

Depression over the Bay of Bengal (30th July- 01st August 2013)

1. Introduction:

A depression formed over northwest Bay of Bengal on 30th July, 2013 Moving west northwestwards, it crossed north Odisha and adjoining West Bengal coast between Balasore and Digha around 0700 UTC of 30th July 2013. It caused heavy to very heavy rainfall over, Odisha, Chhattisgarh, Madhya Pradesh and Maharashtra.

The salient feature of this depression are given below:

- (i). The depression initially moved northwestward before landfall and then it moved westwards up to east Madhya Pradesh.
- (ii) Due to its slow westward movement over east Madhya Pradesh and adjoining Chhattisgarh,, it caused very good rainfall activity over the region.

2. Monitoring and Prediction:

The depression was monitored with satellite, meteorological buoys, coastal, observations and Doppler Weather Radar (DWR) Kolkata & Nagpur. The half hourly INSAT/ Kalpana imageries & scattrometer wind and every 10 minutes DWR imageries and products were used for monitoring of depression. However the genesis of depression could not be detected through the satellite as any T number could not be assign. Previous studies also indicate that Dvorak technique has the limitation in detecting the monsoon depression as these are highly sheared system. Hence the intensity of the depression was mainly monitoring through synoptic observations from coastal stations and buoys over the sea. Various numerical weather prediction (NWP) models including IMD's global and meso-scale models were utilized to predict the track and intensity of the depression. The Tropical Cyclone Module in the digitized forecasting system of IMD was utilized for analysis and comparison of various NWP models and decision making process.

3. Genesis :

Monsoon trough was very active during 3rd and 4th week of July 2013 leading formation of low pressure systems over the north Bay of Bengal one after the other. The eighth low pressure area of the monsoon season, 2013 formed over northwest Bay of Bengal off Odisha and West Bengal coasts on 29th July 2013. The pressure gradient over the Bay of Bengal was very high during this period as the pressure difference between Kolkata and Port Blair was about 10 hpa. As a result of this strong pressure

gradient and associated low pressure area over northwest Bay of Bengal, the southerly surge over the region increased on 29th July 2013 and further on 30th July 2013. The low level convergence and relative vorticity increased over the northwest Bay of Bengal from 29th July to 30th July 2013. The sea surface temperature over north Bay of Bengal was also warmer (> 30°C). The Madden Julian Oscillation (MJO) index lay in phase 4 during 29th July to 4th August, 2013. However, its amplitude was less than 1 on all the days except on 1st August when it was slightly above 1. Past studies indicate that phase – 4 is favourable for genesis of depression as it helps in enhancing the convection. Under these conditions the low pressure area further concentrated into a depression at 0300 UTC of 30th July, 2013 neat Lat. 21.0°N/Long. 88.0°E.

Table 1: Best track positions and other parameters of Depression over the Bay of Bengal during 30th July-01st August, 2013

Date	Time (UTC)	Centre lat. ^o N/ long. ^o E	C.I. NO	Estimated Central Pressure (hPa)	Estimated Maximum Sustained Surface Wind (kt)	Estimated Pressure drop at the Centre (hPa)	Grade
30.07.2013	0300	21.0/88.0	1.5	0990	25	3	D
	0600	21.5/87.5	1.5	0990	25	3	D
	The system crossed north Odisha and adjoining West Bengal coast between Balasore and Digha around 0700 UTC						
	1200	21.7/87.0	-	0990	25	3	D
	1800	21.7/85.5	-	0992	20	3	D
31.07.2013	0000	21.8/84.0	-	0992	20	3	D
	0300	21.8/83.0	-	0992	20	3	D
	0600	21.8/82.5	-	0992	20	3	D
	1200	22.0/80.5	-	0992	20	3	D
01.08.2013	0000	22.5/80.0	-	0992	20	3	D
	0300	The system weakened into a well marked low pressure area over southeast Madhya Pradesh and adjoining Chhattisgarh and Vidarbha.					

