Indian Meteorological Society, Chennai Chapter
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Dear members of IMS Chennai chapter and readers of Breeze,

At the outset, on behalf of IMS Chennai chapter let me extend the seasons' greetings, '**a very happy and prosperous 2012**'. Though we planned to release the current issue of Breeze during late 2011 / early 2012, we could not do so due to multifarious reasons. The gentle wind blowing as 'Breeze' started roaring and ultimately intensified into a cyclone during the last week of December 2011. It is not out of place to make a mention here, in regional language, about the distinction between Breeze and Cyclone as காற்று தவழ்ந்தால் தென்றல், சீறினால் புயல். As the Thane cyclone (28-30 December 2011) had kept many of our members busy, a few scientific lectures planned during December 2011 / January 2012 could not be arranged. Taking advantage of the delay in releasing the current issue, we could accommodate in this issue of Breeze a gist / brief summary of lectures being delivered today, the 8.2.2012 as part of our chapter's usual seminar on review of both southwest and northeast monsoons of the previous year. Enjoy reading.

The newly elected council of our chapter for the term 2011-2013 had its first local council meeting on 10th August 2011 to discuss about the ongoing and ensuing activities. The local council has co-opted Dr. S. Gomathinayagam and Dr. B.V. Appa Rao as council members and constituted the editorial board of the chapter's newsletter *BREEZE* for the term 2011-2013.

In regard to the chapter news, a scientific talk on *Space Weather – Solar Terrestrial Connections* by Dr. K. Sundararaman, Senior Scientist, Indian Institute of Astrophysics, Kodaikanal was held on 11th October 2011 and a few more has been planned. Five new life members have enrolled and 6 annual members have become life members during this period.

New set of office bearers assumed office at IMS Hq. We are planning to expand our scientific activities with the active support from the IMS Hq.

With best regards
R.Suresh
Chairman, IMS Chennai Chapter.
08 Feb 2012, Chennai

Membership details of IMS-Chennai Chapter (as on 8 Feb 2012)
Life Members: 132 Ordinary Members: 20 Total : 152

Those who wish to become members of IMS, Chennai Chapter may please mail to
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SPACE WEATHER – SUN EARTH CONNECTIONS

by

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Introduction

Sun, a star of spectral type G2 is the main source of energy to the Earth. Being close to the Earth, Sun provides a resolvable disk of great detail, which is not possible for other stars. The temperature of the stars determines the physical and chemical conditions prevailing in their atmospheres. In the spectrum of O type stars, the singly ionized helium lines are strong, and in the late type M stars the molecular lines appear to be stronger. It was the great M.N Saha who pointed out through his publication in 'Nature' during 1921 that sun like G type stars show strong singly ionized Ca K and H lines. In addition the H alpha line is also found to be strong in sun like stars. These lines are highly sensitive to magnetic field and temperature variations. Sun generates enormous amount of magnetic field to the tune of 5000 gauss in some of the localized regions in its surface that are called 'sunspots'. Since sun is not a rigid solid body, its surface extends up to 100 km. Sun's surface is called 'photosphere' since light is poured out in the form of photons or electromagnetic radiation from here. Sunspots appear darker due to the low temperature of 4000 K compared to the surrounding temperature of 5780 K in the photosphere. The interior of the sun is made up of hard core where the density, temperature and pressure are conducive for the thermo nuclear energy production takes places in a sustained manner. These factors do not permit us to observe the interior of the sun directly. However, the stage is now set for probing the interior through the study of helioseismology.. The atmosphere of the sun has full of magnetic features like sunspots in the photosphere and other bright and dark active regions in the chromosphere and outer atmosphere corona. But for the magnetic activity of the sun, it will be boring object for the physicists to study. Sunspots wax and wane once in 11 years. The chromosphere of the sun is studied by taking the picture of the sun in H alpha and Ca K lines. The outer atmosphere of the sun can be photographed during total solar eclipse. As corona emits X-rays due to its high temperature, coronal images can also be obtained by having X-ray spectrometer in a spacecraft.

Some Past Histories of Solar Events

Solar flares are known to disrupt ground communication, cell phone activity, power grids, air travel and satellite activity. Places in high latitude belts like USA and Canada are highly vulnerable to solar flares and coronal mass ejections (CME). The CME is a huge plasma eruption, consisting of charged particles from the sun. The high power grids that transmit power would attract currents from this highly ionized plasma, which in turn will ruin transformers. As power is needed for sewage treatment, running water and many other life supporting infrastructures, the loss of power for days or weeks would be deadly for the life on the Earth. One of the greatest solar storms occurred in 1859, the '**Carrington Event**' caused major fire in USA and Europe by short-circuiting the telegraph wires. A huge solar flare on August 4, 1972, knocked out long-distance telephone communication across Illinois. It has made AT&T, the largest telephone provider in USA to redesign its power system for transatlantic cables. A similar flare occurred on March 13, 1989 disrupting hydro-electric power transmission from Quebec, Canada and millions of people were left without power for 9 days. Aurora-induced power surges even melted power transformers in New Jersey at that time. A huge cloud of plasma called prominence extending over 200,000 miles, and about 28 times the diameter of the Earth erupted during 1997 associated with both solar flare and CME causing colourful aurora lights. On 13th July 2000 one intense solar storm nicknamed 'Bastille Day Event' causing energetic proton shower disrupted the satellite functions. An intense geomagnetic storm raged for nearly nine hours after the solar shower's impact. Cameras and star-tracking navigation devices on several satellites were flooded with solar particles. The satellite functions were degraded and temporarily shut down. On the ground, aurora lights were seen as far south as El Paso, Texas. Power companies suffered geo-magnetically induced currents that tripped capacitors in the transformers. Global Positioning System (GPS) accuracy was degraded for several hours. The flare coincided with a CME from the Sun, releasing billions of tons of plasma into space traveling at 4 million miles per hour. In 2003 a massive solar flare hobbled over the Japanese Advanced Satellite for Cosmology and Astrophysics (ASCA) making it to tumble in orbit. One of the largest solar flare reported in 2006 created a complete blackout of high-frequency communications on the side of earth facing the sun causing disruption in the satellite TV reception and GPS activities in the entire USA. As electronic technology has become more sophisticated into every day life, they have become more vulnerable to solar activity that may be directed towards the earth. A '**Carrington**' type flare may damage 900 plus satellites in orbit that could cost around $ 70 billion. However, there is nothing to worry regarding the life or activities on the earth as lots of preventive measures are already taken to avert the damages that are expected due to these storms by forecasting such events.

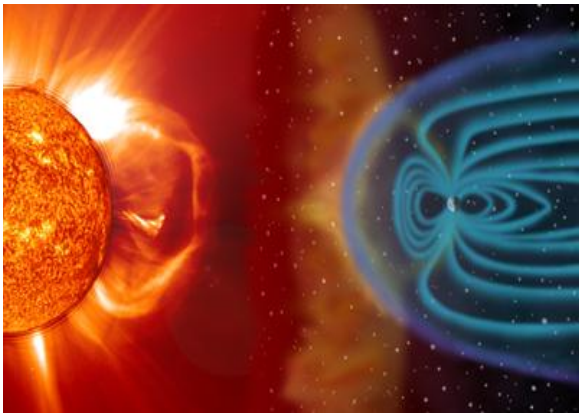

Fig. 1. Space Weather

Fig.2. Solar explosion observed during 2010

Space Weather – Geo-effects of Solar Activity

Space weather refers to the violent transfer of energy and particles from the sun to the earth. Huge volumes of electrified plasma having mass millions to billions of tons will be thrown by the Sun in any or every direction. The phenomena happen almost every day, whereas the occurrence of these storms will be more during the period of solar maximum. However, most of the solar storms are deviated away from the earth during their course of journey from the sun. In the absence of our atmosphere, earth will be roasted and fried due to these powerful storms, as they travel with tremendous amount of thermal and kinetic energy. The high energy radiation from these earth directed storms would take slightly more than 8 minutes to reach the earth, whereas particles may arrive in 3-4 days. Fortunately earth's magnetic field provides protection through its invisible layer. Though it is relatively weak, the extrapolation of this magnetic field around the volume of the earth provides a bubble shaped shied (Figure 1) deflecting the charged particles. Thus cosmic, solar electrons and ions are driven away from the most heavily inhabited areas of the earth's surface in spite of the influx of particles toward the magnetic poles getting enhanced. When a sudden transient event like a magnetic storm from the sun arrive the regions of the Earth's magnetic field, the protection some times breaks down depending on the power of the storm and life on the ground gets affected.

Thus a powerful CME could induce electricity in large overloading electrical systems and cause massive damage in power grids due to bad space weather. Long distance telephone communications through cable distribution and GPS operations will be disturbed. Satellite operations, TV and Internet transmission, and mobile communications will be partially or totally halted. Earth directed powerful storm or flare can permanently damage the spacecrafts. The astronauts on board and the high altitude air travels are prone for attack. As we are put up close to the earth's equator, chances of such happenings are rare in our regions. However, when the solar particles try to penetrate the earth's atmosphere their energy will be dissipated. Their interaction with our atmospheric particles produces colourful skies known as 'auroras' that are visible in high latitude belts.

The present Sun

We are slowly approaching towards the next solar maximum that is expected during 2012. But the sunspot activity during this cycle has not picked up rapidly. Unusually the spotless days during this cycle has exceeded 800. Sunspots started appearing slowly from 2009 onwards and we could find not find frequent big sun spot groups. The slow pick up of the solar activity may not give rise to powerful storms or CMEs contrary to the media reports which say that a severe killer storm may arrive from the sun during 2012. Fortunately such a type of 'carrington event' will be rare to happen may be once in half a millennium. Figure 2 shows the image of the solar eruption observed on September 8, 2010. A medium class flare associated with a CME occurred due to the magnetic instability of the sunspot 1105 observed near the limb of the Sun. Aurora lights were observed 2 days later on September 10, 2010 in North Carolina and there was no damage reported due to this event. Nearly half a dozen high intense X-type flares were reported only during September-October 2011, some of them accompanied by CMEs. Unusually the solar activity is relatively low during this 24th solar cycle.

The present scenario for tackling bad space weather

It has now been realized how to safeguard the power grids by configuring it with the direction and speed of the electric currents induced due to bad space weather. Also the satellites are equipped with devices to safeguard them from the surges in current due to solar events. The stage is set for warning the astronauts on space to take protective measures. The study of space weather has made it possible for us to avert majority of the damages that may be caused due to solar storms. The present stage is set for getting continuous solar data both from space and ground with high time cadence thus making the predictions of such events easier. Once these events are predicted, the quick communication to the technological systems in the earth will avert the damages due to the solar particle events. Therefore, the panic situation need not arise at all. Sun provides the illumination to the earth, warms us, nurtures our crops, and influences our weather. A slight change in the energy output of the sun will have consequences in the energy balance of the earth. Therefore, it is important for us to study the changing sun. We can safely welcome the next solar maximum during 2012-2013 by enjoying the bounties of the sun.

SEASONAL AND MEDIUM RANGE PREDICTION OF INDIAN NORTHEAST MONSOON - 2011 AND ACCURATE PREDICTION OF TRACK AND INTENSITY OF VSCS THANE, 25-31 DECEMBER 2011 – BY IMD

by

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The southwest monsoon season of June-September is the major rainy season for India. The rainfall realised during this season is of utmost importance, providing agricultural and hydrological sustenance for the ever increasing 120+ crore population of India. However, for the meteorological subdivision of Tamil Nadu, the northeast monsoon (NEM) season of October to December (OND) is the major rainy season and the state substantially depends on the OND rainfall for its agricultural and hydrological requirements. The coefficient of variation (CV) of northeast monsoon rainfall of Tamil Nadu (NRT) is very high at 27% which is a manifestation of frequent occurrences of large excess and deficient rainfall during individual years. Reliable forecasts of excess or deficient NRT well in advance would serve as crucial inputs for civil administrators and agricultural planners. As such, seasonal forecasting of NRT has assumed importance of late, even though, NEM itself is a small scale monsoon confined to parts of southern peninsula. The first attempt on seasonal forecasting of NEM dates back to Doraiswamy Iyer (1941). Further attempts were made during last 2-3 decades. Raj (1989 & 1998), Raj & Geetha (2008) and Geetha & Raj (2009) have identified some potential predictors for NRT.

Based on the identified predictors, experimental outlooks on NRT have been prepared every year on real time basis, by the end of September, for the last several years at RMC Chennai. Initial predictions were based on 2-3 predictors and subsequently, some more predictors were added and others redefined and the prediction scheme, slightly altered. Table-1 presents the performance of seasonal prediction of NRT during the decade 2001-2010 in a nutshell. In Table-2 the list of six predictors presently in use for seasonal prediction of NRT, the types of relation existing between each predictor and NRT and also individual predictions for NRT 2011 are presented.

Based on the individual predictions (Table-2), the final outlook for the year 2011 was prepared as given below:

OUTLOOK FOR NRT 2011

Except PR3, individual outlooks based on all the other five parameters indicate near normal to normal NRT. With predictions of continuing trend towards La Nina conditions in equatorial Pacific during 2011, the overall outlook could be taken as ***Near normal to Normal*** *rainfall during Oct-Dec 2011. The performance could be slightly subdued during the first half of the season with normal onset but may pick up during the later half of the season. (Normal onset date: 20th Oct with SD of 6-7 days). Normal RF for the season for TN is nearly 43 cm with a CV of nearly 27%.*

An overall outlook could be taken as Near normal to Normal rainfall for Tamil nadu for the period Oct-Dec 2011.

Fig.1 presents the time series of daily rainfall realised over the meteorological sub division of Tamil Nadu and Pondicherry during OND 2011. The NEM onset took place on 24th October and good rainfall activity associated with the onset phase continued up to the first week of November. Thereafter, the rainfall activity was very poor during the next two weeks of November and almost during the entire month of December barring the days of cyclonic activity associated with passage of *Very Severe Cyclonic Storm (VSCS), Thane* that crossed North Tamil Nadu coast near Cuddalore and Pondicherry on 30th thereby causing heavy rainfall during 29-31 December. But the season extended to January 2012 and cessation of NEM rainfall over Tamil Nadu was declared by the India Meteorological Department (IMD) on 10th January 2012 only. For 2011 NRT during OND was 23% excess. Due to slightly late onset, the NEM activity was rather subdued initially but picked up towards the fag end of the season. This aspect, though not in actual terms, was predicted to some extent.

Despite positive SOI/ La Nina conditions persisting, the season ended up with excess rainfall though onset was delayed by 4 days with reference to the normal onset date of 20 October. The weaker than normal Tropical Easterly Jet (TEJ) at 150 hPa during August-September had given an indication of positive rainfall departure. Thus, the performance of NEM 2011 clearly reiterates the fact that seasonal predictions with greater dependence on a single parameter such as ENSO would not be reliable and an ensemble approach using an aggregate of predictors would be more appropriate. From the year 2004 NRT has remained positive in every year until now and 2011 is the 8-th consecutive year of positive rainfall anomaly. This prolonged positive run includes several years (2005, 2007, 2008, 2010 & 2011) of excess rainfall (20 % or more) with some years receiving large excess (Table 1). This type of abnormal behaviour of NEM, though must be very welcome for the farmers and planners, considerably upsets the stationary behaviour of the time series presenting more problems in statistical prediction of seasonal rainfall.

Based on Numerical Weather Prediction (NWP) models [products of European Centre for Medium Range Weather Forecasting (ECMWF), National Centre for Medium Range Weather Forecasting (NCMRWF), New Delhi, IMD HQ’s Multi Model Ensemble (MME) & Regional Meteorological Centre (RMC), Chennai’s Weather Research & Forecasting (WRF)], the onset of NEM on 24th October, the commencement of next major rain spell on 26 November were accurately predicted 4-5 days in advance and were disseminated to the users through the media. The spatial variation of rainfall day to day was also predicted accurately well in advance. The medium / short range predictions by Joint Typhoon Warning Centre (JTWC) of an approaching easterly wave and its subsequent development into *VSCS Thane* and the predictions of NWP groups of IMD, New Delhi and RMC, Chennai, even 3-4 days in advance of landfall, provided valuable inputs for forecasting the genesis, movement and intensification of *VSCS Thane* accurately.

The experience gained and success achieved in respect of short and medium range forecasts of NEM rainfall for the year 2011 has shown that accurate forecasts on rain spells could be provided even 5-7 days in advance with the help of NWP models. This calls for more emphasis on the use of NWP models in short and medium range forecasting and also in ingesting locally available data from modern observing systems such as DWR and AWS into the models. The conventional chart based synoptic and statistical forecasting systems would continue as supplementary systems. As for seasonal forecasting of NEM, perhaps further advancement is needed before real time operationally viable long range forecasts could be issued in operational mode.

