Deep Depression over northwest Bay of Bengal and neighborhood
(06-09 August, 2019): A Report

INSAT-3D enhanced Colored IR imagery based on 0500 UTC of 07th August

Cyclone Warning Division
India Meteorological Department
New Delhi
August 2019
Deep Depression over northwest Bay of Bengal off north Odisha- West Bengal coasts during 6-9 August, 2019

1. **Introduction**

   A low pressure area formed over north Bay of Bengal (BoB) and adjoining coastal areas of Bangladesh & West Bengal in the morning (0300 UTC) of 5th August, 2019. It concentrated into a depression over northwest BoB off north Odisha - West Bengal coasts in the morning (0300 UTC) of 6th. It moved northwesterly and intensified into a Deep Depression (DD) over the same region in the early morning (0000 UTC) of 7th. Moving northwesterly, it crossed north Odisha-West Bengal coasts close to north of Balasore in the same afternoon (during 0800 - 0900 UTC) of 7th. Thereafter, it moved west-northwestwards from the evening (1200 UTC) of 7th and weakened into a depression over northeast Chhattisgarh & neighbourhood in the early morning (0000 UTC) of 8th August. It moved northwesterly and weakened into a well-marked low pressure area over southeast Rajasthan & neighbourhood in the evening (1200 UTC) of 9th August, 2019. Thereafter, it moved nearly west-southwestwards during next 3 days and weakened into a low pressure area over northwest Arabian Sea and neighbourhood in the evening (1200 UTC) of 12th.

   The salient features of the system were as follows:
   (i) It had a near westward moving track.
   (ii) It had a life period of 81 hours.
   (iii) It had a track length of 1284 km.
   (iv) Under the influence of this system and its remnant low pressure area, widespread and intense rainfall activity was observed over the northern and central parts of the country extending from Odisha, Gangetic West Bengal, Chhattisgarh, Jharkhand, Bihar, Madhya Pradesh, Vidarbha, Rajasthan and Gujarat. Extremely heavy rainfall occurred over Odisha on 7th, Chhattisgarh on 8th, Gujarat region on 9th & 10th and Saurashtra & Kutch on 10th & 11th.

   IMD mobilised all its resources to track the system and regular warnings w.r.t. track, intensity, landfall and associated adverse weather were issued to concerned central and state disaster management agencies, print & electronic media and general public. Regular advisories were also issued to WMO/ESCAP Panel member countries including Bangladesh. Its genesis, movement and associated adverse weather could be predicted well by IMD.

   The brief life history, associated weather and forecast performance of IMD/RSMC, New Delhi are presented in following sections.

2. **Brief Life History:**

   On 5th August, the Madden Julian Oscillation (MJO) index lay in phase 4 with amplitude more than 1. It was expected to continue in same phase with amplitude greater than 1 for next 5 days. Hence, MJO was favouring enhancement of convective activity over BoB. Also southwest monsoon was in it’s active phase with the monsoon trough extending over the north BoB and strong cross equatorial flow
was prevailing over the BoB. Considering the environmental conditions, the sea surface temperature (SST) was 28-30°C over northwest and adjoining westcentral BoB. The tropical cyclone heat potential was around 80-90 KJ/cm² over the system area. The lower level positive vorticity was about 80 x 10⁻⁸sec⁻¹ over central parts of BoB with east-west oriented positive vorticity zone extending from Myanmar to parts of central India. The low level convergence was about 20 x 10⁻⁵sec⁻¹ over westcentral BoB. The upper level divergence was about 5-10 x 10⁻⁵sec⁻¹ over westcentral BoB. Vertical wind shear was high (30-40 knots) over the north BoB becoming 10-20 knots over extreme north BoB. The cyclonic circulation associated with the system was extending upto 200 hPa level and was tilting southwestwards with height. Under these favourable environmental conditions, a Low Pressure Area formed over north BoB and adjoining coastal areas of Bangladesh & West Bengal in the morning (0830 hrs IST /0300 UTC) of 5th August, 2019 along the axis of monsoon trough.

On 6th August, the MJO continued in same phase and was supporting enhancement of convective activity over BoB and central India during next 5 days. Similar thermal conditions prevailed. As regarding the dynamical features, the lower level positive vorticity increased significantly and was about 150 x 10⁻⁶sec⁻¹ over central parts of north BoB and adjoining central BoB. The low level convergence was about 20 x 10⁻⁵sec⁻¹. The upper level divergence was about 5-10 x 10⁻⁵sec⁻¹. Vertical wind shear was moderate (10-15 knots) over northwest BoB around the system centre. The cyclonic circulation associated with the system was extending upto 200 hPa level. Under these conditions depression formed over the northwest BoB and adjoining areas by 0830 hrs IST /0300 UTC of 6th. The presence of strong easterly winds in the upper tropospheric levels and the extension of monsoon trough across the plains of north India indicated nearly westward movement of the system.

At 0530 hrs IST/0000 UTC of 7th, the positive vorticity zone at 850 hPa level increased and was about 170 x 10⁻⁶sec⁻¹ over northwest BoB off West Bengal-Odisha coasts. The vertical wind shear was moderate (15-20 knots) over northwest BoB around the system centre. It showed a decreasing trend in the northwest direction over the central and western parts of Indian region. The low level convergence increased and was about 40 x 10⁻⁵sec⁻¹ over coastal Odisha to the southwest of system centre. The upper level divergence also increased and was about 40 x 10⁻⁵ sec⁻¹ to the southwest of the system. The cyclonic circulation associated with the system extended upto 200 hPa level and was tilting south-westwards with height. Similar thermal conditions prevailed. Under these conditions, the system further intensified into a DD by 0000 UTC of 7th over northwest BoB off north Odisha-West Bengal coasts. The same steering flow persisted and the system moved north-westwards and crossed north Odisha-West Bengal coasts close to north of Balasore during 1330-1430 hrs IST (0800-0900 UTC) of 7th.

The system maintained the intensity of DD for next 10 hrs even after crossing the coast because of continuous moisture influx and low wind shear over central India. Gradually, due to land interactions and decrease in low level vorticity (100 x 10⁻⁶sec⁻¹), low level convergence (10 x 10⁻⁵sec⁻¹) and upper level divergence (20 x 10⁻⁵sec⁻¹) over central India, the system weakened into a depression over northeast Chhattisgarh & neighbourhood at 0530 hrs IST/0000 UTC of 8th and into a WML over southeast Rajasthan & neighbourhood in the evening (1200 UTC) of 9th August, 2019. The observed track of Deep depression over northwest BoB is presented in Fig.1.
The best track parameters of the system are presented in Table 1. The typical satellite imageries are presented in Fig. 2.

