TROPICAL CYCLONE, ROUGH SEAS AND SEVERE WEATHER MONITORING AND EARLY WARNING SYSTEM IN MALAYSIA

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OUTLINE

- Introduction
- Multi-Hazard Early Warning System
- Disaster Management
- Tropical Storm Greg and Typhoon Vamei
- Issues and Challenges
- Strategies for Improvement

Introduction

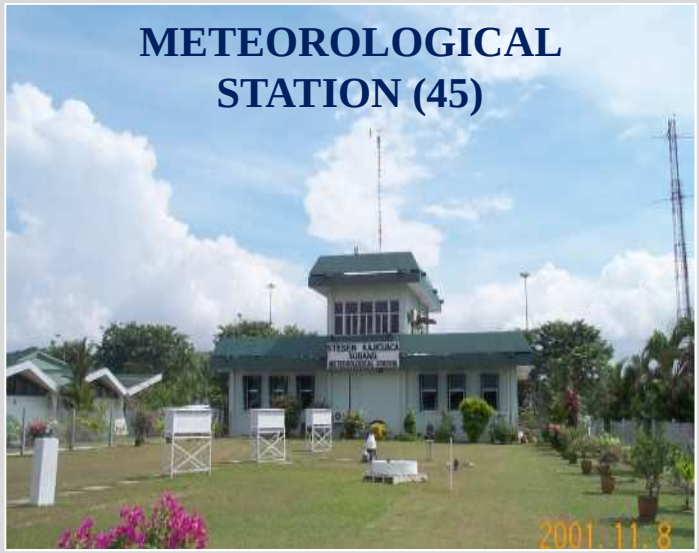
Due to its geographical position, Malaysia is relatively safe from direct tropical cyclone hit.

Only two tropical cyclones, Tropical Storm Greg (Dec 1996) and Typhoon Vamei(Dec 2001) , had made landfall in Malaysia.

In spite of this, TCs are severe weather phenomena which could cause substantial damage and loss of lives and should not be taken lightly.

DATA ACQUISITION

METEOROLOGICAL STATION (45)



WEATHER CAMERA STATION (17)

RADAR STATION (13)

GROUND RECEIVING STATION (1)

AUXILIARY STATIONS(339)

- **AWS (141)**
- **Climatological Station (39)**
- **Rainfall Station (159)**

Main Meteorological Offices (15)

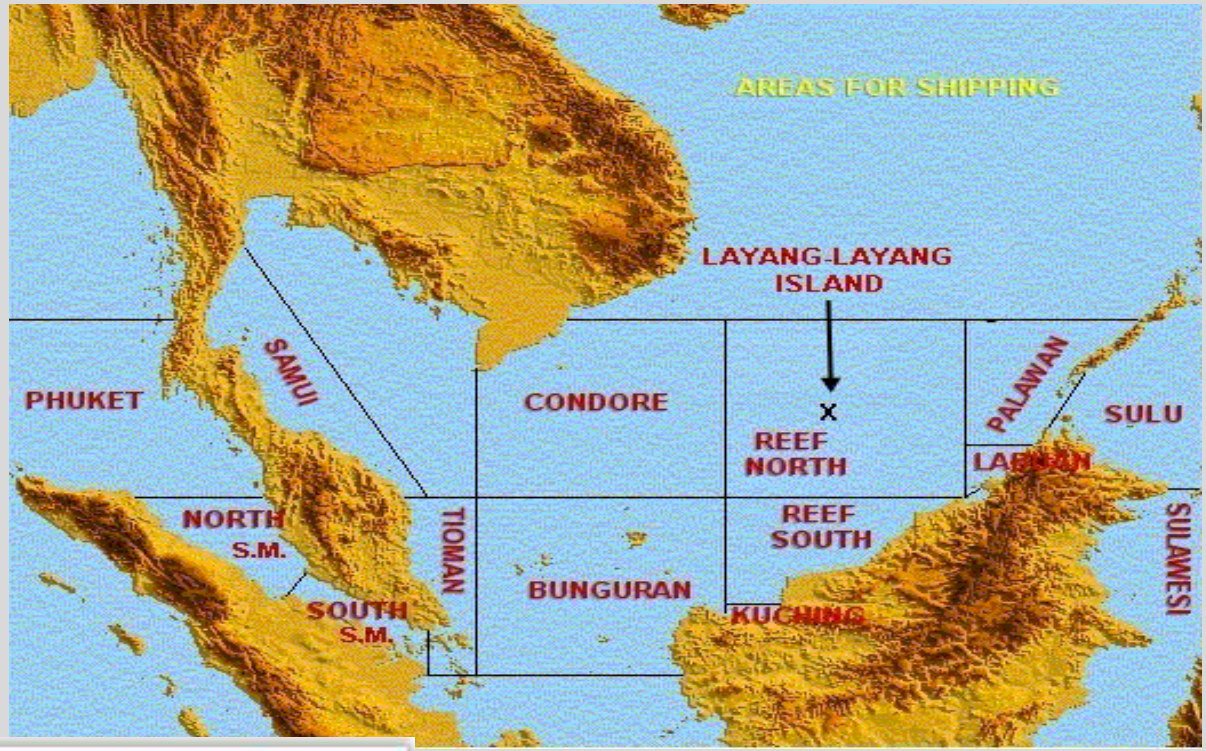
National Aviation Meteorological Centre
KLIA

