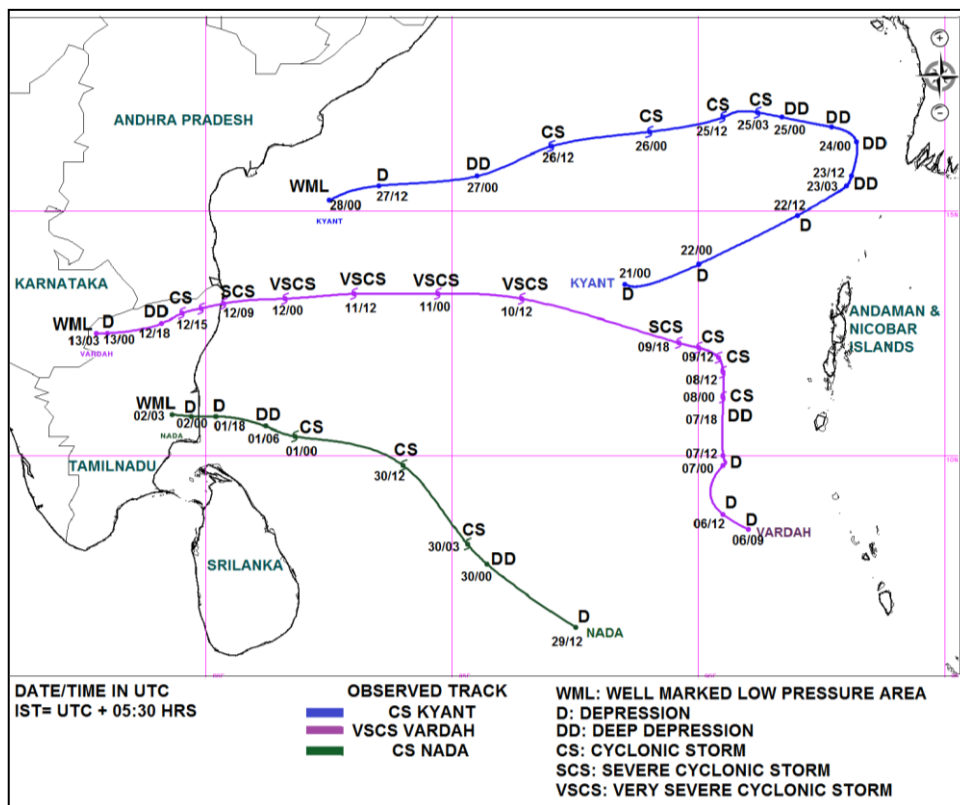


## Severe Weather Events: Post-Monsoon Season (July-December, 2016)

As per the climatology, Tropical Cyclones (TCs) occur in Indian Ocean prominently during pre-monsoon season and post-monsoon season but the maximum frequency is in the two months of October and November, in Bay of Bengal. The Bay of Bengal TCs more often strike Orissa-West Bengal coast in October, Andhra coast in November and the Tamil Nadu coast in December. Over 60% of the TCs in the Bay of Bengal strike different parts of the

east coast of India, 30% strike coasts of Bangladesh and Myanmar and about 10% dissipate over the sea itself. Although North Odisha and West Bengal coastal districts are very highly prone to cyclonic activity, but during Post-monsoon period of 2016 three cyclones, Kyant, Nada and Vardah formed in Bay of Bengal and all of them affected Andhra Pradesh and Tamil Nadu coast. The Tracks followed by these cyclones are depicted in Fig.1



**Fig.1 Observed Tracks of Cyclones during Post-Monsoon season 2016 for CS KYANT (21-28 October), CS NADA (29 November-2 December), CS VARDAH (6 -12 December)**

### 1. Cyclonic Storm “Kyant” over Bay of Bengal (21-28 October 2016)

Kyant originated over east central, Bay of Bengal and crossed southern Andhra Pradesh coast on 28 October, 2016 as a depression with wind speed 35-45 km/hr gusting to 50 km/hr. Moderate rains were reported in Andhra Pradesh and Tamil Nadu areas with no major damage to human lives. The track followed by the system was rare in nature as it experienced two recurvatures during its life period. First recurvature occurred in the evening of 23 October before the intensification of system into Cyclonic Storm and the other occurred in the afternoon of 25 October during the weakening phase.

The recurvature was anticlockwise against the normal clockwise recurvature over the Bay of Bengal. The last such recurvature over the BOB occurred in case

of VSCS Madi (December, 2013). It was one of the longest track in recent years with life period of 7 days. While the rate of intensification was slow and steady taking about 4 days to become Cyclonic Storm from the stage of depression, the rate of weakening was rapid as it reduced to a well marked low pressure area from the Cyclonic Stage stage within 30 hours.

