Early Warning and Monitoring of Cyclone in Bangladesh Using Space Based Data and Technology

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Abstract: Cyclones occur in Bangladesh almost every year and lives and properties are lost. Early warning is necessary to mitigate the losses and thus monitoring of cyclones is very important. Meteorological satellites are the main sources of information which allow to monitor the cyclones with the help of computer facilities. Methodology suggested by D’Vorak was also very useful for analysis cyclone intensity called T-number, corresponding maximum sustained wind speed and pressure around it. Cyclone MOHASEN was initially formed as a low in the Bay near Andaman’s at the 2nd week of May 2013 and gradually intensified into Cyclonic storm afterwards. The formation, duration and movement were monitored by 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, speed, intensification, etc. of cyclone necessary for early warning and preparedness. MOHASEN was moving towards northwest direction at the primary stage very slowly and northwestward rapidly for the next couple of days. It was intensified gradually but not significantly. The pick intensity was found as T3.0. It made land fall on Bangladesh coast near Borguna-Potuakhali on May 16, 2013 at the morning with max sustained wind speed of 70-80 km/hr which made the wave propagated over 6 to 7 ft high. It was weakened after hit the land due to frictional force and battering the area with heavy rain and strong winds. In this paper, monitoring of cyclone “MOASEN” has been conducted through remote sensing technology.

Key word: Early warning, computer science, intensity, monitored, remote sensing technology.

1. Introduction

Bangladesh is one of the most disaster-prone nations in the world, having an approximate area of 147,570 sq.km bounded between 20°34’ to 26°38’N latitude and 88°01’ to 92°41’E longitude. Himalayas situates at its north and Bay of Bengal situates at its south. Due to funnel shape coast and the geographical location, the country frequently suffers from devastating natural disasters. Cyclones are the most common and destructive events among them [1]. It usually occurs during pre-monsoon period (Mar.-May) and post-monsoon (Oct.-Nov.). Some of them are turned into severe up to super cyclones [2, 3]. It is a tropical storm or tropical disturbance or atmospheric turbulence involving circular motion of winds [1]. It occurs in Bangladesh almost every year, and lives and properties are lost which hampers the sustainable development. Cyclones cause damage to crops that reduces the rice production. Man can not stop but can mitigate the losses due to them adapting the preparedness and safety timely. Early warning is very essential for that. Space technology/remote sensing plays an important role in this regard. SPARRSO monitors all natural calamities like depression, cyclone formed in the Bay of Bengal and North Indian Ocean regularly since 1980 using remote sensing & GIS as well as computer facilities to disseminate early warning on time. It helps the disaster management and
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preparedness program of the government, for saving lives and properties towards the sustainable development of the country.

Cyclone MOHASEN named by UN/ESCAP was the tropical cyclone of 2013 that hit Bangladesh. We the scientists of SPARRSO made continuous observation on it using remote sensing technology. The images received from SPARRSO ground station from latest Geo Stationary satellites FY-2D/E & MTSAT-1 were processed and analyzed to monitor the formation, cloud system, and evolution of cyclone on real time basis. The observation was conducted to identify the nature and track of cyclone in order 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: to study the movement and behavior, to identify and track the cyclone, to monitor the formation and evolution of cloud systems, to find out the intensity of the cyclone, to provide early warning that would be useful to help the disaster management and preparedness program of the country.

3. Data Used

Mainly space based remotely sensed data obtained from Geostationary Satellites were used in this study. The data of FY-2D/E and MTSAT-1 satellites received hourly basis at SPARRSO ground station was used to monitor the cyclone and the full disk MTSAT-1 data were used to extract its different parameters with the help computerized module. Information from website and data from special bulletin for cyclones provided by Bangladesh Meteorological Dept. was also used to validate the space based data received at SPARRSO ground station.

4. Methodology

Methodology included remote sensing technique and D’Vorak method to monitor the cyclone and provide early warning. We processed and analyzed the spaced based data received from FY-2 & MTSAT-1 satellites at SPARRSO ground station in every hour using computer science & facilities. 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 CDO (cloud dense overcast) 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. Analysis Procedure

Step 1. The analyst determines the intensity of a tropical cyclone by first locating the cloud system center and then by analyzing the storm cloud pattern in two different ways.

Step 2. The first intensity estimate is made in Step 2 by measuring the cloud features related to storm intensity. This is done when the cloud pattern being analyzed contains cloud features. When the measurement derived from Step 2 is clear cut giving an intensity estimate that falls within prescribed limits, it is used as the final intensity.

Step 3, which was passed over previously, is used when the cloud pattern exhibits a CCD (central cold cover). The appearance of this pattern type indicates that the storms development has been (or soon will be) arrested.

The cloud pattern descriptions used in the technique. The curved band pattern type is the primary developmental pattern type used in the technique. It is the most commonly observed pattern in both visible and IR pictures and is especially useful when low
resolution or unenhanced IR pictures are used. The pattern is observed when a storm is developing in an environment of average amounts of vertical shear and convection. For this pattern type, the storm intensity is determined from the extent to which a dense overcast cloud band encircles the storm center. At the minimal tropical storm stage, the band is observed to curve about halfway around the storm center. When the band has coiled completely around the storm center the hurricane stage has been attained if a required minimum length of time has elapsed during the coiling. Continued strengthening of the hurricane or typhoon results either in continued coiling of the curved band or the formation of a center or “eye” (cloud minimum) embedded in a dense overcast that appears central to the band curvature. When the eye is observed the intensity determination depends on the characteristics of the eye, the amount of dense overcast clouds surrounding it, and the amount of outer banding around these central features.

