



**NATIONAL CENTER FOR HYDRO-METEOROLOGICAL
FORECASTING**

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

Tokyo, Japan

11 – 14 March 2014

**An introduction to TC forecasting system
at NHMS of Viet Nam**

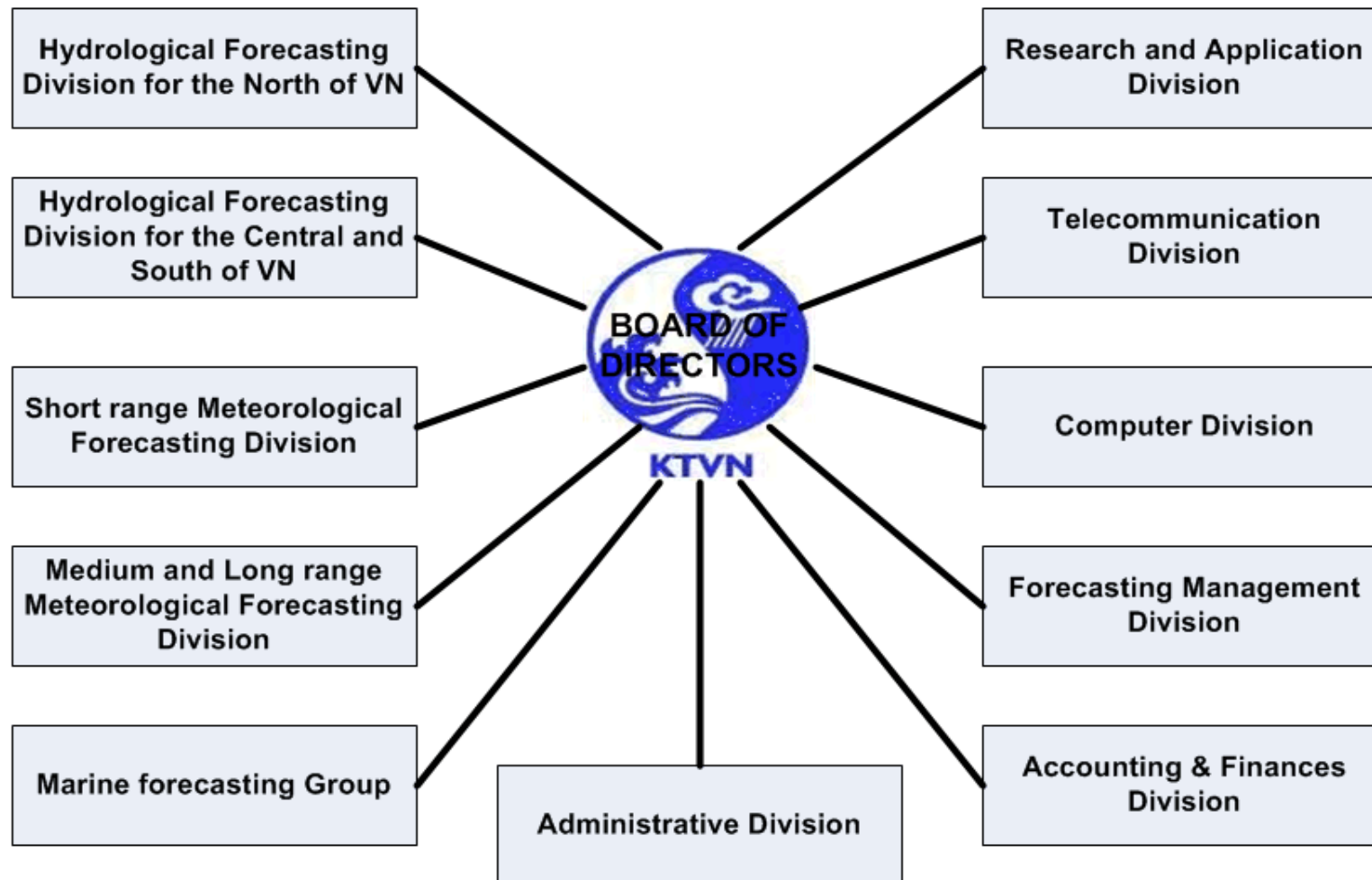


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1. Overview of TC forecasting at NCHMF

