



Country Report of Bangladesh On

EFFECTIVE TROPICAL CYCLONE WARNING IN BANGLADESH



Presented

At

**JMA/WMO WORKSHOP ON EFFECTIVE TROPICAL CYCLONE WARNING
IN SOUTHEAST ASIA**

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Summary

The peculiar geographic location and complex funneling shape of the Bangladesh coast have made the weather system complicated. It is the most disaster prone area in the world. The Lion numbers of cyclones formed in the Bay of Bengal initially move towards the west or northwest and recurved towards right due to the effect of the Coriolis force. The coastal geometry and bathymetric condition of Head Bay is very complex. 5% of the total Global tropical cyclone occurs over the Bay of Bengal which causes 80% of the Global casualties. Maximum number of Tropical Cyclone is observed in this region during Pre-monsoon (March – May) and Post-monsoon (October - November). Tropical cyclone is monitored from the formation stage till its landfall by using Satellite imageries from different satellite, NWP products from different centers.

1. Tropical Cyclone Monitoring, Analysis and Forecasting

1.1 Tropical Cyclone Monitoring

Storm Warning Centre (SWC) of Bangladesh Meteorological Department (BMD) is responsible for the issuance of warning for the tropical cyclone and all kinds of weather warnings and weather forecasts. During cyclone season, SWC, Dhaka keeps a very watchful eye on the development of any disturbance in the Bay of Bengal for issuing timely cyclone warning to minimize the loss of life and properties.

1.1.1 Tropical Cyclogenesis Monitoring

It is monitored from the formation stage till its landfall and forecast of the track is made by using Satellite imageries from different satellite, NWP products from different centers and information and products from RSMC, New Delhi. Modern technology has provided the means of early detection and constant tracking.

1.1.2 Tropical Depression (TD) Warnings

To issue warning messages for the following stages:-

- | | |
|------------------|------------------------------|
| a) Warning: | 24 hours in advance. |
| b) Danger: | Minimum 18 hours in advance. |
| c) Great Danger: | Minimum 10 hours in advance. |

1.1.3 Challenges, Needs and Improvement Plans

In the Storm Warning Center conventional methods are used for analyses and subjective forecast is made. So, forecasting depends on personal skills. However, the major decision is taken by the Director of BMD and /or the Deputy Director of SWC after consultation with the operational meteorologist. In SWC NWP models (NHM on PC-cluster and WRF on a PC) is run experimentally on routine basis. Training is needed to enhance skill of the forecasters on the NWP technique.

1.2 Tropical Cyclone Analysis

1.2.1 Parameters and Methods

Parameter	Time (UTC)	Methods	Other sources
Position, speed, central pressure, maximum sustainable wind.	Every Three hours or as required.	Satellite-based and non satellite-based methods used for analysis of respective parameters.	RSMC New Delhi, JTWC, ECMWF, JMA, KMA.

1.2.2 Challenges, Needs and Improvement Plans

Training is needed to enhance skill of the forecasters on the NWP technique.

1.3 Tropical Cyclone Forecasting

1.3.1 Parameter and Method

Parameter	Issuance Time (UTC)	Lead time (hours)	Methods
Track, central pressure, maximum sustainable wind and strong wind areas.	Every Three hours or as required.	As required.	The formation stage till its landfall and forecast of the track is made by using Satellite imageries from different satellite, NWP products from different centers and information and products from RSMC, New Delhi. Modern technology has provided the means of early detection and constant tracking.