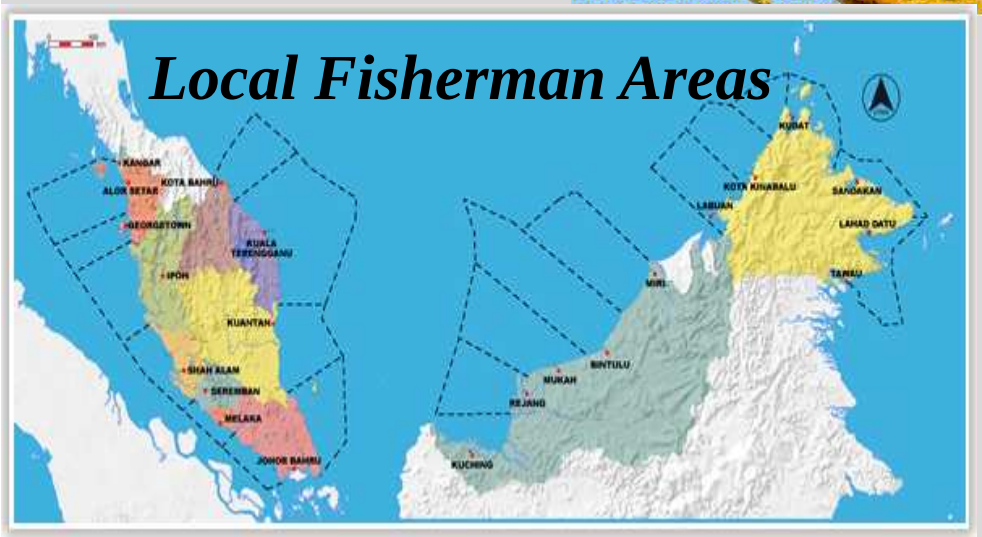
National Weather Centre

Terengganu
Meteorological Office

Marine Regions

Shipping Areas





Marine Regions for issuance of forecasts and warnings of weather and sea state conditions

Marine Observational Network

- 4 Acoustic Doppler Current Profiler (ADCP) and 2 Recording Doppler Current Profiler (RDCP) -real time

- Data from various agencies : Royal Navy, Marine Dept, Oil & Gas, Scientific Expedition etc

- Voluntary Observing Ship (VOS)

TYPHOON BOGUSSING, STORM SURGE MODELS

Overview

The model is two-dimensional based on shallow water equations which are linearized by eliminating advection terms. Storm surges (sea level rise) due to wind setup and inverted barometer effect are computed by the model. The resolution of the model is one minute (1 nautical mile).

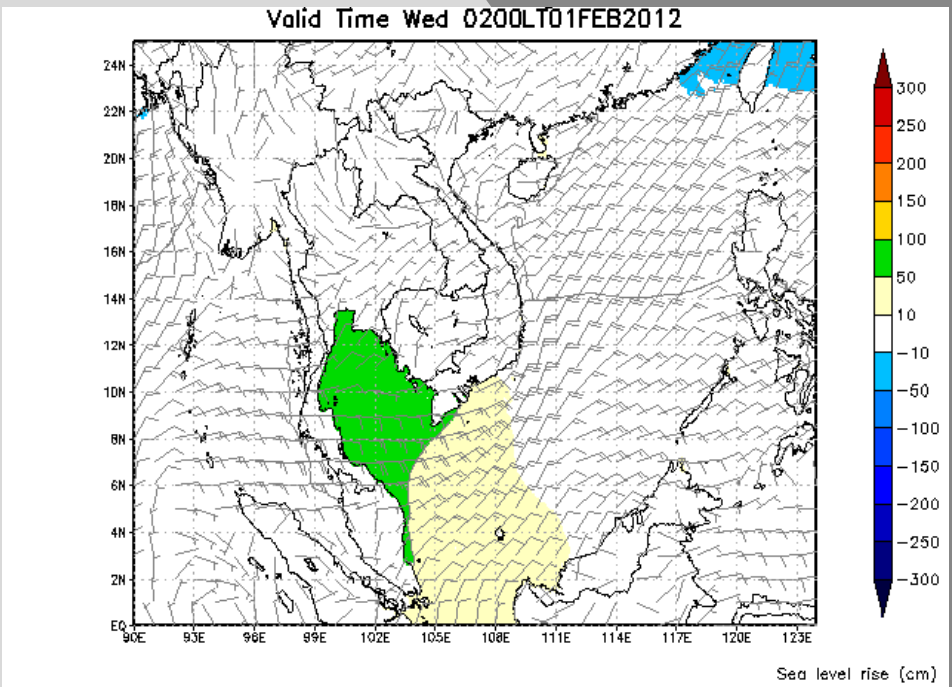
Model Input

The model accepts two kinds of meteorological forcing data:

i) GRIB1 format files containing surface wind and pressure fields from atmospheric models i.e. MMD-MM5 (with typhoon bogussing), NCEP-GFS, NOGAPS, JMAGSM etc.
ii) Tropical Cyclone Best Track Data provided by RSMC Tokyo - Typhoon Center.

