Monitoring of Cyclone “THANE” Using Remote Sensing Technology

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Abstract - In this paper, study of Cyclone THANE, formed in the North Indian Ocean in December, 2011, has been conducted through remote sensing technology. The formation, duration and evolution of the cyclone was monitored at SPARRSO ground station mainly using the hourly basis data obtained from MTSAT-1 and FY-2D/E Geo-stationary satellites. The imageries were analyzed using Vimsat, Gmsoft and Dvorak’s algorithm to find out the location, intensification and to observe the movement of the cyclone which is necessary for early warning and preparedness. The analysis showed that cyclone THANE was formed as a low on December 25. It was moving northwesterly at the early stage and then westward very slowly following a zigzag path. It was intensified gradually at the forming stage and rapidly afterwards. The pick was found on December 29, 2011. THANE then weakened slightly and made landfall on December 30 at early morning on South Indian coast battering the area with heavy rain and strong winds.

Index Terms – Early warning. Intensification, Monitored, Remote sensing

1. Introduction:

Cyclones are usually formed in the deep seas and hence their study has been very difficult. It is only with the advent of the Space age that weather satellites have provided valuable information about them [1]. Meteorological satellites are the main sources of information which allow monitoring the formation, development and movement of tropical cyclones. D’Vorak (1975, 1985) suggested the methodology of tropical cyclone analysis, The analysis provide Tropical cyclone intensity number called T-number and the maximum sustained wind speed of the cyclone [2] as well as the pressure around it.

Bangladesh is one of the most disastrous country in the world. Among them, cyclone is the most common and destructive one. It is a tropical storm or atmospheric turbulence involving circular motion of winds, occurs in Bangladesh almost every year [1]. Some of them are turned into severe up to super cyclones. It usually occurs during pre-monsoon period (March – May) and during post-monsoon (Oct-Nov).

Cyclones cause damage to crops that reduces the rice production. Every year it losses lives and properties which hampers the sustainable development of the country. None can stop but can mitigate the losses due to them adapting the preparedness timely. Early warning is very essential for that and thus Space Technology/Remote Sensing plays an important role in this regard. SPARRSO monitors all depressions, cyclones formed in the Bay of Bengal and North Indian Ocean regularly since 1980 using Remote Sensing & GIS and disseminate early warning on time to help the disaster management and preparedness program of the Govt. for saving lives and properties towards the sustainable development of the country.

Cyclone ‘THANE’ named by Barma was the strongest tropical cyclone of 2011 formed at the end of that year. Initially it was developed in the North Indian Ocean as a low and gradually intensified into a very severe cyclonic storm. We, the scientists of SPARRSO made continuous observation on it. We processed and analyzed the images received at SPARRSO ground station from latest Geo Stationary
satellites FY-2D/E & MTSAT-1 to monitor the cloud system, the formation and evolution of cyclone THANE on real time basis. This was conducted in order to identify the nature and track of cyclone and to find out the necessary information regarding early warning and preparedness as well as for this study.

2. Objectives:

The objective of the study can be summarized as follows:
To monitor the formation and evolution of cloud systems in order to identify and track of the cyclone formed in the North Indian Ocean; to find out the intensity of the cyclone; to study its movement and behavior, to provide early warning that would useful for disaster management and preparedness program of the Govt. towards sustainable development.

3. Data Used:

This study was conducted mainly using the remotely sensed data obtained from Geostationary Satellites received at SPARRSO Ground station. The hourly data of FY-2D/E and MTSAT-1 satellites were used to monitor the cyclone and the full disk MTSAT-1 data were used to extract its different parameters. Data from Special Bulletin for cyclones provided by Bangladesh Meteorological Dept. and information from website were used to validate the space based data received at SPARRSO ground station.

4. Methodology:

The methodology of the study included Remote Sensing Technique and D’Vorak method. We processed and analyzed the images received from the FY-2 & MTSAT-1 satellites at SPARRSO Ground station in every hour. Data received from MTSAT-1 were made contrast of Channel 2 and 4 with the help of its module/software for analysis. The satellite images of FY-2D/E and MTSAT-1 were enhanced to identify clearly the cloud system, its coverage and cloud dense overcast (CDO) to find out the center of cyclone. The location of cyclone center and its distances from important places were extracted using the existing software (Vimsat and Gmsoft) installed with FY-2D/E ground station at SPARRSO. The Full Disk data of MTSAT-1 and D’Vorak method were used to find out the intensity (T-number) of the cyclone, pressure and the corresponding maximum sustained wind speed around the cyclone center.

