INDIA METEOROLOGICAL DEPARTMENT
MINISTRY OF EARTH SCIENCES
GOVERNMENT OF INDIA

Very Severe Cyclonic Storm "NIVAR" over the Bay of Bengal (22nd - 27th November 2020): A Preliminary report

1. Brief Life History of very severe cyclonic storm, 'NIVAR':

- A Low Pressure Area (LPA) formed over Equatorial Indian Ocean (EIO) and adjoining central parts of south Bay of Bengal (BoB) on 21st November.
- It lay as a Well Marked Low Pressure Area (WML) over southwest & adjoining southeast Bay of Bengal on 22nd November.
- It concentrated into a depression over the same region in the early hours (0230 hrs IST / 2100 UTC of 22nd) of 23rd November.
- Moving west-northwestwards, it intensified into a deep depression in the evening of 23rd and further into the cyclonic storm **"NIVAR"** in the early morning (0530 hrs IST / 0000 UTC) of 24th over southwest BoB.
- Continuing to move west-northwestwards, it further intensified into a severe cyclonic storm in the midnight (2330 hrs IST / 1800 UTC) of 24th and into a very severe cyclonic storm in the afternoon (1430 hrs IST / 0900 UTC) of 25th.
- Moving further northwestwards, it crossed Tamilnadu & Puducherry coasts near Puducherry (near lat. 12.1°N and long. 79.9°E) during 2330 IST of 25th to 0230 IST of 26th as a very severe cyclonic storm with estimated wind speed of 120 kmph gusting to 135 kmph.
- Continuing to move northwestwards, it weakened into a severe cyclonic storm in the early morning hours (0230 hrs IST) of 26th.
- Thereafter, it moved north-northwestwards and weakened into a cyclonic storm in the morning (0830 hrs IST / 0300 UTC) of 26th November, 2020 over north coastal Tamilnadu.
- Thereafter, it started recurving north-northeastwards and weakened into a deep depression in the afternoon (1430 hrs IST) of 26th over south Rayalaseema, into a depression in the same midnight (2330 hrs IST) over south coastal Andhra Pradesh.
- Thereafter, it weakened into a well marked low pressure area over south coastal Andhra Pradesh and adjoining westcentral BoB in the early morning (0000 UTC)of 27th November.
- Under the influence of this system, intense rainfall activity occurred over north Tamil Nadu & Puducherry, Rayalseema and south coastal Andhra Pradesh.

Heavy to very heavy rainfall occurred at a few places and isolated extremely heavy rainfall (≥ 20 cm) occurred over north Tamilnadu, Puducherry on 24th, 25th & 26th and over Rayalaseema & south coastal AP on 25th and 26th.

- The observed track of the system during 22nd to 27th November is presented in Fig. 1.