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TABLE-1
Performance of experimental prediction of NRT during 2001-10, prepared at RMC Chennai

Year	No. of predictors	Overall outlook	Realised rainfall	Forecast performance
2001	3	Near normal	Slightly deficient (-15%)	Correct
2002	3	Normal	Normal with negative departure (-12%)	Partly correct
2003	3	Normal with a reasonable chance of positive departure	Deficient (-25%)	Wrong
2004	4	Normal with a reasonable chance of positive departure	Normal (+1%)	Correct
2005	4	Normal with a reasonable chance of positive departure	Excess (+79%)	Partly correct
2006	5	Normal with a reasonable chance of positive departure	Higher side of normal (+15%)	Correct
2007	6	Normal with a slightly negative departure	Above normal (+21%)	Wrong
2008	5	No clear signal; 3 parameters indicated positive departure and the other 2 indicated negative departure	Excess (+31%)	--
2009	6	Normal	Normal (+13%)	Correct
2010	6	Near normal	Excess (+42%)	Wrong

TABLE-2
List of predictors used for seasonal prediction of NRT and their predictions for NRT 2011

Predictor	**Type of relation with NRT**	**Long term mean (based on NCEP reanalysis datasets)**	**Conditions during 2011**	**Outlook on NRT based on the predictor**
PR1: Apr, 200 hPa Zonal wind anomaly Over India (a.ave 70-95E, 5-30N)	Strong westerly winds (positive anomaly) favour good NRT; Weak wind, poor NRT	**15.49**m/sec	Weaker by 1 m/sec	Near normal
PR2: JJAS, 200 hPa Temperature anomaly over central India (aave 74-85E, 8-20N)	Negative anomaly favours good NRT; Positive anomaly, poor NRT	**-64.38**˚C	Slightly positive anomaly (+0.15˚C)	Near normal to Normal
PR3: Aug-Sep, 150 hPa Strength of TEJ over the extreme south peninsula (a.ave 76-79E, 7-10N)	Strong TEJ, poor NRT; Weak TEJ, good NRT	**-31.96**m/sec (upto 16 Sep)	TEJ weaker by 4.5 m/sec	Positive departure
PR4: JJAS, SOI	Negative SOI, good NRT; Positive SOI, poor NRT		Normal SOI during JJAS; Presently neutral (+4.1); trend towards La Nina as per models	Normal; initially slightly subdued with better activity in the second half of the season
PR5: IMR of JJAS	Slightly discordant negative relationship; Conditional means (CM) give a better indication		IMR is +1%	Near Normal
PR6:Aug-Sep, MSLP over Siberian region (87-103˚E; 47-53˚N)	Negative anomaly is associated with slightly deficient NRT(ON) but may lead to an excess NRT(Dec)	**1011.71** hPa	Slightly positive anomaly (+0.66 hPa)	Normal

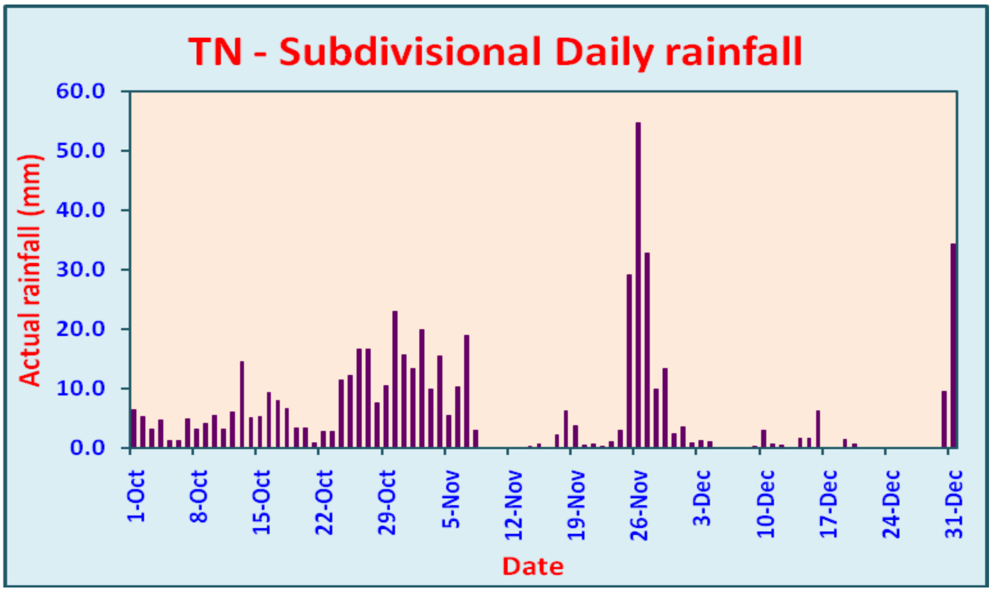

Fig.1 Sub divisional rainfall realised over Tamil Nadu during OND 2011

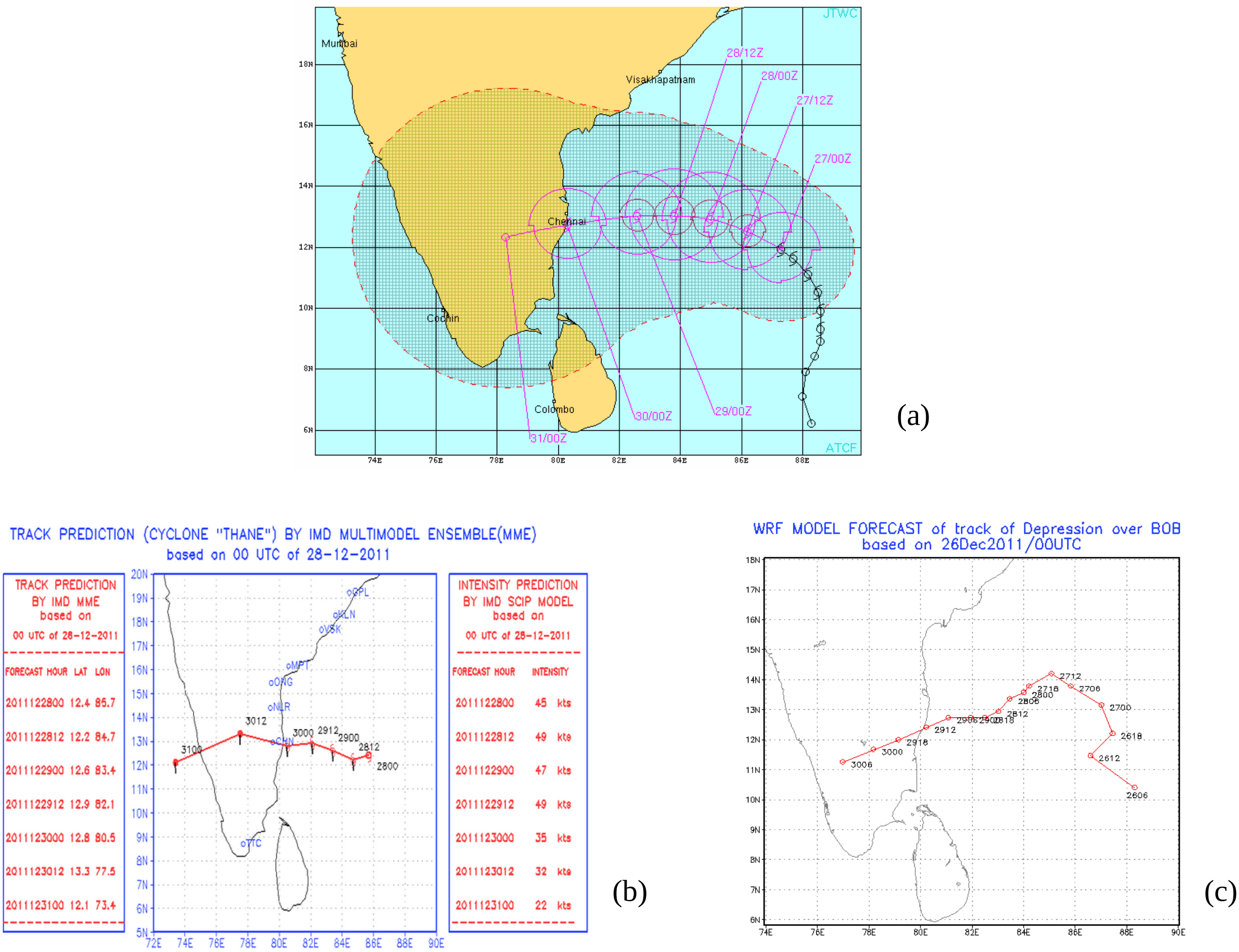

Fig.2 Sample track forecasts of VSCS Thane by (a) JTWC, (b) IMD NewDelhi and (c) RMC Chennai

INDIA'S LATEST MET – OCEAN SATELLITE MISSIONS

by
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Indian Space Research Organisation (ISRO) successfully put into orbit an important meteorological satellite – Megha Tropiques - on October 12, 2011 with the help of its workhorse Polar Satellite Launch Vehicle (PSLV). Megha Tropiques launch is a collaborative venture of ISRO and CNES, France intended for studying water cycle and energy exchanges in the tropics using four advanced meteorological payloads. These payloads have been configured on the Indian Remote Sensing (IRS) satellite platform.
Megha Tropiques has been launched in a unique low inclination (20 deg) orbit at an altitude of 867 km (ground swath of 1700 - 2200 km), so that it can provide higher temporal sampling of the rapidly evolving tropical convective systems (typically 3 - 6 samplings of ITCZ per day).

The payloads on Megha Tropiques satellite are:

MADRAS (Microwave Analysis and Detection of Rain and Atmospheric Structures), a multi-frequency scanning microwave imager at 18, 23, 37, 85 and 157 GHz to measure tropical precipitation and cloud properties. The parameters measured over ocean are: cloud liquid water, precipitation, integrated water vapour and surface wind speed. The two higher frequencies additionally provide information on convective cloud ice particles both over land and ocean. The ground resolution of the different channels vary from 20 – 40 km at nadir. This instrument was developed jointly by ISRO and CNES.

SAPHIR (Soundeur Atmospherique du Profil d'Humidite Intertropicale par Radiometrie), a millimeter wave 6 - channel humidity sounder operating at 183 GHz water vapour absorption line. This provides information on water vapour in six atmospheric layers from ocean surface up to about 12 km altitude at a horizontal resolution of 10 km at nadir.

ScaRaB (Scanner for Radiation Budget), a four channel Earth radiation budget instrument operating in the 0.5 to 12.5 micrometer range of the electromagnetic spectrum, with a spatial resolution of about 40 km. It measures the outgoing longwave and shortwave radiations at the top of the atmosphere. The SAPHIR and ScaRaB instruments have been provided by CNES.

GPS – ROS (Global Position System – Radio Occultation System), a dual frequency (1575 and 1227 MHz) system provided by the Italian Space Agency (ASI), for deriving temperature - humidity profiles from refractivity measurements at high vertical resolution along a very narrow swath.

Megha Tropiques instruments are presently undergoing calibration and preliminary validation phase at ISRO and CNES. The various data products from Megha Tropiques mission will be available in a couple of months to the scientists from India, France and other International countries whose project proposals have been accepted by the Mission Science Team. For other users, it will be available on the web site in another six months.

In many ways the MADRAS data products will be similar to those produced by TRMM Microwave Imager (TMI). A rainfall image of Thane cyclone as seen by TMI (MADRAS will provide similar results, albeit at a lower spatial resolution) instrument is shown in Fig 1. Megha Tropiques will be one of the eight satellites with passive microwave imagers providing higher temporal observations of rainfall (for calibrating indirect estimation of rainfall from infrared channels of the geostationary satellites, like INSAT) during the Global Precipitation Mission (GPM) - to be in place by 2013.

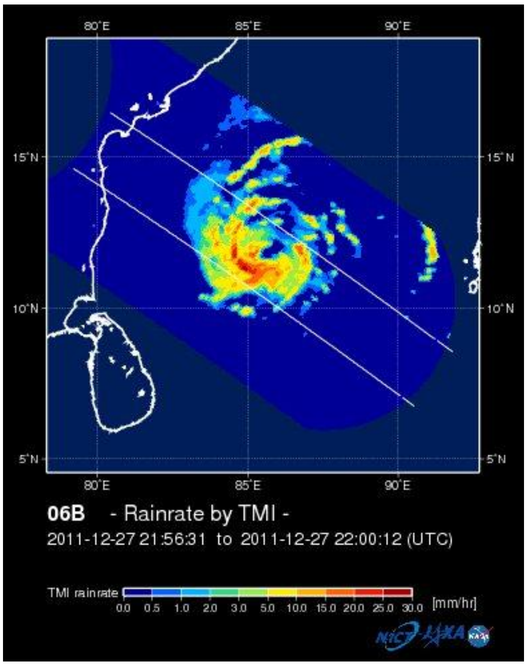

Fig.1 TMI based rainrate associated with TC Thane on 27 December 2011 / 22 UTC

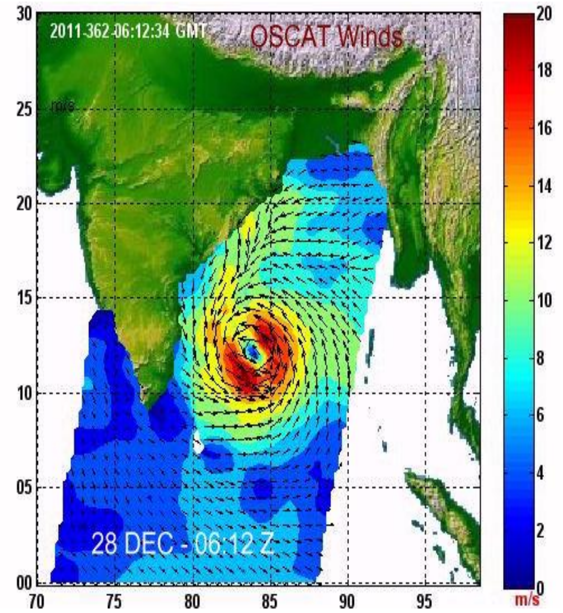

Fig.2 Vector winds observed by Indian OSCAT on 28 December 2011

Another important Indian satellite launched in November 2009 that has made very significant impact for the met – ocean community, is the polar orbiting Oceansat – 2 with a Ku band (13.5 GHz) scatterometer (OSCAT) providing ocean surface winds over the global oceans. It has additionally a 8 - channel Ocean Colour Monitor (OCM) to study coastal ocean biological processes. Oceansat – 2 is in a polar orbit at an altitude of 720 km. The OSCAT instrument has a swath of 1400 - 1840 km with a ground resolution of 50 km. Many cyclones over Pacific and Atlantic oceans, besides over the Indian ocean, have been monitored and studied using the OSCAT with success. Surface vector winds of the Thane cyclone by the OSCAT instrument is shown in Fig 2.

INSAT – 3D with a state of art temperature – humidity sounder and a 6 - channel very high resolution radiometer (VHRR) in the geostationary altitude is to launched by end 2012. India will be only the second country to launch a temperature – humidity sounder in a geostationary orbit. These three satellites together will provide very important data for weather monitoring in general and for NWP in particular.

EXPERIMENTAL OUTLOOK ON CYCLONIC ACTIVITY OVER THE NORTH INDIAN OCEAN FOR THE NORTHEAST MONSOON SEASON, 2011 AND ITS VERIFICATION

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The Northeast monsoon season of October to December (OND) is the primary season of cyclonic activity (CA) over the North Indian Ocean (NIO). Reliable forecasts of seasonal cyclonic activity over the NIO would serve as important inputs for civic administrator and disaster managers. Statistical models are quite commonly used to get a likelihood scenario of the future weather events, despite their known limitations such as secular variations of correlation, choice of optimum number of predictors, test period etc.

Balachandran and Geetha (2012) have developed a statistical prediction model for seasonal cyclonic activity during October to December over the North Indian Ocean using well known climate indices and regional circulation features of the recent 30 years of 1971-2000 and tested the same for an independent period of 2001-2009. The model is able to give an idea on the extent of CA over the NIO even though it has some limitations in predicting the extreme years.

In this study, the CA is expressed as the number of days of cyclonic disturbances over the NIO that includes the stages of Depression (D), Deep Depression (DD), Cyclonic Storm CS), Severe Cyclonic Storm (SCS), Very Severe Cyclonic Storm (VSCS) and Super Cyclone(SuCS) and is generally referred as ***CD days***. Over NIO, the CA during OND has a mean of 20 days with standard deviation of 8 days. The following classification is considered for expressing the CA qualitatively:

No. of CD days less than 12: subdued CA.
No. of CD days between 12 and 16: below normal CA.
No. of CD days between 16 and 24: Normal CA.
No. of CD days greater than 24: above normal CA.