The system weakened over the sea due to entrainment of dry and cold air from northwest India in association with anticyclonic circulation lying to the northwest of the system centre in middle and upper troposphere (Fig.2a-b). The cumulative rainfall during the CS Kyant (21-27 Oct, 2016) is shown in Fig.3

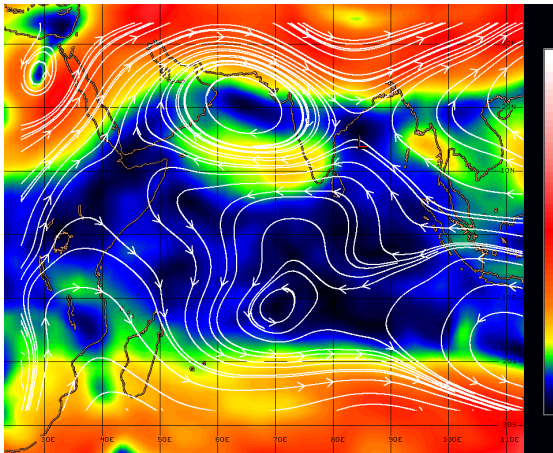


Fig. 2a Deep layer mean steering 200--700 hPa on 27 October 2016

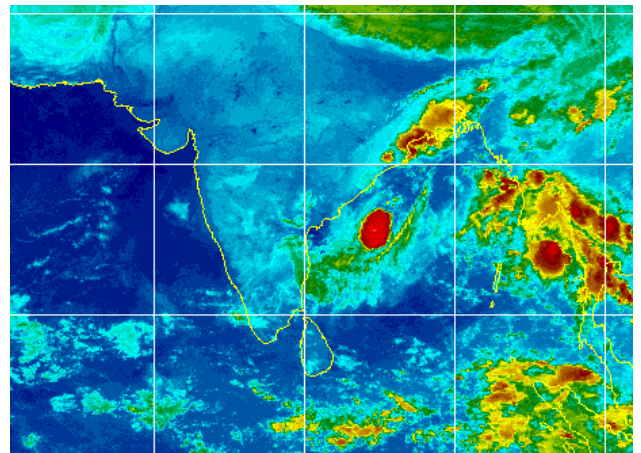


Fig. 2b Infrared Satellite Imagery on 27 October 2016

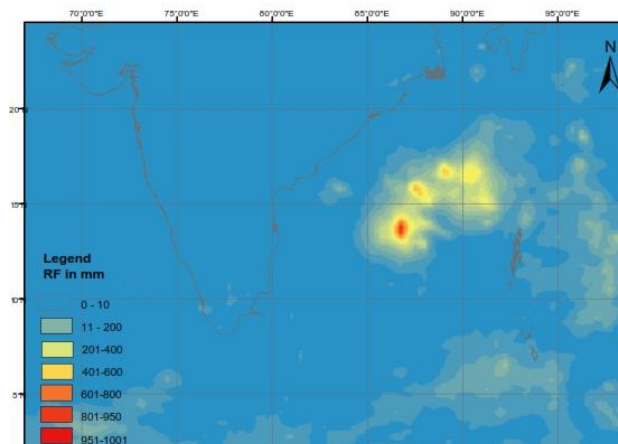


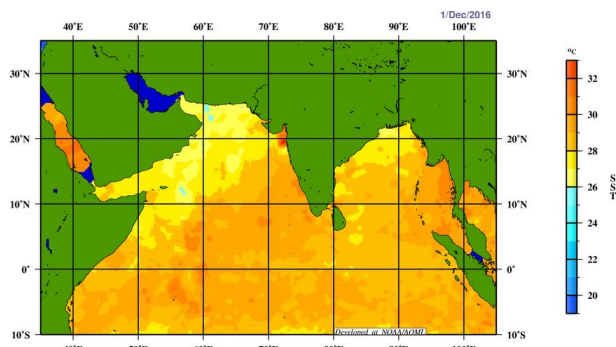
Fig.3 Cummulative rainfall during the Cyclone Kyant (21-27 Oct, 2016)