Organization & Infrastructure





1. Overview of TC forecasting at NCHMF (cont.)

1. Tropical Cyclone Monitoring, Analysis and Forecasting

1.1. Tropical Cyclone Monitoring

- + Using Drovak method for analyzing cloud patterns which could be developed to TD or TS;
- + Using upper air and surface analysis maps;
- + Using NWP products including regional model running at National Center for Hydro-Meteorological Forecasting (NCHMF) such as HRM and WRF, and global model forecast from international centers (NCEP, ECMWF, JMA, DWD, CMC);



1. Overview of TC forecasting at NCHMF (cont.)

1. Tropical Cyclone Monitoring, Analysis and Forecasting

1.2 Tropical Cyclone Analysis

Parameter	Time (UTC)	Methods	Other sources
Position; intensity; maximum wind; maximum gust wind; motion direction of TC (previous time and next 24, 48 and 72 hours)	Normally is every 6 hours at 00, 06, 12 and 18UTC In case of urgent situation (TC is going to made landfall in next 24hrs), warning bulletin can be issued every 1hrs	With satellite images, we have been using Dvorak TC intensity estimation technique for determining intensity of TC every 30 minutes to 1 hours	TC information extracted from NWP (both global forecast (NCEP, ECMWF, DWD, JMA) and regional models (HRM, WRF) running at NCHMF,



1. Overview of TC forecasting at NCHMF (cont.)

1. Tropical Cyclone Monitoring, Analysis and Forecasting

1.3 Tropical Cyclone Forecasting

Parameter	Issuance Time (UTC)	Lead time (hours)	Methods
Position; intensity; maximum wind; maximum gust wind; motion direction of TC	- Normally is every 6 hours at 00, 06, 12 and 18UTC - In case of urgent situation (TC is going to made landfall in next 24hrs), warning bulletin can be issued every 1hrr	- 24hrs, 48hrs and 72hrs - up to 24hrs with every 3hrs inverval	- Synoptic map analysis - TC information extracted from NWP productions at NCHMF: - Track forecast from international centers: -From ensemble forecast of ECMWF: - From HKO - From US Navy - From JMA

1. Overview of TC forecasting at NCHMF (cont.)

1. Tropical Cyclone Monitoring, Analysis and Forecasting

1.4 Tropical Cyclone Products

1.4.1 TC Products

After discussing the forecast of position and intensity of TC, forecasters will use in-house software named TC Aid for plotting official TC forecast map as shown in Fig. 1