The search for potential predictors is based on correlation analysis and the final predictors are identified using screening regression technique. The predictors chosen (*PR1*, *PR2*, *PR3 and PR4*) are defined below and depicted in Fig.1:
PR1 : meridional wind at 200 hPa over 95-105˚E & 5˚S to 2˚N during August (v200)
PR2: zonal wind at 200 hPa over 30-42˚E & 7˚S to 5˚N during August (u200)
PR3: SST over 46-56˚E & 38-34˚S during July & August.
PR4: zonal wind at 700 hPa over 73-80˚E & 5˚S to Equator during August (u700).
The above parameters refer to the same calendar year as the year for which outlook is prepared.

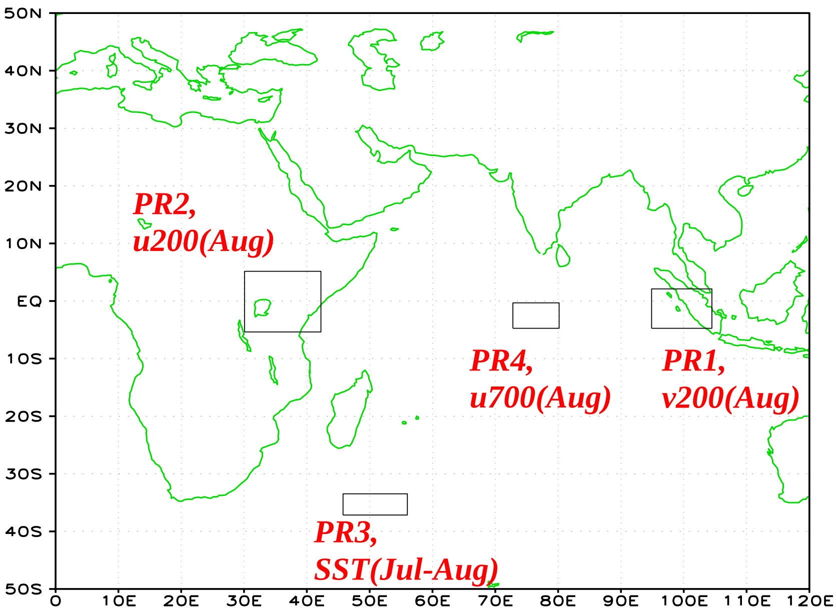

Fig.1 Predictors and the locations of the predictors chosen

The statistical parameters of the predictors *PR1*, *PR2*, *PR3* and *PR*4 and their relationship (expressed as Correlation Coefficient) with CA during OND over NIO, based on data of 1971-2000 are given in Table 1.

Table 1

Parameter	**Mean**	**Std. Deviation**	**CC with CD days /CA**
PR1, v200 (aug)	-7.31 m/s	1.35m/s	0.65**
PR2, u200 (aug)	-7.98 m/s	2.61m/s	-0.59**
PR3, SST (jul-aug)	16.68˚C	0.29ºC	-0.57**
PR4 u700 (aug)	4.74 m/s	1.84m/s	0.40*

**: significant at 1% level; *: significant at 5% level

The outlook is prepared based on two schemes:

(i) **Conditional means of number of CD days for various intervals of the predicting parameters PR1,PR2,PR3 and PR4 .**

(ii) **Multiple regression equation with the same predictors PR1, PR2, PR3 and PR4 .**

For the year **2011**, the expected cyclonic activity during OND over the NIO is determined as shown below.

Prediction based on Conditional mean analysis

The conditional means of CD days for various intervals of PR1, PR2, PR3 and PR4 are given in Table 2.

Table 2

S.No	Predictor	Interval	Conditional Mean (days)	n
1.	*PR1,v200 (Aug)*	< -8.5 m/s	12.00	6
		-8.5 to -7.0	17.67	12
		-7.0 to -5.5	24.10	10
		> -5.5	31.00	2
2.	*PR2,u200 (Aug)*	< -10.5 m/s	27.7	3
		-10.5 to -8.0	21.3	15
		-8.0 to -5.5	22.5	4
		> -5.5	11.9	8
3	*PR3, SST (Jul-Aug)*	< 16.4 ˚C	28.5	6
		16.4 to 16.7	21.3	10
		16.7 to 17.0	14.5	14
		> 17.0	---	0
4	*PR4, u700(Aug)*	<3.0 m/s	15.7	7
		3.0-5.0	17.9	9
		5.0-7.0	21.8	11
		>7.0	25.3	3

The values of the four parameters for the year 2011 and the predictions for CA during 2011 based on the conditional means of CD days are given in Table 3.

<u>Table 3</u>

Values of PR1, PR2, PR3, PR4 & predictions for the number of CD days (CA) based on Conditional means analysis

Year	Predictor	Value	Predicted number of CD days / CA
2010	*PR1, v200 (Aug)*	-7.13 m/s	18
	PR2, u200 (Aug)	-9.98 m/s	21
	PR3, SST (Jul-Aug)	16.29˚C	29
	PR4, u700(Aug)	1.23 m/s	16

Thus, for the year 2011, one parameter (PR3) indicated above normal CA and the other three parameters (PR1, PR2 and PR4) indicated normal CA with PR4 on the lower side of normal. Thus, 3 out of 4 predictions indicated normal CA.

Prediction based on Multiple Regression

The Multiple regression equation developed with the four predictors PR1, PR2,PR3 and PR4 is given below:

$$\text{No. of CD days} = 157.747 + 1.277 * v_2 200(Aug) - 1.081 * u200(Aug) - 8.524 * sst(Jul,Aug) + 1.001 * u700(Aug)$$

For the year 2011, the MR equation indicated 21.8 days of CD which lies in the category of normal CA.

Overall prediction

Outputs from both schemes indicated normal cyclonic activity over NIO during October to December 2011.

Validation

During the period October-December 2011, five low pressure systems formed over NIO - 2 over Bay of Bengal (1 VSCS (Thane), 1 D) and 3 over Arabian Sea (1 CS (Keila) & 2 DD). The number of days of cyclonic activity was 25 days which comes under the category of ***above normal CA***. The predicted activity was *normal CA*. The multiple regression model indicated 22 days of CA. Two individual predictions, based on conditional mean analysis, indicated 18 and 21 days of CA. Only one predictor, **PR3 (SST over 46-56˚E & 38-34˚S during July & August*)*,** indicated *above normal CA*. The 4th predictor indicated 16 days of CA which is on the lower side of *normal*.

Concluding remarks

Thus, the prediction for seasonal cyclonic activity during October-December, 2011 was not fully correct. Perhaps, the unusual Arabian Sea activity might not have been captured by the model properly. The model may be refined by defining cyclonic activity in terms of hours rather than days and may also be further improved by including other atmospheric and oceanic circulation features until more precise and accurate dynamical models are developed for prediction of seasonal cyclonic activity over the NIO.

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GLOBAL WARMING – CLIMATE CHANGE

by
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Introduction

Global warming and the resulting climate change are among the most serious environmental problems facing the World Community. Climate is the description of the long term pattern of weather in a particular area. Climate change does not take place overnight. It takes a large time for the climate to change. Changing climate will affect people around the world. Rising global temperature is expected to raise sea levels and change precipitation and other local climate conditions. Since pre industrial times increasing emissions of Green House Gases, (GHGs') due to human activities have lead to marked increase in atmospheric GHG concentrations.

Rising temperatures will also have a direct impact on crops around the world. The crop that grow today, are bred to flourish in this climate. As the weather changes, they will be increasingly out of sync with their environment. Even a minor increase in temperature will dramatically shrink crop yields. A 2004 study published by US National Academy of Sciences showed that for each one degree Celsius rise in temperature during the growing season, a 10% decline in rice yield can be expected. This appears to be hold good for wheat and corn as well. A crop shrinking heat wave in a major grain producing region could lead to food shortages and political instability. Recently concluded Intergovernmental Panel on Climate Change (IPCC) has projected some impacts due to climate change in different parts of the world.

Africa: By 2020, between 75 and 250 million people are projected to be exposed to an increase of water stress. Agricultural production, including access to food, in many African countries and regions is projected to be severely compromised by climate variability and change. In some countries, yields from rain -fed agriculture could be reduced by up to 50% by 2020. Towards the end of 21st century, projected sea-level rise will affect low -laying coastal areas with large population. Mangroves and coral reefs are projected to be further degraded.

Polar Region: In the Polar Regions, the main projected biophysical effects are reductions in thickness and extent of glaciers and ice sheets, and changes in natural ecosystems with detrimental effects on many organisms including migratory birds, mammals and higher predators.

Small islands: Climate change is projected by the mid-century to reduce water resources in many small islands. Small islands, whether located in the tropics or higher latitudes, have characteristics which make them especially vulnerable to the effects of climate change, sea level rise and extreme events.

Australia: Water security problems are projected to intensify by 2030 in southern and eastern Australia, in New Zealand, in Northland and some eastern regions. Significant loss of biodiversity is projected to occur by 2020 in some ecologically rich sites.

Europe: Nearly all-European regions are anticipated to be negatively affected by some future impacts of climate change. The impacts include increased risk of inland flash floods, and more frequent coastal flooding and increased erosion due to storminess and sea-level rise. Other projected negative impacts are high temperatures, drought, reduction of water temperatures, drought, reduction of water availability and crop productivity in South; decrease in summer precipitation, water stress, health risks due to heat waves and decline in forest productivity in Central and East; and mixed effects in Northern Europe.

American countries: By mid- century, increase in temperature and associated decrease in soil water are projected to lead to gradual replacement of tropical forest by Savanna in Eastern Amazonian. Semi-arid vegetation will tend to be replaced by arid-land vegetation. There is also a risk of significant biodiversity loss through species extinctions. It is also projected to lead in salinisation and desertification of agricultural land especially in drier areas. Sea-level rise is projected to cause increased risk of flooding in low-lying areas. Other negative impacts are increase in sea surface temperature, adverse effects on coral reefs, change in precipitation patterns and disappearance of glaciers.

Asia: Glacier melt in the Himalayas is projected to increase flooding, and rock avalanches from destabilized slopes and to effect water resources within next two to three decades. Fresh water availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease along with population growth and increasing demand arising from higher standards of living, could adversely affect more than a billion people by the 2050s coastal areas, especially heavily- populated mega-delta regions, East and Southeast Asia, will be at greatest risk due to increased flooding from the sea and, in some mega- deltas, flooding from the rivers. Climate change will impinge on sustainable development of most developing countries of Asia, as it compounds the pressures on natural resources and the environment associated with rapid urbanization, industrialization and economic development. The crop yield is projected to decrease up to 30% in Central and South Asia by the mid- 21st century. The risk of hunger will be very high in general developing countries. Water related health hazards are projected to rise in East, South and Southeast Asia.

Causes of Climate Change: As mentioned already, climate change is not a sudden process. It takes a large time for the climate to change. Some anthropogenic activates which are affecting the climate to some extent may be outlined. Every time we turn on a light switch, use a computer; watch television or cook a meal, we are creating carbon dioxide which is not only a naturally occurring gas crucial to our survival, but also the main contributor to climate change. The electricity we use is generated by power stations, most of which burn 'fossil fuels'. We also burn fossil fuels in other ways- every time we drive a vehicle. Burning of fossil fuels such as coal, oil and natural gas generates carbon dioxide. Carbon dioxide and other green house gases occur naturally and form a blanket around the Earth, trapping heat. We have been pumping additional Carbon dioxide into the atmosphere for 200 years, since the industrial revolution, thus intensifying the green house effect and increasing the Earth's temperature. Carbon dioxide emissions in the atmosphere have increased by about 30% over the past century. It is being worsened by the addition of other natural Green House Gases such as Nitrous oxide and Methane, threatening all life on the planet. If something not done immediately to stop the increase in the concentration of these gases, there will be catastrophic consequences in the next few decades. Glaciers will melt, sea level will rise, low lying areas will submerged, crops will be damaged, extreme weather events like cyclones and storms will become more frequent. In short, the world will become a difficult place to live in and millions of people may lose their lives. The pressing need of the hour is energy that will have zero-emissions and will not run out like fossil fuels, also known as clean or zero-emissions renewable energy. While the sun is the largest source of this form of energy there are other sources like water, wind and geothermal energy as well. However, tapping these types of energy and converting them into usable forms needs research, innovation and ingenuity.

Impacts of Climate Change on Global Environment: Natural climate change is inseparably linked to the history of the earth and its development. Human activity has had a massive impact on the climate system over the past one hundred years - a unique experiment with an indefinite outcome. Climate is a central natural resource and the basis of all life. But man's treatment of this valuable asset is both reckless and ruthless. The consequence is that the climate is gradually becoming a risk.

The forces of nature remain unnoticed by the general public until they disrupt its daily routines. The scientific world is then expected to integrate extreme events into a larger system and give its interpretation of them. Historical records have a very important role to play in this context.

Higher CO_2 in the air will almost always come with a higher level of pollutants (other than CO_2) and hence health will be seriously affected when measured over a sufficiently long period of time. The higher release of CO_2 mainly because most of this is released where we are attempting to convert some fuel resource to release energy and waste product is CO_2 at a level that is larger than what can be absorbed by the planet's plants in the oceans and on land. This is the largest source of emission. On the other hand, we are also reducing the area under forests that capture carbon and store them as woody biomass, soil organic matter, etc. Finally and most importantly, many of the wastes that we generate in the process of emitting GHGs we also pollute the environment significantly with higher CO_2as well as other pollutants. Almost always, this kind of CO_2 is released with other pollutants.

Climate Change in the Industrial Age - Observations, Causes and Signals: Ever since the earth was born, it has known climate change. The industrial era is of special significance: first, because a wealth of reliable data is now available and can draw a highly accurate picture of climatic variability over time and space and, second, because mankind is emerging more and more clearly as an additional climate factor. Empirical statistical methods supplement usual climate models and expose mankind as a culprit.

Climate Change and El Nino: The El Nino phenomenon is the most powerful short-term natural climate fluctuation on timescales ranging from a few months to several years. Although El Nino originates in the Tropics, it has an impact on the global climate. There is a risk of the statistics for El Nino being influenced by anthropogenic climate change.

Climate Change and Volcanism: Mighty volcanic eruptions can severely interfere with the global climate and influence it for many years. This was illustrated very strikingly by the eruption of Tambora in Indonesia. The year 1816 went down in history as the year without a summer.

Detection of Climate Change by means of Satellite Remote Sensing: Spectacular remote sensing images are one of today's main sources of information for accurate weather forecasts. In the context of environment and disaster monitoring, too, satellite data provide a basis for identifying and observing phenomena that are influenced directly or indirectly by the weather.

Changing Coastal and Marine Conditions: The Ocean plays an important role as an agent in the global climate system as well as a relevant resource for humans n the coastal zones. The presently emerging anthropogenic climate change has an impact on the performance of the global player “ocean” as well as on the risks in coastal zones.

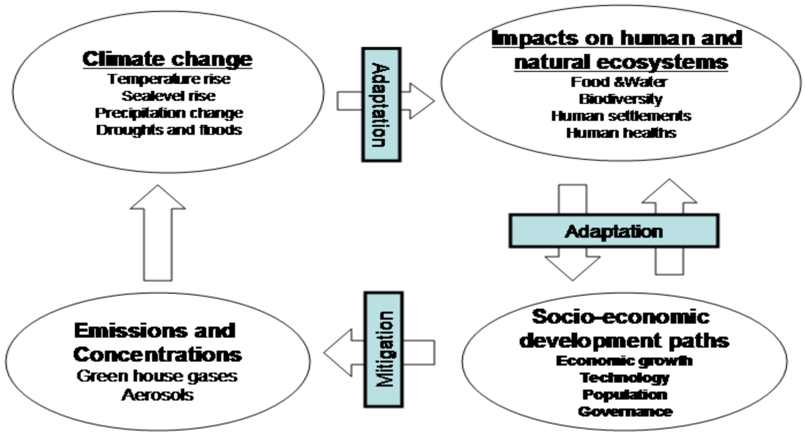
Glaciers Bear Witness to Climate Change: Glaciers are excellent climate archives. By observing their reactions, we can trace recent climate developments. Although the retreat since 1850 must be viewed in the context of the end of the Little Ice Age, the rapid decline in ice masses during the last two decades provides dramatic evidence of just how much this is influenced by anthropogenic factors.

Effects of Climate Change on Humans: Climate change has a direct impact on humans. Extreme events like heat waves, windstorms, and floods raise the mortality rate, while the living conditions for disease agents may improve, allowing diseases to spread into regions that were not affected before.

Climate Protection Options: Research into global climate change leaves no doubt about it: humans have quite obviously been interfering with natural processes. The German government has deliberately assumed a pioneering role in the cause of international climate protection and has developed an extremely ambitious climate protection programme.