5. Case Study of cyclone THANE:

Cyclone “THANE” was initially formed in the last week of December, 2011. It was formed in the north Indian Ocean as a tropical disturbance within monsoon trough at the west of Indonesia. Over the next couple of days it gradually developed into a Depression during 25 December’2011 and was moving towards northwesterly. The cloud coverage was spread almost over the whole Bay.

The depression then started to turn towards the west under the influence of a subtropical ridge of high pressure before its further development. It was turned into a deep depression on 26 December over almost the same area. The pressure was found 997 hpa and the intensity of the cyclone (T-number) was found T2.5 extracted using D’Vorak method. It was located at Lat 9.5 N and long 87.0 E on the same day (Fig-1) at 08:31 BDT (GMT +6). The wind speed corresponding to T-number was found 63 km/hr.

The deep depression was intensified further and turned into a cyclonic storm named “THANE” with pressure 994 hpa and T3.0 during the rest of the day. The corresponding wind speed was observed as 81 km/hr. Bangladesh Meteorological Department (BMD) also recorded the maximum sustained wind speed almost same. The sea became rough.
It then started moving towards west under the influence of subtropical ridge of high pressure before its further development. It was slowed down during December 27 (Fig-2), as a strong outflow and marginally favorable sea surface temperature fought with persistent vertical wind shear.

THANE was intensifying further more and more over the ocean and started moving slightly in west – northwest direction. It was then intensified into a severe cyclonic storm on December 28 and located at Lat 12.5 N and Lon 85.0 E at 09:01 BDT (Fig-3).

The center of THANE was at Lat 12.2 N and Long 83.9 E at 16:30 BDT (Fig-4) on the same day. The intensity was estimated as T4.0 and the maximum wind speed corresponding to T-number was around 117km/hr. The sea became very rough.
The cyclone then started moving towards westward and gradually intensified into a very severe cyclonic storm at early morning of December 29. The center of the cyclone was located at Lat 12.5 N and Long 82.3 E at 07:31 BDT (Fig-5).

The intensity of the cyclone was then reached the strength of T4.5 with pressure 973 hpa. Corresponding maximum wind speed was then found about 139 km/hr and above. The periphery of the cyclone touched the Indian coast during the same day. The Cyclonic storm THANE was weakened a little while started to interact with land(Fig-6).

Cyclone THANE then made landfall on the South Indian coast near Chennai/Tamil Nadu and Andhra Pradesh on December 30, 2011 early morning at 05:30 (Fig-7). At this time the intensity of the cyclone was slightly decreased and quasi-steady between T3.5-T4.0. It became weaker after making landfall and battering the area with heavy rain and strong winds.
The Track of the cyclone THANE has drawn using the Gmsoft of FY-2D to study the movement of the cyclone and has shown in Fig-8. The T-number, maximum wind speed and the pressure observed were recorded in Table-1 and plotted (Fig-9, 10, 11) to study the intensity and behavior of cyclone THANE.

Table -1: Data for Cyclone THANE extracted from SPARRSO ground station

<table>
<thead>
<tr>
<th>Date</th>
<th>Time in BDT (GMT+6) hr</th>
<th>Location</th>
<th>Intensity T-number observed from D’vorak method</th>
<th>Corresponding Max wind speed V-max (km./h)</th>
<th>Max wind speed observed (km/h)</th>
<th>Pressure (hpa)</th>
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<tr>
<td>25.12.11</td>
<td>08:31</td>
<td>9.2</td>
<td>87.3</td>
<td>1.5</td>
<td>49</td>
<td>1003</td>
</tr>
<tr>
<td>26.11.11</td>
<td>08:31</td>
<td>9.5</td>
<td>87.0</td>
<td>2.5</td>
<td>63</td>
<td>997</td>
</tr>
<tr>
<td>26.12.11</td>
<td>12:31</td>
<td>10.5</td>
<td>86.7</td>
<td>3.0</td>
<td>81</td>
<td>994</td>
</tr>
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<td>27.12.11</td>
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<td>86.2</td>
<td>3.0</td>
<td>81</td>
<td>991</td>
</tr>
<tr>
<td>27.12.11</td>
<td>18:31</td>
<td>12.0</td>
<td>85.9</td>
<td>3.5</td>
<td>99</td>
<td>983</td>
</tr>
<tr>
<td>28.12.11</td>
<td>09:01</td>
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<td>85.9</td>
<td>4.0</td>
<td>117</td>
<td>979</td>
</tr>
<tr>
<td>28.12.11</td>
<td>16:30</td>
<td>12.2</td>
<td>83.9</td>
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<td>117</td>
<td>981</td>
</tr>
</tbody>
</table>