In some curved band patterns, the formation of a tightly curved “wall cloud” can also be used to tell when a disturbance has reached storm intensity. When visible, the wall cloud first appears at the concave edge of the curved band at the week tropical storm stage (T2.5). Most often it appears as a cloud minimum area of about 1° latitude in diameter with deep-layer convective clouds forming about half the distance around the area. A forming wall cloud is visible in the T2.5 pattern.

The CDO pattern is used in the analysis when a dense overcast cloud mass appears either over the curved cloud features that define the storm center or as a dense overcast surrounding the eye of the storm. The CDO can be thought of as a dense overcast mass of cloud that covers the most tightly curved inner coils of the curved band pattern. The CDO patterns are used only with visible pictures. In IR imagery, the thin cirrus clouds often appear cloud enough to obscure the boundaries of the CDO making its size larger than the size observed in visible imagery. When the CDO pattern is observed, it is the size of the dense cloud.

Occasionally the coiling occurs more rapidly than pressure falls are known to occur. When this happens, the rules of the technique hold back the classification until the minimum length of time passed. Mass that is used as a measure of intensity when no eye is observed. The size increases with increasing intensity. An eye usually becomes visible within the CDO before the T5 stage. When the CDO contains an eye, the distance the eye is embedded within the CDO is used in the intensity estimate. For cloud patterns containing CDO’s and for most patterns of hurricane intensity, it is often necessary to make two measurements. The first is a measure of the CF (central feature), such as the CDO size or the embedded distance of the eye. The second is a measure of the BF (banding feature), which is the amount of banding that coils around the central dense overcast. The banding features can be very important in the VIS analysis, adding as much as 2.5 T-numbers to the intensity estimate. The banding feature number increases with the amount of banding and the central feature number increases as the eye becomes more deeply embedded within the CDO. Another important factor in determining the T-number is the vertical depth of the clouds involved in the central and banding features. An estimation of the vertical depth is made subjectively when using visible pictures. Enhanced IR technique objective measures of the vertical depth (which are temperature measurements) of cloud features play the major role in the new method. When analysis rules are needed to adjust the intensity estimation, the equation for determining intensity can be written as

\[ T\text{-Number} = (CF + BF + Vert\ Depth) + Rules \]

6. Monitoring

A cyclone was formed in May 2013 in the Bay of Bengal initially as a low. It then developed day by day and turned into a depression on May 10 [4]. The depression over southeast Bay and adjoining area
moved slightly northward and intensified into a deep depression and was centered at lat 5.5 N and Long 920 E on same day [5, 6]. It was moving towards northwest direction very slowly under the influence of a subtropical ridge of high pressure before its further development [6]. The depression was turned into a deep depression almost over the same area on May 11, 2013 and intensified further into cyclonic storm MOHASEN afterwards. The center of the cyclone was at lat 10.4 N and Long 86.7 E on May 12 at 17:31 BDT (Fig. 1).

It was then located 1,215 km apart from Mongla port, 1,290km apart from Cox Bazar and 1,345 km apart from Chittagong port [5]. At that time, the intensity of the cyclone was observed as T1.5.

The monitoring was conducted every hourly. Within next couple of days, cyclone MOHASEN intensified further the pick was found on May 15 as T3.0. It changed its direction slightly towards north and north-west direction and started moving towards Bangladesh coast rapidly [4, 6, 7].

Continuous observation (Figs. 2-4) was made using the satellite data in SPARRSO Ground station to study the cyclone track and its behavior. MOHASEN then made landfall near Barguna-Potuakhali of Bangladesh coast battering the area with heavy rain and strong winds [6, 8].

It was observed that the cyclone became weak after hit the coastal area of Bangladesh due to frictional force associated [4, 6]. At that time the intensity of the cyclone was found as T3.0 and the corresponding max sustained wind speed was observed as 70-80 km/hr [4, 5, 8]. The track of cyclone is shown in Fig. 5.

7. Results

Data extracted from SPARRSO ground station for cyclone MOHASEN are listed in Tables 1-3.

8. Conclusions

Cyclone is a common meteorological disaster in Bangladesh. When such events occur water-borne
diseases and mass internal displacements are inevitable consequences. Large-scale disasters in such a small country can negate poverty-reduction efforts and divert development resources from more productive uses. The colossal losses of lives and properties caused by natural disasters with repeated frequency in short intervals make Bangladesh as one of the most disaster prone countries in the world and make barrier to its sustainable development. Space technology is used to monitor all cyclones formed in Bay of Bengal. Cyclone MOHASEN was monitored at SPARRSO Ground station on real time basis using space based data received from Geostationary Satellites and computer facilities. The data were processed and analyzed for necessary information for early warning. The computerized analysis showed that the cyclone was initially formed as a low in the Bay near Andaman’s at the 2nd week of May 2013 and gradually intensified into cyclonic storm MOHASEN afterwards. It was moving towards northwest direction at the primary stage very slowly and northwestward rapidly in developing stage [5, 6]. It was gradually intensified but not significantly. The pick was found on May 15, 2013. The intensity, i.e., the T number of the cyclone was then found as T3.0. The corresponding max sustained wind speed was then 70-80 km/hr [4, 8]. Cyclone MOHASEN then made landfall on Bangladesh coast near Borguna-Potuakhali on May 16, 2013 at the morning at 08:31 BDT. It became weaker after hit the land due to frictional force and battering the area with heavy rain and strong winds. It made the wave propagated over 6 to 7 ft high [6-8]. Timely preparedness is necessary to reduce the losses due to any disaster/cyclone. Space technology as well as computer science contribute a lot in this regard. The weather report and early warning we provide on time using space technology help 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. More study is needed to find out the cyclone path, the behavior of cyclone formed in Bay of Bengal and to characterize them.
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References