Mitigation and Adaptation: Impacts of climate can be changed through adaptation and mitigation. Adaptation is aimed at reducing the effects while the mitigation is at reducing the causes of climate change in particular the emissions of the gases that give rise to it. Predictions of the future climate are surrounded with considerable uncertainty that arises from imperfect knowledge of climate change and of the future scale of the human activities that are its causes. Politicians and others making decisions are therefore faced with the need to weigh all aspects of uncertainty against the desirability and the cost of the various actions that can be taken in response to the threat of climate change. Some mitigating action can be taken easily at relatively little cost (for instance the development of programs to conserve/save energy and many schemes for reducing deforestation and encouraging the planting of trees). Other actions include a large shift to energy sources that are free from significant carbon dioxide emissions (renewable sources-biomass, hydro, wind or solar energy). It is increasingly realized that problem of the environment are linked to other global problems such as population growth, poverty, the overuse of resources and global society. All these pose global challenges must be met by global solutions.

Mitigation measures - at the local level: An integrated view of anthropogenic climate change is presented.



The socio-economic activity, both large and small scale, results in emission of greenhouse gases and aerosols. These emissions lead to changes in atmospheric concentrations of important constituents that alter the energy input and output of the climate system and hence cause changes in the climate. These climate changes impact both humans and natural ecosystems altering patterns of resource availability and affecting human livelihood, human development (changes in land use that lead to deforestation and loss of biodiversity and health).

Adaptation to climate change: Numerous possible adaptations can reduce adverse impacts and enhance beneficial effects of climate change and can also produce immediate ancillary benefits.

Sector/ systems	**Adaptation options**
Human health	➢ Rebuild and improve public health infrastructure. ➢ Improve epidemic preparedness and develop capacities for epidemic forecasting and early warning. ➢ Monitor the environmental, biological and health status. ➢ Improve housing, sanitations and water quality. ➢ Integrate urban design to reduce heat island effect (use of vegetation and light coloured surfaces) conduct public awareness education that reduces health risks.
Coastal areas and marine fisheries	➢ Prevent or phase-out development in coastal areas vulnerable to erosion, inundation and storm surge flooding. Use 'hard' (dikes, levees, seawalls) or 'soft' (beach nourishment, dune and wetland restoration, afforestation) structure to protect coasts. ➢ Implement storm warning systems and evacuation plans. ➢ Protect and restore wetlands, estuaries and flood plains to preserve essential habitat for fisheries. ➢ Modify and strengthen fisheries management institutions and policies to promote conservation of fisheries. ➢ Conduct research and monitoring to better support integrated management of fisheries.

Many of the options listed are presently employed to cope with current climate variability and extremes and their expanded use can also enhance both current and future capacity building. But such actions may not be as effective in the future as the amount and rate of climate change increase. Possible adaptation options can be applied effectively. However, much more information is urgently required.

What we can do to slow down climate change? : Although the problem is severe, we can all contribute as individuals and as a society to the efforts that will reduce Green House Gas emissions and thereby the harmful effects of climate change.

- Share what we have learnt about climate change and tell others about it.
- Buy more efficient household appliances.
- Replace all incandescent bulbs by compact fluorescent bulbs that last four times longer and use just one-fourth of the electricity.
- Build houses so that they let in sunlight during the daytime reducing the need for artificial lighting.
- Use sodium vapour lights for street lighting; these are more efficient.
- Keep car engines well tuned and use more fuel-efficient vehicles.
- Idling the engine for long periods of time wastes a great deal of fuel. This can easily be a avoided, especially at crossings and during a traffic jam by switching off the engine.
- Form car pools and encourage parents and friends to do the same.3.
- Cycle or walk to the neighborhood market.
- Manage vehicular traffic better to reduce fuel consumption and hence pollution. France and Italy have 'No Car Days' and have limited city parking to alternate days for off-and even- licensed numbers.
- Turn off all lights, television, fans, air conditioners, computers and other electrical appliance and gadgets when they are not being used.
- Plant trees in your neighborhood and look after them.
- Recycle all cans, bottles, and plastic bags and buy recycled items as far as possible.
- Generate as little trash as possible, because trash in landfills emits large quantities of methane, and if it is burnt, carbon dioxide is released.
- Climatic scientists are expecting an average temperature increase of between 1.4 ^{o}C and 5.8 ^{o}C over the next 100 years. These will also widespread impacts on climatic condition all over the world.

Facts to Fret Over

- By the end of this century, the Earth is predicted to be hotter than at any time in the past 150,000 years.
- By 2100, global temperatures are forecast to rise by up to 8 degrees Celsius – or even more – over land, with sea levels up to 88 centimetres higher.
- Carbon dioxide concentrations in the atmosphere may be higher than at any time in the last 20 million years.
- In the year 2010, 1 in 30 of the world's population was affected by natural disasters.
- By 2025, 5 billion people will live in countries with inadequate water supplies
- Within 50 years all the world's great reefs may have been wiped out by higher sea temperatures.
- The winter sports industry is unlikely to survive to 2100 in its current form.
- The probability of the West Antarctic Ice Sheet melting in the next two hundred years in 1 in 20. If this happens, all the world's coastal cities will be drowned, from New York to London to Sydney.

Conclusion: With the global warming crisis, already having a measurable effect on current weather patterns, sea levels and environment, it has become imperative that the countries of the world pool their resources and find clean energy sources to reduce its impacts.

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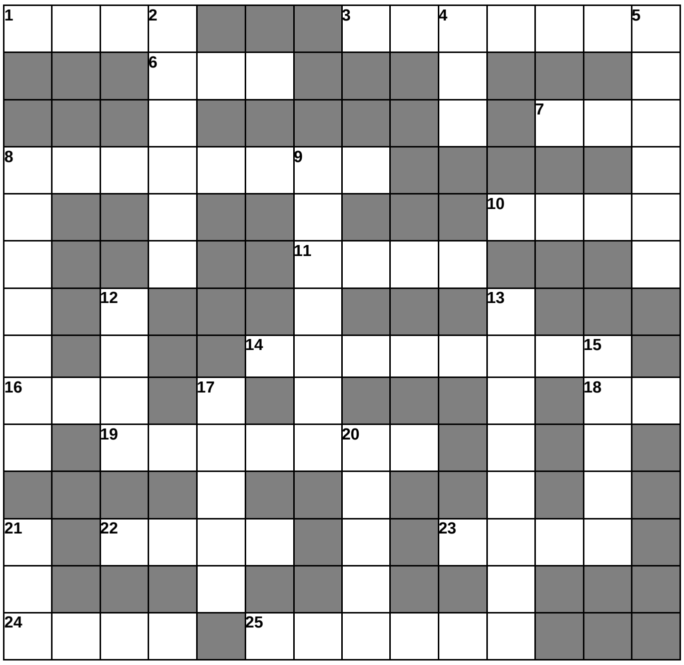
Weather Puzzle



Across

1 – mariners' way of measuring wind speed
3 – Hail it in Deutsche
6 – world regulates clock and time with this
7 – particles on which water vapour condenses in short
8 – zone of trouble abutting prime latitude
10 – natural satellite
11 – American national service
14 – force that affects direction and not speed
16 – area delineated by a single closed isobar
18 – weather shorthand
19 – what is common to spring and vernal
22 – area that is barren and dry not supporting vegetation
23 – when eye moves this is the period after which wind direction reverses
24 – sudden increase in air movement
25 – air that is gentle

Down

2 – Area vast with perma frost subsoil
4 – not manual observations
5 – Australians like this girl
8 – stratified clouds precipitate
9 – seasonal change in wind direction
12 – instrument measuring wind at distance abbreviated
13 – a small change in meridian leads to height
15 – manifestation of distant disturbance in sea
17 – term for describing water vapour in air
20 – gas hole filled by Montreal accord
21 – affects flight schedules in winter

S.R.Ramanan

REVIEW OF SOUTHWEST AND NORTHEAST MONSOONS, 2011

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Southwest monsoon (June-September)

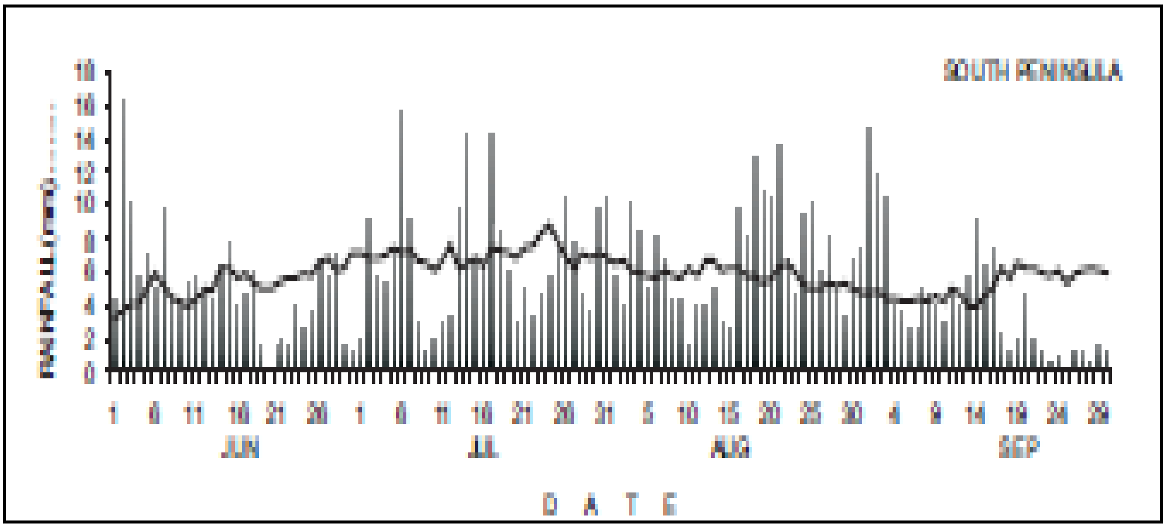
Onset and withdrawal

During the year 2011, southwest monsoon (SWM) set in over Kerala on 29th May, three days ahead of the normal date of onset (1st June) and steadily advanced northwards thereby covering the entire country by 9th July, 6 days ahead of the normal (15th July). The withdrawal started from the extreme northwestern parts of the country on 23rd September and completely withdrew from the entire country on 24th October.

Rainfall features

The SWM seasonal rainfall for the country as a whole was normal at 101% of its Long Period Average (LPA). The spatial rainfall distribution was 107% of LPA over northwestern parts, 110% of LPA over Central India, 100% over southern peninsula and 86% over northeastern parts. Of the 36 meteorological sub divisions, 33 subdivisions received normal or excess rainfall and the three northeastern subdivisions of Arunachal Pradesh, Assam & Meghalaya and NMMT ended up deficient. Monthly rainfall over the country as a whole was 112% of LPA in June, 85% of LPA in July, 110% of LPA in August and 106% of LPA in September.

In the southern region, all the four states of Kerala, Karnataka, Andhra Pradesh and Tamil Nadu received normal rainfall during the season.
The progress of the monsoon over the southern peninsula on daily basis is presented in Fig.1. The daily realised rainfall is presented as bars and the normals are indicated by the line graph. Rainfall during August was in excess but September rainfall was deficient. The subdivision of Tamil Nadu experienced 30% excess (Chennai, 123% excess) during August.



(Source: India Met. Dept., Climate Diagnostics Bulletin of India, Southwest monsoon-2011)

Fig.1 Daily rainfall over southern peninsula during the SWM monsoon season

The monthly and seasonal rainfall distribution over the southern subdivisions are presented in Table-1.

TABLE-1
Monthly and Seasonal rainfall distribution in the southern region

Subdivision	Jun	Jul	Aug	Sep	Season
Kerala	Excess	Deficient	Normal	Excess	Normal (+9%)
Lakshadweep	Deficient	Excess	Normal	Excess	Normal (+2%)
Coastal Karnataka (CK)	Excess	Excess	Excess	Excess	Excess (+22%)
South Interior Karnataka (SIK)	Normal	Normal	Normal	Deficient	Normal (-3%)
North Interior Karnataka (NIK)	Normal	Normal	Excess	Deficient	Normal (-13%)
Coastal Andhra Pradesh (CAP)	Deficient	Normal	Excess	Deficient	Normal (-7%)
Telengana	Deficient	Normal	Normal	Deficient	Normal (-12%)
Rayalaseema (RYS)	Deficient	Normal	Excess	Scanty	Normal (-5%)
Tamil Nadu & Pondicherry(TN&PDC)	Deficient	Normal	Excess	Deficient	Normal (-6%)

Excess:≥20%; Normal: -19% to +19%; Deficient: -59% to -20%; Scanty: ≤-60%

Chief synoptic scale features

The pressure anomalies were negative over most parts of the country except the northern parts and parts of extreme southern peninsula. At 850 hPa, an anomalous cyclonic circulation over the Northwest and Central Arabian Sea and an anomalous east-west trough from the centre of this anomalous circulation to the central parts of the country was observed. These anomalous features extended up to 500 hPa also. Over the peninsular region, anomalous westerlies (stronger than normal) were observed at 500 and 250 hPa levels.

Synoptic scale systems

Four monsoon depressions formed during the season. The first depression of the season was a short-lived one, which formed on 11th June over northeast Arabian Sea, crossed south Gujarat coast and dissipated on 13th. The second one formed over the northwest Bay of Bengal on 16th June, moved northwestwards across central parts of the country and dissipated over West Madhya Pradesh on 24th. The third depression formed over land on 22nd July over the central parts of the country and dissipated on the next day itself. The last depression formed on 22nd September over Northwest Bay of Bengal, moved in a north-north-westward direction causing flood situations over Orissa and Bihar and weakened over Jharkhand on 23rd.

Northeast monsoon (October-December)

Onset and withdrawal

The onset of easterlies over South Coastal Andhra Pradesh and North Coastal Tamil Nadu took place during the second week of October. But, a depression over the Bay of Bengal that moved towards Bangladesh during 18-19 October, delayed the northeast monsoon (NEM) onset. The onset of the NEM over the southern peninsular India took place simultaneously along with the withdrawal of the SWM from the entire country on 24th October (normal date of onset: 20th October). The cessation of NEM rainfall over the Indian region occurred on 10th January 2012.

Rainfall features

The NEM seasonal rainfall over the five meteorological subdivisions benefitted by the NEM are presented in Table-2.

TABLE-2

NEM seasonal rainfall over the five meteorological subdivisions benefitted by NEM

Sub division	Actual (mm)	Normal (mm)	% departure from normal
Tamil Nadu & Pondicherry	542	442	23
Kerala	164	218	-25
Coastal Andhra Pradesh	167	326	-49
Rayalaseema	164	218	-25
South Interior Karnataka	209	210	0

The subdivision of Tamil Nadu and Pondicherry (TN&PDC) registered excess rainfall (+23%) and Coastal Andhra Pradesh (CAP), Rayalaseema (RYS) and Kerala ended up deficient.

The number of days of vigorous / active NEM conditions over the five subdivisions are presented in Table-3. It can be seen that CAP experienced only one day of active NEM condition and one day of vigorous NEM condition (over SCAP) during the entire season. Tamil Nadu experienced 6 , 12 and 2 days of good activity (vigorous/active) during October, November and December respectively.

TABLE-3

Month-wise distribution of no. of days of vigorous or active NEM conditions

Month	NEM activity	Subdivision				
		TN	Kerala	RYS	CAP	SIK
Oct	**Vig**	1			1 (SCAP)	
	Active	5	3	3		4
Nov	**Vig**	3	3	2		2
	Active	9	5	1	1	
Dec	**Vig**	2	1			
	Active			1		

All the districts in the subdivision of Tamil Nadu and Pondicherry received normal or excess rainfall during the season. However, the progress of the NEM was not uniform throughout the season. The daily subdivisional rainfall of Tamil Nadu during October-December (OND) is presented in Fig.2. It can be seen that during the onset phase, the wet spell continued for about 15 days from 24th October to 7 November after which, NEM was subdued / weak for the next two weeks. The next wet spell occurred during the last week of November. The month of December was almost dry up to 28th. During 29th-31st December, another wet spell was experienced in association with passage of *Very Severe Cyclonic Storm (VSCS), Thane*.