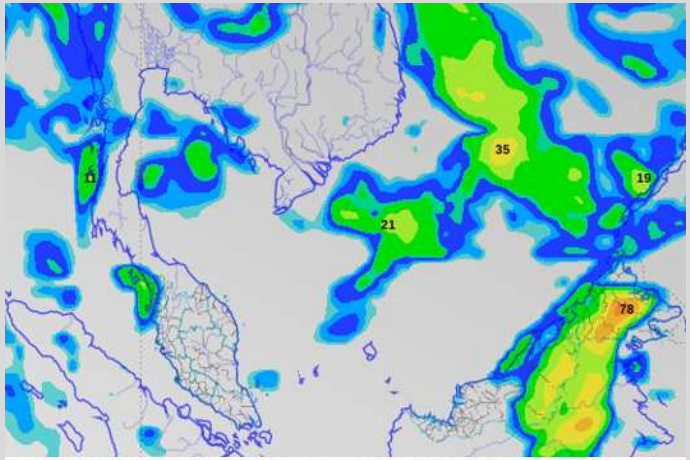
Execution and Visualisation

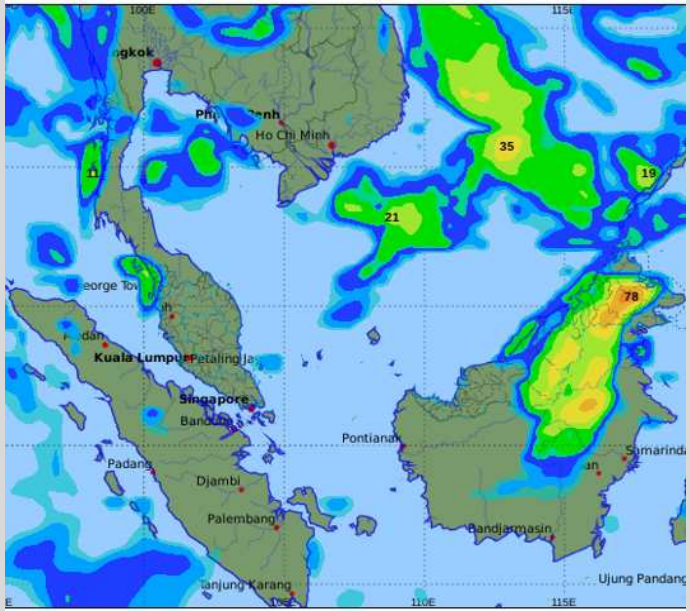
The data are downloaded automatically twice daily as input into the model. It takes approximately 30 minutes for the whole model run to be completed. The storm surge calculation results are written into a GRIB1 file. Maps of sea level rise and time-series at specified coastal points are generated as the final outputs.



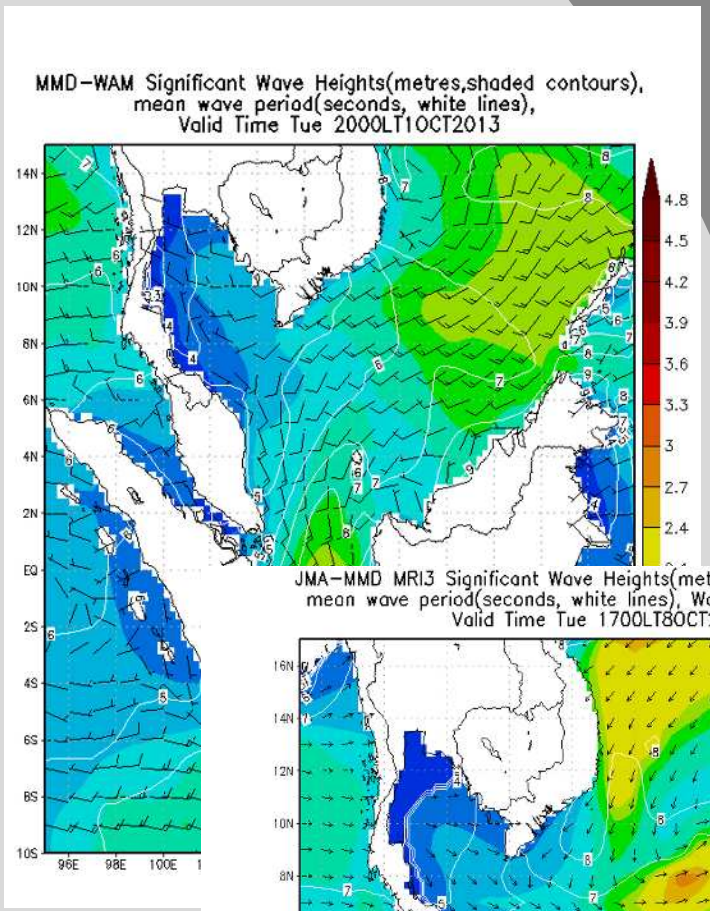
Cooperation with Office of Marine Prediction, Japan Meteorological Agency (JMA). MetMalaysia receives technical support and updates for JMA Storm Surge Model.

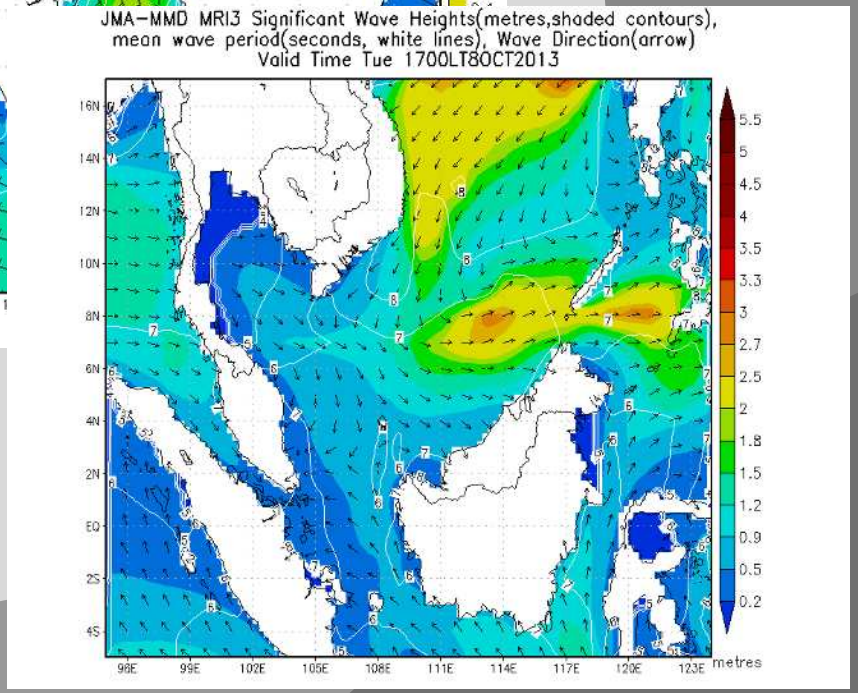
Other Operational Atmospheric and Marine NWP MODELS