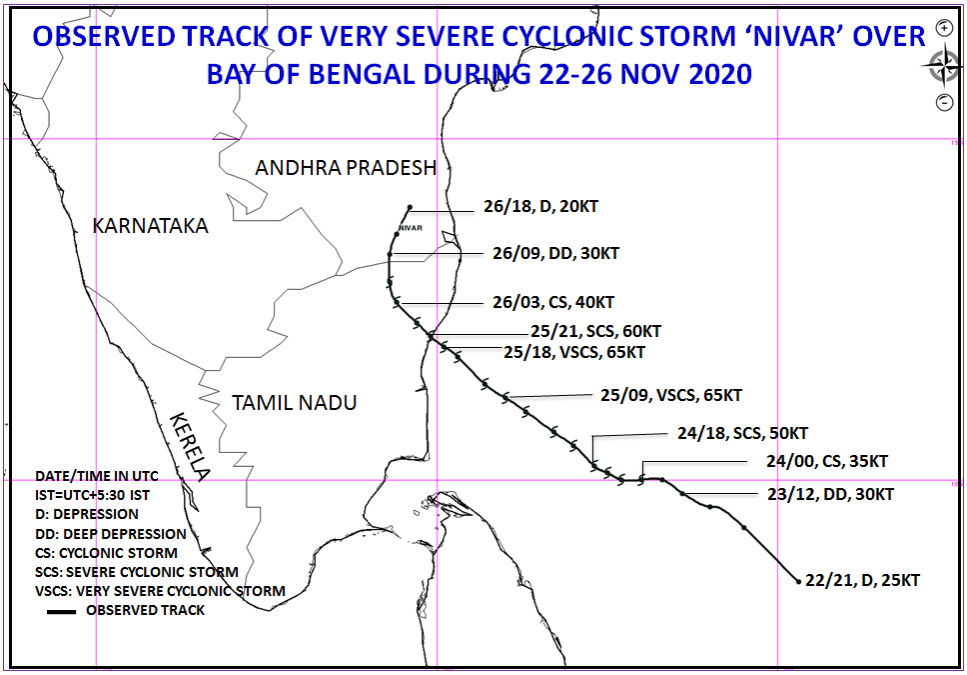

Fig.1: Observed track of very severe cyclonic storm "NIVAR" over Bay of Bengal

2. Monitoring of "NIVAR:

India Meteorological Department (IMD) maintained round the clock watch over the north Indian Ocean and the cyclone was monitored since 5th November, about 16 days prior to the formation of low pressure area over equatorial Indian Ocean and adjoining central parts of south BoB on 21st November and 18 days prior to the formation of depression over central parts of south BoB on 23rd. The cyclone was monitored with the help of available satellite observations from INSAT 3D and 3DR, SCAT SAT, polar orbiting satellites and available ships & buoy observations in the region. The system was also monitored by Doppler Weather RADARs (DWR) Chennai, Karaikal and Sriharikota. Various numerical weather prediction models run by Ministry of Earth Sciences (MoES) institutions (IMD, IITM, NCMRWF, INCOIS), global models and dynamical-statistical models were utilized to predict the genesis, track, landfall and intensity of the cyclone. A digitized forecasting system of IMD was utilized for analysis and comparison of various

models' guidance, decision making process and warning products generation. Typical satellite and radar imageries are presented in Fig. 2.

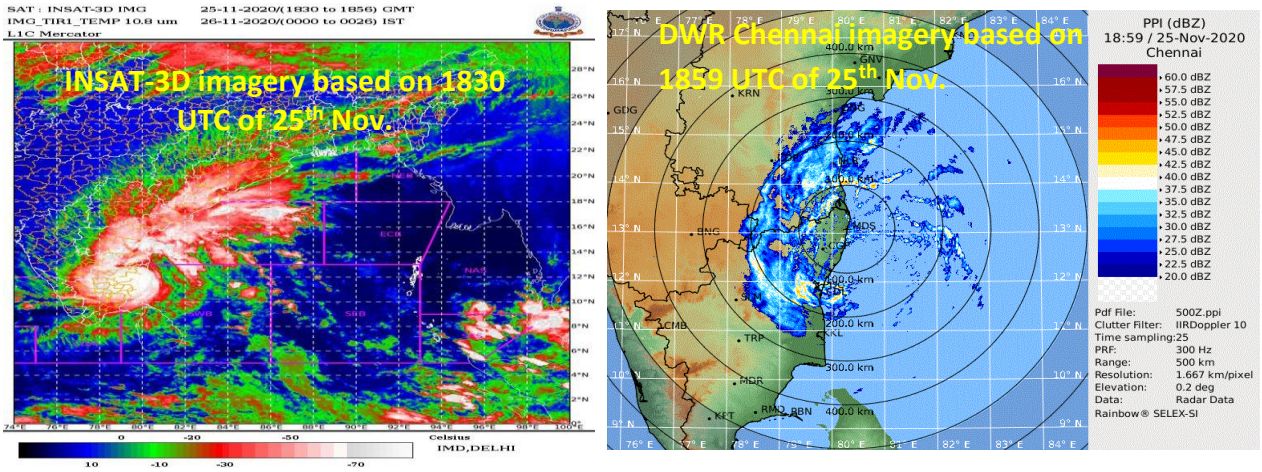

Fig.2: Typical satellite and radar imageries from DWR Chennai of VSCS "NIVAR"