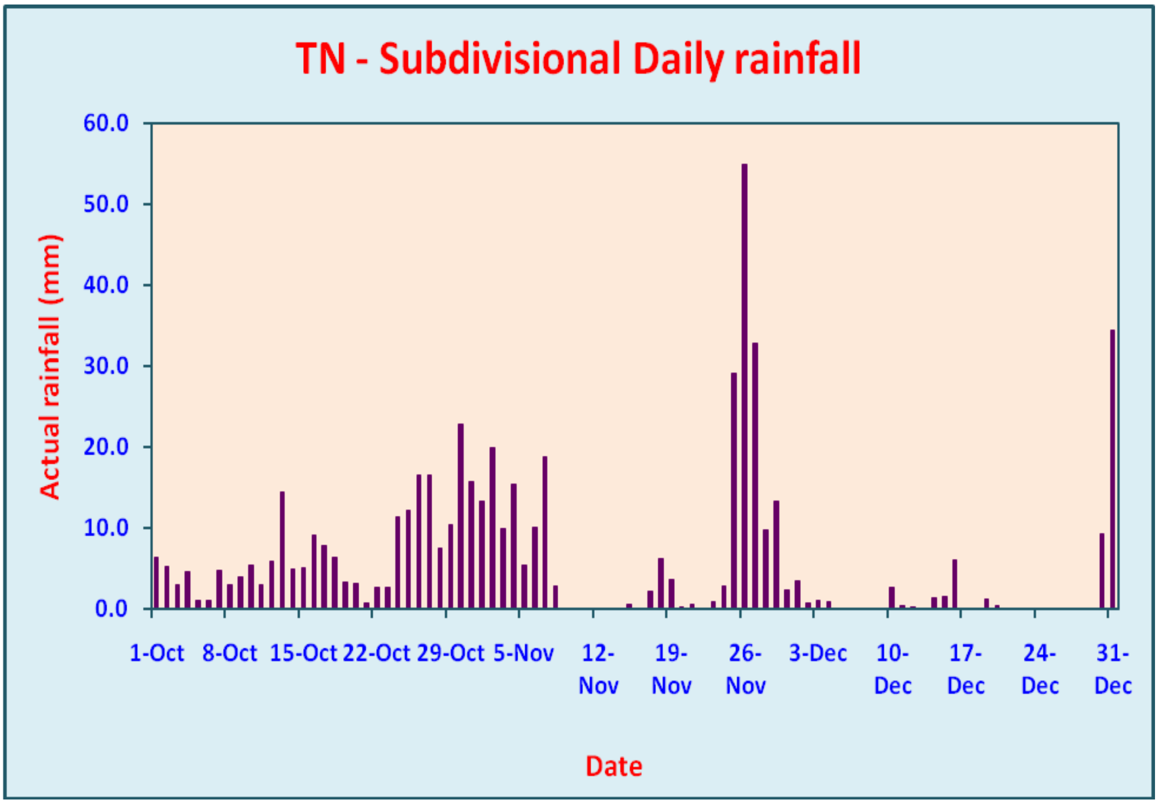


Fig.2 Daily rainfall over Tamil Nadu during the NEM season

Synoptic scale systems

During the OND 2011, 3depressions and 2 tropical cyclones formed over the North Indian Ocean. Of these, one depression and one *VSCS, Thane* and one depression formed over the Bay of Bengal; two depressions and one Cyclonic Storm *Keila* formed over the Arabian Sea. The tracks of these systems are presented in Fig.3. The VSCS Thane crossed coast between Cuddalore and Pondicherry on 30th December and caused extensive damages in region of its landfall.

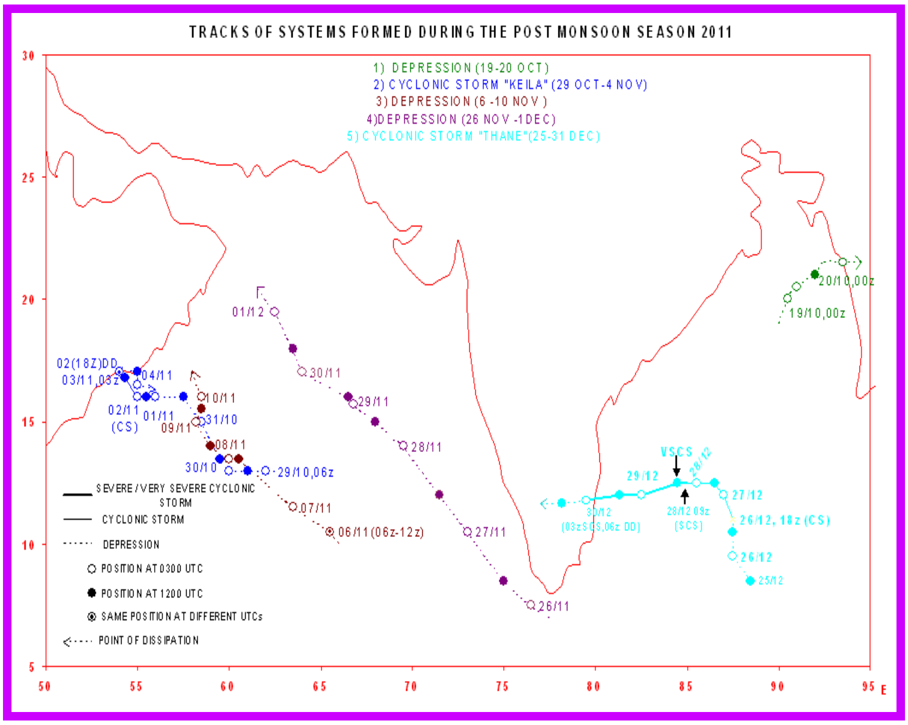


Fig.3 Tracks of cyclones and depressions during the NEM season

Global features

ENSO is a climate phenomenon known to influence northeast monsoon. During 2011, the SST over Eastern Equatorial Pacific ocean was below normal and La Nina conditions prevailed over the region. It is generally observed that during La Nina years, NEM is below normal but, in 2011, the realised rainfall over Tamil Nadu was above normal.

Summary

All the southern subdivisions registered normal/excess rainfall during the southwest monsoon 2011. The subdivision of Tamil Nadu & Pondicherry registered excess/ normal northeast monsoon rainfall for the eighth year in succession. No synoptic scale system crossed Andhra Pradesh coast during both southwest and northeast monsoon seasons and the subdivisions of coastal Andhra Pradesh and Rayalaseema ended up with deficient NEM. Arabian sea was quite active during the NEM 2011. The VSCS Thane crossed North Tamil Nadu coast on 30th December and caused extensive damages in the region of its landfall.

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MUSINGS ON NORTHEAST MONSOON RAINFALL OF ENNORE

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During the northeast monsoon(NEM) season in Chennai, early mornings of rainy days are always memorable moments. Thanks to my eco-friendly neighbourhood in Anna Nagar where I live, we are blessed with lush greenery around us in this otherwise concrete city, due to many trees and flowering plants enthusiastically planted around 35 years back. The chirping of birds and occasionally the song of the cuckoo during dawn wake us up daily from the peaceful slumber, in contrast to the always "alarming" alarm of the digital clock. When the rains commence, it is a different story altogether! It is the sound of croaks of frogs, all through the night which keeps me aware of the downpour amidst my otherwise deep log-like sleep! Invariably, even from childhood, out of sheer ignorance, I have always wondered where the frogs came from even after an overnight's rain. Again, awareness opens my eyes to the blessings of Mother Nature and the metamorphosis of life in all its splendour. Blissfully, I move on enjoying all of it!

During the past few years, I face challenges of just two different kinds during monsoon season when the rains pour without respite. Priority number one being to reach home safely (Life is precious!) after a long and tiring day of work, surmounting streams and rivers……I mean…water-logged roads and lanes, with pot holes tending to barrel-holes, if you can call them so. Driving becomes so difficult and literally I pray to God at least twenty times, in the 10 km long drive, that I should not get a lumbar disc prolapse when the tyres lay themselves on big trenches in the roads. The other challenge being the official duty of ensuring functionality and accurate reporting of rainfall (Isn't this the first priority in the true sense?) by Automatic Weather Stations(AWS) during adverse weather for which I am paid by the Government.

Till year 2010, we had just one AWS in Chennai which was installed during the year 2007, that too in Nungambakkam(NGB) from where the weather bulletins are issued for the city. During October 2010, two more AWS were installed in the suburban Chennai region to monitor the urban variability in weather. One is at Madhavaram(MDV) and the other one at Ennore Port(EPT). They were hitherto meteorologically unrepresented. So, it has been the interest as well as the curiosity of my team members and me to closely monitor these two AWS in particular, to see the variability in rainfall around Chennai. There are 105 such AWS in the southern peninsula installed by India Meteorological Department (IMD) (Refer Breeze, Vol.13, No.1, June 2011)

When the NEM was active / vigourous over Tamil Nadu during 24-29 November 2011, we were observing the rainfall variability of AWS in Chennai region through the web link of India Meteorological Department, http://www.imdaws.com. The next few paragraphs are about the rainfall recorded at EPT during 27-28 November 2011 which I wanted to share and that is the purpose of the rather long chattering above which I hope the readers would forgive!

It was remarkable that EPT AWS recorded a cumulative rainfall of 210 mm for the 24-hours period ending at 03 UTC on 28th November(Nov) and rather unbelievable, at first sight! The fleeting mind is always sceptical before logical analysis takes over and I was no exception that day in succumbing to its modulations! AWS which are validated and maintained well provide reliable and accurate records of rainfall and EPT is one of them. It was an amazingly heavy rainfall record for a location so close to the Bay of Bengal coast with ideal meteorological exposure. We don't have authenticated meteorological records of rainfall till now for EPT. The hourly rainfall intensity ranged from 30 mm/hr to 50 mm/hr from 03 UTC of 27th Nov(Fig.1). Eyewitness accounts too corroborate, though qualitatively, that heavy rainfall occurred from morning up to around noon which was also shown by the hourly rainfall intensities of EPT. Port officials said that their activities on that day were affected significantly. Interestingly, NGB and MDV recorded just 22 and 31 mm respectively on the same day. However, Nellore Airport and Nellore observatory north of EPT recorded 190 and 180mm, whereas AWS Sriharikota located mid-way between EPT and Nellore recorded 78mm. It was quite evident from the satellite cloud pictures and the derived hourly water vapour winds of 27-28th November that under the influence of the northeasterly winds the moisture from the sea was drawn inland and favourable atmospheric conditions caused such a localised and continuous downpour of very heavy rainfall in EPT.

The WRF model products had predicted rainfall in the range of 35-64 mm around the EPT area for 27-28 Nov, But, various dynamical and physical parameters which induce changes in the water vapour content and atmospheric moisture incursion into the land steered by the northeasterly winds during such low level circulations are possible reasons for the heavy rainfall of 210 mm. Prior to such a heavy rainfall occurrence wind speed recorded by EPT ranged from 15-20 knots on 26th and 27th but during the rainfall period up to 28th Nov the wind speed was less than 6 knots. Wind direction was varying from northeasterlies to southeasterlies up to 28th. Table 1 shows the rainfall realised during 2010 and 2011 by the two observatories and three AWS around Chennai.

From the preliminary analysis of the rainfall data in Table 1 it can be inferred that there is indeed a significant spatial variability in rainfall during NEM season in the urban scenario. During 2010, NEM rainfall at Meenambakkam was least among the four sites (NGB has both AWS and conventional observatory co-located and slight differences between both the rainfall measurements are inevitable as one is automated and the other one is by manual measurements) and highest during 2011. There was one cyclonic storm "Jal" during 5-8 Nov 2010 and Very Severe Cyclonic Storm(VSCS) "Thane" during 28-30 December(Dec) 2011 which perhaps contributed towards such a variability in rainfall. Influences due to local terrain in addition to those of cyclonic situations are evident from Table 1 in terms of the contrasting features of rainfall records. Fig.2 shows the rainfall variability in the three AWS sites. Among the three AWS, EPT has recorded the highest rainfall during 2010 and 2011 and MDV the lowest. More months of rainfall data will enlighten us further on the spatial variability. In fact, it is worth mentioning here that EPT recorded a wind speed of 30 knots on 29th Dec 2011 at 18 UTC, when the VSCS "Thane" was nearing land. The other sites did not record such high wind speeds due to their locations in the midst of high friction loadings due to concrete buildings. "Thane" had landfall on 30th Dec at 01:47 UTC close to Cuddalore. Meteorologically ideal sites like EPT do provide such invaluable data for operational weather forecasters.

I would like to end on an optimistic note that such datasets infuse trust on automated measurements, while at the same time reiterating the importance of time-tested and established practices of ensuring periodic maintenance of electronic equipments to get assured success in data availability. Automation provides tremendous opportunities to seekers willing to explore and unravel the variabilities in meteorological parameters of hitherto unrepresented areas!

Table 1 Rainfall of stations in the neighbourhood of Chennai

AWS	*2010*	*2011*			*Total (mm)*
	Oct-Dec	*Oct*	*Nov*	*Dec*	
Chennai Nungambakkam	740.5	249.5	438.5	133	821
Madhavaram	700.0	245.0	408.0	82	735
Ennore	766.0	199.0	572.0	103	874
Conventional observatory					
Nungambakkam	757.1	260.0	457.2	135	852
Meenambakkam	660.1	304.3	474.6	210	989

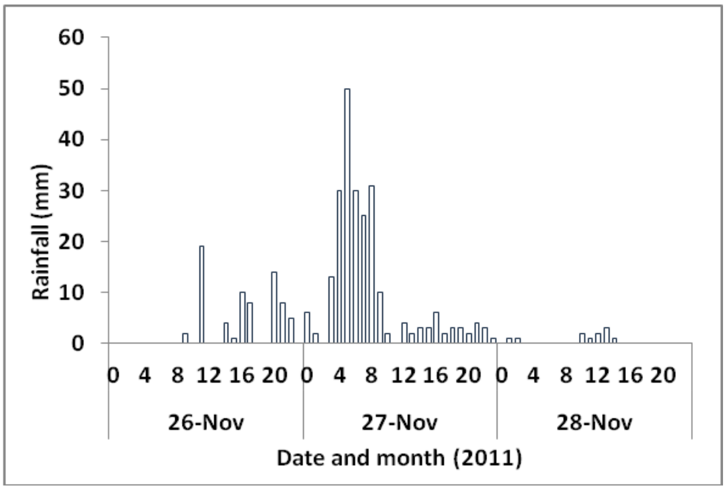

Fig.1 Hourly rainfall variability obtained from AWS at Ennore (26-28 Nov 2011)

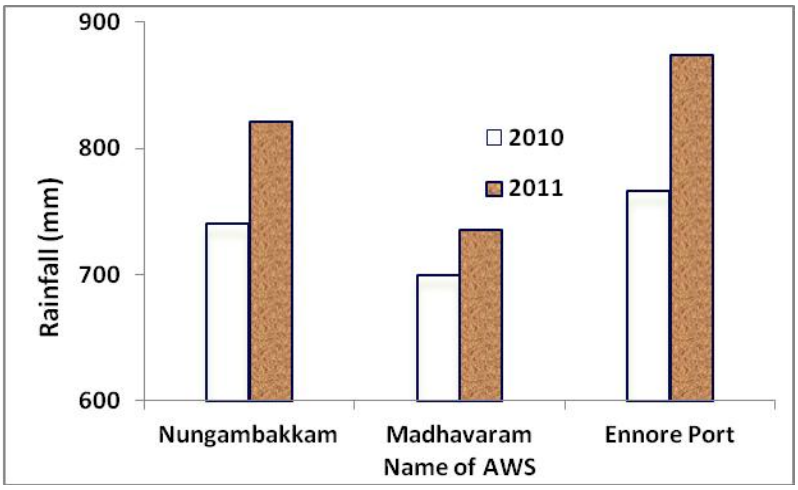

Fig.2 Rainfall of AWS in Chennai during Oct to Dec, 2010 & 2011

REPORT ON THANE VSCS OVER BAY OF BENGAL DURING 25.12.2011 TO 31.12.2011

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Introduction

A Very Severe Cyclonic Storm crossed near Cuddalore on 30th December morning, causing damage to life and property in North coastal areas, especially in Puducherry, Cuddalore and Vilupuram districts in the Tamilnadu/Puducherry subdivision. This report describes the genesis, development, tracking, landfall and damage caused by this system.

Life history of the system

A low pressure area formed over Southeast Bay of Bengal in the morning of 24.12.2011 and became well marked in the evening of 24th. It concentrated into a Depression and lay over Southeast Bay of Bengal at 1730 hrs IST of 25th near Latitude 8.5 degree North and Longitude 88.5 degree East at about a distance of 1000 kilometers southeast of Chennai. It then moved in a Northwesterly direction and further concentrated into a Deep Depression and lay near 9.5 º N and 87.5 º E at 0530 hours IST on 26th at about 900 kms Southeast of Chennai.

