms east-northeast of Machilipatnam at 0300 UTC of 26th. It moved west-southwestwards and lay centred over westcentral Bay of Bengal near Lat. 16.3° N/Long. 87.0° E, about 400 kms southeast of Gopalpur, 430 kms east-southeast of Vishakhapatnam and 620 kms east-northeast of Machilipatnam at 1200 UTC of 26th. It further moved west-southwestwards and weakened into a D D and lay centered over westcentral Bay of Bengal, near Lat. 15.9° N/ Long. 85.9° E, 390 kms south-southeast of

Gopalpur, 340 kms southeast of Vishakhapatnam and 500 kms east of Machilipatnam at 2100 UTC of 26th. It continued to move west-southwestwards and lay centred over the same region, near Lat. 15.3° N/Long. 85.1° E, 550 kms east-northeast of Nellore, 310 kms southeast of Vishakhapatnam and 420 kms east of Machilipatnam at 0300 UTC of 27th. It moved westwards and weakened into a D and lay centred over the same region, near Lat. 15.4° N/ Long. 83.5° E, about 240 kms south-southeast of Vishakhapatnam and 260 kms east-southeast of Machilipatnam and 390 kms east-northeast of Nellore at 1200 UTC of 27th. It moved west-southwestwards and lay centred over the same region, near Lat. 15.3° N/ Long. 83.0° E, about 260 kms south-southwest of Vishakhapatnam and 220 kms east-southeast of Machilipatnam and 330 kms east-northeast of Nellore at 1800 UTC of 27th. It further weakened and lay as a well marked low pressure area over westcentral Bay of Bengal off Andhra Pradesh coast at 0000 UTC of 28th.

2.6.2. Other features observed

The highest maximum wind speed reported by Ship AUXE (12.0/88.0) was 30 kts at 1200 UTC of 21st. A Mean Sea level Pressure of 1001.6 hPa, was reported at Port Blair on 22nd at 0300 UTC. System initially moved east-northeastwards, slightly northwards and then west-northwest and west-southwestwards.

2.6.3. Weather and damage caused

Isolated to widespread rainfall occurred over Andaman & Nicobar Islands. Isolated rainfall occurred over Tamil Nadu & Puducherry.

Chief amounts of 24 hrs rainfall (more than 7 cm) ending at 0300 UTC from 21st to 26th October, 2016 are given below:

21 October, 2016

Tamil Nadu & Puducherry

Mulanur and Chatrapatti (Odanchatra) 8 each, Erode and Kumarapalayam 7 each

22 October, 2016

Tamil Nadu & Puducherry

Sholavandan 10, Usilampatti and Peraiyur 8 each, Vadipatti

23 October, 2016

Nil

24 October, 2016**Tamil Nadu & Puducherry**

Grand Anaicut 7

25 October, 2016

Nil

26 October, 2016

Nil

2.7. Depression over over Andaman Sea and adjoining areas of southeast Bay of Bengal (2 - 6 November, 2016)

2.7.1. A cyclonic circulation extending upto mid tropospheric levels lay over Malay peninsula and neighbourhood on 30th October and over south Andaman Sea and neighbourhood on 31st October. Under its influence, a low pressure area formed over the same region on 1st November. It intensified into a well marked low pressure area over Andaman sea and adjoining areas of southeast Bay of Bengal on 1st November evening and lay over southeast Bay of Bengal and neighbourhood on 2nd. It concentrated into a D and lay centred at 1500 UTC of 2nd over the same region near Lat. 12.8° N/Long. 88.2° E. It moved northwestwards and lies centred over westcentral and southeast Bay of Bengal near Lat. 13.5° N /Long. 86.5° E, about 570 km southeast of Vishakhapatnam, 750 km south of Paradip and 1020 km south southwest of Khepupara (Bangladesh) at 0300 UTC of 3rd. It moved northwestwards and lay centred over westcentral Bay of Bengal near Lat. 14.2° N/Long. 85.5° E, about 450 kms south-southeast of Vishakhapatnam, 680 kms south-southwest of Paradip and 990 kms south-southwest of Khepupara (Bangladesh) at 1200 UTC of 3rd. It further moved northwards and lay centered over same region near Lat. 15.5° N/Long. 85.0° E, about 300 kms south-southeast of Vishakhapatnam, 550 kms south-southwest of Paradip and 900 kms southwest of Khepupara (Bangladesh) at 0000 UTC of 4th. It moved north-northwestwards and lay centered over westcentral Bay of Bengal near Lat. 16.0° N/Long. 84.7° E, about 240 kms southeast of Vishakhapatnam, 520 kms south-southwest of Paradip and 880 kms south-southwest of Khepupara (Bangladesh) at 0300 UTC of 4th. It moved northwards and lay centred over westcentral Bay of Bengal near Lat. 16.3° N / Long. 84.7° E, about 210 kms southeast of