![Observed track of Depression over northwest Bay of Bengal and neighborhood](image)

**Fig.1. Observed track of Depression over northwest Bay of Bengal and neighborhood (06-09 August, 2019)**

**Table 1: Best track positions and other parameters of the Deep Depression over northwest Bay of Bengal off north Odisha – West Bengal coasts during 06-09 August, 2019**

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<th>Date</th>
<th>Time (UTC)</th>
<th>Centre lat.° N/long.° E</th>
<th>C.I. NO.</th>
<th>Estimated Central Pressure (hPa)</th>
<th>Estimated Maximum Sustained Surface Wind (kt)</th>
<th>Estimated Pressure drop at the Centre (hPa)</th>
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Weakened into a well-marked low pressure area over southeast Rajasthan & neighborhood by 1200 UTC of 9th August 2019
3. **Feature observed through Satellites and Radar:**

Satellite monitoring of the system was mainly done by using half hourly INSAT-3D imageries. Satellite imageries of international geostationary satellites Meteosat-8 and microwave & SCAT Sat imageries were also considered. Typical INSAT-3D IR, visible, enhanced colored and cloud top brightness temperature imageries are presented in Fig. 2. The typical Doppler weather Radar (DWR), Kolkata imageries of the system are presented in Fig.3. All these imageries indicate the shear pattern of the system and intense convection in the southwest sector.

![INSAT-3D IR imageries during 05-12 August, 2019](image)

**Fig. 2(i): INSAT-3D IR imageries during 05-12 August, 2019**
Fig. 2(ii): INSAT-3D enhanced colored imageries during 06-12 August, 2019
Fig. 2(iii): INSAT-3D Visible imageries during 05-12 August, 2019
Fig. 3: Typical Radar imageries of DWR Kolkata during **06-08 August, 2019**
3. Dynamical features

IMD GFS (T1534) analysis fields of mean sea level pressure (MSLP), winds at 10 m, 850, 500 and 200 hPa levels are presented in Fig.4. At 0000 UTC of 6th August, it indicated a low pressure area over northwest BoB. The circulation was seen extending upto 500 hPa level tilting southwestwards with height. At 200 hPa level strong easterly flow is seen. On 6th, IMD GFS underestimated the intensity of the system.

![Fig 4(i): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 6th August 2019](image)
At 0000 UTC of 7th August, IMD GFS indicated a deep depression over northwest BoB off north Odisha-West Bengal coasts. The circulation was seen extending upto 500 hPa level tilting southwestwards with height. At 200 hPa level strong easterly flow is seen. On 7th, the intensity of the system was correctly picked up.

Fig4 (ii): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 7th August 2019
At 0000 UTC of 8th August, IMD GFS indicated a depression over north Chhattisgarh. The circulation was seen extending up to 500 hPa level tilting southwestwards with height. The intensity of the system and movement was correctly picked.

Fig 4 (iii): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 8th August 2019
At 0000 UTC of 9th August, IMD GFS indicated depression over east Madhya Pradesh. The circulation was seen extending upto 500 hPa level. Even on 9th, moisture influx is seen into the core of the system. The intensity of the system and movement was correctly picked.

Fig 4 (iv): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 9th August 2019
At 0000 UTC of 10th August, IMD GFS indicated a well marked low pressure area over west Madhya Pradesh. The circulation was seen extending upto 500 hPa level. Even on 10th, moisture influx is seen into the core of the system. The weakening of the system and movement was correctly picked.

Fig 4 (v): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 10th August 2019
At 0000 UTC of 11th August, IMD GFS indicated a well marked low pressure area over southeast Pakistan.

Fig4 (vi): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 11th August 2019
At 0000 UTC of 12th August, circulation is seen over northeast Arabian Sea.

Fig 4 (vii): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 12th August

Thus, IMD GFS initially underestimated the intensity of the system and couldn’t pick up the genesis of the system on 6th. However, subsequently movement and intensity of the system could be captured well.
4. Realized Weather:

Under the influence of this system, heavy to very heavy rainfall at isolated places over Odisha, heavy rainfall at isolated places over Jharkhand, Bihar & east Madhya Pradesh (MP) and very heavy rainfall at isolated places over west Madhya Pradesh (MP) occurred on 6th August. On 7th, it caused heavy rainfall at isolated places over Gangetic West Bengal, Bihar and east MP, extremely heavy rainfall at isolated places with heavy to very heavy falls at many places over Odisha, heavy to very heavy falls at isolated places over Jharkhand, west MP, Vidarbha & Chhattisgarh. On 8th, it caused extremely heavy falls at isolated places over Chhattisgarh, heavy to very falls at isolated places over Vidarbha and a few places over east & west MP and east Rajasthan. On 9th, it caused heavy to very heavy rainfall at a few places east MP, Vidarbha, isolated extremely heavy rainfall with heavy to very heavy falls at many places over west MP & a few places over east Rajasthan, heavy falls at isolated places over west Rajasthan and heavy to very heavy falls at a few places with isolated extremely heavy falls over Gujarat region. On 10th, it caused heavy to very falls at a few places over west MP & east Rajasthan, heavy to very heavy falls at many places with extremely heavy falls at a few places over Gujarat region and Saurashtra & Kutch. On 11th, it caused heavy to very heavy rainfall at few places over Gujarat region and heavy to very heavy falls at few places with isolated extremely heavy falls over Saurashtra & Kutch. The daily rainfall distribution ending at 0300 UTC of each date during 06-12 August, 2019 based on merged gridded rainfall data of IMD/NCMRWF is shown in Fig.5.