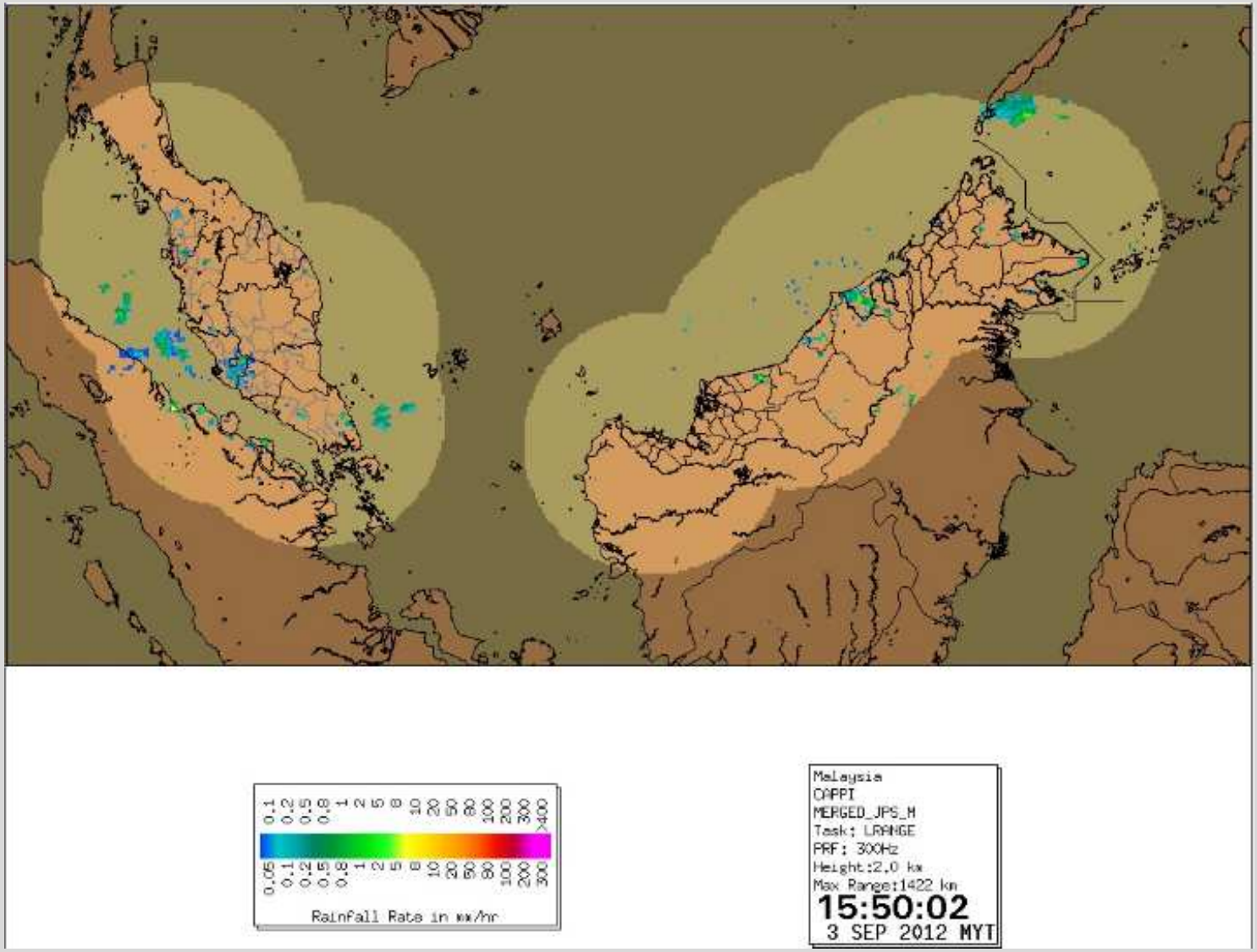
MMD-WRF / MM5 Regional Models





MMD Wave Models

Radar Coverage



Tropical Cyclogenesis Monitoring

Potential TCs are monitored based on analysis of satellite imageries(MTSAT,FY,ASCAT), wind charts, NWP products and information from tropical cyclone monitoring centres such as RSMC Tokyo-Typhoon Center, JTWC and RSMC Tropical Cyclones New Delhi.

A TC Warning is issued for tropical depression/tropical storm/typhoon in the Malaysian Exclusive Economic Zone (EEZ) or if the TC is forecast to enter Malaysia EEZ within 24 hours.

A TC Advisory is issued for TCs outside the Malaysian EEZ but within the area bounded by 0-30^{O}N and 90-130^{O}E.