vishakhapatnam, 490 kms south-southwest of paradip and 850 kms south-southwest of Khepupara (Bangladesh) at 1200 UTC 4th. It moved east-northeastwards and lay centred over westcentral and adjoining northwest Bay of Bengal near Lat. 18.5° N / Long. 87.5° E, about 470 km south-southwest of Kolkata, 210 km southeast of Paradip and 480 km south-southwest of Khepupara (Bangladesh) at 0300 UTC of 5th. It moved northeastwards and lay centred over northwest Bay of Bengal near Lat. 19.0° N/ Long. 88.7° E, about 410 kms south-southeast of Kolkata, 250 kms east-southeast of Paradip and 370 kms south-southwest of Khepupara (Bangladesh) at 1200 UTC of 5th. It moved further northeastwards and lay centred over northeast Bay of Bengal near Lat. 21.0° N/Long. 91.5° E, about 360 kms east-southeast of Kolkata, 150 kms southwest of Chittagong (Bangladesh) and 170 kms southeast of Khepupara (Bangladesh) at 0300 UTC of 6th. It moved northeastwards and crossed southeast Bangladesh coast near Long. 92.0° E at 1200 UTC the 6th and weakened into a well marked low pressure area over southeast Bangladesh & adjoining northeast Bay of Bengal and lay as a low pressure area over southeast Bangladesh and neighbourhood at 0000 UTC of 7th.

2.7.2. Other features observed

The lowest observed pressure of 1000.5 hPa was reported by Buoy 23092(17.6/89.6) at 1200 UTC of 5th. The maximum sustained wind speed of 25 kts was reported by Ship VWXS (15.1/87.5) 1200 UTC of 4th.

2.7.3. Weather and damage caused

System caused fairly widespread rainfall with isolated heavy falls over north coastal Andhra Pradesh, coastal Odisha, coastal West Bengal, south Assam, Tripura and Mizoram for one day each.

Chief amounts of 24 hrs rainfall (7 cm or more) ending at 0300 UTC from 2nd to 4th November are given below:

4 November, 2016**Coastal Andhra Pradesh**

Kalingapatnam 9, Mandasa 7

5 November, 2016**Odisha**

Tirtol Arg and Paradeep Cwr 10 each, Marsaghai ARG 9, Astaranga ARG, Derabis Arg, Chandbali and Garadapur ARG 8 each, Balikuda ARG, Kendrapara,

Kujanga ARG and Rajkanika 7

6 November, 2016

Nagaland-Manipur- Mizoram-Tripura

Arundhutinagar 13, Khowai, Agartala Aero and Kailashahar Aero 12 each, Kamalpur and Bishalgarh 11 each, Gokulpur - AWS, Udaipur and Belonia 10 each, Sonamura and B P Ghat 9 each, Karimganj and Sabroom 8 each, Aizwal and Halflong 7