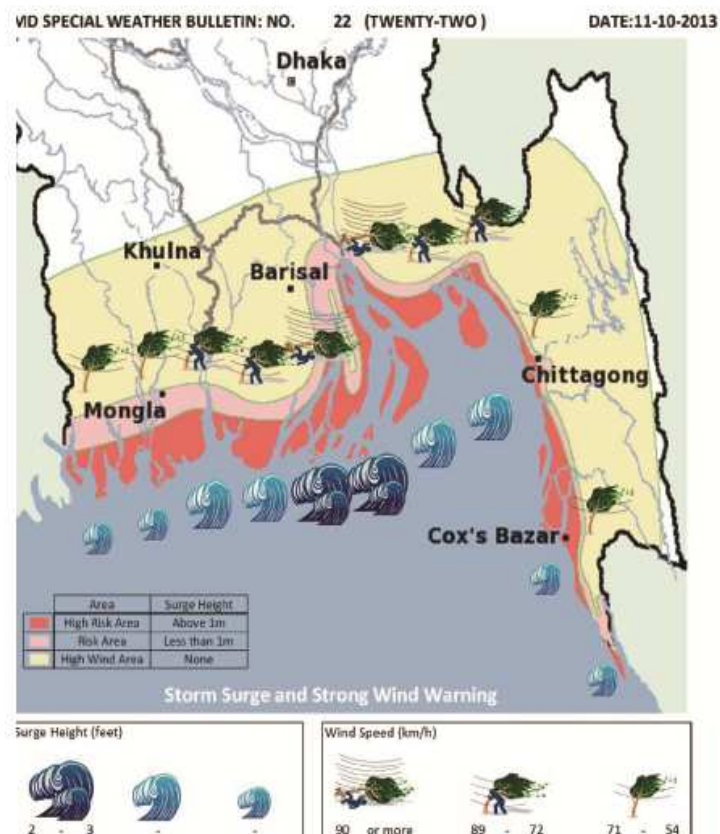
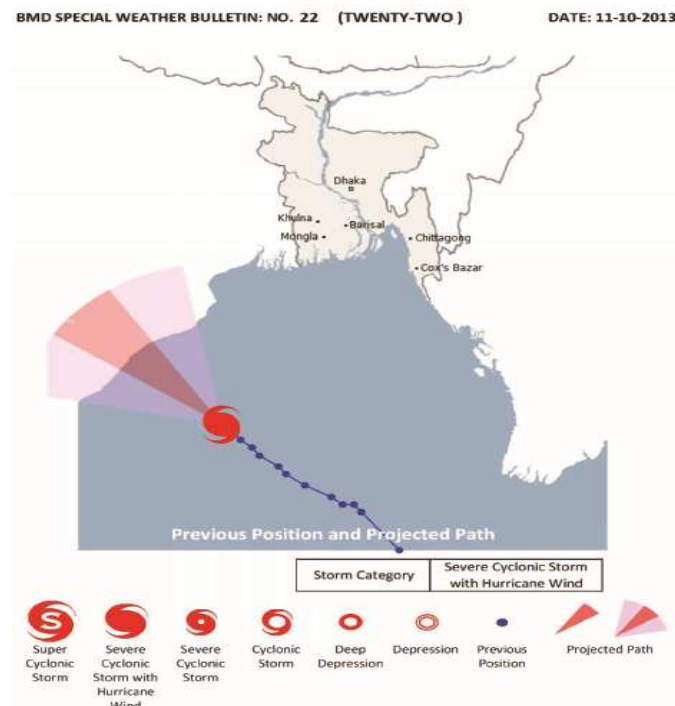
1.3.2 Challenges, Needs and Improvement Plans

Analysis system in BMD is mainly conventional. Advance NWP techniques (guidance and ensemble) are needed to be introduced in BMD. Advance Dvorak Technique (ADT) also needs to introduce in BMD.

1.4 Tropical Cyclone Products

1.4.1 TC Products

Special Weather Bulletins including Observed and projected path of the cyclone, strong wind zone and surge height.



1.4.2 Challenges, Needs and Improvement Plans

For the preparation of Cyclone products the main challenge is the preparation of easy understandable products/graphics for end users and dissemination.

Training needed for the preparation of easy understandable products/graphics.

BMD already has a plan to improve cyclone products/graphics. To do that a GIS unit is working.

1.5 Computing Platform (including software)

To run WRF, NHM, IIT_D storm surge model and MRI storm surge and MRI wave model LINUX is being using. For Satellite imagery analysis SATAID software is using. Statistical software R and ArcInfo are using for preparation of different products and graphics.

2 Numerical Weather Prediction Status for Effective Warning

At present WRF model is running in BMD since July 2010 experimentally for 72 hours in a small domain and low resolution (20 Km). NHM model is running in BMD since July 2011 under JICA project. It is also in a small domain and low resolution (20 Km). After well tested and simulated for different cyclones with different parameter IIT-D Storm Surge Model is operationally using in BMD. MRI Storm Surge Model and MRI Wave model are also running experimentally in BMD. All models are using for day to day weather forecasting and Effective Warning purpose.