4. Intensification and movement:

As the depression lay close to the coast it interacted with land surface. Further the depression moved fast towards the land and crossed coast within 04 hours. The MJO was not favourable for intensifications of the depression as its amplitude was less. As a result, it could not intensify further. The depression moved westwards and crossed north Odisha and adjoining West Bengal coast between Balasore and Digha around 0700 UTC of 30th July 2013. The system moved west-northwestwards and weakened gradually into a well marked low pressure area over southeast Madhya Pradesh and adjoining Chhattisgarh and Vidarbha at 0300 UTC of 1st August, 2013.

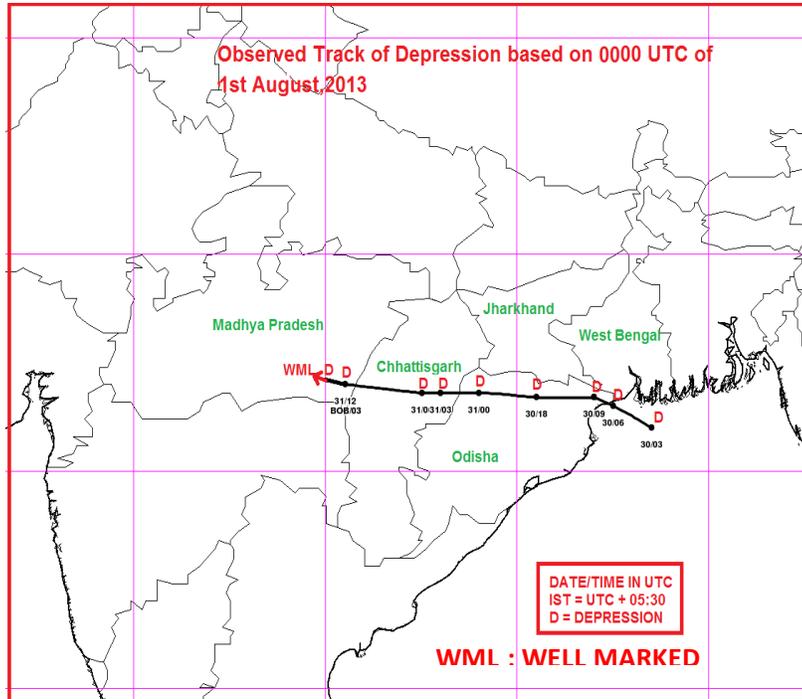


Fig.1. Track of depression over the Bay of Bengal (30th July- 01st August, 2013)

5. Warning services:

The Cyclone Warning Division/ Regional Specialised Meteorological Centre(RSMC)-Tropical Cyclone, IMD, New Delhi mobilised all its resources for monitoring and prediction of depression. It issued 3/6 hourly warning/advisory bulletins to national disaster management agencies including National Disaster Management (NDM), Ministry of Home Affairs (MHA), concerned state Govts. and other users at regular intervals. It also issued advisories to World Meteorological Organisation (WMO)/Economic and Social Cooperation for Asia and the Pacific (ESCAP) Panel member countries including Bangladesh, Myanmar, Thailand, Pakistan, Oman, Sri Lanka and Maldives during depression period.

The number of bulletins issued by the Regional Specialised Meteorological Centre-Tropical Cyclone, New Delhi and by Cyclone Warning Division, IMD, New Delhi are given below:

Bulletins for India	: 09
Special Tropical Weather Outlook WMO/ESCAP Panel countries	: 02