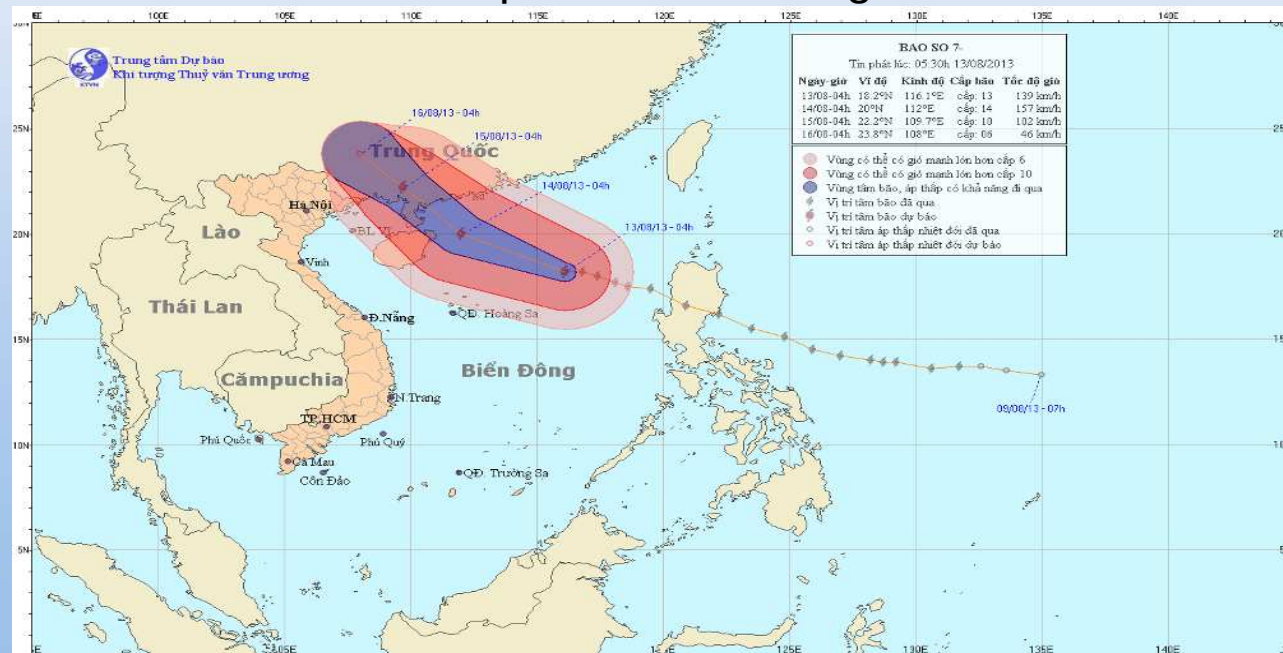


Fig 1. An example for TC track and intensity forecasting map issued by NCHMF



1. Overview of TC forecasting at NCHMF (cont.)

1. Tropical Cyclone Monitoring, Analysis and Forecasting

1.4 Tropical Cyclone Products

1.4.2 Challenges, Needs and Improvement Plans

At present, the quality of TC forecast and warning at NCHMF only has small error for 24hrs leadtime, but still large for higher leadtimes such as 48hrs and 72hrs.

- *Needs:* We need a medium and long training on job related to TC forecasting and analysis. We need standard operational procedure for TC forecasting. We also need a high-resolution regional modeling system with resolution about 2-5km in order to well capture the thermodynamical characteristics of TC. In addition, we also need a early warning system for sudden changes in TC track and intensity.



1. Overview of TC forecasting at NCHMF (cont.)

1. Tropical Cyclone Monitoring, Analysis and Forecasting

1.4 Tropical Cyclone Products

1.4.2 Challenges, Needs and Improvement Plans

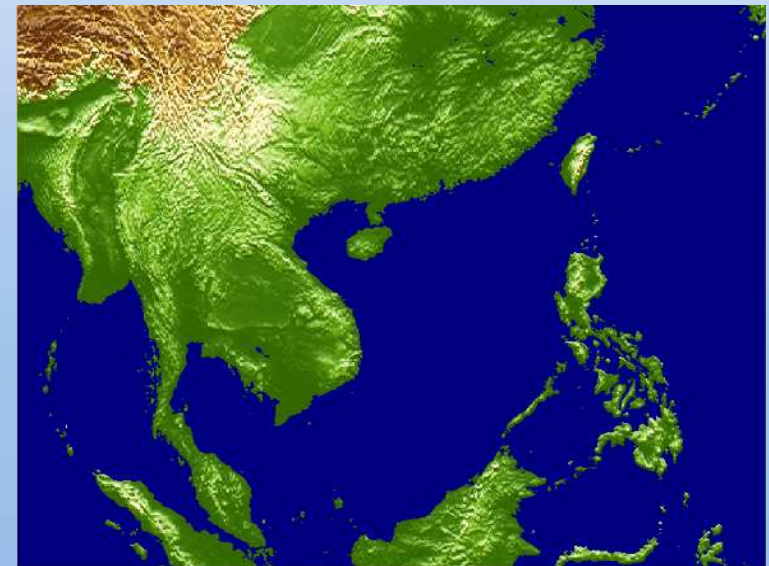
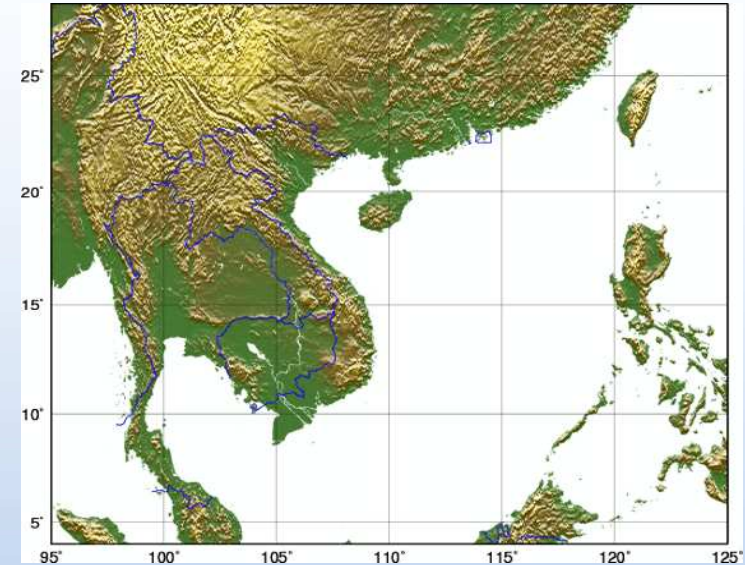
- *Improvement plans:* We have a big plan to modernize Hydro-Met services at NHMS of Viet Nam. Related to TC forecasting, we will build a standard operational procedure for TC forecasting in which provide more useful products not only for track and intensity prediction but also for forecasting sudden change of track and intensity. The high-resolution regional modeling system will be interpreted soon based on non-hydrostatic model in combination data assimilation in which effectively assimilate local observation and remote sensing data (satellite, radar, wind profiler, etc). The operational tools that support for forecaster will be upgraded according to data integrated, flexible, visualizable, informative solutions (all in one click).