Fig.5: Daily rainfall distribution based on merged gridded rainfall data of IMD/NCMRWF during 06-12 August, 2019
(Heavy rainfall distribution: Isolated places: upto 25%, A few places: 26-50%, Many places: 51-75%, Most places: 76-100% of total stations in the region;
Heavy rainfall: 64.5 – 115.5 mm, Very heavy rainfall: 115.6 – 204.4 mm, Extremely heavy rainfall: 204.5 mm or more).
The 24 hour cumulative rainfall (≥ 7 cm) ending at 0830 hours IST of date during 06-11\textsuperscript{th} August is presented below:

**6\textsuperscript{th} August**

**Odisha:** Krishnaprasad-13, Brahmagiri & Thakurmunda -11 each, Puri-9, Karanja-8 and Gopalpur, Jamsolaghat & Swam-Patna–7 each  
**Jharkhand:** Simdega-7  
**Bihar:** Rafiganj 8 and Daudnagar 7  
**West Madhya Pradesh:** Garoth-17  
**East Madhya Pradesh:** Nowgong-10 and Jabalpur & Tikamgarh-8 each

**7\textsuperscript{th} August**

**Gangetic West Bengal:** Purihansa 7  
**Odisha:** Lanjigarh 38; Kashipur 32; Kotagarh 31; Phiringia 29; Kotraguda 26; Tarva 24; Muniguda 23; Kalinga 21; Gudari 19; Tikabali 18; Raikia, Kantamal, Madanpur & Rampur-17 each; G Udayagiri & R.Udaigiri-16 each; Baliguda, Similiguda, Daringibadi & Jeypore-15 each; Koraput & Phulbani-14 each; Nayagarh, Jagatpatna, Bissem-Cuttack, Niali & Berhampur-13 each; Gopalpur, Digapahandi, Hindol, Krishnaprasad, Alipingal & Mohana-12 each; Kantapada, Nuagada, Odagaon, Narla, Purushottampur, Bhurban, Rayagada, Aska, Belaguntha & Puri-11 each; K Nuagaon, Malkangiri, Gop, Gunupur, Banki & Chhatrapur-10 each; Nimpara, Jagannath Prasad, Tentulkhunti, Bhanjanagar, Sorada, Danagadi & Korei -9 each; Bhawanipatna, Khandapara, Kakatpur, Satyabadi, Astaranga & Banpur-8 each and Raghunathpur, Balipatna, Jagatsinghpur, Pottangi, Madhabarida, Joshipur, Khairimal & Narsinghpur-7 each.  
**Jharkhand:** Manatu 9, Chandil & Latehar-7 each  
**Bihar:** Galgalia 7  
**West Madhya Pradesh:** Salwani/Silvani, Pachmarhi & Multai-10 each; Suvasara-8 and Biaora, Neemuch & Udaipura-7 each.  
**East Madhya Pradesh:** Katangi 7.  
**Vidarbh:** Katol-13, Narkhed-9, Sironcha-7.  
**Chhattisgarh:** Rajpur-17; Konta-14; Bhairamgarh & Usoor-13 each; Chhindgarh & Bijapur-12 each; Katekalyan & Korba-11 each; Sukma & Bhopalpatnam-10 each; Kuakonda-9; Darba-8 and Lohandiguda, Jagdalpur & Dantewara-7 each.  
**Coastal A.P. & Yanam:** Chintur-21; Koida-14; Vararamachandrapur, Velairpad & Kunavaram-13 each; Paderu-12; Narsipatnam & Kukunoor-10 each; Chintapalle & Sompeta-8 each and Mandasa-7.  
**Telangana:** Venkatapuram-17; Etunagaram-14; Mudhole, Perur & Aswapuram-12 each; Dummuugudem, Bhopalpalle & Burgampadu-11 each; Manthani, Gundala, Pinapaka, Venkatapur & Armur-10 each; Gudurwrgl, Nandipet, Velpur & Palawancha-9 each; Mortad, Bhadrachalam, Kothaguda, Govindaraopet, Makloor, Mulakalapalle, Tekulapalle, Yellandu & Metpalle-8 each and Kothagudem, Kammar Palle, Luxettipet, Navipet, Balkonda, Manuguru, Ramgundam & Kaleswaram-7 each.

**8\textsuperscript{th} August**

**East Rajasthan:** Hindoli-11; Kotri-10; Mandalgarh-9 and Sapotra & Dug-8 each.  
**West Madhya Pradesh:** Ashoknagar-19; Sonkatch, Khandwa & Sardarpur-14 each; Tarana 13; Guna, Petlawad, Khaknar, Khargone & Mungaoli-11 each; Thikri &
Pachmarhi-10 each; Chanderi, Dhar, Neopanagar & Ashta-Arg-9 each; Shegaon, Tonkhurd & Burhanpur-8 each and Suvasara, Nalchha & Gandhwani-7 each.

**East Madhya Pradesh:** Malanjhhand-14; Jabalpur & Rehli-11; Chindwara & Waraseoni-10 each; Khuraj & Deori-9 each; Garhakota, Singhauri & Mandla-8 each and Lanji, Patan, Paraswad & Balaghat-7 each.

**Gujarat Region:** Quant-26 and Chhota Udepur-7

**Vidarbh:** Dhamni-13; Dhanora-8 and Gondia-7

**Chhattisgarh:** Deobhog-30; Lohandiguda-27; Mana-Raipur-23; Raipur, Pusaur & Jagdalpur-18 each; Orcha, Bastanar, Ahanpur, Bhairamgarh & Thanhhamariya-17 each; Sahasapurlohara-16; Bilaspur-15; Rajim, Kharsiya & Patan-13 each; Bakavand, Mahasamund, Kawardha, Kurud, Arang, Bastar, Chhura, Tokapal & Katekalyan-12 each; Bhatapara, Magarlod, Bemetara, Makadi, Raigarh, Simga, Narayanpur & Saja-11 each; Gidam, Pithora, Gandai & Basana-10 each; Chhindgarh, Kashdol, Pakhanjur, Masturi, Darbha, Pallari/Palari & Tamnar-9 each; Berla, Durg, Lailunga, Bijapur, Dantewara, Sukma, Bagbahara & Ghaghoda-8 each and Gariabund, Kuakonda, Saraipali, Baderajpur, Tilda, Baloda Bazar, Manpur, Dhamda, Khairagarh, Dhabhara, Sakti, Pharasgaon, Jaijaipur & Champa-7 each.