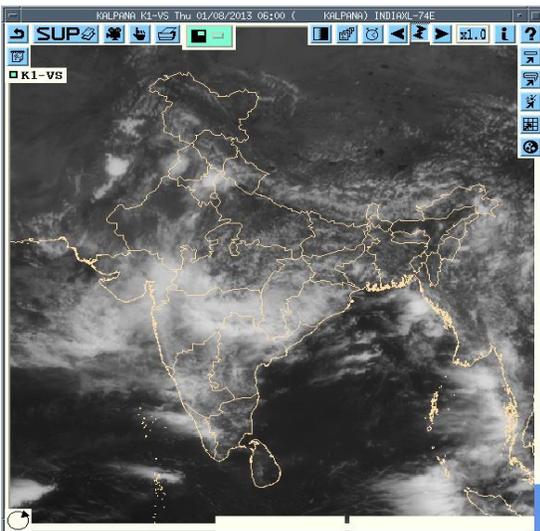
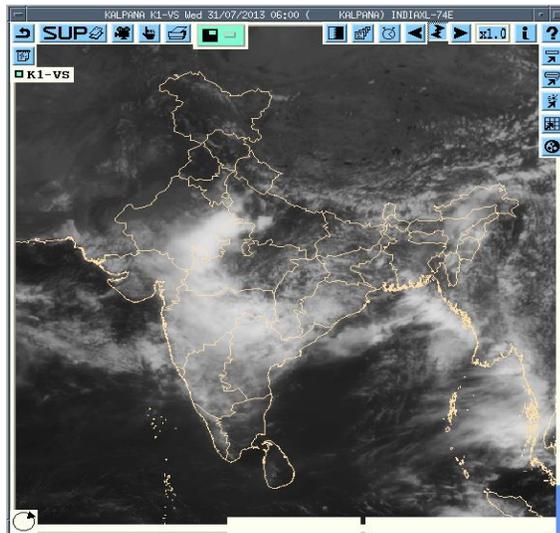
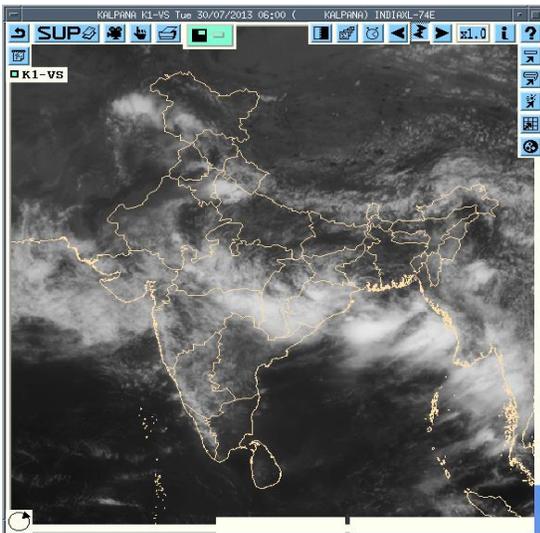
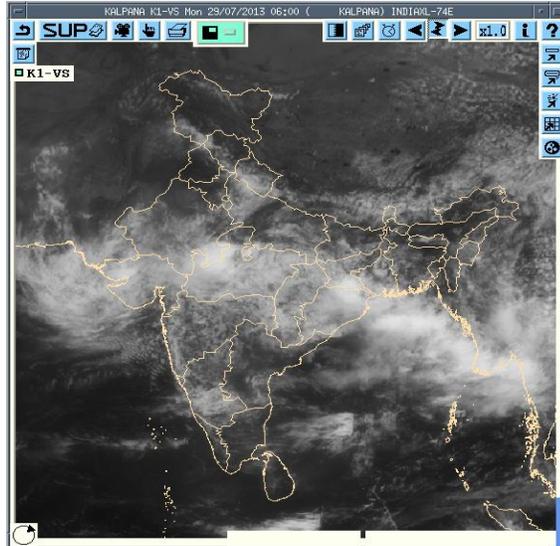
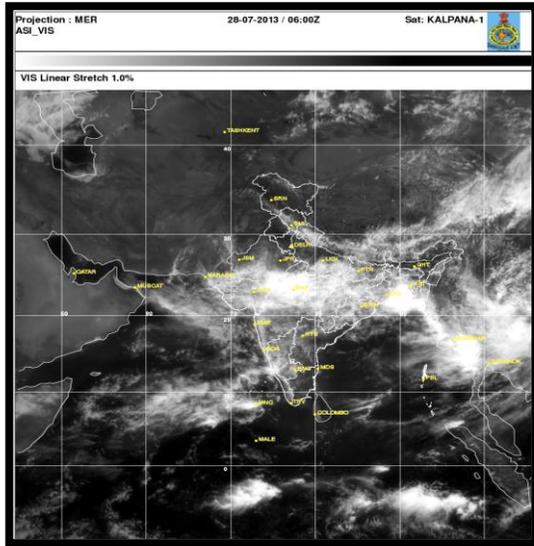


Fig.2. Typical Kalpana-1 Satellite imageries of depression at 0600 UTC of 28th July To 01st August 2013