2.1 NWP in Operational Use

Model	Domain (square degree)	Resolution (horizontal & vertical)	Initial Time	Forecast Range (hours)	Run by (own/foreign centers)
WRF	16.5X16.5	20 Km, 28 levels	00 UTC	72 Hours	BMD
NHM	30X19	20 Km, 40 levels	00 UTC	72 Hours	BMD

2.2 Application Techniques of NWP Products for Operational Forecasts

At present different products from WRF and NHM are using for short range weather forecasting. Along with that ECMWF model products and model products from JMA (GSM) also using for short range weather forecasting. Validation of models are going on but guidance are not using till now.

2.3 Challenges, Needs and Improvement Plans

Training is needed to enhance skill of the forecasters on the NWP technique.

3. Storm Surge

1) Storm Surge Information

a. Issuing√ b. not issuing

(For those who answered “b.” in 1))

a. No use (inland / no storm surge) b. No forecast are available

c. Other ()

3) How the information is issued?

- a. Independent storm surge information b. Included in TC information✓
c. Other ()

Simulated surge for cyclonic storm Sidr'2007 Maximum value of peak surge = 5.56 m



Model	Domain and resolution	Forecast Range (hours)	Frequency	Considered factors (Tide/ensemble/inundation, etc.)
IIT-D	18.0°N to 23.0°N latitude and 83.5°E to 94.5°E longitude (Head Bay)	As required	As required	If a cyclonic storm of moderate to severe intensity hits Bangladesh coast at night during high tide time, there is colossal damage of life and properties. Aftermath of a storm is more dangerous.
MRI	Bay of Bengal area	36 Hours	As required	Astronomical tide

6) In case your Service issue storm surge forecast without your own model, please briefly explain the operational procedure.

4. Effective Warnings

4.1 Emergency Response for TC Disasters

4.1.1 Legal Framework for TC Disaster Management

The Disaster Management Act creates the legislative framework under which disaster risk reduction and emergency response management is undertaken in Bangladesh, and the legal basis from which activities and actions are managed. It also creates mandatory obligations and responsibilities on Ministries, committees and appointments.

4.1.2 Emergency Response Mechanism

An Emergency Operation Centre (EOC) at national level is an important prerequisite for effective and coordinated response to any disastrous emergency. For this a National Emergency Operation Centre (NEOC) has been setup at Disaster Management and Relief Division of Bangladesh Secretariat in Bangladesh which would operate 24x7 hours to manage information, resources and activities. It has provided with human resources, equipment and methodologies including coordination, information and telecommunication technology facilities. The Standing Order on Disaster provides that an NEOC is to provide secretarial support to the National Disaster Response Coordination Group (NDRCG). For the purpose of better communication, it is decided to use the National Disaster Response Coordination Centre (NDRCC) to be equivalent to the NEOC.

4.1.3 Organs Responsible for Warnings and Evacuation Orders

Severe Weather Phenomena	Organs responsible for Warnings	Organs responsible for Evacuation Orders
Tropical Cyclone	BMD	DDM
Heavy Rain	BMD	DDM
Strong Wind	BMD	DDM
River Flood	FFWC	DDM
Storm Surge	BMD	DDM