2.8 Cyclonic Storm "Nada" over Bay of Bengal (29th November to 2nd December, 2016)

2.8.1 A trough of low at mean sea level lay over southeast Bay of Bengal and adjoining equatorial Indian Ocean on 27th. Under its influence, a low pressure area formed over the same region with associated cyclonic circulation extending upto 3.1 kms a. s. l. on 28th. It lay as a well marked low pressure area over the same region on 28th evening. It persisted over the same region with associated cyclonic circulation extending upto mid tropospheric levels on 29th morning. It concentrated into a D over southeast Bay of Bengal and lay centered near Lat. 6.5° N / Long. 87.5° E, about 1070 kms east-southeast of Chennai, 1030 kms east-southeast of Puducherry and 720 kms east-southeast of Trincomalee (Srilanka) at 1200 UTC of 29th. It moved west northwestwards and intensified into a D D over southwest and adjoining southeast Bay of Bengal and lay centered near Lat. 7.8° N / Long. 85.7° E, about 830 kms southeast of Chennai, 780 kms east southeast of Puducherry and 490 kms eastsoutheast of Trincomalee (Srilanka) at 0000 UTC of 30th Nov. It then moved northwestwards and further intensified into C S 'Nada' over southwest & adjoining southeast Bay of Bengal and lay centred near Lat. 8.2° N / Long. 85.3° E, about 770 kms southeast of Chennai, 730 kms east-southeast of Puducherry and 450 kms east-southeast of Trincomalee (Srilanka) at 0300 UTC 30th November. It moved northwestwards and lay centred over southwest Bay of Bengal near Lat. 9.8° N / Long. 84.0° E, about 550 kms southeast of Chennai, 520 kms east-southeast of Puducherry and 330 kms east-southeast of Trincomalee (Srilanka) at 1200 UTC of 30th November. It then moved west-northwestwards and lay over southwest Bay of Bengal centred near Lat. 10.4° N / Long. 81.7° E, about 330 kms south-southeast of Chennai, 270 kms southeast of Puducherry and 210 kms north-northeast of Trincomalee (Srilanka) at 0300 UTC of 1st December. It then moved west-northwestwards, weakened into a D D and lay centred over southwest Bay of Bengal near Lat. 10.6° N / Long. 81.2° E, about 290 kms south-southeast of Chennai and 210 kms southeast of Puducherry at 0600 UTC of 1st December. It further moved west-

northwestwards and lay centred over southwest Bay of Bengal near Lat. 10.7° N / Long. 80.7° E, about 90 kms east-southeast of Karaikal and 150 kms southeast of Cuddalore at 1200 UTC of 1st December. Continuing to move west-northwestwards, it weakened into a D and lay centred over southwest Bay of Bengal off north Tamil Nadu coast near Lat. 11° N / Long. 80.4° E, about 40 kms east-southeast of Karaikal at 1800 UTC of 1st December. Then it moved westwards, crossed north Tamil Nadu coast near Nagapattinam (about 20 kms south of Karaikal) between 2230 & 2330 UTC of 1st December and lay centred over north Tamil Nadu near Lat. 11.0° N / Long. 79.9° E, about 15 kms west of Nagapattinam and 20 kms southwest of Karaikal at 0000 UTC of 2nd December. It further weakened and lay as a well marked low pressure area over interior Tamil Nadu & neighbourhood on 2nd.

2.8.2. Other features observed

The lowest observed pressure of 1008.1 hPa, was reported by Hambantota at 1200 UTC of 30th November. The maximum sustained wind speed of 23 kts was reported by Buoy 23094 (13.4/84.2) at 1200 UTC of 30th November, when system was towards south of it.

2.8.3. Weather and damage caused

Crossing phase of the system caused active northeast monsoon conditions over Tamil Nadu. Over 50,000 fishermen from coastal villages in Kanyakumari (Tamil Nadu) abstained from fishing due to 'Nada'.