Tropical Depression (TD) Advisories/Warnings

TD Warnings and TD Advisories (for TDs which are significant enough) are disseminated to the disaster management agencies via short message system (SMS), facsimile and telephone calls.

The public can access the TD Advisories/Warnings through the Internet, social media(Facebook and Twitter), live media broadcast, TV, Radio and the print media.

WMO’s SWIdget Project

The MetMalaysia also participates in the WMO’s SWIdget Project, which is a widget that allows users to obtain local severe weather warnings issued by official weather services.

The following advisories/warnings issued by the MetMalaysia are accessible through SWIdget:

Heavy Rain/Thunderstorm Warning
Strong Winds and Rough Seas Warning
Tropical Cyclone and Storm Advisory/Warning

TC Analysis & Forecasting

Parameter	Time (UTC)	Methods	Other sources
Position and maximum sustainable wind	On Adhoc basis	MTSAT and FY imageries are used in conjunction with ASCAT imageries to identify the position and maximum sustainable wind.	RSMC Tokyo-Typhoon Center, JTWC and RSMC Tropical Cyclones New Delhi.

Parameter	Issuance Time (UTC)	Lead time (hours)	Methods
Track, central pressure, maximum sustainable wind, strong wind areas.	On adhoc basis	3	MetMalaysia refers to RSMC Tokyo-Typhoon Center, JTWC and RSMC Tropical Cyclones New Delhi for TC forecasts.

TC Advisory Sample

Tropical Depression Advisory
Issued at 02:56PM 09 December 2012

Stage : Tropical Depression.
Time of Observation : 2.00 pm, 9 December 2012.
Location : Latitude 18.0 North; Longitude 120.0 East; approximately 391 km North-Northwest of Manila, Philippines.
Movement : Southeastwards slowly.
Distance from nearest town: Approximately 1,281 km North-Northeast of Kudat, Sabah.

Threat to Malaysia:
These conditions may cause thunderstorms activities, strong winds and rough seas over waters off Sarawak (Miri), Labuan FT, Sabah (Interior, West coast and Kudat), Condore, Reef North, Layang-layang, Palawan and Sulu.

Operational NWP Models

Model	Domain (square degree)	Resolution (horizontal & vertical)	Initial Time	Forecast Range (hours)	Run by (own/foreign centers)
MMD-WRF	85 – 135 ° E and 20 ° S – 30 ° N 98 – 121.5 ° E and 1.8 ° S – 12 ° N 99 ° E – 105.5 ° E and 1 ° N – 8 ° N and 109 – 120.5 ° E and 0.5 ° N – 8.5 ° N	36,12,4 km 30 vertical levels	00,12 UTC	72	Own
MMD-MM5	85 – 135 ° E and 20 ° S – 30 ° N 98 – 121.5 ° E and 1.8 ° S – 12 ° N 99 ° E – 105.5 ° E and 1 ° N – 8 ° N and	36,12,4 km 23 half sigma levels	00,12 UTC	72	Own
MMD-HRM	98 ° E– 121.5 ° E and 1.8 ° S – 12 ° N	60 vertical levels	00,12 UTC	72	Own

Storm Surge Model

Model	Domain and resolution	Forecast Range (hours)	Frequency	Considered factors (Tide/ ensemble/ inundation, etc.)
JMA Storm Surge	0°-25°N, 90°-125°E, resolution 1'x1'	192	Twice daily	-

TC Disaster Management

The National Security Council (NSC) is the principal policy making and coordinating body for disaster management.

The NSC coordinates and plans all activities related to preparedness, prevention, response/relief operations and recovery/rehabilitation.

The National Security Council Directive No. 20 (NSC No. 20): The Policy and Mechanism for National Disaster Management is the main guideline for disaster management in Malaysia which prescribes the mechanism on the management of disasters through the establishment of the Disaster Management Committee at three different levels (federal, state and district) depending on the severity of the disaster.

Emergency Response Mechanism

Level I Disaster(District Level Authority)
Local incident which are controllable and with no potentiality of spreading out.

Level II Disaster(State Level Authority)
More serious incident covers a wide area or has exceeding two (2) districts and has a potential to spread out.

Level III Disaster(Central Authority)
Any incident caused by Level III Disaster is more complex in nature or affecting a wide area or more than two states.

Warnings and Evacuation Orders

Severe Weather Phenomena	Organs responsible for Warnings	Organs responsible for Evacuation Orders
Tropical Cyclone	The Malaysian Meteorological Department	The National Security Council of Malaysia
Heavy Rain	The Malaysian Meteorological Department	The National Security Council of Malaysia
Strong Wind	The Malaysian Meteorological Department	The National Security Council of Malaysia
River Flood	The Department of Irrigation and Drainage, Malaysia	The National Security Council of Malaysia
Storm Surge	The Malaysian Meteorological Department	The National Security Council of Malaysia

Tropical Cyclone Advisories/Warnings

Warnings/Advisories and corresponding emergency responses	**ATTACHMENT 1**
Potential Disaster Risks	Heavy rainfall, flash floods, strong winds and rough seas.
Target (warning areas)	Marine regions under MetMalaysia responsibility for issuing sea state conditions.
Meteorological variables/indices used for criteria/thresholds for warnings/advisories	Rainfall intensity, wind speed and wave height.
Criteria/Thresholds	A TC Warning is issued for tropical depression/tropical storm/typhoon in the Malaysian Exclusive Economic Zone (EEZ) or if the TC is forecast to enter Malaysia EEZ within 24 hours. A TC Advisory is issued for TCs outside the Malaysian EEZ but within the area bounded by 0-30^{O}N and 90-130^{O}E. There are two categories of TC warning namely Orange and Red. i. Orange : Tropical depression is in the Malaysian EEZ or is going to enter the Malaysian EEZ within 24 hours ii. Red : Tropical storm / typhoon is in the Malaysian EEZ or is going to enter the Malaysian EEZ within 24 hours