9th August

**West Rajasthan:** Desuri & Shergarh-7 each

**East Rajasthan:** Mount Abu, Mount Abu Tehsil, Khushalgarh, Girva & Pindwara-13 each; Gangdar-12; Udaipur/D-Aero & Mavli-11 each; Vallabhgarh & Arnod -10 each; Garhi, Ganeshpur & Aspur-9 each; Pachpahar Sr, Sahada Sr, Sallopat Sr, Danpur, Sarara, Gogunda, Sagwara & Bari-Sadri-8 each and Arthuna, Pirawa, Gallakot, Railmagra, Nithuwa, Jahazpur, Sajjangarh, Shergarh & Jhadol-7 each.

**East Madhya Pradesh:** Tarana 21; Maheshwar, Kasarwad & Bhikangaon-19 each; Jhabua-18; Thandla & Shajapur-17; Thikri, Bhainsdehi & Dhar-16 each; Raisein-15; Sardarpur & Neopanagar-14 each; Khandwa, Manawar, Khaknar & Shegaon-13 each; Sendhwa, Depalpur, Gandhwani, Nalchha, Salwani & Silvani-12 each; Alirajpur, Suvasara & Khargone & Sonkatch-11 each; Burhanpur, Khategaon, Agar, Bhopal & Badwani-10 each; Petlawad, Jaora, Ujjain, Tonkhurd, Jabot, Begumganj, Ichhawar, Mandsaur, Mhow, Kannod & Bagli-9; Manasa, Gautampura, Udaipur, Pandhana, Bhabhra & Indore-8 each and Harda, Sarangpur, Multai, Nusrulgunj-Arg, Bhanpura, Mahidpur, Garoth, Kukshi, Sehere, Pachmarhi, Badnawar, Khachrod & Ashta-7each.

**East Madhya Pradesh:** Tendukheda & Karel-15 each; Narsinghpur-12; Mandla & Nainpur-9 each; Gadanwara-8 and Deori, Keolari & Ghansore-7 each.

**Gujarat Region:** Chhota Udepur-34; Quant-28; Jetpur Pavi & Nizer-17 each; Naswadi-16; Dhanpur-12; Godhra; Bodeli; Dahod & Sanjeli 11 each; Devgadh Bara, Umerpada, Limkheda, Jambughoda, Vijaynagar, Dediapada, Fatepura, Sagbara & Subir 9 each; Dabhoi; Rajipala; Shahera; Garbada & Ukai 8 each; Uchchhal; Vadodara; Kadana; Halol & Morva Hadaf 7 each

**Vidarbh:** Mauda 12; Chikhalda 11; Dhamni, Nagpur & Akot 9 each; Chandur Bazar; Bhandara, Hingna & Arvi 8 each; Mohadi; Tumsar; Ashti; Wardha & Morsi 7 each.

10th August

**East Rajasthan:** Pratapgarh-15; Kherwara & Salumber - 12; Sarara - 11; Jagpura, Aspur, Devel, Ghatol, Dungarpur Tehsil, Loharia & Bhungra - 8 each and Ganeshpur, Pipalkhunt, Arnod, Nithuwa, Reodar, Kesarpura & Arthuna - 7 each
West Madhya Pradesh: Bhabhra 19; Sardarpur & Manawar 9 each; Alirajpur, Nalchha & Mandsaur 8 each and Jabot & Sendhwa 7 each

Gujarat Region: Mahudha 34, Dhandhuka 32, Kadi 30, Galteshwar 26, Dholera 24, Kalol 23, Jotana 21, Nadiad & Chhota Udepur 20 each, Bodeli & Dediapada 19 each; Godhra, Sanand, Mahesana, Kathalal & Anand 18 each, Desar, Thasra & Dholka 17 each, Umerpada, Bayad, Petlad & Vijapur 16 each, Amod, V.Vidyanagar, Umreth, Jetpur Pavi & Matar 15 each, Jambughoda, Mahemdavad, Kambhat, Saraswati, Borsad & Dhansura 14 each, Subir, Halol, Karjan, Sojitra, Sami & Tarapur 13 each, Savli 12, Kapadvanj, Ghoghamba, Vaso, Abad City, Kheda, Dabhoi, Mansa, Netrang & Wanakbori 11 each, Patan, Anklav, Songadh, Prantij, Sagbara, Garudeshwar, Gandhinagar, Vijaynagar, Waghai, Vagra, Dhanpur, Himatanagar, Tilkwada, Shankheshvar, Nandod, Bavla, Shahera, Sankheda, Vadodara, Idar & Kalol 9 each, Nizer, Khanpur, Becharaji, Dahegam, Vansda, Detroj, Bhabhar, Bhiloda, Dantiwada, Naswadi & Jambuser 8 each and Harij, Talod, Vyara, Radhanpur & Quant 7 each.

Saurashtra & Kutch: Barvala 38, Gadhda & Botad 29 each, Ranpur 26, Chuda 24, Kandla New, Dhrangadhra, Surendranagar & Vallabhipur 21 each, Rajkot 20, Rapar, Thangadh & Wadhvan 19 each, Gandhidham & Umrala 18 each, Bhachau, Halvad & Vichhiya 17 each, Chotila, Morbi, Kandla Airport, Tankara & Dhrol 16 each, Kotdasangani & Lalpur 15 each, Jodha, Karharogha, Amreli & Gondal 14 each, Dasada, Sayla, Lakhtar, Mulhi, Limbdi, Lodhiha & Kalyanpur 13 each, Babra, Shihor, Lathi & Porbandar 12 each, Vadia, Paddhari, Jamnagar & Bhavnagar 11 each, Naliya, Jasdan, Maliamiana & Anjar 10 each, Okha, Wankaner, Kalavad & Abdasa 9 each, Visavadar & Dwarka 8 each, Bhanvad, Nakhatrana, Jamkandorna, Mundra, Bhesan & Mandvi 7 each.