4.2 Warnings/Advisories for Severe Weather Phenomena

4.2.1 Tropical Cyclone

Warnings/Advisories and corresponding emergency responses	Special Weather Bulletin. BMD is issuing warnings/advisories for severe weather associated with cyclone including condition of ocean state.
Potential Disaster Risks	The strong winds, heavy rains and storm surges associated with tropical cyclones are the factors that eventually lead to loss of life and property.
Target (warning areas)	Coastal area of Bangladesh.
Meteorological variables/indices used for criteria/thresholds for warnings/advisories	Pressure drop, Radius of maximum wind, maximum sustained wind and astronomical tide. T-number for Cyclone intensity.
Criteria/Thresholds	There are four stages are as follows:- 1. Alert stage (Signal Nos. I, II & III) 2. Warning Stage (Signal No. IV) 3. Disaster Stage (Signal Nos. V, VI, VII & VIII, IX, X) 4. Post Disaster Stage (immediately after the cyclone till normalcy is attained).
Contents of Warning/Advisory Message	Position and intensity of Cyclone, Distance from the coast, Past movement and expected future movement Ocean state. Information about Wind, Storm surge, inundation and Heavy rainfall. Advisories for fishermen.
Sample Warning/Advisory Message	<p>SPECIAL WEATHER BULLETIN: SL. NO. 26 (TWENTY SIX), Date: 12-10-2013</p> <p>THE VERY SEVERE CYCLONIC STORM "PHAILIN" OVER WESTCENTRAL BAY AND ADJOINING NORTHWEST BAY MOVED SLIGHTLY NORTHWESTWARDS OVER THE SAME AREA AND WAS CENTRED AT 06 PM TODAY (THE 12 OCTOBER 2013) ABOUT 855 KMS WEST-SOUTHWEST OF CHITTAGONG PORT, 830 KMS WEST-SOUTHWEST OF COX'S BAZAR PORT AND 645 KMS WEST-SOUTHWEST OF MONGLA PORT (NEAR LAT 19.00N AND LONG 84.80 E). THE VERY SEVERE CYCLONIC STORM STARTED CROSSING ORISSA COAST OF INDIA SOUTH OF PURI NEAR GOPALPUR AND MAY COMPLETE CROSSING THE COAST DURING NEXT 3-4 HOURS. MAXIMUM SUSTAINED WIND SPEED WITHIN 74 KMS OF THE STORM CENTRE IS ABOUT 200 KPH RISING TO 220 KPH IN GUSTS/ SQUALLS. SEA WILL REMAIN VERY ROUGH.</p> <p>UNDER THE PERIPHERIAL INFLUENCE OF THE VERY SEVERE CYCLONIC STORM, DEEP CONVECTION IS TAKING PLACE OVER NORTH BAY. GUSTY/SQUALLY WIND MAY AFFECT NORTH BAY, THE COASTAL REGIONS AND MARITIME PORTS OF BANGLADESH.</p> <p>MARITIME PORTS OF CHITTAGONG, COX'S BAZAR AND MONGLA HAVE BEEN ADVISED TO KEEP HOISTED LOCAL CAUTIONARY SIGNAL NUMBER 03 (THREE) (R) 03 (THREE).</p>

4.2.2 Heavy Rain

Warnings/Advisories and corresponding emergency responses	Heavy Rainfall Warning (including in Special Weather Bulletin).								
Potential Disaster Risks	Coastal flood and Land slide.								
Target (warning areas)	Coastal area of Bangladesh including other vulnerable area.								
Meteorological variables/indices used for criteria/thresholds for warnings/advisories	Intensity of the cyclone and also season take in consideration.								
Criteria/Thresholds	<table> <tr> <th><u>Amount of Rainfall</u></th><th><u>Rainfall Intensity</u></th></tr> <tr> <td>22 - 44 mm</td><td>Moderately Heavy</td></tr> <tr> <td>45 - 88 mm</td><td>Heavy</td></tr> <tr> <td>89 mm or more</td><td>Very Heavy</td></tr> </table>	<u>Amount of Rainfall</u>	<u>Rainfall Intensity</u>	22 - 44 mm	Moderately Heavy	45 - 88 mm	Heavy	89 mm or more	Very Heavy
<u>Amount of Rainfall</u>	<u>Rainfall Intensity</u>								
22 - 44 mm	Moderately Heavy								
45 - 88 mm	Heavy								
89 mm or more	Very Heavy								
Contents of Warning/Advisory Message	Same as special Weather Bulletin.								
Sample Warning/Advisory Message	By NWP product.								