**2. Cyclonic Storm “NADA” over Bay of Bengal (29 November-02 December, 2016)**

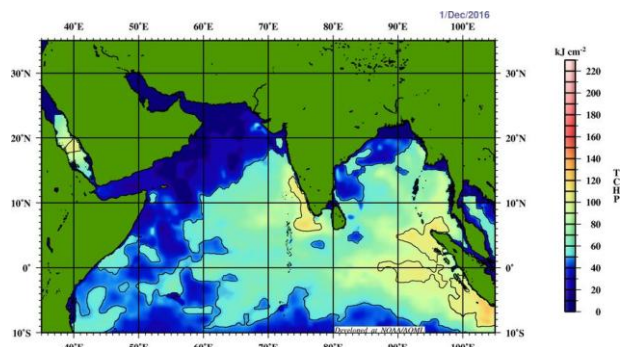
The cyclonic storm “Nada” over southwest Bay of Bengal moved west-northwestwards and maintained its cyclonic storm intensity till forenoon of 1 Dec. As it moved close to the coast, it encountered the colder sea surface area (Fig.4), lower Ocean thermal energy (< 50 KJ/cm<sup>2</sup>) (Fig.5) and also the dry air incursion from the northwest in association with an anticyclone lying to the northwest of the system centre (Fig.6). As a result, while moving west-northwestwards, it weakened into a deep depression and lay centred at 0600

UTC of 1st December, 2016 near latitude 10.6°N and longitude 81.2°E over southwest Bay of Bengal. The intensity of the system reduced further and it weakened into a depression at 1800UTC of 1 December, 2016 over southwest Bay of Bengal.

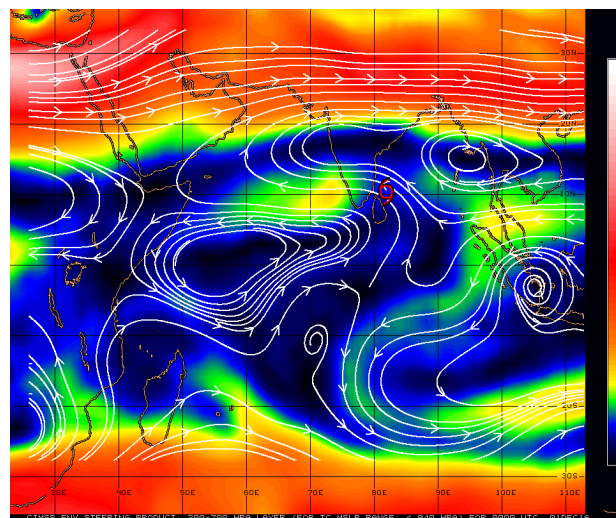
Nada made landfall near Nagapattinum in Tamil Nadu on 2 December, with winds of the order of 60 Km/hr. Rains upto 4 cm were recorded in Cuddalore, Puducherry and Nagapattinam with no major damage to life and property. It was the second CS over BOB during post monsoon season. The Cummulative rainfall during the cyclone period is depicted in Fig.7.



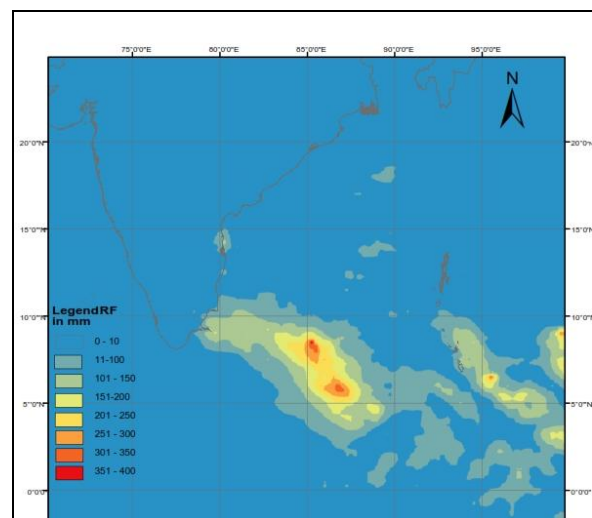
**Fig.4 Sea Surface Temperature (°C) on 1st December, 2016**



**Fig.5 Ocean thermal energy (kJ/cm<sup>2</sup>) on 1st December, 2016**



**Fig.6 Deep layer mean steering 200-700hPa on 1st December, 2016**



**Fig.7 Cumulative rainfall during the Cyclone Nada (29Nov-2 Dec, 2016)**

### 3. Very Severe Cyclonic Storm “Vardah” over Bay of Bengal (06-13 December, 2016)

Vardah originated over West Central & adjoining southwest Bay of Bengal. It made Landfall over Chennai on 13 December at