3. Forecast Performance:

3.1. Genesis, track, landfall and intensity forecast:

- The extended range outlook issued on 12th November, indicated that a low pressure area would form over BoB during first half of week (20-26 November) and depression would form over south Bay of Bengal later half of the week. Actually, low pressure area formed over EIO and adjoining central parts of south BoB on 21st November and depression formed over central parts south BoB in on 23rd November. Thus, the genesis of "NIVAR" was predicted by IMD about 12 days in advance.
- The daily national bulletin issued at 1210 hrs IST of 20th November indicated that a low pressure area would form over central parts of south Bay of Bengal around 23rd November, 2020. It was also indicated that it would concentrate into a depression over southwest Bay of Bengal and move west-northwestwards towards Tamilnadu coast by 25th. Actually, the system moved northwestwards towards Tamilnadu coast and crossed the coast in the late night of 25th. Thus, track of "NIVAR" was predicted correctly by IMD about 5 days in advance.
- The first special bulletin and press release issued at 1500 hrs IST of 21st November indicated that a depression would form over southwest BoB around 23rd. It was also indicated that, it would intensify further and move west-northwestwards towards Sri Lanka-south Tamil Nadu coast and reach near Tamil Nadu & Puducherry coast on 25th November, 2020 (about 4 days and 8 hours prior to landfall near Puducherry).

- In the bulletin issued at 1130 hrs IST of 22nd November. It was indicated that the cyclone would cross Tamilnadu and Puducherry coasts between Karaikal and Mammalapuram during 25th afternoon (3 days and 12 hours prior to landfall). **For the first time IMD indicated landfall area of the cyclone, when the system was in the stage of low pressure area.**
- First information that the system would cross Tamilnadu coast close to Puducherry in the evening of 25th with a wind speed of 100-110 kmph gusting to 120 kmph was released in the bulletin issued at 0830 hrs IST of 23rd (about 2 days and 18 hours prior to landfall). The cyclone crossed coast near Puducherry during midnight of 25th to early hours of 26th November with a wind speed of about 120 kmph.
- Since 20th November, regular warnings about the heavy rainfall and strong winds were issued for the states of Tamilnadu, Puducherry and Andhra Pradesh.
- The observed and forecast track based on 0530 hrs IST of 23rd about 72 hrs prior to landfall demonstrating accuracy in track, landfall and intensity prediction is presented in Fig. 3. The black and red lines indicate the observed (actual) track and forecast track respectively. The closeness of these two lines indicate very accurate forecast of track (movement) and landfall point of cyclone, NIVAR.