4.2.3 Strong Wind

Warnings/Advisories and corresponding emergency responses	Special Weather Bulletin and corresponding emergency responses by Disaster Management and Relief Division of Bangladesh Secretariat.	
Potential Disaster Risks	There is colossal damage of life, houses and properties.	
Target (warning areas)	Coastal area of Bangladesh including other vulnerable area.	
Meteorological variables/indices used for criteria/thresholds for warnings/advisories	<u>Category Speed</u>	<u>Associated Wind (kms/hour)</u>
	i) Low	17 - 30
	ii) Well Marked Low	31 - 40
	iii) Depression	41 - 50
	iv) Deep Depression	51 - 61
	v) Cyclonic Storm	62 - 88
	vi) Severe Cyclonic Storm	89 - 117
	vii) Severe Cyclonic Storm with a Core of Hurricane Wind	118 - 219
	viii) Super Cyclone	>= 220

Criteria/Thresholds	As above.
Contents of Warning/Advisory Message	Wind speed.
Sample Warning/Advisory Message	<p>SPECIAL WEATHER BULLETIN: SL. NO. 13 (THIRTEEN), Date: 13-05-2013</p> <p>THE CYCLONIC STORM "MAHASSEN" (WITH ECP 998 HPA) OVER SOUTHEAST BAY AND ADJOINING SOUTHWESTBAY MOVED SLIGHTLY NORTHWARDS OVER THE SAME AREA AND WAS CENTRED AT 06 PM TODAY (THE 13 MAY 2013) ABOUT 1285 KMS SOUTH SOUTHWEST OF CHITTAGONG PORT, 1210 KMS SOUTH SOUTHWEST OF COX'S BAZAR PORT AND 1195 KMS SOUTH SOUTHWEST OF MONGLA PORT (NEAR LAT 12.00 N AND LONG 86.50 E). IT IS LIKELY TO INTENSIFY FURTHER AND MOVE IN A NORTHERLY DIRECTION.</p> <p>MAXIMUM SUSTAINED WIND SPEED WITHIN 54 KMS OF THE STORM CENTRE IS ABOUT 62 KPH RISING TO 88 KPH IN GUSTS/ SQUALLS. SEA WILL REMAIN VERY ROUGH NEAR THE STORM CENTRE.</p> <p>MARITIME PORTS OF CHITTAGONG, COX'S BAZAR AND MONGLA HAVE BEEN ADVISED TO KEEP HOISTED LOCAL WARNING SIGNAL NUMBER FOUR (R) FOUR.</p> <p>ALL FISHING BOATS, TRAWLERS AND MARINE VESSELS OVER NORTH BAY AND DEEP SEA HAVE BEEN ADVISED TO COME CLOSE TO THE COAST AND REMAIN NEAR THE COAST SO THAT THEY CAN TAKE SHELTER WITHIN SHORT NOTICE.</p>

4.2.4 River Flood **(BMD not responsible for River Flood.)**

Warnings/Advisories and corresponding emergency responses	<i>[Please list warnings/advisories issued for river floods and corresponding emergency responses by relevant authorities and residents.]</i>
Potential Disaster Risks	<i>[Please describe potential disaster risks when the respective warnings/advisories listed above are issued.]</i>
Target (warning areas)	<i>[Please specify unit of warning areas (e.g. prefectural government).]</i>
Meteorological variables/indices used for criteria/thresholds for warnings/advisories	<i>[Please describe meteorological variables/indices used for criteria/thresholds for warnings/advisories.]</i>
Criteria/Thresholds	<i>[Please describe how the above criteria/thresholds for warnings/advisories are determined.]</i>
Contents of Warning/Advisory Message	<i>[Please describe contents of warning/advisory message for river floods.]</i>
Sample Warning/Advisory Message	<i>[Please provide a sample warning/advisory message for river floods.]</i>