Tropical Cyclone Advisories/Warnings

Contents of Warning/Advisory Message	Time and date of warning/advisory issuance, TC stage, time of observation, location, movement, distance from nearest town and potential disaster risks to Malaysia.
Sample Warning/Advisory Message	**Tropical Depression Advisory** **Issued at 05:55AM 03 January 2013** Stage : Tropical Depression. Time of Observation: 5.00 am, 3rd January 2013. Location: Latitude 8.3 North; Longitude 124.4 East; approximately 123 km Southeast of Mindanao, Philippines. Movement: Westwards at estimated speed of 45 kmph. Distant from nearest town: Approximately 783 km Northeast of Semporna, Sabah. Threat to Malaysia: These conditions may cause strong winds and rough seas over waters off Sulu Sea.

Heavy Rain Advisories/Warnings

Warnings/Advisories and corresponding emergency responses	**ATTACHMENT 1**
Potential Disaster Risks	Floods over low-lying areas.
Target (warning areas)	District.
Meteorological variables/indices used for criteria/thresholds for warnings/advisories	**Rainfall intensity.**

Heavy Rain Advisories/Warnings

Criteria/Thresholds	There are three categories of heavy rain warning/advisory due to TCs that is Yellow, Orange and Red. i. Yellow (Advisory): Moderate rains with strong winds expected in the next 1- 2 days to come. ii. Orange (Warning): Moderate rainfall with intensity 2.5 ≤ i <10.0 mm / hr(which is intensifying) and with strong winds are occurring or expected to occur in less than 24 hours. iii. Red (Warning): Heavy rainfall with intensity >=10.0 mm / hr and with strong winds are occurring or expected to occur within the next few hours.
Contents of Warning/Advisory Message	Warning/advisory stage (Yellow, Orange, Red), date and time of issuance, TC location, wind speed over affected areas, associated severe weather phenomena, warning/advisory affected areas, duration of occurrence and potential disaster risks.

Heavy Rain Advisories/Warnings

Sample Warning/Advisory Message	**Heavy Rain Warning (Orange Stage)** **Issued at : 09:31AM, 03 January 2013** **A Tropical Depression is observed at 8.3 North, 124.4 East with wind speed between 50-60 kmph. In conjunction to that, widespread thunderstorms are expected to occur over the states of Sabah: Divisions of Sandakan (Beluran, Kinabatangan and Sandakan Districts), Tawau (Lahad Datu District) and Kudat (Pitas, Kudat and Kota Marudu Districts) from tonight, 3rd January 2013 until Friday, 4th January 2013.** **This condition will cause floods over low-lying areas and strong winds.**

Strong Winds Advisories/Warnings

Warnings/ Advisories and corresponding emergency responses	**ATTACHMENT 1**
Potential Disaster Risks	Dangerous for small boats, ferry services, fishing, recreational activities, sea sports, shipping, coastal activities and workers on oil platforms.
Target (warning areas)	Marine regions under MetMalaysia responsibility for issuing sea state conditions.
Meteorological variables/indices used for criteria/ thresholds for warnings/ advisories	Wind speed and wave height.

Strong Winds Advisories/Warnings

Criteria/ Thresholds	There are three categories of strong wind warning/advisory due to TCs that is First, Second and Third category. i. First Category: Strong winds with speeds up to 50 kmph and rough seas with wave height up to 3.5 m. ii. Second Category: Strong winds with speeds up to 60 kmph and rough seas with wave height up to 4.5 m. iii.Third Category: Strong winds with speeds exceeding 60 kmph and rough seas with wave height exceeding 4.5 m.
Contents of Warning/Advisory Message	Warning/advisory stage (First, Second or Third category), date and time of issuance, TC information, associated severe weather phenomena, wind speed & wave height over affected areas, warning/advisory affected areas, duration of occurrence and potential disaster risks.

Strong Winds Advisories/Warnings

Sample Warning/ Advisory Message	THIRD CATEGORY WARNING WARNING ON STRONG WINDS AND ROUGH SEAS *Updated:* Tropical Depression is located at Latitude 8.3 N and Longitude 124.4 E, at 5:00 am, 3rd January 2013, approximately 783 km Northeast of Semporna, Sabah and moved Westwards with estimated speed of 45 km/h. STRONG WINDS AND ROUGH SEAS (THIRD CATEGORY) - Update Strong Northeasterly winds over 60 kmph with waves more than 5.5 metres occurring over the waters off Kelantan, Terengganu, Samui, Condore, Reef North, Layang-Layang & Palawan are expected to continue until Friday, 4th January 2013. In addition, the coastal areas of Kelantan & Terengganu are vulnerable to sea level rise. This condition is expected to continue until Friday, 4th January 2013. This condition of strong winds and rough seas is dangerous to all coastal and shipping activities including workers on oil platform.