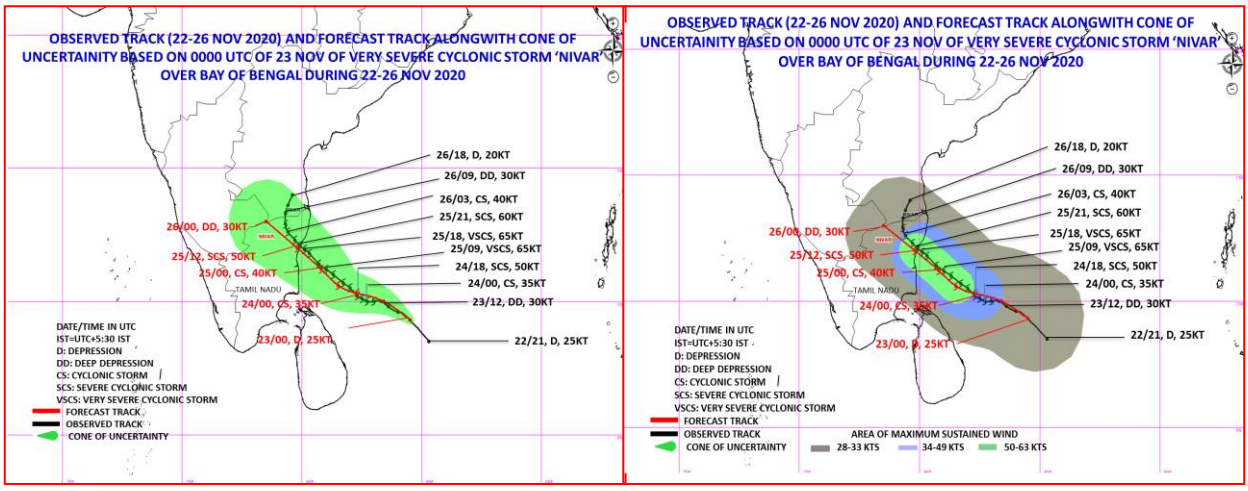

Fig 3: Observed and forecast track of VSCS NIVAR based on 0530 hours IST of 23rd (72hrs in advance of landfall) demonstrating accuracy in track, landfall and intensity forecast

3.2 Landfall forecast error

The landfall point and time Forecast errors compared to long period average (LPA) errors during 2015-19 are presented in Fig. 4 (a-b). The landfall point forecast errors for 24, 48 and 72 hrs lead period were 25, 25 and 16 km respectively against the LPA errors (2015-19) of 44.7, 69.4 and 109.3 km during 2015-19 respectively. The landfall time forecast errors for 24, 48 and 72 hrs lead period were 0.5, 5.0, and 8.5 hours

respectively against the LPA errors (2015-19) of 3.0, 5.4 and 8.6 hours during 2015-19 respectively. **For all lead periods, the landfall point errors were exceptionally less than the LPA errors during 2015-19.**

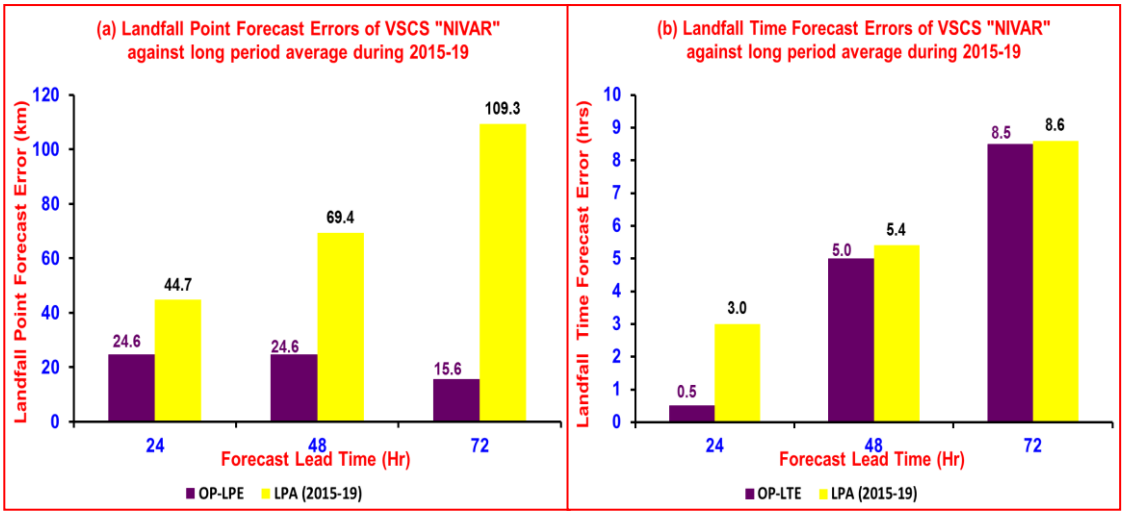

Fig.4: Landfall (a) point and (b) time forecast errors of VSCS 'NIVAR" as compared to long period average (2015-19)

3.3 Track forecast error and skill

The track forecast errors (Forecast position – Actual position of Cyclone centre) and skill as compared to Climatological and Persistence forecast are presented in Fig. 5 (a-b). The track forecast errors for 24, 48 and 72 hrs lead period were 86.1, 126.8, and 185.0 km respectively against the LPA errors (2015-19) of 80.6, 125.5, and 171.2 km respectively (Fig.5a). The track forecast skill was about 61%, 72%, and 79% against the LPA skill of 61%, 73%, and 74% for 24, 48 and 72 hrs lead period respectively (Fig.5b).