2. Numerical Weather Prediction Status for Effective Warning (cont.)

The SREPS consists of 20 members by running 4 regional models including HRM, WRF-ARW, WRF-NMM, BoLAM in hydrostatic mode with initial and boundary conditions from 5 global forecasts (GEM, GFS, GME, GSM, NOGAPS). The forecast range is 3 days ahead with every 3 hours output. The model run operationally 4 times a day at 00Z, 06Z, 12Z and 18Z.

The LEPS consists of 21 members. This system operates 4 times per day (00Z, 06Z, 12Z and 18Z) and forecast 5 days ahead.





2. Numerical Weather Prediction Status for Effective Warning (cont.)

Tropical Cyclone Track System: A tropical cyclone (TC) tracker is developed to track TC movement from model forecasts. TC tracks are detected from global products and regional ensemble systems.

Tropical Cyclone Track Ensemble System: an ensemble mean track from all track predictions from global models, operationally regional NWP systems and operational track forecasts of international centres such as JMA, HKO, CMA, Guam, US Navy, etc.



2. Numerical Weather Prediction Status for Effective Warning (cont.)

2.1 NWP in Operational Use

Global NWP products in operational use at NCHMF

Model	Domain (square degree)	Resolution (horizontal & vertical)	Initial Time	(hours)	Run by (own/foreign centers)
GEM	79.8°E-145.2°E; 10.2°S-40.2°N	0.6° x 0.6°, 28 pressure levels	00UTC and 12UTC	72hrs with 3hr interval	CMC (Canadian Meteorological Center)
GFS	60°E - 155°E; 15°S - 60°N	0.5° x 0.5°, 26 pressure levels	00UTC, 06UTC, 12UTC and 12UTC	72hrs with 3hr interval	NCEP
GME	80.25°E - 130.2°E; 5°S - 35°N	30km, 60 model levels	(00 and 12UTC) & (06 and 18UTC),	72hrs with 3hrs interval 48hrs, 3hrs interval	DWD (Deutscher Wetterdienst)
GSM	60°E - 155°E; 5°S - 60°N	0.5° x 0.5°, 21 pressure levels	00UTC and 12UTC	72hrs with 3hr interval	JMA
NOGAPS	80°E - 145°E; 10°S - 40°N	1.0° x 1.0°, 29 pressure levels	00UTC and 12UTC	72hrs with 6hr interval	US Navy
UM	78.875°E - 145.125°E; 10.125°S - 40.125°N	0.5625° x 0.375°, 10 pressure levels	00UTC and 12UTC	72hrs with 6hr interval	KMA
IFS	80°E - 140°E; 20°S - 40°N	0.125° x 0.125°, 25 pressure levels	00UTC and 12UTC	240hrs with 6hr interval	ECMWF
GEFS	80°E - 145°E; 10°S - 40°N	1.0°x1.0°, 26 pressure levels	00UTC, 06UTC, 12UTC and 12UTC	6 days with 6-hour interval	Global EPS of NCEP (21 members)
VarEPS	80°E - 140°E; 20°S - 40°N	0.25° x 0.25°, 8 pressure levels	00UTC and 12UTC	240hrs with 6hr interval	Global EPS of ECMWF (51 members)