River Flood Advisories/Warnings

Warnings/Advisories and corresponding emergency responses	Flood warnings are disseminated via SMS(people in a particular area,disaster management agencies), web site (http://infobanjir.water.gov.my/), sirens. No river flood warning associated with tropical cyclones was ever issued.
Potential Disaster Risks	Floods.
Target (warning areas)	Housing area/District.
Meteorological variables/indices used for criteria/thresholds for warnings/ advisories	Rainfall amount and rates.
Criteria/Thresholds	**-**
Contents of Warning/Advisory Message	**-**
Sample Warning/Advisory Message	**-**

Storm Surge Advisories/Warnings

Warnings/Advisories and corresponding emergency responses	Storm surge warnings are not issued separately but the possible impact is included in the Strong Winds and Rough Seas Advisory/Warning.
Potential Disaster Risks	Coastal areas are vulnerable to sea level rise.
Target (warning areas)	State.
Meteorological variables/indices used for criteria/thresholds for warnings/advisories	-
Criteria/Thresholds	-
Contents of Warning/Advisory Message	-
Sample Warning/Advisory Message	-

Dissemination of Advisories/Warnings on Tropical Cyclones

- SMS
- TV Broadcast
  - RTM1 - Selamat Pagi 1Malaysia & Regional News
  - TV Crawler
- Radio Broadcast(Light FM, Radio 24 etc.)
- Facsimile(All disaster management agencies)
- Mass Media (Print and Electronic)
- Web page: *www.met.gov.my*
- Social Media Network
- Facebook: *www.facebook.com/malaysiamet*
  - Twitter: *twitter.com/#!/malaysianmet*

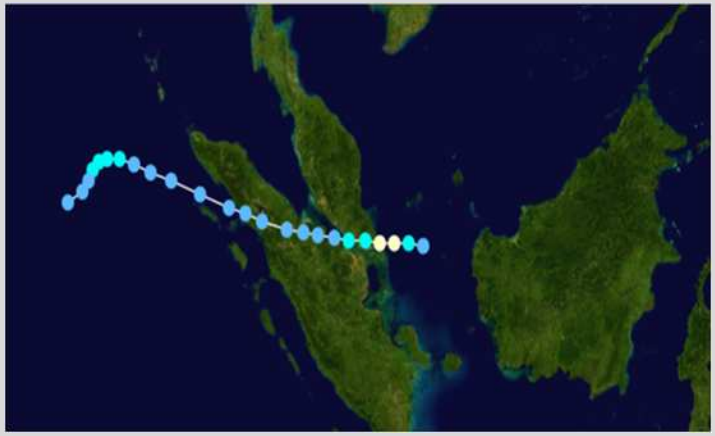
Coordination with Disaster Management Authorities and The Media

Warning Coordination	Meetings, seminars, workshops and awareness programmes are held regularly to discuss about enhancement of our services with regard to warnings and advisories.
Needs from Disaster Management Authorities	Disaster management authorities should only refer to warnings and advisories issued by MetMalaysia and not from other sources. Information from unofficial sources such as from social media, SMS and The Internet have been known to cause problems.
Warning Coordination (Media)	The MetMalaysia has a mini studio where the weather reports are broadcasted live four times daily. Advisories/warnings are also broadcasted through TV crawlers, news(TV, Radio, printed, electronic) and interview sessions.
Needs from Media	Our local media provide us with a lot of coverage regarding warnings/advisories to the public. There is a need to set up a TV channel fully dedicated to broadcasting information such as weather forecasts/warnings.

Previous Significant Tropical Cyclones Impacting Malaysia

However, there were two tropical storms that had direct significant impacts on Malaysia :

1) In December 1996, Tropical Storm Greg hit Sabah.



2) Typhoon Vamei landed over southwest Johor in December 2001

Impacts of Tropical Storm Greg

• Greg[?] moved into Sabah at around 251600Z (Christmas night), depositing heavy rains that triggered floods and caused rivers to overflow their banks.

• The storm affected a total of 17,000 people and 226 villages along the Sabah's southwest coast. It destroyed 4,925 houses and killed 230 people.