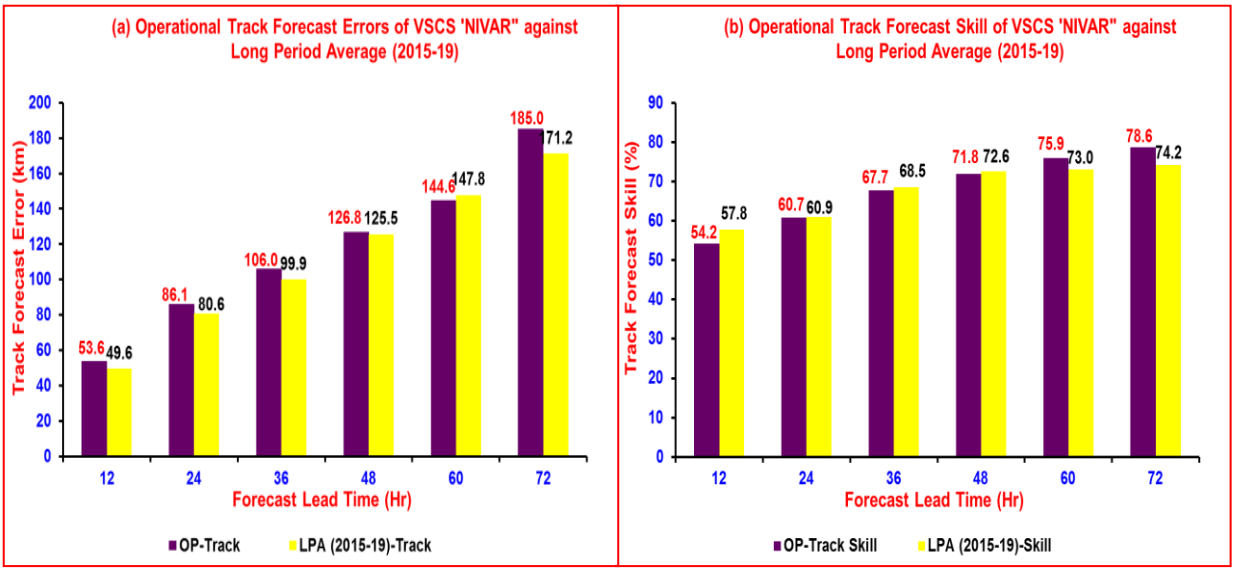

Fig.5: Track forecast (a) errors and (b) skill of VSCS 'NIVAR" as compared to long period average (2015-19)

3.4 Intensity forecast error and skill

The intensity forecast errors (Forecast wind – Actual wind) and skill based on absolute errors and root mean square errors are presented in Fig. 6 & 7 respectively.

The absolute error (AE) of intensity (wind) forecast for 24, 48 and 72 hrs lead period were 4.3, 6.5 and 10.2 knots against the LPA errors of 8.9, 13.0, and 15.4 knots during 2015-19 respectively (Fig. 6a). The root mean square error (RMSE) of intensity (wind) forecast for 24, 48 and 72 hrs lead period were 5.0, 9.2 and 11.8 knots against the LPA errors of 11.5, 16.7, and 19.2 knots respectively (Fig. 6b).

The skill (%) in intensity forecast as compared to persistence forecast based on AE for 24, 48 and 72 hrs lead period was 79%, 76% and 59% against the LPA of 45%, 69% and 72% respectively (Fig. 7a). The skill (%) in intensity forecast based on RMSE for 24, 48 and 72 hrs lead period was 82%, 75% and 65% against the LPA of 49%, 63% and 76% respectively (Fig. 7b).