2. Numerical Weather Prediction Status for Effective Warning (cont.)

2.1 NWP in Operational Use

Regional NWP products in operational use at NCHMF

Model	Domain (square degree)	Resolution (horizontal & vertical)	Initial Time	(hours)	Run by (own/foreign centers)
WRF	96 ⁰ E - 124 ⁰ E; 5 ⁰ S - 27 ⁰ N	15km x 15km and 40 vertical levels	00UTC and 12UTC	72hrs with 3hr interval	NCHMF (deterministic modeling system in combination with 3DVAR)
WRF	96 ⁰ E - 124 ⁰ E; 5 ⁰ S - 27 ⁰ N	5km x 5km and 60 vertical levels	00UTC and 12UTC	48hrs with 1hr interval	NCHMF (in research mode, inputs from WRF 15km)
SREFS	0 ⁰ -28 ⁰ N; 95 ⁰ E-128 ⁰ E	0.15 ⁰ x 0.15 ⁰ , 201 x 161 grid points, 31 levels.	00UTC, 06UTC, 12UTC and 12UTC	72hrs with 3hr interval	NCHMF (Regional EPS)
LEPS	0 ⁰ -32 ⁰ N; 91 ⁰ E-131 ⁰ E	0.2 ⁰ x 0.2 ⁰ , 201 x 161 grid points, 31 levels	00UTC, 06UTC, 12UTC and 12UTC	120hrs with 6hrs interval	NCHMF (Regional EPS)



2. Numerical Weather Prediction Status for Effective Warning (cont.)

2.2 Application Techniques of NWP Products for Operational Forecasts

The global and regional NWP products of deterministic and ensemble system is display as weather chart including surface maps (rainfall, wind speed and direction, pmsl, tmax, tmin, specific and relative humidity, etc) and uppair maps (i.e. geopotential height, wind, divergence, convergence, stream line, potential vorticity, relative vorticity, etc).

For some speicial location, the crossing section diagram, Skew-T diagram, Meteogram and EPSgram is displayed. For EPS products, the porbability maps is displayed for special atmospheric variables such as heavy rainfall, strong wind, track, etc.



2. Numerical Weather Prediction Status for Effective Warning (cont.)

2.3 Challenges, Needs and Improvement Plans

In fact, NCHMF use a lot of global and regional NWP products in operational TC prediction. However, there still aren't any information about quality of these NWP system. This caused a lot difficulties for forecaster during the operational forecast. In addition, most of forecaster is well training in synoptic method and has a little knowledge in NWP.

Hence, they sometime misunderstand the true meaning of NWP products, specially for probabilistic products. We really need some short and medium training course for NCHMF's forecaster in which more pay attention to how to understand and interpret NWP products.



3. Storm Surge

1. Storm Surge Information

Issuing

2. How the information is issued?

Independent storm surge information

Included in TC information

c. Included in tide information

3. What products (observations /forecasts) are referred to?

4. We usually refer to JMA storm surge forecasting products

If your Service runs a storm surge model by yourself, please describe the way in detail.