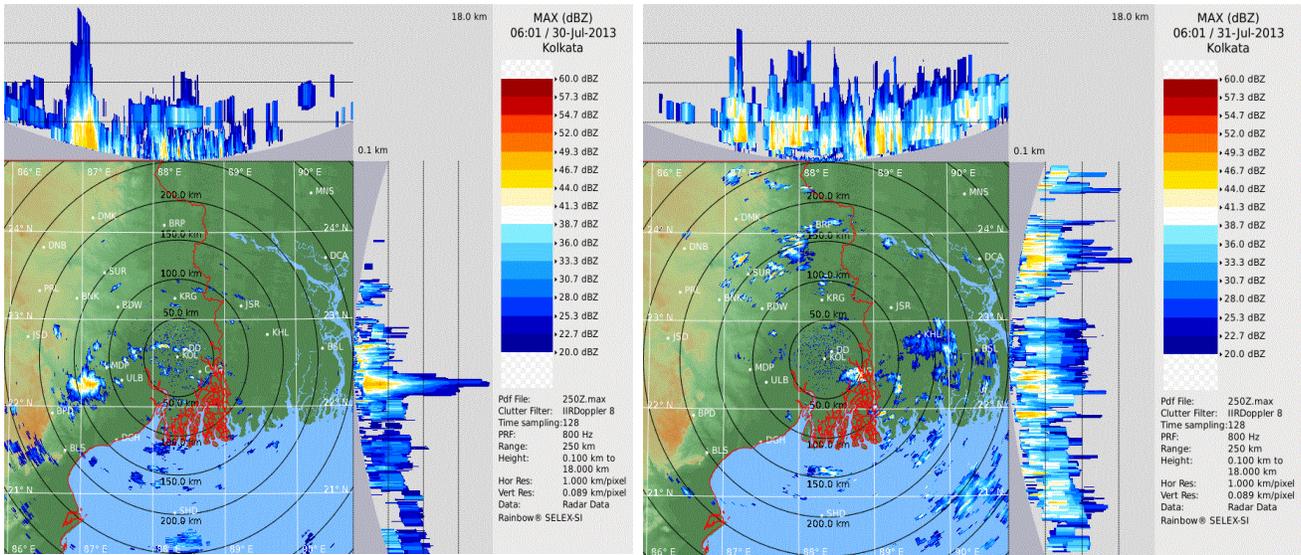


Fig.3. DWR, Kolkata imageries (maximum reflectivity) of Kolkata at 0600 UTC of 30th & 31st July 2013