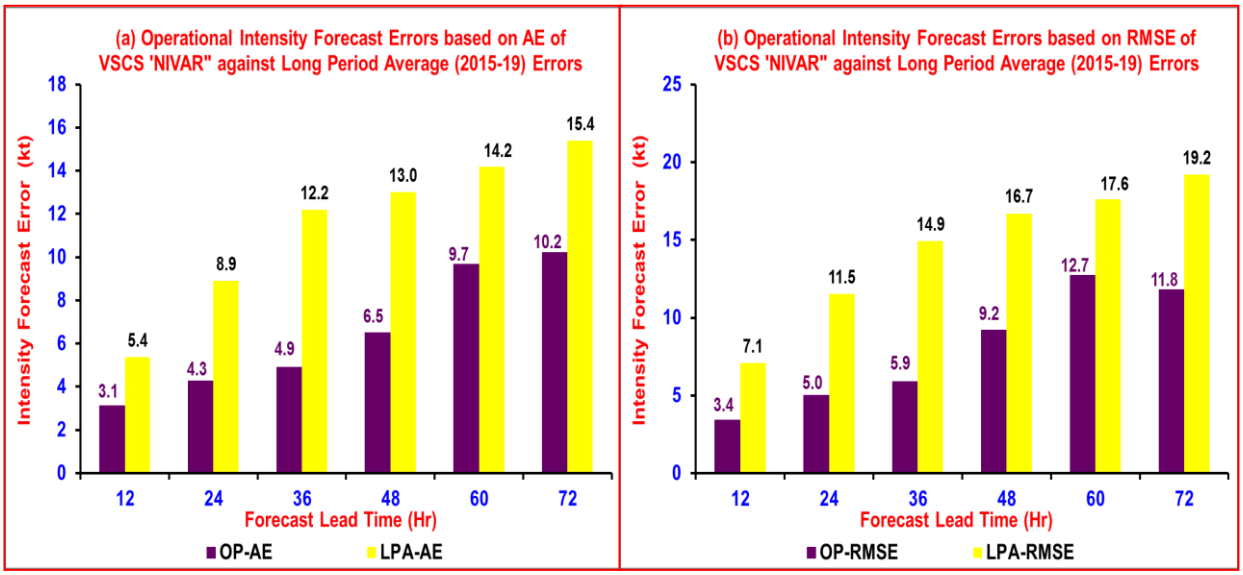

Fig.6: Absolute errors (AE) and Root Mean Square errors (RMSE) in intensity forecast (winds in knots) of VSCS 'NIVAR" as compared to long period average (2015-19)