11th August

Gujarat Region: Radhanpur 18, Suigam 13, Gandevi 9, Chikhli, Valod & Vyara -8 each and Jalalpor 7,
Saurashtra & Kutch: Nakhatrana 32, Naliya & Tankara 27 each, Morbi 26, Abdasa 25, Rapar, Dhrangadhra & Lakhpat 21 each, Kalavad & Malia & Miana 20 each, Lodhiha 18, Paddhari, Okha & Jodha 16 each, Rajkot 15, Anjar & Bhesan 13 each, Visavadar, Vanthali, Kambhalia, Mendor & Jamnagar 12 each, Kandla New, Bhachau & Dasada 11 each, Dwarka & Junagadh 10 each, Kalyanpur, Gandhidham, Dhrol, Kandla Airport, Wankaner, Halvad, Ranavav, Mandvi, Jamkandorna & Malia 9 each, Kotdasangani & Bhuj- 8 each and Gondal, Bhanvad, Kutiana, Jamjodhpur, Lalpur, Thangadh, Karharogha & Bagasra- 7 each

5. Bulletins issued by IMD

IMD issued regular bulletins to WMO/ESCAP Panel member countries including Bangladesh and Myanmar, National & State Disaster Management Agencies of Andhra Pradesh, Odisha, Chattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, Telangana, Uttar Pradesh and Rajasthan, general public and media. Regular Bulletins every six hourly were issued since formation of depression over northwest BoB. In addition, RSMC New Delhi also issued Press Release and SMS to registered users.
5.1: Bulletins issued by Cyclone Warning Division, New Delhi
Bulletins issued by Cyclone Warning Division of IMD in association with the system are given in Table 2

**Table 2(a): Bulletins issued by Cyclone Warning Division, IMD, New Delhi**

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Bulletins</th>
<th>No. of Bulletins</th>
<th>Issued to</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>National Bulletin</td>
<td>18</td>
<td>1. IMD’s website&lt;br&gt;2. FAX and e-mail to Control Room NDM, Ministry of Home affairs, Control Room NDMA, Cabinet Secretariat, Minister of Sc. &amp; Tech, Secretary MoES, DST, HQ Integrated Defence Staff, DG Doordarshan, All India Radio, DG-NDRF, Director Indian Railways, Indian Navy, IAF, Chief Secretary: Odisha, Chattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, Telangana, Rajasthan, West Bengal, Gujarat and Telengna</td>
</tr>
<tr>
<td>2</td>
<td>RSMC Bulletin</td>
<td>6</td>
<td>1. IMD’s website&lt;br&gt;2. All WMO/ESCAP member countries through GTS and E-mail.&lt;br&gt;3. Indian Navy, IAF by E-mail</td>
</tr>
<tr>
<td>3</td>
<td>Press Release</td>
<td>5</td>
<td>1. Disaster Managers, Media persons by email and uploaded on website</td>
</tr>
<tr>
<td>4</td>
<td>Facebook /Twitter</td>
<td>4 times a day</td>
<td>Highlights uploaded on facebook/twitter since formation of depression.</td>
</tr>
<tr>
<td>5</td>
<td>SMS</td>
<td>4 times a day</td>
<td>To disaster managers of central and state level and general public registered with RSMC website.</td>
</tr>
</tbody>
</table>

**Table-2(b): Bulletins issued by Cyclone Warning Centre (CWC) Bhubaneswar**

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Type of Bulletin</th>
<th>Number of Bulletins issued by CWC Bhubaneswar</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sea Area Bulletins</td>
<td>NIL</td>
</tr>
<tr>
<td>2</td>
<td>Coastal Weather Bulletins</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>Fishermen Warnings issued</td>
<td>41</td>
</tr>
<tr>
<td>4</td>
<td>Port Warnings</td>
<td>24</td>
</tr>
<tr>
<td>5</td>
<td>Heavy Rainfall Warning</td>
<td>07</td>
</tr>
<tr>
<td>6</td>
<td>Gale Wind Warning</td>
<td>NIL</td>
</tr>
<tr>
<td>7</td>
<td>Storm surge warning</td>
<td>NIL</td>
</tr>
<tr>
<td>8</td>
<td>Information &amp; Warning issued to State Government and other Agencies</td>
<td>11</td>
</tr>
<tr>
<td>9</td>
<td>SMS/Whatsapp (message in group)</td>
<td>650</td>
</tr>
</tbody>
</table>
6. Operational Forecast Performance

- First information about likely formation of an LPA over northeast BoB and neighbourhood around 4th August was given in the Tropical Weather Outlook (TWO) issued at 0600 UTC of 1st August. It was also indicated that the system would intensify further and expected cyclogenesis was predicted around 5th August with fair confidence (51-75%).
- In the TWO bulletin issued at 0600 UTC of 2nd August, cyclogenesis was predicted around 6th with fair confidence (51-75%).
- Actually LPA formed over north BoB and adjoining areas at 0300 UTC of 5th and depression formed northwest BoB & adjoining areas at 0300 UTC of 6th. Thus formation of LPA could be predicted about 5 days in advance and cyclogenesis could be correctly predicted about 4 days in advance.
- In the first bulletin issued at 1030 hrs IST (0500 UTC) of 6th August, it was predicted that the system would intensify into a deep depression by 7th. It was also predicted that the system would move west-northwestwards across Odisha - West Bengal coasts during next 48 hours.
- Actually, the system intensified into a DD on 7th. It also moved west-northwestwards across Odisha-West Bengal coasts.
- In the bulletin issued at 1930 hrs IST (1400 UTC) of 6th, it was predicted that the system would move west northwestwards and cross north Odisha - West Bengal coasts near Balasore by noon of 7th August 2019. Actually, the system crossed north Odisha-West Bengal coasts close to north of Balasore during 0800-0900 UTC of 7th. Thus landfall point could be predicted about 19 hrs in advance.

IMD issued regular warning bulletins to the concerned central and state disaster management authorities and press & media. The verification of heavy rainfall warnings issued by IMD for the deep depression during 7th - 9th August is presented in Table 3. It can be found that the occurrence of heavy rainfall in association with the system could be predicted well in advance.
Table 3: Verification of heavy rainfall warning issued by IMD for Deep Depression over northwest Bay of Bengal and neighborhood (06-11 August, 2019)