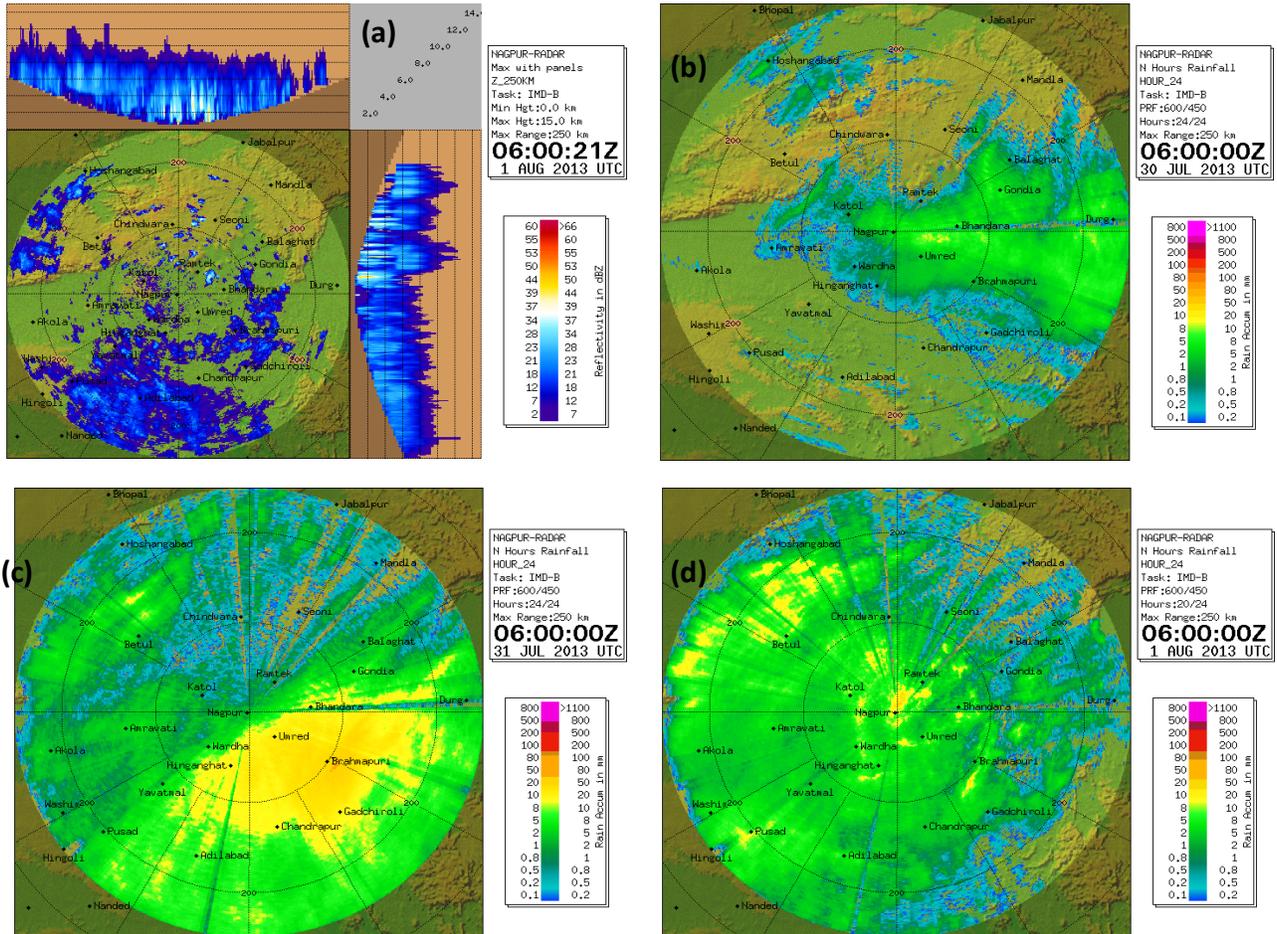


Fig.4. DWR, Nagpur imageries (a) maximum reflectivity at 0600 UTC of 1st Aug. 2013 and (b-d) 24 hr cumulative rainfall recorded at 0600 UTC of 30th & 31st July and 1st Aug. 2013.

3. Realised Weather:

Chief amounts of 24 hrs. rainfall (7 cm or more) ending at 0300 UTC of 31st

July -1st August, 2013 are given below:

31.7.2013:

Jharkhand: Arki -7

Odisha: Komna -19, Khariar -17, Jujumura (ARG) - 6, Padampur, Bijepur, Raigarh (ARG), Titlagarh-13 each, Kesinga ARG)- 12, Boden (ARG), Chandahandi (ARG) -11each, Patnagarh, Turekela, Sinapali (ARG), Sonapur -10 each, Batagaon, Pallahara, Junagarh - 9 each, Khaprakhola (ARG), Ullunda (ARG), Banaigarh (AWS), Paikma, Belgaon, Dunguripalli, Madanpur, Rampur, Nawapara, Khairama, Jhorigam (ARG)- 8 each, Sohela, Laikera, Atabira (ARG), Boudhgarh, Birmaharajpur (ARG), Rajkishorenagar, Batli (ARG), Ambabhona, Tarva (ARG), Loisingha (ARG), Saintala (ARG), Kirmira (ARG), Kolabira (ARG) -7 each.

Chhattisgarh: AmbagarhChowki-17, Bemetara -16, Simga, Dongargaon- 15 each, Dhamtari-14, Raipur, Bijapur, Arang, Rajnandgaon-13 each, Dongargarh, Dondilohara- 12 each, Balod-11, Gariabund-10, Rajim, Saraipali, Raipur(AP) -9 each, Deobhog, Sarangarh-8 each, Durg-7.