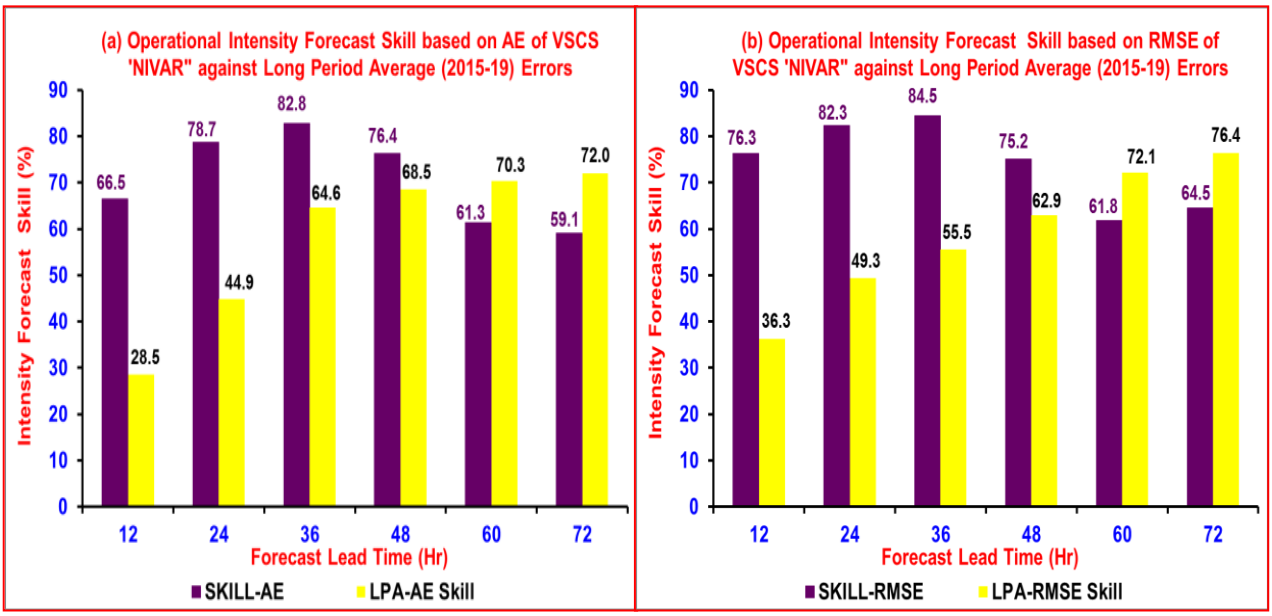

Fig.7: Skill (%) in intensity forecast based on (a) Absolute errors (AE) and (b) Root Mean Square errors (RMSE) of VSCS 'NIVAR" as compared to long period average (2015-19)

4. Warning & advisories issued by IMD

- **First Press Release and Special Bulletin** for east coast states were issued at 1500 hrs IST of 21st November (4 days 10 hrs prior to landfall)
- **Pre cyclone watch for Tamilnadu and Puducherry coasts** was issued at 1300 hrs IST of 22nd November when the system lay as a well marked low pressure over central parts of south BoB (about 3 days and 16 hours prior to landfall of NIVAR).
- **Cyclone Alert for Tamilnadu and Puducherry coasts** was issued at 0550 hrs IST of 23rd at depression stage (about 70 hours prior to landfall)
- **Cyclone Warning for Tamil Nadu & Puducherry coasts** was issued at 0900 hrs IST of 24th (about 40 hours prior to landfall)
- **Post Landfall Outllook for interior districts of TN & Puducherry** was issued at 1345 hrs IST of 25th (about 10 hours prior to landfall)
- A total of 38 bulletins to national level disaster managers & chief secretaries of Tamilnadu, Puducherry, Andhra Pradesh, Telangana, Andaman & Nicobar Islands, West Bengal, Odisha, Kerala and Lakshadweep. In addition, 7 Nos. of press release, 6 bulletins from Director General of Meteorology to senior Government Officers, 13 bulletins for civil aviation, regular media briefings and joint press conference addressed by DGM IMD and DG NDRF on 24th. The 3 hourly advisories were uploaded on all websites of IMD namely www.mausam.imd.gov.in and www.rscmcnewdelhi.imd.gov.in. Warnings were also uploaded on all social networking sites including Facebook, Twitter, Whatsapp etc. frequently and SMS were also sent to registered users on RSMC website, national level disaster managers and chief secretaries of concerned states. Hourly bulletins were also issued 12 hours prior to landfall.
- **The cyclone warning track and wind graphics were provided in IMD and RSMC, New Delhi website through interactive web-GIS map.**

5. Realised rainfall:

Realized 24 hrs accumulated rainfall (≥7cm) ending at 0830 hrs IST of date during the life cycle of the system is presented below:

24 November 2020

Tamilnadu, Puducherry & Karaikal: Tambaram-9, MGR Nagar, Chennai-8 each, Alandur-7.

25 November 2020

Tamilnadu, Puducherry & Karaikal: Chennai (Nungambakkam)-16, Anna University, Chennai (Meenambakkam), Sholinganallur-15 each, Taramani, Anna University, DGP

Office, MGR Nagar-14 each, Mahabalipuram, Alandur, Hindusthan University, Puzhal, Chembarambakkam-12 each, Tambaram, Ambathur-11 each, Perambur, Red Hills, Kolapakkam, Poonamallee-10 each, Ennore, Thirupporur, Cholavaram- 9 each, Maduranthagam, Kelambakkam-8 each, Sriperumbudur-7.

26 November 2020

Andhra Pradesh: Kodur-25, Venkatagiri-24, Gudur-19, Rapur-16, Atmakur, Sullurpeta-15 each, Nellore, Kavali, Satyavedu, Sambepalle-14 each, Nagari, Rajampet, Tirupati-13 each, Thottambedu, Puttur-12 each, Palamaner, Srikalahasti, Tada-11 each, Penagaluru, Kalakada-10 each, Palasamudram, Royachoti, Amalapuram-9 each, Vinjamur, Udayagiri, Pullampeta, Pakala-8 each, Chittoor, Chinnamandem, Cuddapah, Madanapalle-7 each.