Chief amounts of 24 hrs rainfall (7 cm or more) ending at 0300 UTC of 1st & 2nd December are given below:

1 December, 2013

Nil

2 December, 2013

Tamil Nadu & Puducherry

Mahabalipuram 11, Gudur 9

2.9 Very Severe Cyclonic Storm 'VARDAH' over the Bay of Bengal (6 - 13 December, 2016)

2.9.1. A cyclonic circulation extending upto mid tropospheric levels lay over southern parts of Malay peninsula and neighbourhood on 2nd and over northern parts of Sumatra and neighbourhood on 3rd. Under its influence, a low pressure area formed over south Andaman Sea and adjoining Sumatra with associated

cyclonic circulation extending upto mid tropospheric levels on 4th. It lay as a well marked low pressure area over the same region in the evening. It lay over south Andaman Sea and adjoining southeast Bay of Bengal with the associated cyclonic circulation extending upto 5.8 kms a.s.l. on 5th & 6th. It concentrated into a D over southeast Bay of Bengal and lay centred near Lat. 8.5° N / Long. 91.0° E, about 1320 kms south-southeast of Vishakhapatnam, 1360 kms south-southeast of Gopalpur and 210 kms west-southwest of Car Nicobar at 0900 UTC of 6th. It moved west-northwestwards and lay over the same region, centred near Lat. 8.8° N / Long. 90.5° E, about 1260 kms south-southeast of Vishakhapatnam, 1310 kms south-southeast of Gopalpur and 260 kms west-southwest of Car Nicobar at 1200 UTC of 6th. It moved northwards and lay over southeast Bay of Bengal and centred near Lat. 9.8° N / Long. 90.5° E, about 1180 kms south-southeast of Vishakhapatnam, 1210 kms south-southeast of Gopalpur, 260 kms west-northwest of Car Nicobar and 310 kms south-southwest of Port Blair at 0300 UTC of 7th and lay centred near Lat. 10.0° N / Long. 90.5° E, about 1160 kms southeast of Visakhapatnam & 1220 kms east-southeast of Machilipatnam at 1200 UTC of 7th. Continuing the northward movement, it further intensified into a D D over southeast Bay of Bengal, centred near Lat. 10.8° N / Long. 90.5° E, about 1090 kms southeast of Visakhapatnam & 1170 kms east-southeast of Machilipatnam at 1800 UTC of 7th. It further moved northwards and intensified into C S 'VARDAH' and lay centred over southeast Bay of Bengal near Lat. 11.2° N / Long. 90.5° E about 1060 kms southeast of Vishakhapatnam, 1150 kms east-southeast of Machilipatnam and 240 kms of west-southwest of Portblair at 0000 UTC of 8th. It further moved northwards and lay over the same region near Lat. 11.5° N / Long. 90.5° E, about 1040 km east-southeast of Visakhapatnam, 1135 kms east-southeast of Machilipatnam and 240 kms west-southwest of Port Blair at 0300 UTC of 8th. It moved slowly northwards and lay over the same region centred near Lat. 11.7° N / Long. 90.5° E, about 1020 kms east-southeast of Visakhapatnam, 1120 kms east-southeast of Machilipatnam and 240 kms west-southwest of Port Blair, at 1200 UTC of 8th. It then moved north-northwestwards, slightly intensified further and lay centred over southeast Bay of Bengal, centred near Lat. 12.1° N / Long. 90.4° E, about 990 kms southeast of Visakhapatnam, 1090 kms east-southeast of Machilipatnam and 250 kms west-northwest of Port Blair at 0300 UTC of 9th. It moved west-northwestwards and lay centred over southeast Bay of Bengal near Lat. 12.2° N / Long. 90.0° E, about 950 kms south-southeast of Visakhapatnam, 1050 kms southeast of Machilipatnam and 300 kms west-northwest of Port Blair at 1200 UTC 9th. It further moved west-northwestwards, intensified into a Severe Cyclonic Storm (SCS) and lay centred over southeast Bay of Bengal near Lat. 12.3° N /