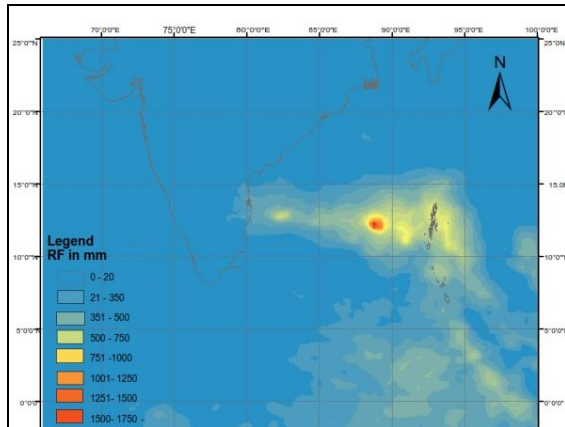


**Fig.8 Damage caused by CS Vardah in Chennai**

around 13.30 hrs IST as a severe cyclonic storm with a velocity of 100-110 km/hr gusting to 120 Km/hr. 16 people were killed in Tamil Nadu and 2 in Chittoor. Severe damage to property was also reported in both states (Fig.8).

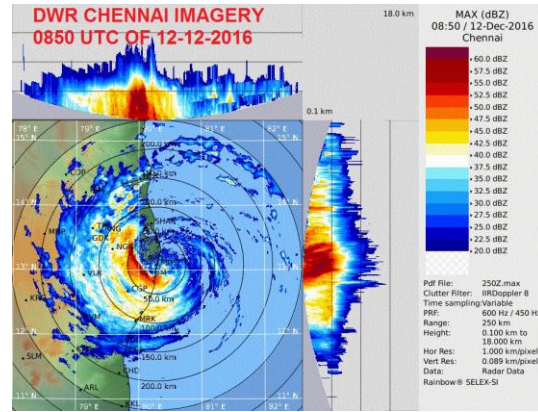
It was the first severe cyclonic storm of the year 2016. Vardah was the fourth consecutive cyclone with recurving track after cyclones Roanu, Kyant and Nada during the year, as it changed its track from initial northwards movement to west-north-westwards and then west-south-westwards after landfall. Unlike the previous two cyclones in the post-monsoon season, it crossed the coast with the cyclone intensity. Gradual incursion of cold, dry air from northwest into the system led to cutting off supply of cross equatorial moist air into the system and thus rapid weakening of the system after landfall. The peak maximum sustained wind speed of the cyclone was 130 kmph gusting to 145 kmph over westcentral

BOB. However, the maximum sustained wind speed of the cyclone was 110 kmph gusting to 125 kmph at the time of landfall. The life period of cyclone was 159 hours (6.6 days) against the normal of 4.7 days over north Indian Ocean during post-monsoon season for VSCS category. The track length of the cyclone was 1795 km. During genesis stage cyclone Vardah caused heavy to very heavy rainfall over Andaman & Nicobar Islands and squally wind speed reaching 50-60 kmph prevailed along and off Andaman & Nicobar Islands. It caused heavy to very heavy rainfall at many places with isolated extremely heavy rainfall over Chennai, Thiruvallur and Kanchipuram districts of Tamil Nadu and heavy to very heavy rainfall at a few places over Nellore district of Andhra Pradesh (Fig.9). As the system was moving along the east coast, it was tracked by DWR Chennai and Machillipatnam. Typical Radar imagery from DWR Chennai on 12<sup>th</sup> December is shown in Fig.10.



**Fig.9 Cummulative rainfall during CS Vardah (6-12 Dec, 2016)**

As per media report, Cyclone Vardah wreaked havoc in the remote islands of Andaman like Diglipur, Rangat and Billyground that witnessed a flood-like situation due to torrential rains (Fig.9 ). Landslides were reported along the Andaman Trunk Road, while several houses and crops have been damaged in areas located in the northern and central Andaman. There was no power in several areas for two days due to the snapping of power cables. More than 1,400 tourists were stranded on the Havelock and Neil Islands of the Archipelago. However, no casualty was reported from Andaman & Nicobar Islands. Severe Crop damages



**Fig.10 Typical MAX (dBZ) imagery at 08.50 UTC of 12 December from DWR Chennai**

occurred in Tiruvallur, Kanchipuram, Vellore and Tiruvannamalai districts of north Tamil Nadu. There was damage to paddy, groundnut, blackgram, greengram and coconut causing a loss of nearly 33 % in these districts in an area of 34206.13 Hectare.

#### **Acknowledgements**

While preparing the above article, the reports prepared by RSMC, IMD, New Delhi have been referred to.

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