<table>
<thead>
<tr>
<th>Date/Base Time of observation (UTC)</th>
<th>24 hr Heavy rainfall warning ending at 0830 hrs IST of next day</th>
<th>Realised 24-hour heavy rainfall ending at 0300 UTC of date</th>
</tr>
</thead>
<tbody>
<tr>
<td>06/08/2019 0300 UTC</td>
<td><strong>6th August</strong></td>
<td><strong>6th August</strong></td>
</tr>
<tr>
<td></td>
<td>• Heavy to very heavy rainfall at a few places and isolated <strong>extremely heavy falls</strong> (≥ 20cm) very likely over Odisha.</td>
<td><strong>Odisha:</strong> Krishnaprasad-13, Brahmagiri &amp; Thakurmunda -11 each, Puri-9, Karanjia-8 and Gopalpur, Jamsolaghat &amp; Swam-Patna–7 each</td>
</tr>
<tr>
<td></td>
<td>• Isolated heavy to very heavy and extremely heavy falls very likely over south Chhattisgarh.</td>
<td><strong>Jharkhand:</strong> Simdega-7</td>
</tr>
<tr>
<td></td>
<td>• Isolated heavy to very heavy falls are also very likely over Gangetic West Bengal and Jharkhand.</td>
<td><strong>Bihar:</strong> Rafiganj 8 and Daudnagar 7</td>
</tr>
<tr>
<td></td>
<td>• Heavy to very heavy falls at isolated places very likely over Madhya Pradesh on 6th August</td>
<td><strong>West Madhya Pradesh:</strong> Garoth-17</td>
</tr>
<tr>
<td></td>
<td><strong>7th August</strong></td>
<td><strong>East Madhya Pradesh:</strong> Nowgong-10 and Jabalpur &amp; Tikamgarh-8 each</td>
</tr>
<tr>
<td></td>
<td>• Heavy to very heavy rainfall at a few places and isolated <strong>extremely heavy falls</strong> (≥ 20cm) very likely over Odisha.</td>
<td><strong>Gangetic West Bengal:</strong> Purihansa 7</td>
</tr>
<tr>
<td></td>
<td>• Isolated heavy to very heavy and extremely heavy falls very likely over south Chhattisgarh.</td>
<td><strong>Odisha:</strong> Lanjigarh 38; Kashipur 32; Kotagarh 31; Phiringia 29; Kotraguda 26; Tarva 24; Muniguda 23; Kalinga 21; Gudari 19; Tikabali 18; Raikia, Kantamal, Madanpur &amp; Rampur-17 each; G Udayagiri &amp; R.Udaigiri-16 each; Baliguda, Similiguda, Daringibadi &amp; Jeypore-15 each; Koraput &amp; Phulbani-14 each; Nayagarh, Jaipatna, Bissem-Cuttack, Niali &amp; Berhampur-13 each; Gopalpur, Digapahandi, Hindol, Krishnaprasad, Alipangal &amp; Mohana-12 each; Kantapada, Nuagada, Odagaon, Narla, Purushottampur, Bhuban, Rayagada, Aska, Belaguntha &amp; Puri-11 each; K Nuagaon, Malkangiri, Gop, Gunupur, Banki &amp; Chhatrapur-10 each; Nimpara, Jagannath Prasad, Tentulikhunti, Bhanjnagar, Sorada, Danagadi &amp; Korei -9 each; Bhawanipatna, Khandapara, Kakatpur, Satyabadi, Astaranga &amp; Banpur-8 each and Raghunathpur, Balipatna, Jagatsinghpur, Pottangi, Madhabarida, Joshipur, Khairamal &amp; Narsinghpur-7 each.</td>
</tr>
<tr>
<td></td>
<td>• Isolated heavy to very heavy falls are also very likely over Gangetic West Bengal and Jharkhand.</td>
<td><strong>Jharkhand:</strong> Manatu 9, Chandil &amp; Latehar-7 each</td>
</tr>
<tr>
<td></td>
<td>• Heavy to very heavy falls with isolated <strong>extremely heavy falls</strong> (≥ 20cm) very likely over Madhya Pradesh.</td>
<td><strong>Bihar:</strong> Galgalia 7</td>
</tr>
<tr>
<td></td>
<td><strong>8th August</strong></td>
<td><strong>West Madhya Pradesh:</strong> Salwani/Silvani, Pachmarhi &amp; Multai-10 each; Suvasara-8 and Biaora, Neemuch &amp; Udaipur-7 each.</td>
</tr>
<tr>
<td></td>
<td>• Heavy to very heavy falls with isolated <strong>extremely heavy falls</strong> (≥ 20cm) very likely over Madhya Pradesh on 7th and 8th August.</td>
<td><strong>East Madhya Pradesh:</strong> Katangi 7</td>
</tr>
<tr>
<td>07/08/2019</td>
<td><strong>7th August</strong></td>
<td><strong>Vidarbhia:</strong> Katol-13, Narkheda-9, Sironcha-7.</td>
</tr>
<tr>
<td></td>
<td>• Heavy to very heavy</td>
<td><strong>Chhattisgarh:</strong> Rajpur-17; Konta-14;</td>
</tr>
</tbody>
</table>
rainfall at a few places and isolated **extremely heavy falls** (≥ 20cm) very likely over Odisha and Chhattisgarh.

- **Heavy to very heavy & extremely heavy falls** very likely over east Madhya Pradesh.
- Isolated heavy falls are also very likely over Gangetic West Bengal, Bihar and Jharkhand.
- Heavy to very heavy falls at a few places very likely over north Andhra Pradesh and Telangana during next 24 hours, over Chhattisgarh during the subsequent 24 hours and over Vidarbha during next 48 hours.

### 8th August

- Heavy to very heavy falls and isolated **extremely heavy falls** (≥ 20cm) over west Madhya Pradesh and east Rajasthan.

### 9th August

- Heavy to very heavy rainfall at isolated places is likely to continue over west Madhya Pradesh and east.
- Heavy to very heavy rainfall at a few places and isolated **extremely heavy falls** (≥ 20cm) very likely over Gujarat.

### 8/08/2019 0300 UTC

- **Vidarbha:** Dharni-13; Dhanora-8 and Gondia-7
- **Chhattisgarh:** Deobhog-30; Lohandiguda-27; Mana-Raipur-23; Raipur, Pusaur & Jagdalpur-18 each; Orcha, Bastanar, Abhanpur, Bhairamgarh & Thankhamariya-17 each; Sahaspurlohaba-16; Bilaspur-15; Rajim, Kharsiya & Patan-13 each; Bakavand, Mahasamund, Kawkadha, Kurud, Arang, Dharmapuri & Bhairamgarh-12 each; Chhindgarh & Korba-11 each; Sukma & Bhopalpatnam-10 each; Kuakonda-9; Darbha-8 and Lohandiguda, Jagdalpur & Dantewara-7 each.
- **Coastal A.P. & Yanam:** Chintur-21; Koida-14; Vararamachandrapur, Velairpad & Kunavaram-13 each; Paderu-12; Narsipatnam & Kukunoor-10 each; Chintapalle & Sompeta-8 each and Mandasa-7.
- **Telangana:** Venkatapuram-17; Etturnagaram-14; Mudhole, Perur & Aswaparam-12 each; Dummugudem, Bhupalpalle & Burgampadu-11 each; Manthani, Gundala, Pinapaka, Venkatapur & Armur-10 each; Gudurwrgl, Nandipet, Velpur & Palawancha-9 each; Mortad, Bhadrachalam, Kothaguda, Govindaraoopet, Makloor, Mulakalapalle, Tekulapalle, Yellandu & Metpalle-8 each and Kothagudem, Kammar Palle, Luxettipet, Navipe, Balkonda, Manuguru, Ramgundam & Kaleswaram-7 each.