Long. 89.6° E about 910 kms south-southeast of Visakhapatnam, 1000 kms southeast of Machilipatnam and 340 kms west-northwest of Port Blair at 1800 UTC of 9th. It continued to move west-northwestwards and lay centred over southeast Bay of Bengal near Lat. 12.7° N / Long. 88.0° E, about 880 kms east-southeast of Nellore and 830 kms east-southeast of Machilipatnam at 0300 UTC of 10th. It then moved west-northwestwards and further intensified into a VSCS and lay over west central and adjoining south Bay of Bengal, centred near Lat. 13.2° N/Long. 86.4° E, about 710 kms east-southeast of Nellore, 650 kms east-southeast of Machilipatnam and 660 kms east of Chennai at 1200 UTC 10th. It then moved nearly westwards (west-northwest wards upto mid-night, west wards upto early morning and west-southwest wards in the morning hours) and lay over west central and adjoining southwest Bay of Bengal, centred near Lat. 13.1° N / Long. 84.3° E, about 490 kms east-southeast of Nellore, 480 kms southeast of Machilipatnam and 440 kms east of Chennai at 0300 UTC of 11th. It moved westwards and lay over the same region centred near Lat. 13.3° N / Long. 83.0° E, about 300 kms east of Chennai and 350 kms east - southeast of Nellore at 1200 UTC of 11th. It further moved westwards and lay over west central and adjoining southwest Bay of Bengal centred near Lat. 13.2° N / Long. 81.2° E, about 105 kms east-northeast of Chennai at 0300 UTC of 12th. Subsequently it moved nearly westwards, weakened into a SCS near Lat. 13.1° N / Long. 80.3° E close to Chennai Coast at 0900 UTC of 12th. It further moved nearly westwards, crossed north Tamil Nadu Coast close to Chennai between 0930-1130 UTC of 12th as a SCS and lay centred over north Tamil Nadu near Lat. 13.0° N / Long. 79.9° E, about 40 kms west of Chennai at 1200 UTC of 12th. It continued to move westwards and weakened into a C S near Lat. 12.9° N / Long. 79.5° E, about 40 kms east of Vellore and 80 kms west-southwest of Chennai. at 1500 UTC of 12th. It continued to move westwards, weakened into a D D and lay centred over north interior Tamil Nadu near Lat. 12.7° N / Long. 79.1° E, about 25 kms southeast of Vellore and 60 kms of east-northeast of Tiruppattur at 1800 UTC of 12th. It move west-southwestwards, weakened into a D and lay centred over north interior Tamil Nadu near Lat. 12.5° N / Long. 78.0° E, about 50 kms west of Tiruppattur at 0000 UTC of 13th. It further moved westwards, weakened into a well marked low pressure area over north interior Tamil Nadu and adjoining south interior Karnataka at 0300 UTC of 13th.

2.9.2. Other features observed

The lowest observed pressure of 980.5 hPa and maximum sustained wind speed of 50 kts was reported by Chennai at 0900 UTC of 12th December when system was close to Chennai coast.

2.9.3. Weather and damage caused

System created havoc over Chennai and adjoining districts of north Tamil Nadu due to strong winds and very heavy rainfall. It took a toll of 18 lives, uprooting 6,000 trees, power supply and mobile services remained disrupted, schools and colleges also closed at many places in Chennai, Tamil Nadu.

Chief amounts of 24 hrs rainfall (7 cm or more) ending at 0300 UTC from 13th December are given below:

Tamil Nadu

Satyabama university (Kancheepuram) 38, Kattukuppam (Kancheepuram) 34, Kancheepuram (Kancheepuram) 28, Kalavai (Vellore) 23, Poonamallee (Tiruvallur) 22, Chembarabakkam (Tiruvallur) 21, Meenambakkam 20, Sriperumbudur (Kancheepuram) 17, Chembara mbakkam (Tiruvallur) 16, Yercaud (Salem) and Alangayam (Vellore) 15 each, Tambaram (Kancheepuram) 14, Nugampakam 12, Vellore 11, Melalathur (Vellore) and Poondi (Tiruvallur) 9 each, Tirppattur 8, Mahabalipuram (Kancheepuram), Uthiramerur (Kancheepuram), Tirupattur (Vellore), Maduranthagam (Kancheepuram), Krishnagiri (Krishnagiri), Shoolagiri (Krishnagiri), Hosur (Krishnagiri), Vandavasi (Tiruvannamalai), Marakkanam (Villupuram), Vaniyambadi (Vellore), Gudiyatham (Vellore) and Cheyyur (Kancheepuram) 7 each