The Deep Depression over Southeast Bay of Bengal remained practically stationary for some more time, moved further in a northwesterly direction and intensified into a Cyclonic Storm "THANE" at 2330 hours IST. It lay near 11.0 º N and 87.5 º E at about 800 kms east- southeast of Chennai on 26th. The Cyclonic Storm "THANE" slightly moved northwestwards and remained practically stationary further for some more time over Southeast Bay of Bengal and lay centered at 0830 hours IST on 27th near 12.0 º N and 87.0 º E at about 750 kms east-southeast of Chennai. It further moved in west-northwesterly direction and lay centered at 1730 hours IST over Southeast Bay of Bengal near 12.5 º N and 86.5 º E at about 650 kms east-southeast of Chennai. It moved further in west-northwesterly direction and remained practically stationary for few hours and lay centered at 0830 hours IST on 28th over Southwest and adjoining Southeast Bay of Bengal near 12.5 º N and 85.5 º E at about 550 kms east-southeast of Chennai; the system further moved in a west-northwesterly direction and intensified into a Severe Cyclonic Storm over Southwest and adjoining Southeast Bay of Bengal and lay centered at 1430 hours IST near 12.5 º N and 85.0 º E at about 500 kms east-southeast of Chennai.

The Cyclonic Storm "Thane" further intensified into a Very Severe Cyclonic Storm and moved in west-northwesterly direction and lay centered at 1730 hours IST on 28th near 12.5 º N and 84.5 º E over Southwest Bay and adjoining Southeast Bay of Bengal at about 450 kms east-southeast of Chennai.

The VSCS "Thane" over Southwest Bay of Bengal moved westwards and lay centered at 0830 hours IST on 29th December 2011 near 12.0 º N and 82.5 º E at about 270 kms east of Puducherry and 250 kms east-southeast of Chennai. It further moved westwards and lay centered over Southwest Bay at 1730 hours IST near 12.0 degree º N and 81.3 º E at about 160 kms east of Puducherry and southeast of Chennai. The VSCS "Thane" moved further westwards and lay centered over southwest Bay of Bengal at

2330 hours IST near 12.0 º N and 80.6 º E, at about 90 kms east of Puducherry. It further moved westwards and lay centered at 0530 hours IST on 30th December 2011 near 11.8 º N and 79.9 º E very close to southeast of Puducherry. It further moved westwards and crossed North Tamilnadu coast about 10-20 kms south of Cuddalore between 0630 and 0730 hours IST on 30th December with wind speeds of the order of 120-140 kmph.

The VSCS "Thane" after crossing the coast continued to move westwards and weakened into a SCS around 0830 hours IST of 30th December 2011 and lay centered near Latitude 11.8 º N and 79.5 º E, at about 30 kms west of Cuddalore and 35 kms southwest of Puducherry. It further moved westwards and weakened rapidly into a Deep Depression and lay centered at 1130 hours IST near 11.8 º N and 79.0 º E, at about 100 kms west of Cuddalore. The system further moved West-southwestwards and weakened into a Depression and lay centered at 1730 hours IST of 30th December 2011 very close to Salem. The Depression over North Tamilnadu moved further westwards and emerged into Arabian sea and weakened into a Well marked low pressure over Lakshadweep area on 31st December 2011; it further weakened into a low pressure over Lakshadweep area at 0830 hours IST on 1st January 2012.

During the night of 29th December 2011, the wind speed reaching 60-70 Kmph prevailed over Chennai, Tiruvallur, Kanchipuram, Karaikal and Nagapattinam districts. Squally weather with wind speed reaching 90 - 100 Kmph accompanied by rain was also experienced over Cuddalore and Puducherry districts. At the time of crossing the coast the wind speed was 120-140 Kmph on 30th morning over Cuddalore and Puducherry districts.

Monitoring and prediction

The system was monitored mainly by satellite during its genesis and further intensification stage. In addition the surface observations from buoys and ships supported monitoring. When the system came within the radar range, DWR, Chennai monitored it and hourly inputs were provided to cyclone forecasters since evening of 28th December 2011. It helped in accurate monitoring of location and better estimation of intensity and associated landfall processes including heavy rainfall location and intensity and gale wind speed. When the system came close to coast, it was monitored by coastal observations in addition to satellite and DWR, Chennai. Hourly radar information was utilized for issuing hourly bulletins for All India Radio.

Role of Numerical weather prediction models

Numerical models were utilized as an aid for forecasting the system right from the genesis stage. One or two models predicted more northerly movement. The consensus of other models was for a landfall over north Tamilnadu coast and much closer to Puduchery and Cuddlore. Certainly they helped the forecasters to warn fishermen from 25th night onwards to return to the coast.

Why the system never weakened

The system after its formation in the south east bay intensified gradually and moved in a north northwesterly direction till it reached 12°N and moved practically in a westerly direction till landfall. When it was moving in a westerly direction, the wind shear aloft in the forecast track area was not conducive for the system's intensification. As time progressed, wind shear aloft reduced. So it was not an inhibiting factor for intensification. The sea surface was just at the threshold level. The system after becoming a very severe cyclonic storm moved westward and weakened after landfall.

Determination of landfall

Coastal observations (Hourly observations) and radar observations indicated that the system crossed close to cuddalore. Post cyclone survey indicated that the system has crossed near thyagavalli (11.6°N, 79.7°E) and it is located 14 kms south of cuddalore.

Rainfall

(a) Heavy Rainfall

Heavy to very heavy rainfall occurred at a few places over north Tamil Nadu and Puducherry on 30th and 31st December. Isolated heavy rainfall also occurred over south Tamil Nadu, south coastal Andhra Pradesh, Rayalaseema during this period and over Kerala on 31st December.

The following stations recorded past 24 hrs heavy rainfall (centimeters) at 0830 hrs IST of 30th and 31st December 2011.

30 December 2011

Puducherry : Puducherry airport 15,

Tamil Nadu : Kalpakkam and Kelambakkam (both Kanchipuram dt) 10 each, Cuddalore, Maduranthagam and Uthiramerur (both Kanchipuram dt) 9 each, Chengalpattu and Mahabalipuram (both Kanchipuram dt) 8 each and Chennai airport, Tiruvallur and Chidambaram (Cuddalore dt) 7 each.

Andhra Pradesh : Rapur (Nellore dt), Puttur (Chittoor dt) 7 each,

31 December 2011

Kerala : Haripad (Alapuzha dt) 22, Tiruvananthapuram 18, Nedumangad (Tiruvanathapuram dt) 16, Kayamkulam (Alapuzha dt) 15, Thiruvalla (Pattanamthitta dt) 14, Chengannur (Alapuzha dt) 12, Neyyatinkara (Tiruvananthapuram dt) 11, Mavelikara (Alapuzha dt) 10, Konni (Pattanamthitta dt), Kanjirapally (Kottayam dt), Kottayam, Alapuzha 9 each, Varkala (Tiruvananthapuram dt), Kozha (Kottayam dt) 7 each,

Puducherry : Puducherry airport 10

Tamil Nadu : Kallakurichi (Villupuram dt) 18, Gingee (Villupuram dt) 16 each, Sankarapuram (Villupuram dt), Mylaudy and Nagerkoil (both Kanyakumari dt) 14 each, Uthiramerur (Kanchipuram dt) and Kuzhithurai (Kanyakumari dt) 13 each, Virudhachalam (Cuddalore dt), Cheyyar (Tiruvannamalai dt) 12 each, Mancompu (Alapuzha dt), Tozhudur (Cuddalore dt), Tirukoilur (Villupuram dt), Polur, Vanthavasi and Sathanur Dam (all Tiruvannamalai dt) 11 each, Kanchipuram, Maduranthagam (Kanchipuram dt), Arani (Tiruvannamalai dt) 10 each, Chengalpattu (Kanchipuram dt), Chembarambakkam (Tiruvallur dt), Ulundurpet (Villupuram dt) and Tiruvannamalai 9 each, Punalur, Tiruvallur, Boothapandy (Kanyakumari dt), Kanyakumari, Chengam (Tiruvannamalai dt) and Sholingur (Vellore dt) 8 each and Chennai airport, Cheyyur, Kelambakkam and Sriperumpudhur (all Kanchipuram dt), Poonamalli, Ramakrishnarajupet and Tiruvalangadu (all Tiruvallur dt), Tiruttani, Sethiyathope (Cuddalore dt) and Tindivanam (Villupuram dt), Kumbakonam (Thanjavur dt), Arakonam and Kaveripakkam (both Vellore dt), Vellore, Attur (Salem dt), Coonoor, Jayamkondam (Ariyalur dt) and Padallur (Perambalur dt) 7 each.

Damage caused

As per media /press reports, due to the VSCS "Thane" 26 persons died in Cuddalore district; seven in Puducherry; 3 in Kancheepuram; 2 each in Villupuram and Tiruvallur districts and one each in Chennai and Theni districts.

The samba crop grown in 1700 hectares in Thanjavur district; 2000 hectares in Tiruvarur district; Paddy crop in Cuddalore, Nagapattinam, Villupuram, Kanchipuram, parts of Thanjavur, Tiruvarur and Thiruvallur were affected besides sugarcane in 6000 hectares and coconut in about 500 hectares. In Salem district, many acres of tapioca, betel nuts, and banana crops were also affected.

When the storm crossed the coast, heavy rains accompanied by squally winds speed reaching 140 Kmph uprooted trees, electric posts, disrupted power supply and transport services in Cuddalore district and Puducherry. Due to wind and rain, 793 trees more than 35 years old in the roadside were uprooted In the cyclone affected coastal areas.

Around 6000 persons in Cuddalore, Villupuram, and Nagapattinam, Tiruvallur and Kancheepuram districts and low level areas were shifted to shelters. Besides, the supply of water, milk, diesel and kerosene has been affected and essential commodities go scarce in Cuddalore district and Puducherry. In Puducherry the storm has caused considerable loss to the Tourism Industry and the Silver beach in Cuddalore has been reduced to a strip as sea erosion caused the coast leaving little space for the sand.

About 73292 thatched houses were fully damaged and 94633 houses were partially damaged by wind and rain in the various affected districts of the state. In agricultural sector, paddy crop in 58,200 hectares; sugarcane in 5,752; groundnut in 1,402; black gram in 945; coconut in 490 hectares were damaged in the entire cyclone affected areas. In horticultural sector, cashew in 23,500 hectares; banana plantation in 2,860; Jackfruit in 340; vegetables in 320; Mango trees in 317; Guava in 270; flowers in 250; betel nuts in 128; tuber in 73; amla in 12 hectares were damaged.

In Cuddalore district alone 4500 electric poles, 4500 transformer, 27 electric towers were damaged. Electric wire in 10,500 Km length was damaged. The damages are worked out to be 1300 to 1500 crores.

In fishing sector, in the coastal villages of Cuddalore and Puducherry, 240 country boats; 67 numbers motorized boats; 58 catamarans and four mechanized boats were fully damaged. In the cyclone affected coastal areas, 1,430 catamarans; 106 motor boats; 101 mechanised boats and 16 country boats were partially damaged. Apart from this damage 1,94,000 fishing nets and 1262 engines were damaged. In animal husbandry sector, 47 Cows; 32 Calves; 9 Buffaloes; 5 Buffaloes calves and 4 Bullocks were dead. About 52,938 Chickens; 6200 Kadai; 1000 ducks and 246 goats also perished.

Storm Surge

IMD predicted storm surge of 1-1.5 meter height above the astronomical tide over Puducherry, Tiruvallur, Villupuram, Chennai and Kanchipuram districts of north Tamil Nadu at the time of landfall. As per post-cyclone survey conducted by IMD, the storm surge of about 1 meter height inundated the low lying coastal areas of Cuddalore, Puducherry and Villuparam districts at the time of landfall. Cuddalore Port reported 0.9 meter surge above astronomical tide level. Studies conducted by MoES scientists indicated a storm surge of 1.3 meter above normal tide level.

Bulletins issued

- ✓ Port Warnings - 25
- ✓ Cyclone Alert - 8
- ✓ Cyclone Warning Bulletin – 12
- ✓ Post Landfall outlook – 2
- ✓ AIR/DD -28 (Including 18 hourly position based on hourly observation)
- ✓ Fisherman Warning – 38
- ✓ Fishermen advised to return- issued at 25/12UTC
- ✓ Fishermen advised not to venture on 26/03UTC

Summary & Conclusion

The system right from its genesis was monitored timely warnings were issued and advisories and warnings were disseminated properly and fewer deaths for a strong system of this magnitude. Practically no fishermen ventured out in to open sea and as a result no fishermen died in the sea. The disaster managers of the government and the media (both electronic and print) disseminated the warnings to the people at large and this is one the main reason in minimizing the casualty.

Solutions to the weather puzzle on page 22

1 K	N	O	2 T				3 G	R	4 A	U	P	E	5 L
			6 U	T	C				W				A
			N						S		7 C	C	N
8 D	O	L	D	R	U	9 M	S						I
R			R			O				10 M	O	O	N
I			A			11 N	O	A	A				A
Z		12 D				S				13 A			
Z		I			14 C	O	R	I	O	L	I	15 S	
16 L	O	W		17 H		O				T		18 W	X
E		19 E	Q	U	I	N	20 O	X		I		E	
				M			Z			T		L	
21 F		22 A	R	I	D		O		23 L	U	L	L	
O				D			N			D			
24 G	U	S	T		25 B	R	E	E	Z	E			

புயல்களுக்குப் பெயரிடும் முறை

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வெப்ப மண்டலப் பகுதிகளில் உருவாகும் புயல்களால் மனித உயிர்களுக்கும் உடமைகளுக்கும் ஏற்படும் சேதம் உலக அளவில் கடற்கரையோரப் பகுதிகளில் ஆண்டுதோறும் ஏற்படும் ஒரு நிகழ்வாகும். வங்கக் கடல்பகுதியில் இத்தகைய சேதம் சற்று கடுமையானது. குறிப்பாக வங்கக்கடலின் வடபகுதிகள் புயலால் ஏற்படும் பொங்கலைகளால் அதிகம் பாதிப்புறும் பகுதியாகும். கடந்த சில ஆண்டுகளில் அதிக அளவில் உயிர்ச்சேதம் ஏற்படுத்திய பத்து புயல்களில் ஒன்பது புயல்கள் வங்கக்கடல் மற்றும் அரபிக்கடல் பகுதிகளில் ஏற்பட்டுள்ளன. (வங்கதேசம் – 5, இந்தியா – 3, மியன்மார் – 1) உலகிலேயே மிக உயரமான பொங்கலைகளை (45 அடி) ஏற்படுத்திய கடும்புயல் இப்பகுதியில்தான் ஏற்பட்டுள்ளது. (**பக்ஹர்கன்ஞ் புயல், வங்கதேசம், 1876**) இதனைக் கருத்தில்கொண்டு உலக வானிலை ஆய்வுக் கழகம் (World Meteorological Organisation) மற்றும் ஆசியா – பசுபிக் பொருளாதார சமூகக் குழு (Economic and Social Commission for Asia and the Pacific-ESCAP) ஆகிய இரண்டு உலக அமைப்புகளும் இணைந்து 1972இல், இப்பகுதியில் உருவாகும் புயல்களைக் கண்காணித்து, உரிய முறையில் முன்னெச்சரிக்கைகள் வழங்க ஒரு புதிய **புயல் எச்சரிக்கை சேவை** வழங்கும் அமைப்பினை உருவாக்கின. **எஸ்கேப் பேனல் ஆன் ட்ராபிகல் சைக்ளோன்ஸ்** (ESCAP Panel on Tropical Cyclones) என ஆங்கிலத்தில் வழங்கப்படும் இவ்வமைப்பில் தொடக்கத்தில் வங்கதேசம், இந்தியா, மியன்மார், பாகிஸ்தான், இலங்கை, தாய்லாந்து ஆகிய நாடுகள் இவ்வமைப்பில் உறுப்பினர்களாக இருந்தன. பின்னர் 1982இல் மாலத்தீவுகள் மற்றும் 1997இல் ஓமன் ஆகிய நாடுகள் இவ்வமைப்பில் இணைந்தன. இப்பகுதியில் உள்ள கடல்களில் உருவாகும் புயல்கள் பற்றிய முன்னெச்சரிக்கைகளை வழங்குதலில் சிறப்பான கவனம் செலுத்துதலே இவ்வமைப்பின் முக்கிய நோக்கமாகும். புயல் எச்சரிக்கைகள் பணியில் தரக்கட்டுப்பாட்டினைக் கொண்டுவருதல், ஒரு புயல் உருவாகும்போது அதனால் பாதிப்படையக்கூடிய எல்லா உறுப்பு நாடுகளுக்கும் விரைவாக வானிலைத் தகவல்களையும் புயல் பற்றிய எச்சரிக்கைகளையும் அனுப்பதல் ஆகிய இரண்டும் இதனுடைய முக்கியமான பணியாகும். இதன் தலைமையகமான வட்டார சிறப்பு வானிலையாய்வு மையம் (Regional Specialised Meteorological Centre - RSMC) இந்திய வானிலையாய்வுத்துறையின் (Inida Meteorological Department - IMD) தலைமை அலுவலகம் அமைந்துள்ள புதுதில்லியில் அமைக்கப்பட்டுள்ளது.