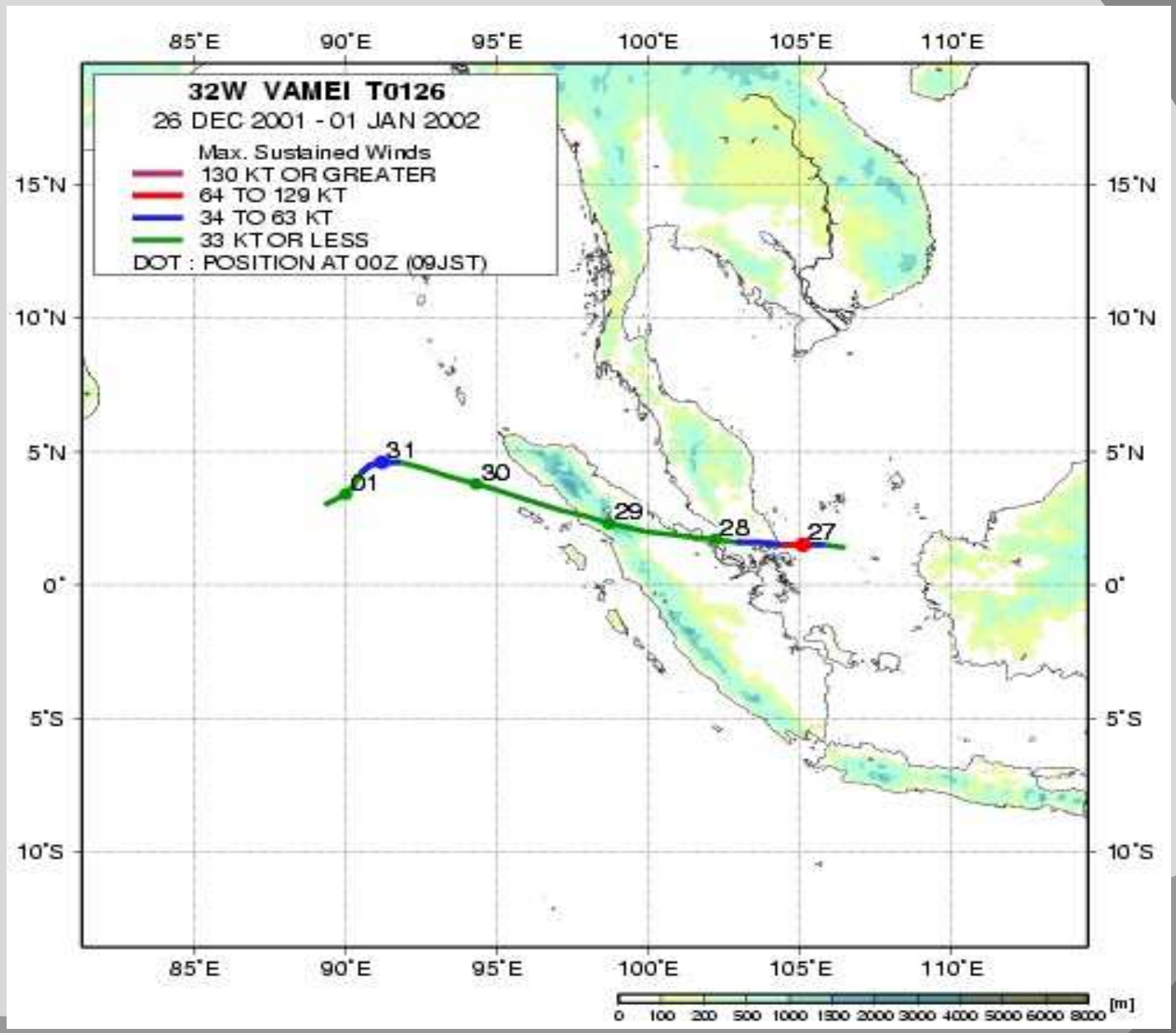
• Tropical Storm Greg was the most devastating tropical storm ever to hit Malaysia with an estimated economic loss around USD 280 million.

Typhoon Vamei : Rare Typhoon of the Equator

Satellite imagery of Typhoon Vamei on 27th December 2001

This rare event was first detected by observations of typhoon strength winds from a US navy ship, and the existence of an eye structure was confirmed by satellite and radar imageries

Typhoon Vamei : Rare Typhoon of the Equator



Typhoon Vamei track shows the Typhoon path

Impacts of Typhoon Vamei

- Caused flood in SE part of Johore
- Typhoon Vamei claimed 5 casualties.
- Estimated economic loss around USD 4.2 million.

CHALLENGES

- Inadequate coverage of observational stations: automatic weather and marine stations, and radar.
- Disruption in information dissemination system particularly SMS and Internet during peak season/hours.
- Huge cost of acquiring and maintaining observational instruments and systems.
- Public awareness - limited capacity and resources to educate the public.

STRATEGIES FOR IMPROVEMENT

- Establishing observational stations at strategic locations and upgrading existing ones.

- Operationalization of advanced numerical models especially high resolution storm surge and wave models.

- Enhancing the dissemination of warnings through various telecommunication channels.

- Conducting regular disaster awareness programs.

PEOPLE-CENTRED MULTI-HAZARD EARLY WARNING SYSTEM

RISK KNOWLEDGE




OBSERVATION & WARNING SYSTEM






DISSEMINATION & COMMUNICATION




RESPONSE CAPACITY




Severe Weather Awareness Programs

EXHIBITIONS

DIALOGUES

COMMUNITY PARTICIPATION

MEDIA SESSIONS

STRATEGIES FOR IMPROVEMENT

Identify risk areas and propose to the local authority to produce inundation maps for high risk zones.

Colloboration with local authority involved in disaster management on data sharing and local and international agencies on tropical cyclone research (Blue Ocean Strategy).

Thank You

ATTACHMENT 1

No.	Tropical Cyclone Name	Category	Date		Total No. of TC Warnings/ Advisories	Total No. of Heavy Rain Warnings/ Advisories (due to TC)	Total No. of Strong Wind and Rough Seas Warnings/ Advisories (due to TC)
			Start	End			
1	SONAMU	Depression	01/01/2013	03/01/2013	50	1	40
		Tropical Storm	03/01/2013	04/01/2013			
		Severe Tropical Storm	05/01/2013	06/01/2013			
		Tropical Storm	06/01/2013	07/01/2013			
		Depression	08/01/2013	10/01/2013			
2	MINDANAO	Depression	08/01/2013	10/01/2013	NIL	NIL	NIL
3	SHANSHAN	Depression	18/02/2013	21/02/2013	27	NIL	22
		Tropical Storm	22/02/2013	23/02/2013			
		Depression	23/02/2013	23/02/2013			
4	YAGI	Depression	06/06/2013	08/06/2013	7	NIL	NIL
		Tropical Storm	08/06/2013	12/06/2013			
		Depression	12/06/2013	12/06/2013			
5	LEEPI	Depression	16/06/2013	17/06/2013	30	NIL	26
		Tropical Storm	18/06/2013	20/06/2013			
6	BEBINCA	Depression	19/06/2013	20/06/2013	27	NIL	27
		Tropical Storm	21/06/2013	24/06/2013			
		Depression	24/06/2013	24/06/2013			