Plot of T-number, wind speed and pressure drop
6. Results and Discussions

Cyclone THANE was developed as a tropical disturbance initially. Convection surrounding the system of the cyclone had started to consolidate over a weak low level circulation center that was being fed by an enhanced westerly flow associated with the precursor system to a tropical cyclone [5]. It was gradually developed into a Depression on 25 December’2011 and intensified into a very severe cyclonic storm afterwards. The system continued to move westwards and weakened slightly when started to interact with land. Very Severe Cyclone THANE then pummeled the southern Indian coast on December 30’2011 at the early morning [6]. After it had made landfall, frictional forces made THANE rapidly weaken into a depression [5].

We have studied the track of cyclone which is shown in Fig-8. We have correlated our data observed from SPARRSO ground station with the data observed by BMD, specially the center of cyclone and its distance from important places which were found very closer. Maximum sustained wind speed observed by BMD with the max wind speed corresponding to T-number was almost matched. We have seen from the study that the cyclone moved following a zigzag path and the pick of the cyclone intensity was observed as T-number 4.5 on December 29. The corresponding maximum sustained wind speed was found as 139km/h and lowest pressure was found as 973 hpa at the mature stage. It was also found that the cyclone intensity is directly proportional to wind speed and inversely proportional to pressure around it.

7. Conclusion:

Cyclone THANE crossed the coast on December 30, 2011 and made landfall near Tamil Nadu and Androprodesh of India causing thousands of people to flee from their homes and left an immense trial of destruction all along the coast [7]. The Maximum wind speed was about 139 km/h. This made the
wave propagated over 1.5m high above the sea shore leaving in its wake 35 deaths besides untold devastation [8]. Timely preparedness is necessary to reduce the losses due to any disaster/cyclone. Space technology contributes a lot in this regard. The weather report and early warning we provide on time using space technology helps+ the Government and its organizations to take necessary steps and preparedness in the respective areas (pre and post disaster management program of the Government). This can save lives and properties towards sustainable development of the country.

8. References:

[5] From Wikipedia, the free Encyclopedia
[8] Officials said

Biographies of Author :

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First A. Author was born in Mymensingh District of Bangladesh on 31-01-1959. She has passed Master of Science (M.Sc) in the field of Physics from Dhaka University, in 1982 with 1st position in 1st class, in Dhaka city, Bangladesh.

She has joined Bangladesh Space Research & Remote Sensing Organization in 1985 as a Scientific Officer. She has been working mainly with meteorological disasters as well as crop monitoring using Remote Sensing Technology from the beginning. She is now working as a Principal Scientific Officer and especially involved with cyclone studies.

Three out of her publications are as follows:

ii) Begum,S. & M. Nessa - Application of Space Techniques in Disaster Monitoring , Assessment and Mitigation in Bangladesh “,- presented in the UN Regional Seminar on “Use of Space Technology for Disaster Management for Western Asia”, from (2-6)Oct.,2004, held in Riyadh ,Saudi Arabia .(proceedings)
She has done Research works on different meteorological disasters to find out their parameters and characters towards disaster management of the country. Some are listed below:

i) Temperature-Rainfall Relationship using remote sensing data.
ii) Monitoring and analysis of tornado and nor'westers using satellite data.
iii) Study on Devastating Tornado occurred in Lalmonirhat in 2002
v) Studied the characters of cyclone SIDR and its impacts on coastal areas of Bangladesh using NOAA-AVHRR &FY-2C Satellite data and RS/GIS Techniques.
vi) Impact of Rainfall on Flood 2008 in Bangladesh”, using In-situ Meteorological & conventional rainfall data and Remote Sensing Technology.

Some of her on going works are listed below:

i) Working as a Sr. scientist under the Project- “Expansion & Capacity Building of SPARRSO for Climate Change Research & Impact Study(CRAIST)”
ii) Estimation of Rainfall Based on Satellite Data and GNSS (Phase-1) as the annual research work

Membership:

i) Member of Bangladesh Physical Society
ii) Member of Biggyani o Biggyanjibi Samitee(Society for Scientists of Bangladesh)
iii) Member of “Complaint Committee” of Defense Ministry