3. Storm Surge (cont.)

Model	Domain and resolution	(hours)	Frequency	Considered factors (Tide/ensemble/ inundation, etc.)
JMA	Model area cover: 8- 22°N and 105 - 120°E -Grid type: Rectilinear. - Grid solution: two minutes.	48hrs with 6hrs interval	4 foracasts/day	
CTS	Model area cover: 8- 23°N and 104 - 120°E -Grid type: Rectilinear. -Grid solution: two minutes. 1/4degree	48hrs with 6hrs interval	4 foracasts/day	
Delfd3D	Model area cover: 8- 22°N and 105 - 120°E -Grid type: Curverlinear.	48hrs with 6hrs interval	In research mode	Tidel



4. Effective Warnings

4.1 Emergency Response for TC Disasters

4.1.1 Legal Framework for TC Disaster Management

4.1.2 Emergency Response Mechanism

4.1.3 Organs Responsible for Warnings and Evacuation Orders

Severe Weather Phenomena	Organs responsible for Warnings	Organs responsible for Evacuation Orders
Tropical Cyclone	National center of Hydro-Meteorological Forecasting (NCHMF)	Central Committee of Flood and Storm Control at national and provincial level (CCFSCs)
Heavy Rain	NCHMF	CCFSCs
Strong Wind	NCHMF	CCFSCs
River Flood	NCHMF	CCFSCs
Storm Surge	NCHMF	CCFSCs



4. Effective Warnings (cont.)

4.2 Warnings/Advisories for Severe Weather Phenomena

4.2.1 Tropical Cyclone

Warnings/Advisories and corresponding emergency responses	Warning for strong wind, heavy rainfall, flash flood and landslide, thunderstorm, storm surge, etc
Potential Disaster Risks	Strong wind, heavy rainfall, Flash flood, flood, inundation, thunderstorms, hails, etc... will be damaged to human lives and properties of people
Target (warning areas)	All of high potential effected areas will be warned
Meteorological variables/indices used for criteria/thresholds for warnings/advisories	Distance of current TC center in comparison with the coastal line or specific point, category of strong wind, 24hrs accumulated heavy rainfall, influenced radius of strong wind and heavy rainfall
Criteria/Thresholds	Based on climatology (rare events) and dangerous levels (has very high potential in order to cause lost of human and properties)
Contents of Warning/Advisory Message	The warning includes the position, intensity and its effects to specific area about strong wind and heavy rain situation. In addition, the warning related to land slide, flash flood, storm surge and high wave is sometime included in TC warning bulletin or advisories
Sample Warning/Advisory Message	

No: BGB14-17/ DBKT

Hanoi, Day 09 Month 11 Year 2013

TYPHOON WARNING (No 14 – Haiyan)

At 090600Z, Typhoon Haiyan located near 13.5N – 114.8E, approximately 240km North of Song Tu Tay Island (Sparatly Islands). Maximum sustained wind speed near the center is estimated to be 14 – 15 Beaufort (150 to 183 km/h), gust 16 – 17 (184 to 220 km/h).

Forecast to move West – Northwest at about 30 km per hour for the next 24 hours. At 100600Z, the position located near 16.7N – 108.3E. Maximum sustained wind speed near the center is estimated to be 13 – 14 Beaufort (134 to 166 km/h), gust 15 – 16 (167 to 201 km/h).

Forecast to move Northwest at about 20 - 25 km per hour for the next 24 - 48 hours and downgrade into a Tropical depression. At 110600Z, the position is located near 20.8N – 103.8E, over the boundary of Vietnam-Lao. Maximum sustained wind speed near the center is estimated to be 6 – 7 Beaufort (39 to 61 km/h), gust 8 (62 – 74 km/h).

Forecast to move North at about 15km per hour and downgrade into a Low for the next 48 - 72 hours.

Next warnings will be issued at 091030Z.