4.2.5 Storm Surge

Warnings/Advisories and corresponding emergency responses	Special Weather Bulletin and corresponding emergency responses by Disaster Management and Relief Division of Bangladesh Secretariat.
Potential Disaster Risks	Storm surge is the single major cause of devastation from tropical storms. Though, the deaths and destruction are caused directly by the winds in a tropical cyclone as mentioned above, these winds also lead to massive piling of sea water in the form of storm surge that lead to sudden inundation and flooding of coastal regions. The sand and gravel carried by the moving currents at the bottom of the surge can cause sand papering action of the foundations. The huge volume of water can cause such pressure difference that the house "floats" and once the house is lifted from the foundations, water enters the structure that eventually collapses.
Target (warning areas)	Coastal area of Bangladesh.
Meteorological variables/indices used for criteria/thresholds for warnings/advisories	Pressure drop, Radius of maximum wind, maximum sustained wind and astronomical tide.
Criteria/Thresholds	Inundated coastal area by Storm Surge.
Contents of Warning/Advisory Message	Expected surge height above astronomical tide and affected area.
Sample Warning/Advisory Message	<p><i>SPECIAL WEATHER BULLETIN: SL. NO. 28 (Twenty eight) Date: 15-05-2013</i></p> <p>The cyclonic storm "MAHASEN" (with ECP 990 HPA) over west central bay and adjoining north bay moved slightly north-northeastwards and now lies over north bay and adjoining west central bay was centred at 09 pm today. Under the influence of the storm the low-lying areas of the coastal districts of Cox's Bazar, Chittagong, Noakhali, Laxmipur, Feni, Chandpur, Borguna, Bhola, Patuakhali, Barisal, Pirozpur, Jhalokathi, Bagherhat, Khulna, Satkhira and their offshore islands and chars are likely to be inundated by storm surge of 8-10 feet height above normal astronomical tide.</p> <p>MARITIME PORTS OF CHITTAGONG AND COX'S BAZAR HAVE BEEN ADVISED TO KEEP HOISTED DANGER SIGNAL NUMBER SEVEN (7) SEVEN.</p> <p>THE COASTAL DISTRICTS OF COX'S BAZAR, CHITTAGONG, NOAKHALI, LAXMIPUR, FENI, CHANDPUR, BHOLA, BORGUNA, PATUAKHALI, BARISAL AND THEIR OFFSHORE ISLANDS AND CHARS WILL COME UNDER DANGER SIGNAL NUMBER SEVEN (7) SEVEN.</p> <p>MARITIME PORT OF MONGLA HAS BEEN ADVISED TO KEEP HOISTED DANGER SIGNAL NUMBER FIVE (5) FIVE.</p> <p>THE COASTAL DISTRICTS OF PIROZPUR, JHALOKATHI, BAGHERHAT, KHULNA, SATKHIRA AND THEIR OFFSHORE ISLANDS AND CHARS WILL COME UNDER DANGER SIGNAL NUMBER FIVE (5) FIVE.</p> <p>Under the influence of the storm the low-lying areas of the coastal districts of Cox's Bazar, Chittagong, Noakhali.</p>

4.3 Supporting Meteorological Information for Warning/Advisory Messages

Name of Information	Potential Disaster Risks	Target (areas)	Issuance (update) Time	Contents
<i>[Please describe name of information.]</i>	<i>[Please describe potential disaster risks when the this information is issued.]</i>	<i>[Please specify unit of target areas (e.g. prefectural government).]</i>	<i>[Please describe timing of issuance of this information.]</i>	<i>[Please describe contents of this information.]</i>

4.4 Institutional Coordination

4.4.1 Coordination with Disaster Management Authorities

BMD is the only authorized Government agency for all Meteorological activities in the country. Tropical cyclone, storm surge and other Meteorological hazard warnings are also issued by BMD for disaster management.

	<u>Signal</u>	<u>Wind Speed (Km/h)</u>
Warning Coordination	1. Cautionary Signal No. II	20 - 40
	2. Warning Signal No. IV	41 - 61
	3. Danger Signal No. VI	62 - 87
	4. Great Danger Signal No. VIII	88 - 117
	5. Great Danger Signal No. IX	118 - 170
	6. Great Danger Signal No. X	≥ 171
Needs from Disaster Management Authorities	It is hereby noted that the new proposed signal system is under active consideration of the Government. It may be put into practice after inculcating people (particularly coastal people) which may take few years even after the approval of the Government.	

4.4.2 Partnership and Coordination with Media

From Bangladesh Meteorological Department all Tropical Cyclones messages through FAX to Bangladesh Betar (Radio) and Bangladesh Television (BTV) to broadcast and telecast respectively from all stations. In this way BMD coordinate with media on a routine basis and in the case of emergency.

Warning Coordination	There are regular briefing during cyclone by the head of the department or by responsible officer.
Needs from Media	Needs to know terminologies and basics of meteorology.

4.5 Challenges (and Future Plan)

Training is needed to enhance skill of the forecasters on the NWP technique and for the preparation of easy understandable products/graphics. Advance Dvorak Technique (ADT) is also needed to be introduced in BMD.