Vidarbha: Bramhapuri, Desaignanj, Mulchera-19 each, Kurkheda, Armori, Arjuni, Morgaon, Deori-18 each, Korchi -17, Nagbhir, Lakhandur-16 each, Pauni - 15, Sakoli, Bhiwapur, Maregaon -14 each, Gadchiroli, Sadakarjuni, Saoli, Sindewahi-13 each, Chimur, Lakhani, Mul, Dhanora – 11each, Salekasa, Chamorshi-10 each, Etapalli, Chandrapur, Umrer, Bhandara, Bhamragad- 9 each, Kuhi, Zarizamni, Hinganghat, Chikhaldia – 8 each, Korpana, Goregaon, Mauda, Ralegaon, Tirora -7 each

01.08.2013

Odisha: Saintala (ARG) -7,

Chhattisgarh: Sukma-7,

Vidarbha: Armori-22, Desaignanj -21, Dharni -17, Kurkheda, Saoli, adchiroli –14 each, Katol, Mahagaon, Wani – 13 each, Arjuni Morgaon -12, Narkheda, Kamptee, Zarizamni, Umerkhed, Arni, Etapalli, Perseoni -11 each, Ballarpur, Chamorshi, Nagpur Aerodrome, Kalmeshwar, Sironcha, Saoner-10 each, Korpana, Lakhani, Joiti, Yeotmal, Rajura, Mul, Mangrulpur, Warora, Pandherikawara, Amraoti-9 each, Ahiri, Ner, Pombhurna, Digras, Maregaon, Manora, Chandrapur, Washim, Selu, Morsi, Bramhapuri - 8 each, Risod, Paratwada, Akola, Anjangaon, Karanjald, Patur, Nandgaonkazi, Ramtek, Darwha, Bhadravati, Ghatanji,

Gondpipri, Chandur Rlwy, Amgaon, Murtajapur, Bhiwapur, Hinganghat - 7 each.

East Madhya Pradesh: Sausar -10

West Madhya Pradesh:Chicholi– 28, Pachmarhi-25, Betul- 21, Khandwa -20, Khaknar- 19, Shajapur -17, Sarangpur, Khirkiya-15, Bhainsdehi - 14, Harda, Nusrulgunj – 13, Susner- 12, Tarana-11, Neapanagar, Pandhana -10 each, Atner, Tonkhurd, Barwaha – 9 each, Harsud, Karera, Kannod – 8 each, Datia, Bhikangaon, Khategaon, Ashta, Kolaras, Multai, Maheshwar, Sonkatch – 7 each,

Telengana: Perur, Sirpur- 13, Venkatapuram, Eturnagaram, Adilabad(A), Adilabad- 12 each, Utnoor, Mulug- 11 each, Parkal-10, Kaleswaram – 9, Asifabad, Nirmal – 8

Madhya Maharashtra: Mahabaleshwar-25, Gaganbawada-10, Igatpuri, Chandgad, Ajra, Peint – 7 each,

Marathwada: Kinwat – 8, Bhokar, Kallamnuri, Sengaon, Hingoli – 7 each.

East Rajasthan:Dholpur Tehsil, Neemkathana – 10, Tizara -9, Atru – 8, Shahabad – 7

Gujarat region: Valsad, Daman – 7 each,

Kokan & Goa:Poladpur, Jawhar- 11 each, Khed- 10, Mokheda -9, Valpoi, Sanguem, Mandangad, Chiplun, Talasari, Dodamarg -7each.

02.08.2013

West Madhya Pradesh:Badnagar, Ratlam – 11 each, Mhow, Nalchha, Petlawad - 10 each, Sardarpur, Dewas - 9 each, Thandla, Kasarwad, Jhabua - 8 each, Badnawar, Khachrod – 7 each.

Vidarbha:Lakhani, Deori – 11 each, Mahagaon – 10, Sakoli, Sadakarjuni, Washim – 9 each, Digras, Arni, Malegaon – 8 each, Joiti, Manora – 7 each.