4. Effective Warnings (cont.)

4.2.2 Heavy Rain

Warnings/Advisories and corresponding emergency responses	- There are two kinds of heavy rain bulletins, one is from heavy rains occur over large area due to large scale environmental circulations, the another comes from heavy rains accompany with thunderstorms which are the result of local factors. - Once relevant authorities receive heavy rain bulletins from NHMS, they will immediately announce the content to people for better preparedness
Potential Disaster Risks	Flash flood, flood, inundation, thunderstorms, hails, etc... will be damaged to human lives and properties of people
Target (warning areas)	All of high potential affected areas will be warned
Meteorological variables/indices used for criteria/thresholds for warnings/advisories	The rainfall amount and high potential of thunderstorms will be used to be thresholds
Criteria/Thresholds	- For heavy rains due to large scale environmental circulations, the rainfall amount must be at least 16mm within 24 hours. - For heavy rains due to local factors, the rainfall amounts must be at least 25mm. Also, the thunderstorms must be high potential
Contents of Warning/Advisory Message	All warnings include the exact areas will be affected by heavy rain. The time of occurrence and the amount of rainfall are also mentioned. In addition, if heavy rains accompany with thunderstorms or hails, they must be included in the bulletins. Beside, the potential of flash flood, flood and inundation should be mentioned.
Sample Warning/Advisory Message	According to a Low is prevailing over red river delta area from surface up to 5000m high, there could be heavy rain from 11 of August. The areas will be affected including the whole red river delta areas, provinces from Thanh Hoa to Ha Tinh. This occurrence could be ranged from 11 to 15 of August. All the mountainous areas should aware flood as well as flash flood. Next warnings will be issued at 0906Z.



4. Effective Warnings (cont.)

4.2.3 Strong Wind

Warnings/Advisories and corresponding emergency responses	- Strong wind bulletins are normally issued for territorial waters. The bulletins will be issued when strong wind coming from Northeast monsoon and Southwest monsoon. - Once relevant authorities receive strong wind bulletins from NHMS, they will immediately announce the content to people for better preparedness
Potential Disaster Risks	Strong wind over Seas will be severely damage to fishery, especially damage to human lives.
Target (warning areas)	All of high potential affected areas will be warned.
Meteorological variables/indices used for criteria/thresholds for warnings/advisories	Beaufort wind scale will be used for thresholds for warnings
Criteria/Thresholds	Wind speed over 6 category of Beaufort wind scale (strong wind over 11m/s) will be used as criteria for issuing the strong wind bulletins
Contents of Warning/Advisory Message	All warnings include the exact areas will be affected by strong wind. The time of occurrence and the category of strong wind are also mentioned.
Sample Warning/Advisory Message	According to Northeast monsoon is extending to the south to the Biendong sea, there could be strong wind with category ranged from 11 to 17m/s over the North Biendong sea (including Paracel Islands) from 11 of August. The areas of strong wind will be enlarged to the from 12 of August. Next warnings will be issued at 0906Z.



4. Effective Warnings (cont.)

4.2.4 River Flood

Warnings/Advisories and corresponding emergency responses	- Flood Warning; prepare for possible flood situation - Flood Bulletin; - Urgent Flood Bulletin; all resources mobilized for flood response
Potential Disaster Risks	- Possibility of flood occurrence - High level of damages caused by flood - Very high risk and emergency of big flood
Target (warning areas)	- Central Committee of Flood and Storm Control - Provincial Committee of Flood and Storm Control
Meteorological variables/indices used for criteria/thresholds for warnings/advisories	Tropical storm, cold surge, ICTZ, heavy rain
Criteria/Thresholds	Flood warning stages (Level) I, II, III
Contents of Warning/Advisory Message	- Briefing on last 24 hours flood situation on affected area/basin - Forecasting on possible flood warning level for next 24-48 hours. - Possible risk, damage caused by upcoming flood
Sample Warning/Advisory Message	

FLOOD INFORMATION ON THE THAO, CAU, THUONG, LUC NAM RIVERS

I. Remark

In the past 36 hours, moderate to heavy rain occurred in the North of Vietnam due to the affects of storm No. 5. The mean precipitation were recorded between 70 to 150 mm in which high amount of rainfall at Thanh Son (Phu Tho): 217mm; Tam Dao (Vinh Phuc): 274mm, Son Duong (Tuyen Quang): 208mm; Van Chan (Yen Bai): 186mm; Viet Yen (Bac Giang): 167mm; Pho Du (Thai Nguyen): 170mm; Cha (Bac Can): 176mm; Luc Nam (Bac Giang): 161mm

Water levels on the Thao, Cau, Thuong and Luc Nam is sharp rising. Water levels at main stations at 19PM 18/8 is detailed as below:

- On the Thao river at Yen Bai: 30.52m, above Alarm level (AL) 1: 0.52m; at Phu Tho: 16.9m, below AL 1: 0.6m.
- On the Cau river at Dap Cau: 4.08m, below AL 1: 0.22m
- On the Thuong river at Phu Lang Thuong: 3.9m, below AL 1: 0.4m.
- On the Luc Nam tai Luc Nam: 4.85m, below 2: 0.45m.