உலக வானிலையாய்வுக் கழகத்தின் வெப்பமண்டலப் புயல் திட்டத்தின் (Tropical Cyclone Programme – TCP) கீழ் உலகெங்கிலும் இத்தகைய வட்டார சிறப்பு வானிலையாய்வு மையங்கள் ஐந்தும் வெப்பமண்டல புயல் எச்சரிக்கை மையங்கள் (Tropical Cyclone Warning Centres – TCWC) ஆறும் தொடங்கப்பட்டுள்ளன. வட்டார சிறப்பு வானிலையாய்வு மையங்கள் **பிஜி**, **ப்ரான்ஸ்**, **இந்தியா** (புதுதில்லி), **ஜப்பான்**, **அமெரிக்கா** (ஹோனலுாலு, ஹவாய்), **மியாமி** ஆகிய இடங்களிலும் வெப்பமண்டல புயல் எச்சரிக்கை மையங்கள் **பெர்த்**, **டார்வின்**, **பிரிஸ்பேன்**, **பாப்புவா நியூகினியா**, **வெல்லிங்டன்** (நியூசிலாந்து), **ஜகார்த்தா**

(இந்தனோசியா) ஆகிய இடங்களிலும் உள்ளன. புதுதில்லியில் உள்ள வட்டாரச் சிறப்பு வானிலையாய்வு மையம் வட இந்தியப் பெருங்கடலில் உருவாகும் புயல்கள் பற்றிய தகவல்களையும் முன்னெச்சரிக்கைகளையும் இம்மையத்தின் உறுப்பு நாடுகளுக்கு வழங்குகிறது. புயல்களுக்குப் பெயரிடும் பணியும் இம்மையத்தின் பணிகளுள் ஒன்றாகும்.

இந்தியப் பெருங்கடல் பகுதியில் உருவாகும் புயல்களுக்குப் பெயரிடும் முறை 2004ஆம் ஆண்டு அக்டோபர் மாதம் முதல் தொடங்கியது. புயல்களுக்கு பெயரிடுவதற்கென ஒரு பெயர் பட்டியல் தயாரிக்கப்பட்டுள்ளது. வங்கதேசம், இந்தியா, மியன்மார், பாகிஸ்தான், இலங்கை, தாய்லாந்து, மாலத்தீவுகள், ஓமன் ஆகிய உறுப்பு நாடுகள் ஒவ்வொன்றும் தங்கள் கலாச்சாரத்தைப் பிரதிபலிக்கும் வகையிலும், சிறிய பெயராகவும், பொது மக்களும் வானிலையாளர்களும் ஊடகங்களும் எளிதில் புரிந்துகொள்ளும் வகையிலும், யார் மனதையும் புண்படுத்தாத வகையிலும் பெயர்களை இப்பட்டியலில் இணைத்துள்ளன. இப்பட்டியல் இந்திய வானிலையாய்வுத் துறையின் அதிகார பூர்வ இணையதளமான www.imd.gov.in - cyclone page - frequently asked questions என்ற பிரிவில் தரப்பட்டுள்ளது. குறைந்த காற்றழுத்தத் தாழ்வு மண்டலம் புயலாக உருவெடுக்கும் போது புதுதில்லி வட்டார சிறப்பு வானிலையாய்வு மையத்தால் அதற்குப் பெயரிடப்படும்.

புயல்களுக்குப் பெயரிடும் முறை பயன்பாட்டிற்கு வரும் முன்னர், புயல்கள் அட்சரேகை/தீர்க்கரேகை குறிப்பிடப்பட்டு, எண்கள் வழங்கப்பட்டு குறிப்பிடப்பட்டன. இம்முறையில் இருந்த குழப்பங்கள் புயல்களுக்குப் பெயரிடும் முறையால் பெரிதும் தவிர்க்கப்பட்டன. மேற்கு இந்தியப் பகுதிகளில் புயல்களுக்குப் பெயரிடும் முறை இரண்டாம் உலகப் போரின் போதே தொடங்கிவிட்டது. தொடக்கத்தில் பெண்கள் பெயர்கள் வைக்கப்பட்டது. பின்னர் ஆங்கில எழுத்துக்களின் அகர வரிசையைக் குறிப்பிடும் ஆல்பா, ப்ராவோ, சார்லி (Able. Baker, Charlie) என்று பெயரிடும் முறை வழக்கத்தில் இருந்தது. 1978ஆம் ஆண்டு முதல் ஆண், பெண் இருபாலரின் பெயர்களும் வைக்கும் முறை பயன்பாட்டிற்கு வந்தது.

கடந்த சில புயல்களுக்கான பெயர்களான **ஓக்னி, நிஷா, கிரி** ஆகியவை வங்கதேசத்தாலும் **ஆகாஷ், பிஜ்லி, ஜல்** ஆகியவை நம் நாட்டாலும் **கோனு, அய்லா, கெய்லா** ஆகியவை மாலத்தீவுகளாலும் **யேமின், பயன், தாணே** ஆகியவை மாயன்மார் நாட்டாலும் **சிடர்**, **வார்த்** ஆகியவை ஓமன் நாட்டாலும் **நர்கீஸ், லைலா** ஆகியவை பாகிஸ்தானாலும் **ராஷ்மி, பந்து** ஆகியவை இலங்கையாலும் **கைமுக், பெட்** தாய்லாந்தாலும் வைக்கப்பட்ட பெயர்களாகும், ஆங்கில நாவலாசிரியர்களும் ஆங்கிலத் திரைப்படத் தயாரிப்பாளர்களும் புயல் பற்றிய செய்திகளைத் தரும் படைப்புகளை உருவாக்கியுள்ளனர். ஷேக்ஸ்பியரின் **டெம்பஸ்ட்** நாடகம் இதற்கு நல்லதொரு எடுத்துக்காட்டாகும். புகழ்பெற்ற ஆங்கில நாவலாசிரியர் **ஆர்தர் ஹெய்லி** விமானப்படையில் பணிபுரிந்தவர். எனவே அவரது படைப்புகளில் வானிலை பற்றிய சுவாரசியமான வருணனைகள் காணக்கிடைக்கும். தமிழில் **கல்கி** அவர்கள் தம்முடைய படைப்புகளில் புயல்கள் பற்றிய அருமையாக சித்திரித்துள்ளார்.

இவ்வாறு புயல்களுக்குப் பெயரிடும் முறை, புயல்கள் பற்றிய தகவல்களை மேலும், மேலும் அறிந்து கொள்ள வேண்டும் என்ற ஆர்வத்தை மாணவர்கள் இடையேயும் பொது மக்களிடத்தும் அதிகரித்து உள்ளது என்பதில் அய்யமில்லை.

A RADAR ACCOUNT OF THE VERY SEVERE CYCLONIC STORM 'THANE'

by

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Introduction

It is an established fact that as cyclonic storms enter the surveillance zone of, and move closer to, weather radars more and more internal details of the system get revealed and preciseness with which the position and intensity are estimated improve significantly. While monitoring storms within 250 km of their range, Doppler weather radars (DWR) are considered the best of all tools and observing systems available for storm surveillance. Ability to capture the finer details of the spatial and temporal dynamics of the storm instantaneously and in fast succession puts the weather radar on the top of the list. Doppler capability to precisely capture data on the wind field associated with the system, specifically over the eye-wall region of highest vorticity, enhance the utility of radars in cyclone surveillance. Having realized the strength and utility of radars in cyclone surveillance, IMD established a network of Cyclone Detection Radars covering the coastal region decades ago and gradually replaced the aging and obsolete radars with modern digital radars with Doppler capability. The DWR at Chennai, commissioned on 20th Feb 2002 (incidentally, completing ten years of service this month) is the first one in the series of DWRs inducted into IMD's network.

Kept on continuous surveillance mode this radar not only served in cyclone detection and tracking but also has gathered huge volume of data on many other severe and significant weather events and enabled possibilities for creation of a new set of climatological data-set on rainfall distribution in the metropolitan and greater Chennai region. Every year at least one cyclonic storm had come into its surveillance zone and in 2011 it happened on the last few days of the year. Experience, strategy and results associated with surveillance of the very severe cyclonic storm 'Thane' from DWR Chennai are the subject matter here.

Brief history of 'Thane'

A Low Pressure Area formed over southern parts of SE Bay on 24th 03 UTC, has concentrated into a Depression on 25th 12 UTC. The same further intensified into a Deep Depression on 26th 03 UTC, a Cyclonic Storm (named as 'Thane') on 27th 03 UTC, a Severe Cyclonic Storm (SCS) on 28th 09 UTC and a Very Severe Cyclonic Storm (VSCS) on 28th 12 UTC. The system then maintained its intensity and moved in a Westerly direction and crossed the coast near Cuddalore during the early hours of 30th December 2011. After crossing the coast the system weakened gradually. Details on the strength and position of the system are summarized below:

DATE	TIME (UTC)	INTENSITY	ECP (hPa)	LAT(˚N)	Long(˚E)
24.12.11	0300	LOPAR over SE Bay	-		
24.12.11	1200	WML over SE Bay	-		
25.12.11	1200	Depression	-	8.5	88.5
26.12.11	0300	Deep Depression	-	9.5	87.5
27.12.11	0300	Cyclonic Storm	-	12.0	87.0
28.12.11	0900	Severe Cyclonic Storm	1000	12.5	85.0
28.12.11	1200	Very Severe Cyclonic Storm	1000	12.5	84.5
30.12.11	0100		Crossed near Cuddalore		

Radar observations

During the active period of the cyclone 'Thane' the Doppler Weather Radar (DWR) at Chennai remained fully serviceable and kept continuous watch of the system, revealing many interesting features and precise details unavailable from other modes of observation. Regular scan-strategies running in cyclic-loop mode of operation were modified a couple of times to accommodate higher ranges of winds expected. When the cyclone was in the peripheral ranges of the radar, a scan designed for long-range-surveillance (negative elevation angle, low PRF and higher unfolding ratio) was used without disturbing the normal cyclic loop.

In addition to posting of DWR images on IMD website for public consumption and routine dissemination of DWR products by email to the registered users, Plain language bulletins were issued from time to time to all concerned in the real-time decision making. For the first time, detailed radar-bulletins in plain language were issued continuously for 46 hours from 09 UTC on 28th to 06 UTC on 30th Dec. 2011.

Salient features of the cyclone as seen by the radar

The system had attained strength of a cyclonic storm well before entering into the radar field-of-view. Though a small portion of the system became apparent in the radarscope as early as 28th 06 UTC, persistent features sufficient to estimate system centre and intensity could be seen only from 28th 12 UTC. From thereon the system could be seen moving westward, approaching the Indian landmass. As the radar-range to the system decreased, more and more features of the system became evident and the confidence, with which the centre and intensity were fixed, increased steadily. Though clear (echo-free) eye was visible for a long period of observation, prominent eye-wall region could not be seen persistently. Though echoes over eye-wall region are expected to be tall and intense, on a few occasions, echoes over spiral bands were seen taller and more intense. Maximum observed reflectivity was around 55 dBZ.

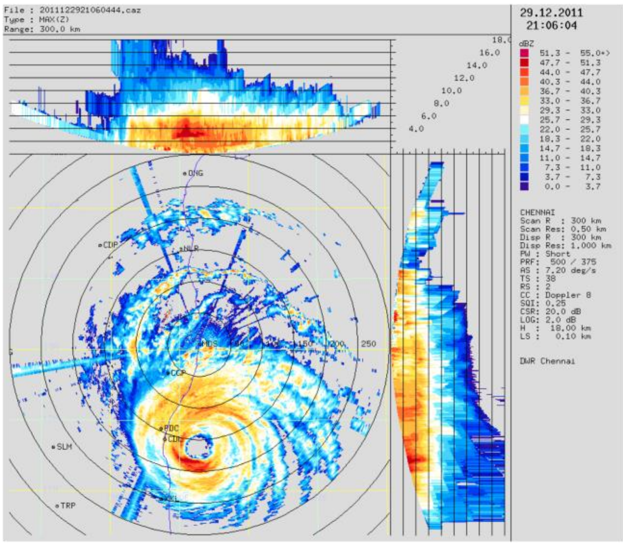
The wind field was more or less symmetric to the eye and the radius-of-maximum wind estimated was about 60 km at the level of about one km from sea level. Maximum velocity of about 53 mps observed in the cyclone field was associated with the eye-wall region.

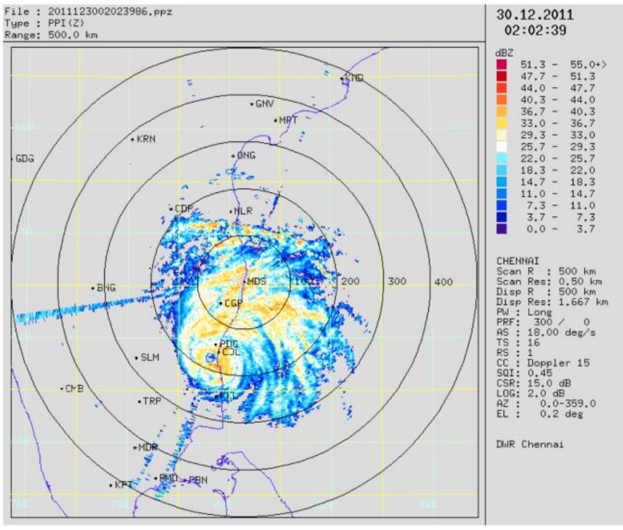
Even after crossing the coast, radar observed features were sufficient to attempt centre fix and intensity estimation for another 06 hour, thereafter the echoes went highly disorganised. Initial slowing of the system before entering the land mass and subsequent steady entry of the system at right angle to the coast etc. could be recorded from the radar very accurately.

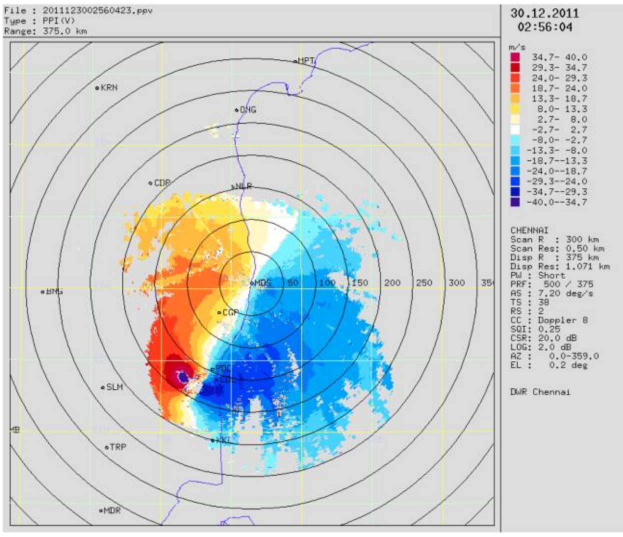
Performance of the radar

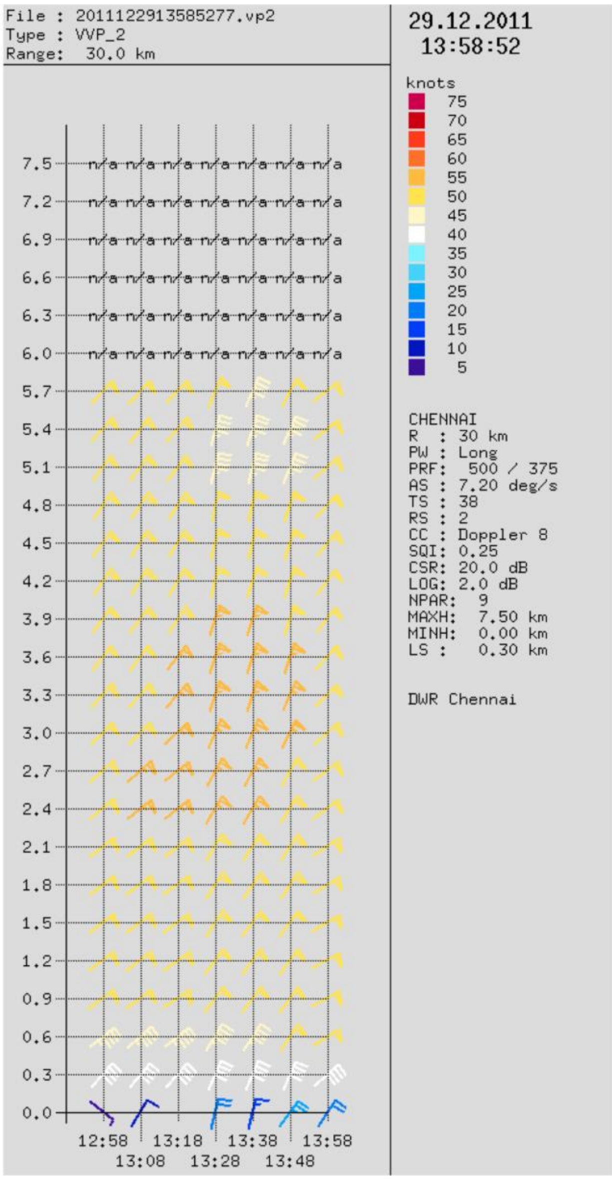
The DWR performance during the cyclone surveillance period had been very good with optimum power output, sensitivity, and stability without any trouble.