Tamilnadu, Puducherry & Karaikal: Tambaram-31, Puducherry-30, Vilupuram-28, Cuddalore-27, DGP Office, Chennai-26, Sholinganallur-22, Thamaraipakkam-19, Parangipettai-18, Pallipattu-17, Cholavaram-16, Gingee, Poonamallee, Ambathur, Tiruvallur, Mahabalipuram, Gummidipoondi-15 each, Tindivanam, Maduranthagam, Chembarabakkam, Anna University, Vanur, Kollidam, Bhuvanagiri-14 each, MGR Nagar, Kancheepuram, Kurinjipadi, Alandur, Chidambaram, Red Hills, Marakkanam, Chengalpattu, Tiruttani, Chidambaram-13 each, Ulundurpet, Poondi, Keelpennathur, Vadapudupattu, Koratur, Sirkali-12 each, Chennai Airport, Vandavasi, Sethiyathope, Vembakkam, Poonamalle-11, Arakonam, Thirukalukundram, Sriperumbudur, Panruti-11 each, Ponneri, Arcot, Taramani, Perambur, Uthiramerur, Sholingur, Cheyyur-10 each, Anna University, Chembarambakkam, Thiruvalangadu, Tirukoilur, Polur, Mayiladuthurai, Thirupporur, Kelambakkam, Karaikal, Manalmedu, Puzhal-9 each, Arani, Chennai (Nungambakkam), Vridhachalam, Vepur, Hindusthan University, Ammundi, Vellore, R.K.Pet, Kodavasal, Manjalaru-8 each, Uthukottai, Ambur, Kaveripakkam, Agaram Seegoor, Tiruttani, Tozhudur, Tarangambadi, Pelandurai, Tiruvannamalai, Srimushnam, Ennore, Needamangalam, Sendurai, Katpadi, Cheyyar, Aduthurai-7 each.

27 November 2020

Andhra Pradesh: Kavali-27, Nambulipulikunta-25, Gurramkonda-21, Sambepalle-20, Royachoti, Madanapalle, Chinnamandem, Kalakada-18 each, Punganur, Udayagiri, Vinjamur- 17 each, Atmakur, Pullampeta, Thambalapalle, Palamaner-16 each, Chapad, Chittoor, Proddutur, Arogyavaram, Avanigada, Ongole, Amalapuram-15 each, Yanam, Marripudi, Podili, Veligandla, Kandukur, Utukuru(A), Vempalle, Kamalapuram-14 each, Atlur-13, Kakinada, Palakoderu, Cuddapah -12 each, Bheemavaram, Bapatla, Vijayawada Airport, Gudivada, Narsapuram, Chimakurthi, Duvvur-11, Raju Palem, Pakala, Palasamudram-11 each, Vallur, Kodur, Rajampet, Karamchedu, Repalle,

Seetharamapuram, Tanuku-10 each, Mundlamuru, Addanki, Mangalagiri, Tadepalligudem, Masulipatnam, Peddapuram, Kaikalur, Jammalamadugu, Badvel, Porumamilla, Puttur-9 each, Pulivendla, Muddanur, Lakkireddipalle, Konakanamitla, Cumbum, Bestavaripeta, Markapur, Nellore, Darsi-8 each, Vijayawada, Tuni, Anakapalle, Rapur, Santhamaguluru, Guntur, Bhimadole, Racherla, Prathipadu, Visakhapatnam, Eluru, Penagaluru, Kadiri, Tanakal, Venkatagiri Kota-7 each.

Tamilnadu, Puducherry & Karaikal: Sholingur-23, Vadapudupattu-16, Vellore, Ponnai Dam, Ammundi-14 each, Ambur, R.K.Pet-13 each, Alangayam, Katpadi-12 each, Vaniyambadi, Tirupuvanam, Kaveripakkam-9 each, Wallajah, Gudiyatham, Virinjipuram-8 each, Devakottai, Vembakkam, Melalathur-7 each.