### 08/08/2019 08th August

- **East Rajasthan:** Hindoli-11; Kotri-10; Mandalgarh-9 and Sapota & Dug-8 each.
- **West Madhya Pradesh:** Ashoknagar-19; Sonkatch, Khandwa & Sardarpur-14 each; Tarana 13; Guna, Petlawad, Khaknar, Khargone & Mungaoi-11 each; Thikri & Pachmarhi-10 each; Chanderi, Dhar, Neapanagar & Ashta-Arg-9 each; Shegaon, Tonkhurd & Bhoranpur-8 each and Suvasara, Nalchha & Gandhwani-7 each.
- **East Madhya Pradesh:** Malanjkhand-14; Jabalpur & Rehli-11; Chindwara & Waraseoni-10 each; Khurai & Deori-9 each; Garhakota, Singrauli & Mandla-8 each and Lanji, Patan, Paraswad & Balaghat-7 each.
- **Gujarat Region:** Quant-26 and Chhota Udepur-7
- **Vidarbha:** Dhami-13; Dhanora-8 and Gondia-7
- **Chhattisgarh:** Deobhog-30; Lohandiguda-27; Mana-Raipur-23; Raipur, Pusaur & Jagdalpur-18 each; Orcha, Bastanar, Abhanpur, Bhairamgarh & Thankhamariya-17 each; Sahaspurlohaba-16; Bilaspur-15; Rajim, Kharsiya & Patan-13 each; Bakavand, Mahasamund, Kawkadha, Kurud, Arang, Dharmapuri & Bhairamgarh-12 each; Chhindgarh & Korba-11 each; Sukma & Bhopalpatnam-10 each; Kuakonda-9; Darbha-8 and Lohandiguda, Jagdalpur & Dantewara-7 each.
- **Coastal A.P. & Yanam:** Chintur-21; Koida-14; Vararamachandrapur, Velairpad & Kunavaram-13 each; Paderu-12; Narsipatnam & Kukunoor-10 each; Chintapalle & Sompeta-8 each and Mandasa-7.
- **Telangana:** Venkatapuram-17; Etturnagaram-14; Mudhole, Perur & Aswaparam-12 each; Dummugudem, Bhupalpalle & Burgampadu-11 each; Manthani, Gundala, Pinapaka, Venkatapur & Armur-10 each; Gudurwrgl, Nandipet, Velpur & Palawancha-9 each; Mortad, Bhadrachalam, Kothaguda, Govindaraoopet, Makloor, Mulakalapalle, Tekulapalle, Yellandu & Metpalle-8 each and Kothagudem, Kammar Palle, Luxettipet, Navipe, Balkonda, Manuguru, Ramgundam & Kaleswaram-7 each.

### 8th August

- Heavy to very heavy rainfall at a few places and isolated **extremely heavy falls** (≥ 20cm) very likely over Odisha and Chhattisgarh.

### 08/08/2019 0300 UTC

- Heavy to very heavy rainfall at a few places with isolated **extremely heavy falls** (≥ 20cm) very likely over Vidarbha and heavy to very heavy rainfall with **extremely**
heavy falls (≥ 20cm) at isolated places over Chhattisgarh, Madhya Pradesh and Gujarat Region

- Heavy to very heavy rainfall at a few places over East Rajasthan, heavy to very heavy rainfall at isolated places over Saurashtra & Kutch and heavy rainfall at isolated places over West

**09th August**

- Heavy to very heavy rainfall at a few places with isolated extremely heavy falls (≥ 20cm) very likely over Gujarat Region and Saurashtra & Kutch and heavy to very heavy rainfall with isolated extremely heavy falls (≥ 20cm) over West Madhya Pradesh and East Rajasthan.

**10th August**

- Heavy to very heavy rainfall at isolated places over Gujarat Region and Saurashtra & Kutch and Light to moderate rainfall at a few places with heavy rainfall at isolated places over West Madhya Pradesh and Rajasthan.

**9th August.**

- Heavy to very heavy rainfall at a few places with isolated extremely heavy falls (≥ 20cm)

- Heavy to very heavy rainfall at isolated places over Chhattisgarh, Madhya Pradesh and Gujarat Region

- Heavy to very heavy rainfall at a few places over East Rajasthan, heavy to very heavy rainfall at isolated places over Saurashtra & Kutch and heavy rainfall at isolated places over West

**09/08/2019 0300 UTC**

**9th August.**

- Heavy to very heavy rainfall at a few places with isolated extremely heavy falls (≥ 20cm)

Bastar, Chhura, Tokapal & Katekalyan-12 each; Bhatapara, Magariod, Bemetara, Makadi, Raigarh, Simga, Narayanpur & Saja-11 each; Gidam, Pithora, Gandai & Basana-10 each; Chhindgarh, Kashdol, Pakhanjur, Masturi, Darbha, Pallari/Palari & Tamnar-9 each; Berla, Durg, Lailunga, Bijapur, Dantewara, Sukma, Bagbahara & Gharhoda-8 each and Gariabund, Kuakonda, Saraipali, Baderajpur, Tilda, Baloda Bazar, Manpur, Dhamdha, Khairagarh, Dhabhara, Sakti, Pharasgaon, Jaijaipur & Champa-7 each.

**West Rajasthan:** Desuri & Shergarh-7 each

**East Rajasthan:** Mount Abu, Mounttabu Tehsil, Khushalgarih, Girva & Pindwara-13 each; Gangdhar-12; Udaipur/D-Aero & Mavli-11 each; Vallabtnagar & Arnod -10 each; Garhi, Ganeshpur & Aspur-9 each; Pachpahar Sr, Sahada Sr, Sallopat Sr, Danpur, Sarara, Gogunda, Sagwara & Bari-Sadri-8 each and Arthuna, Pirawa, Galakot, Railmagra, Nithuwa, Jahazpur, Sajjhangarh, Shergarh & Jhdol-7 each.