Attachments - A few selected radar-images of cyclone ‘Thane’ are attached.

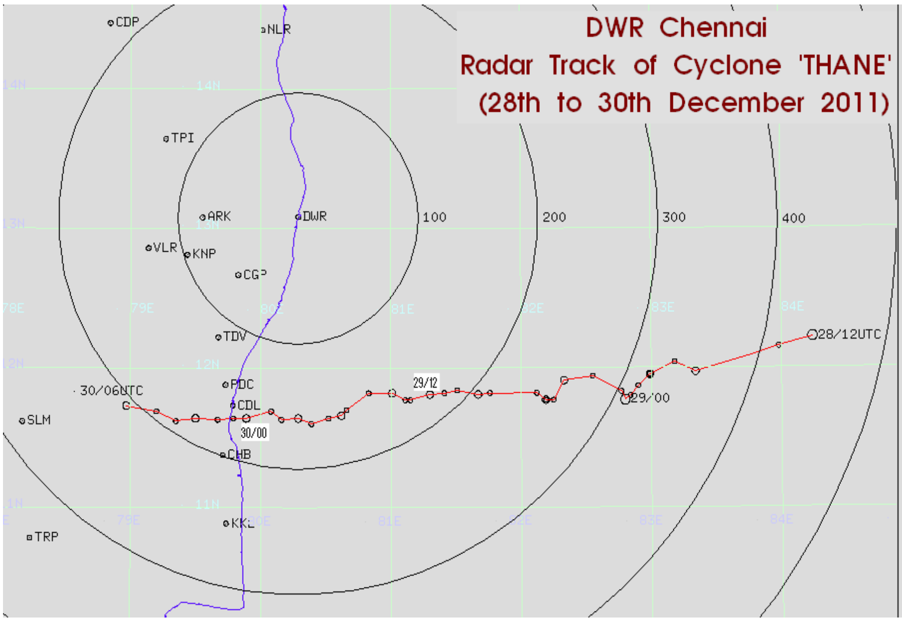








RADAR TRACK OF VSCS 'THANE' 28TH /1200 UTC to 30TH /0600 UTC Dec, 2011



PREPAREDNESS, RELIEF AND REHABILITATION OPERATIONS DURING THANE CYCLONE 2011

by
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Introduction

Even though natural calamities is a recurrent phenomena in Puducherry, the recent Cyclone Thane during Dec. 2011 has caused catastrophic damages to the infrastructures, irreparable damages in many sectors and above all took the life of 8 persons and hundreds of grievous injuries. This Cyclone has caused devastating damages several times more than the damages that were caused by Tsunami 2004 and Nisha Cyclone 2008. Fierce winds and driving rains brought by the most powerful storm ever to Puducherry had lashed the entire coastal belts and land of Puducherry. With winds reaching up to 140 Km/h Cyclone Thane ripped roofs of buildings, multiple hundreds of electricity poles were down and the streets were covered with fallen trees, debris disrupting the traffic flow in Puducherry in whole, which took one 3 days for the Administration to restore to its normalcy . Adding to the above, there were many hamlets in Puducherry, where the Officials of the District Authority were unable to reach the affected hamlets even after one day of the devastation.

Preparedness

<u>On 26-12-2011:</u>

In prompt the District Authority received the Cyclone Warning message from the I.M.D., Chennai from 26-012-2011 onwards. From the day one of the announcement of the Area Cyclone Warning Centre, Chennai, the District Authorities through media publicised the endangering impact of the ensuing Cyclone Thane. The first and foremost warned section of the society was the Fishermen folk NOT to venture in to the sea. The fishermen were disseminated that the tidal surge may be as high as 2 metres in some places, overwhelming low lying coastal areas also.

<u>On 27-12-2011:</u>

The District Authority immediately convened high level meeting with all line Department meeting and analysed the state of preparedness to meet any eventuality of the Cyclone. For the first time 16 nos. of Emergency Support Functions (ESF) were put into operation to tackle the calamity.

Emergency Support Function is the concept of the National Disaster Management Authority, New Delhi, under this the entire process of Disaster Management is put into separate functions. For every function a Sr. Official of the District Authority shall be the TEAM LEADER, under him ESF MEMBERS and QUICK RESPONSE TEAM (QRT) MEMBERS will function.

The District Collector, Puducherry, underlined the duties and responsibilities of all the 16 Emergency Support Functions in the field of (i) Communication; (ii) Emergency Medical Services & Public Health, (iii) Emergency Warning, Public Information & Helpline, (iv) Search & Rescue; (v) Transportation; (vi) Evacuation; (vii) Debris Clearance & Equipment Support; (viii) Damage Assessment; (ix) Relief Camps; (x) Food

& Civil Supplies; (xi) Water Supply & Sanitation; (xii) Electricity Restoration; (xiii) Public Works & Engineering; (xiv) Fire Fighting/Hazardous Materials Response; (xv) Law & Order Enforcement; (xvi) Resources Mobilization, Volunteer & Donation Support to face the calamity.

On 28-12-2011 itself there were incidents of sea water intrusion in the coastal villages and those peoples were evacuated and accommodated in the nearby shelters, thereby the ESF-Evacuation and Relief Camps were put in action. The District Administration made all arrangements in communicating to the general public about the DOs & DON'Ts of Cyclone through press release and Media.

On 28-12-2011

The timely communication of bulletins from IMD helped the Administration to be in the state of preparedness. On 28-12-2011 itself Flag No.8 was hoisted in Puducherry Port. Repeatedly, the impact of the VERY SEVERE CYCLONIC STORM expected with a Squally Wind speed of 140 Km/H and the status and position of the Thane Cyclone were communicated and informed to the general public through the Cable network as well as through various FM Radios and about the expected terrifying wind speed of 140 Km/h with heavy rains. The District Administration made it very clear to the general public to take asylum of the nearby identified official shelters which are almost Government Schools & Buildings were already kept in order for accommodation. Considering the vulnerability the State Government declared holiday to all private and Government Schools & Colleges on 29-12-2011. All the Early Warning Systems (EWS) installed in the line departments and in the fishermen hamlets were checked, which all remained in working condition.

On 29-12-2011

From the morning of 29-12-2011 the gale wind speed of 50 to 60 km/h was felt in Puducherry, with chill weather. Based on the strict warning of IMD through the media general public were instructed not to visit to the sea and to remain in safer places. Moreover, the public were instructed to remain in their house as the system had peaked as a Very Severe Cyclone Storm with 3 minute sustained wind speed of 140 Km/H and to watch the Radio/FM and up date themselves about the cyclone.

On the Midnight of 29-12-2011 Midnight & 30-12-2011

As directed by the District Administration, Puducherry, power supply was cut from 9.00 pm onwards as the squally wind speed gained its momentum every hour. Hectic time to the District Administration started from 11.00 pm onwards when multiple hundreds of phone calls were received from the Emergency Operation Centre (EOC) toll free number 1077. The received messages were communicated to the concern Task Manager of the ESF through the EWS. The telephone numbers and EWS of EOC, District Collectorate, Taluk Office remained ringing and busy.

Every line departments were in rounds up to 12.0 Mid night and slowly it was stopped as the squally wind increased its speed. Up to 1.30 am the Revenue Authorities were in assessment of the situation and there after took shelter in their respective Office. During the start of the wee hours we were able to visible tree tops being shredded by winds that roared like jet engines and water being forced under closed doors by the pressure.

The natural calamity was at its peak from 4.30 am onwards when the Squally wind blow from North to South gained its maximum speed, which Puducherry has never experienced in the recent past. Storm surge estimated to have reached 1 m destroyed several structures along the coast and pushed up to 100 m inland in certain coastal areas. The storm carried even the fishermen Fully Mechanised Steel boats vessels weighing more than 15 tonnes into the land for an height of 1 metre from the water level.

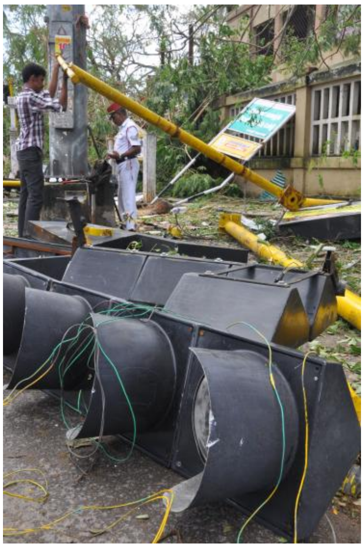
Continuous downpourring with gale wind speed of approximately 120 km/h caused jet engine noise and able to witness vinyl plastic sign boards of firms and establishments flying for more than 20 feet height. Water tanks got detached and fell on the roadside. Catastrophic damage started when there was a three minute wind speed felt as more than 140 km/h during early morning hours when the Squally wind started blowing from South to North direction, which uprooted the trees, electric poles, road signals, huts, kutcha houses, cell phone towers.

Rescue & Relief Operation

Heavy rainfall which lashed Puducherry measuring 150 mm. hampered the rescue operation in initial period. The ESF dealing the Rescue operation were unable to reach most of the most affected villages. In fact, there was no communication available. Cell Phones remained without battery, most of the telephone lines mal functioned and certain numbers of Cell Towers also had fallen down. There was only uprooted trees in every road. 8 human casualties were reported. Heavy damages to public and private properties were reported. Fishermen and Agriculture fields were worst affected.

Damages

More than 80,000 of houses were damaged. About 17,000 Ha. Of agriculture fields fully damaged by the Cyclone. All the poultry farms fully damaged with report of death of more than 250 domestic animals. Multiple hundreds of FRB boats fully damaged. 182 Ha. Of inland fish farms severely damaged. Multiple hundreds of transformers & electric poles, solar plants, bio plants fully uprooted and damaged. Cyclone also left trail destruction in the road sector damaging culverts and bunds. Schools & colleges, sports complex were damaged. Many no. of industries, Old & New Port, tourism interested places, botanical gardens, social forest were all uprooted.



Restoration of normalcy

The Administration took stern effort in mitigating the trail destruction of Cyclone Thane. Fire Services, PWD, LAD, Police, Revenue played a vital role. Besides force from NDRF, Arakonam aided in restoring the normalcy. Power Chain Saw machines were used to cut the trees and with heavy machines the same were kept aside of the road in a record time giving access to artillery routes especially to Hospitals and all Emergency services. There was a huge demand for cutting machines, as all such materials sold within hours of opening of the shop.

Initially affected people were of the view it was their village was worst affected. When slowly power normalcy restored people realised the fact that it was the entire nature and beauty of Puducherry destructed by the cyclone. Commendable services were rendered by the Community itself, without expecting the Administration to clean-up the area, it was the community to first start in cleaning operation.

As there was acute shortage of water most of the pumphouses were operated through Generator Sets. Immediate supply of Kerosene was extended to the affected people along with cash dole of Rs.2,000/- per Ration Card. Supply of food packets continued to the evacuees as well as to the affected peoples. It remained a Himalayan task to the Power Sector in providing power supply. With sparing of huge number of manpower the power was restored within 1 day in the City limit and within 3 days in the rural areas. The State Government has already announced the relief assistance to all the affected sectors.

lessons from thane cyclone

Thane Cyclone has taught many lessons and given experience to us. NO POWER ON THIS EARTH CAN STOP THE NATURE is once again proved. According to me we were not much prepared to face the cyclone. How it could be? In the recent past multiple number of cyclone has crossed across the world with squally wind speed more than Thane Cyclone. To quote an example is the recent Cyclone Yasi which crossed Queensland in Australia.

On the other hand, IMD has predicted the Squally Wind speed as 120 to 140 km/h during crossing of cyclone. With this information the Disaster could have been managed even better. We kept on informing to the general public only about the status and position of the cyclone from 26-12-2011 with few attentions in mitigating it.

At this juncture, I would like to quote how cyclone is managed in one of the under developed country Bangladesh. Cyclone is a routine phenomena in that country. Earlier there were multiple hundreds and thousands of death toll, but the same were in totally minimised. Even though the destruction cannot be averted, the same is minimised through meticulous management of disaster.

(a) Farmers are warned about the speed and directed to harvest their standing paddy or other cash crop prior to the day of the disaster. If this message is strongly sent to the farmers they could have harvested the paddy with permissible limit of moisture. Not only paddy other cash crops could have been managed in the same angle. Banyan plantation could have been harvested and thus the monetary loss could have been minimized.

(b) Fishermen are well in advance keep their boats in safe place and not in the seashore. They remove all engines and other materials from the boat including nets and other fishing connected things. But in Puducherry as was done in the past Fishermen tied their boats in the sea shore coconut trees. Resultant both the tree had fallen and the boats were fully damaged. If there were clear instruction to safeguard their boats definitely the number of boat damages could have been minimized.

(c) General public are well educated in about the Dos and DONTs. All the windows in the houses are kept intact and tight with tape avoiding shattering. But we did not passed clear instructions to the public to make their house intact. Remove all detachable items which cannot with stand heavy wind and many more.

(d) Clean drinking water is stored in sufficient quantity in advance and all.

(e) If this past history knowledge of cyclones is well known to us, in all the fields we could have been much prepared. Say for example, having known the fact that there will be power cut, people could have been instructed to fill their tank and be prepared to live without power supply.

(f) Fortunately, the cyclone crossed in the early morning hours, if it had crossed in the morning hours, there may be huge number of casualties, since despite the instruction public are interested in watching the cyclone from outside. The public should be educated in proper, describing the endanger if they are out of the safer shelters. Having known about the wind speed we should have stopped the bus service. When the cyclone was crossing there was a huge traffic jam in Cuddalore road, since busses were not able to ply. The entire traffic should have been banned and released after the crossing of cyclone. Hosting of Flag no.10 clearly reveals that there is going to be communication cut, which means there is likely chance of devastation.

Thus, instead of conveying and executing the routine style of preparedness, it should have been forecasted and took measures as narrated above. For example the impact of a cyclone of 150 km/h or could have been shown or taught to the public through video clippings of the past cyclone history. This visual knowledge might have help the public to understand the cyclone and be prepared accordingly. Obviously these measures could have at least reduce the impact of the cyclone to a major extent and let us hope in the near future we can do it and we can face the nature in a meticulous manner.

நூல் அறிமுகம்

“வானிலை அறிந்ததும் அறியாததும்”
அண்மையில் வெளியான வானிலையியல் தொடர்பான நூல்

ந. செல்வம்
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சென்ற ஆண்டு டிசம்பர் திங்கள் 24ஆம் நாள் நமது சென்னை மண்டல வானிலை ஆய்வு மையத்தில் பணிபுரியும் உதவி வானிலையாளர்இ திரு கு.வை. பாலசுப்பிரமணியன் அவர்கள் எழுதிய **‘வானிலை அறிந்ததும் அறியாததும்’** என்ற நூல் வெளியிடப்பட்டது. சென்னை மாநிலக் கல்லூரியில் நடந்த ஒரு விழாவில் சென்னை மண்டல வானிலை ஆய்வு மையத் தலை வர் முனைவர் Y.E.A இராஜ் அவர்கள் நூலை வெளியிட தமிழ்நாடு அறிவியல் தொழில்நுட்ப மைய செயல் இயக்குநர் முனைவர் ப . ஐயம்பெருமாள் முதல் பிரதியை பெற்றுக்கொண்டார்.

நூலின் முகப்பு மற்றும் இறுதி பக்கங்கள்

நூல் வெளியீட்டு விழா

இந்நூலில் அடங்கியுள்ள 31 கட்டுரைகளும் பல்வேறு இதழ்களில் முன்னரே வெளியானவை. காற்று, மேகங்கள், புயல், வடகிழக்குப் பருவமழை, ரடார், டாப்ளர் ரடார், செயற்கைக்கோள் ஆகியவை பற்றிய கட்டுரைகளுடன் வானிலை ஆய்வு வளர்ந்த கதை , வரைபடங்களின் வரலாறு, காலக்கணிதம் அறிவோம், காலநிலை நோக்கில் ஞாலம் , சுனாமி மற்று ம் உலக நீர் நாள் பற்றிய கட்டுரைகள் இந்த நூலில் இடம்பெற்றுள்ளன. வானிலை மற்றும் காலநிலை பற்றிய செய்திகளை சுவையான முறையில் எழுதப்பட்ட இந்நூல் அனைவராலும் படித்துப் பயன்பெறத்தக்கது.

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