Madhya Maharashtra: Mahabaleshwar – 17, Gaganbawada – 14, Shahuwadi – 7

Konkan & Goa: Talasari – 23, Mahad- 19, Dahanu – 17, Bhira – 15, Vikramgad, Roha – 14 each, Matheran, Jawhar – 13 each, Dapoli Agri, Khalapur, Chiplun – 10 each, Mumbai, Tala, Mangaon, Guhagarh, Panvel Agri, Khed, Mokheda - 9 each, Poladpur, Mandangad, Tbia, Uran – 8 each, Harnai, Karjat Agri, Sangameshwar Devrukh, Sudhagad Pali, Mumbai (Colaba), Mhasla, Pen – 7 each.

Gujarat Region: Madhbun – 19, Umergam – 15, Idar, Silvassa – 14, Dahod, Sankheda – 13, Daman, Pardi – 12 each, Surat City – 11, Rajpipala, Vapi – 10 each, Bodeli, Chhota Udepur, Kaprada, Limkheda, Tilakwada - 9 each, Bhiloda, Nanipalson – 8 each, Choryasi, Halol, Jalalpor, Jetpur Pavi, Morva Hadaf, Nandod, Naswadi, Navsari, Vijapur – 7 each.

East Rajasthan: Vallabh Nagar – 9, Dungarpur Tehsil, Kanva – 7

West Rajasthan: Pali, Rohat – 9 each, Marwar Junction – 7

03.08.2013

West Madhya Pradesh: Raisen – 7

Madhya Maharashtra: Mahabaleshwar, Ajra – 9 each, Gaganbawada – 8.

Konkan & Goa: Sangameshwar Devrukh – 12, Talasari - 9

Gujarat Region: Tilakwada (ARG) -22, Tilakwada – 21, Nandod – 20, Rantij, Rajpipala– 17 each, Kamrej– 16, Dahegam –15, Gandhinagar, Umergam – 14 each, Dholka, Virangam(ARG), Talod, Kathalal – 13 each, Ghandinagar (AWS) – 12, Olpad, Kalol (G), Himatanagar – 11 each, Dholka (ARG), Songadh – 10 each, Vyara, Valod, Padra - 9 each, Surat, Navsari, Sankheda, Sinor, Sanand, Bhabhar, Surat(AWS), Umerpada, Kaprada – 8 each, Mahuva, Mangrol, Mahudha, Karjan, Kalol (ARG), Thasra, Bardoli (ARG), ChoryasiAbad City, Wav, Jalalpor, Palsana, Dascroi, Khambhat, Bavla – 7 each.

Saurashtra & Kutch : Amreli – 14, Jamnagar – 13, Liliya (ARG) -12, Gariadhar, Lilia – 11 each, Palitana, Lathi – 10 each, Lodhika, Jafrabad, Jafrabad (ARG) – 9 each, Una, Talaja, Botad, Kodinar – 8 each, Lodhika (ARG), Gondal, Lalpur – 7 each.

West Rajasthan: Sanchore, Raniwada – 8 each.

AWS : Automatic Weather Station; ARG : Automatic Rain Gauge; AP: Airport

6. Rainfall forecast verification

The heavy rainfall warning issued by IMD along with the actual heavy rainfall is given in Table 2.

Table 2: Heavy rainfall warning issued by IMD, New Delhi

Date	Synoptic System	Warning issued	24 hr heavy rainfall realised at 0830 IST of date
30 th July 2013 0300 UTC	Depression formed over northwest Bay of Bengal lay centred at Lat.21.0°N and Long. 88.5°E 120 km southwest of Digha and about 180 km east-southeast of Balasore.It would move west-northwards and cross north Odisha coast between Digha	Isolated extremely heavy rainfall - Odisha during next 24 hrs. heavy to very heavy rainfall - Odisha, Chattisgarh and Vidharba during next 48 hours .	31.07.2013 Isolated heavy to very heavy rainfall – Odisha, Vidarbha, Chhattisgarh Isolated heavy rainfall – Jharkhand