II. Forecast

Water level on the Thao river will continue rising. Tomorrow (19/8), WL on the Thao at Yen Bai will be able to reach 31.3m at 7AM (over AL 2: 0.3m), and 31.7m at 19PM (below AL 2: 0.3m) ; at Phu Tho will be able to reach 18.0m at 19PM (below AL 3: 0.3m).

During tonight and early morning of tomorrow, WL on the Cau, Thuong, Luc Nam river will be able to reach a peak. Peaks of flood on the Cau at Dap Cau will reach 4.6m (over AL1: 0.3m); on Thuong river at Phu Lang Thuong : 4.3m (AL 1); on the Luc Nam river at Luc Nam: 5.0m (below AL2: 0.3m).

Flash flood, landslide will be able to occur on streams, small rivers in moutainous areas of provinces as Cao Bang, Bac Giang, Bac Can, Thai Nguyen, Tuyen Quang, Ha Giang, Lao Cai, Yen Bai, Phu Tho...

Flood stitution will be complicated, please following next flood information at 10AM on 19/8.



4. Effective Warnings (cont.)

4.2.5 Storm Surge

Warnings/Advisories and corresponding emergency responses	- storm surge height; total water height and time of storm tide
Potential Disaster Risks	- Possibility of maximum storm surge height and total water height, possible of inundation due to storm surge plus tide
Target (warning areas)	- All of high potential effected areas will be warned;
Meteorological variables/indices used for criteria/thresholds for warnings/advisories	Not used
Criteria/Thresholds	Not yes, future make storm tide level (I, II, III)
Contents of Warning/Advisory Message	- Forecasting on maximum surge height, storm tide height and times. - Possible risk by upcoming maximum surge height, storm tide height
Sample Warning/Advisory Message	

Storm surge forecasting (issue in NCHMF-Website)

Typhoon name:

N°	Town	Province	Period forecasts: (12 or 24 or 36)			
			Tide height (m)	Storm surge height (m)	Total water level height (m)	Time of maximum surge height
1	Quang Ninh	Bai Chay	3.2	1.5	4.7	15h/20/08
		Honghai	3.1	1.7	4.8	14h/20/08
2	Hai Phong	Yen Hung	3.0	2.1	5.1	13h/20/08
		Do Son	2.9	2.0	4.9	13h/20/08
3	Thai Binh	Diem Dien	2.8	1.7	4.5	14h/20/08
		Tien Hai	2.7	1.5	4.2	14h/20/08

Warning : Maximum storm surge can be reach up to 5 m in the Hai Phong Coastal area

Check: Bui Manh Ha

Forecaster: Nguyen Manh Dung



4.5 Challenges (and Future Plan)

The public and emergency responses by relevant authorities always want to know detail and correct forecasting information not only 1-3 days ahead but also more longer range (5-10 days to seasonal range). They also need to know what exactly phenomena is in understandable way. All forecasting bulletins must be written in easy words for easy understanding without specific meteorological terms. The most challenges are the demands of social are higher than the capabilities of forecasting and responding offices.

In order to improve these gaps, NCHMF has a significant plan to modernize observation network, TC forecasting technology, analysis and forecasting support tools, human resources (forecaster and modeller). The operational TC prediction procedures will be revised and improved according to increasing capacity of early warning and prediction of cyclongenesis and sudden changes in track and intensity. In addition, the public education about meteorology and TC affects will be implemented. The TC warning and forecast bulletin disseminating system will be improved in the way increasing both of quality and quantity. The content of bulletin will be changed to capture the requirements of the public.

THANKS FOR YOUR ATTENTION