Coastal Andhra Pradesh

Atmakur (Nellore) 13, Vinjamur (Nellore) 12, Udayagiri (Nellore) 11, Sullurpeta (Nellore) and Kandukur (Prakasam) 9 each, Kavali (Nellore), Nellore (Nellore) and Veligandla (Prakasam) 8 each, Rapur (Nellore), Gudur (Nellore), Venkatagiri (Nellore) and Shar (Nellore) 7 each

Rayalaseema

Tirumalla (Chittoor) 15, Puttur (Chittoor) 14, Nagari (Chittoor) 12, Chittoor, Kodur (Cuddapah) and Satyavedu (Chittoor) 10 each, Venkatagiri Kota (Chittoor) and Palasamudram (Chittoor) 9 each, Nambulipulikunta (Anantapuram), Thottambedu (Chittoor), Tirupati Aero (Chittoor), Atlur (Cuddapah), Rajamet (Cuddapah), Mandapalle (Chittoor), Kuppam (Chittoor), Pakala (Chittoor), Sambepalle (Cuddapah) and Royachoti (Cuddapah) 7 each

2.10. Depression over southwest Arabian Sea (17- 18 December, 2016)

2.10.1. The VSCS 'VARDHAH' weakened into well marked low pressure area over north interior Tamil Nadu and adjoining south interior Karnataka on 13th morning. It further weakened as a low pressure area and lay over southeast Arabian Sea and adjoining areas of coastal Karnataka and Kerala on 14th. Associated cyclonic circulation extended upto 9.5 kms a.s.l. on 13th and upto 7.6 kms a.s.l. on 14th. It further moved westwards and lay over Lakshadweep area and adjoining southeast Arabian Sea with associated cyclonic circulation extending upto mid tropospheric levels on 15th and over southeast Arabian Sea and neighbourhood with the associated cyclonic circulation extending upto mid tropospheric levels on 16th. It moved westwards and became well marked over central parts of south Arabian Sea in the early morning hours of 17th. Further moving westwards, it concentrated into a D and lay over southwest Arabian Sea, centred near Lat. 11.0° N / Long. 62.5° E, about 1110 kms west of Amini Divi, 950 kms east-southeast of Socotra (Yemen) and 1250 kms east-southeast of Bereeda (Somalia) at 0300 UTC on 17th. It moved west-southwestwards and lay over the same region centred near Lat. 10.4° N / Long. 60.5° E, about 1340 kms west of Amini Divi, 760 kms southeast of Socotra (Yemen) and 1040 kms east-southeast of Bereeda (Somalia) at 1200 UTC of 17th. It further moved west-southwestwards and lay over southwest Arabian Sea centred near Lat. 9.4° N / Long. 56.8° E, about 1750 kms west-southwest of Amini Divi, 480 kms southeast of Socotra (Yemen) and 680 kms east-southeast of Bereeda (Somalia) at 0300 UTC on 18th. It further moved west-southwestwards and weakened into a well marked low pressure area over southwest Arabian Sea in the forenoon of 18th December and persisted there in the same evening. It further moved westwards and became un-important on 19th morning.

2.10.2. Other features observed

The lowest observed pressure of 1010.0 hPa was reported by Ship VRFU 9 at 1200 UTC of 17th December.

2.10.3. Weather and damage caused

No weather and Damage was caused.

Chief amounts of 24 hrs rainfall (7 cm or more)

Nil