**West Madhya Pradesh:** Tarana 21; Maheshwar, Kasarwad & Bhikangaon-19 each; Jhabua-18; Thandla & Shajapur-17; Thikri, Bhainsdehi & Dhar-16 each; Raisen-15; Sardarpur & Neapanagar-14 each; Khandwa-, Manawar, Khaknar & Shegaon-13 each; Sendhwa(Med), Depalpur, Gandhwni, Nalchha, Salwani & Silvani-12 each; Alirajpur, Suvasara & Khargone & Sonkatch-11 each; Burhanpur, Khategaon, Agar, Bhopal & Badwani-10 each; Petlawad, Jaora, Ujjain, Tonkhurd, Jabot, Begumganj, Ichhawar, Mandsaur, Mhow, Kannod & Bagli-9; Manasa, Gautampura, Udaipur, Pandhana, Bhabhra & Indore-8 each and Harda, Sarangpur, Multai, Nusrulgunj-Ang, Bhanpur, Mahidpur, Garoth, Kukshi, Sehore-, Pachmarhi, Badnawar, Khachrod & Ashta-7each.

**East Madhya Pradesh:**; ; Tendukheda & Kareli-15 each; Narsinghpur-12; Mandla & Nainpur-9 each; Gadarwarwa-8 and Deori, Keolari & Ghansore-7 each.

**Gujarat Region:** Chhota Udarpur-34; Quant-28; Jetpur Pavi & Nizer-17 each; Naswadi-16; Dhanpur-12; Godhra; Bodeli; Dahod & Sanjeli
very likely over Gujarat Region, Saurashtra & Kutch, southeast Rajasthan and southwest Madhya Pradesh on 10th August

- Heavy to very heavy rainfall at a few places with isolated extremely heavy falls (≥ 20cm) very likely over Saurashtra & Kutch;
- Heavy to very heavy rainfall at isolated places over Gujarat region and Heavy rainfall at isolated places over south Rajasthan

10th August

**East Rajasthan:** Pratapgarh - 15; Kherwara & Salumber - 12; Sarara - 11; Jagpura, Aspur, Devel, Ghatol, Dungarpur Tehsil, Loharia & Bhungra - 8 each and Ganeshpura, Pipalkhunt, Arnod, Nithuwa, Reodar, Kesarpura & Arthuna - 7 each

**West Madhya Pradesh:** Bhabhra 19; Sardarpur & Manawar 9 each; Alirajpur, Nalchha & Mandsaur 8 each and Jabot & Sendhwa 7 each

**Gujarat Region:** Mahudha 34, Dhandhuka 32, Kadi 30, Galteshwar 26, Dholera 24, Kalol 23, Jotana 21, Nadiad & Chhota Udepur 20 each, Bodeli & Dediapada 19 each; Godhra, Sanand, Mahesana, Kathalal & Anand 18 each, Desar, Thasra & Dholka 17 each, Umerpada, Bayad, Pettad & Vijapur 16 each, Amod, V. Vidyanagar, Umreth, Jetpur Pave & Matar 15 each, Jambughoda, Mahendavad, Kambhat, Saraswati, Borsad & Dhansura 14 each, Subir, Halol, Karjan, Sojitra, Sami & Tarapur 13 each, Savli 12, Kapadvanj, Ghoghamba, Vaso, Abad City, Kheda, Dabhoi, Mansa, Netrang & Wanakbori 11 each, Patan, Anklav, Songadh, Prantij, Sagbara, Garudeshwar, Gandhinagar, Vijyinagar, Waghai, Vagra, Dhanpur, Himatanagar, Tilakwada, Shankshhvar, Nandod, Bavla, Shahara, Sankheda, Vadodara, Ida & Kalol 9 each, Nizer, Khanpur, Becharaji, Dahegam, Vansda, Detroj, Bhabhar, Bhiloda, Dantiwada, Naswadi & Jambuser 8 each and Harij, Talod, Vyara, Radhanpur & Quant 7 each.

**Saurashtra & Kutch:** Barvala 38, Gadhsa & Botad 29 each, Ranpur 26, Chuda 24, Kandla New, Dhrangadhra, Surendranagar & Vallabhipur 21 each, Rajkot 20, Rapar, Thangadh & Wadhvan 19 each, Gandhidham &
Summary and Conclusion:

A low pressure area formed over north Bay of Bengal (BoB) and neighbourhood in the morning of 5th August, 2019. It concentrated into a depression over northwest BoB off north Odisha - West Bengal coasts in the morning (0830 hrs IST) of 6th and into a DD on 7th. Moving northwestwards, it crossed north Odisha-West Bengal coasts close to north of Balasore during (1330-1430 hrs IST) of 7th. Thereafter, it moved west-northwestwards and weakened into a depression on 8th August, into a well-marked low pressure area over southeast Rajasthan & neighbourhood on 9th. Thereafter, it moved nearly west-southwestwards during next 3 days and weakened into a Low Pressure Area over northeast Arabian Sea and neighbourhood on 12th.

IMD monitored and predicted the genesis, movement and weather associated with the system accurately and timely bulletins were disseminated to the user agencies.

Acknowledgements:

India Meteorological Department (IMD) duly acknowledges the contribution from all the stake holders who contributed to the successful monitoring, prediction and early warning

7. Summary and Conclusions:

8. Acknowledgements:
service of the system. We specifically acknowledge the contribution from Indian Space Research Organisation (ISRO) and all sister organizations of Ministry of Earth Sciences including National Centre for Medium Range Weather Forecasting Centre (NCMRWF) NOIDA, National Institute of Technology (NIOT) Chennai & Indian National Centre for Ocean Information Services (INCOIS). The support from various Divisions/Sections of IMD including Area Cyclone Warning Centre Kolkata, Regional Meteorological Centre Nagpur, Cyclone Warning Centre Bhubaneswar, Meteorological centres Raipur & Ranchi, Jaipur & Ahmedabad, Numerical Weather Prediction (NWP) Division, Information System & Services Division (ISSD) and Satellite and Radar Division at IMD HQ New Delhi is also duly acknowledged for monitoring and predicting the system.