	and Chandbali close to Balasore by night of 30 th – 31 st July 2013.		
30 th July 2013 0900 UTC	The Depression over northwest Bay of Bengal moved northwestward and crossed north Odisha and adjoining West Bengal coast between Balasore and Digha around 1230 hours IST and lay centred at 1430 hours IST of today, the 30 th July, 2013 over north Odisha and adjoining Gangetic West Bengal, close to north of Balasore.	Heavy to very heavy rainfall at a few places - Odisha and south Chattisgarh during next 24 hours. isolated heavy to very heavy rainfall - north Vidarbha ,Chattisgarh and Jharkhand during next 24 hrs. Heavy to very heavy rainfall at a few places over – Vidarbha during subsequent 24 hours. isolated heavy to very heavy falls - east Madhya Pradesh during next 48 hours.	01.08.2013 Isolated heavy to very heavy rainfall - Vidarbha, West Madhya Pradesh, Telangana, Madhya Maharashtra & Marathawada. Isolated heavy rainfall - Odisha & Chhattisgarh, East Madhya Pradesh
30 th July 2013 1200 UTC	The depression over north Odisha and adjoining Gangetic West Bengal remained practically stationary over the same region and lay centred at 1730 hours IST of today, the 30 th July, 2013, close to north of Balasore.	Heavy to very heavy rainfall at a few places - Odisha and south Chattisgarh during next 24 hours. isolated heavy to very heavy rainfall - north Vidarbha ,Chattisgarh and Jharkhand during next 24 hrs. Heavy to very heavy rainfall at a few places over – Vidarbha during subsequent 24 hours. isolated heavy to very heavy rainfall - east Madhya Pradesh during next 48 hours.	02.08.2013 Heavy to very heavy rainfall at a few places- Gujarat Region, Isolated heavy to very heavy rainfall – West Madhya Pradesh, East Rajasthan, West Rajasthan, Konkan & Goa Isolated heavy rainfall – Vidarbha, Madhya Maharashtra
31 st July 2013 0300 UTC	The depression over interior Odisha and adjoining Chhattisgarh moved west-northwestwards and lay centred at 0830 hours IST of today, the 31 st July, 2013 over north Chhattisgarh, close to	Isolated heavy to very heavy rainfall – Chhattisgarh, and Telangana during next 24 hours. Isolated heavy to very	

	southeast of Pendra. The system would move further west-northwestwards and weaken gradually into a well marked low pressure area during next 24 hrs.	<p>heavy rainfall – Madhya Pradesh, Marathwada and Madhya Maharashtra during next 48 hrs.</p> <p>Heavy to very heavy rainfall - Vidarbha during next 24 hours and isolated heavy to very heavy rainfalls during subsequent 24 hours.</p>	<p>03.08.2013</p> <p>Isolated heavy rainfall –</p> <p>West Madhya Pradesh, Madhya Maharashtra, Konkan & Goa and West Rajasthan.</p> <p>Isolated heavy to very heavy rainfall –</p> <p>Saurashtra & Kutch</p> <p>Heavy to very heavy rainfall at a few places- Gujarat region.</p>
31 st July 2013 1200 UTC	The depression over Chhattisgarh moved westwards and lay centred at 1730 hours IST of today, the 31 st July, 2013 over east Madhya Pradesh and adjoining Chhattisgarh, about 50 km south of Mandla. The system would move west-northwestwards and weaken gradually into a well marked low pressure area during next 24 hrs.	<p>Isolated heavy to very heavy rainfall – Vidarbha, Chhattisgarh and Telengana during next 24 hrs.</p> <p>Heavy to very heavy rainfall at a few places – Vidarbha during next 24 hours and isolated heavy to very heavy rainfalls during subsequent 24 hrs.</p> <p>Isolated heavy to very heavy rainfall - Madhya Pradesh, remaining Maharashtra, Gujarat region, Saurashtra and east Rajasthan during next 48 hrs.</p>	
01 st August 2013 0300 UTC	The depression over southeast Madhya Pradesh and adjoining Chhattisgarh and Vidarbha weakened and lay as a well marked low pressure area over the same region at 0830 hours IST of today, the 1 st August, 2013.	<p>Heavy to very heavy rainfall at a few places – Gujarat region and isolated heavy to very heavy rainfalls during subsequent 24 hours.</p> <p>Isolated heavy rainfall - east Madhya Pradesh, Vidarbha and Marathawada during next 24 hours and at isolated places during subsequent 24 hours.</p> <p>Isolated very heavy rainfall - Isolated places over west Madhya Pradesh. east Rajasthan, Saurashtra & Kutch, Konkan & Goa and Madhya Maharashtra during next 48 hours.</p>	

