Public Weather Services Workshop on Warning of Real-Time Hazards by Using Nowcasting Technology

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Application of Nowcasting Techniques Towards Strengthening National Warning Capabilities on Hydrometeorological and Landslides Hazards

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INTRODUCTION

The weather in Malaysia is mainly influenced by two monsoon regimes, namely, the Southwest Monsoon from late May to September, and the Northeast Monsoon from November to March. The Northeast Monsoon brings heavy rainfall, particularly to the east coast states of Peninsular Malaysia and western Sarawak, whereas the Southwest Monsoon normally signifies relatively drier weather. In the past, widespread floods have occurred especially during the northeast monsoon season.

Malaysia has always been complacent and perceived to be relatively free from major hydrometeorological and geological hazards. The last decade sees a change in the occurrence of natural disasters in the country. With rapid development in high-rise buildings and other infrastructures, the occurrences of hydrometeorological and geological hazards have been increased. These natural hazards include monsoon flood, flash flood in the cities, severe storms, storm surge, landslides, earthquakes and tsunami.

The government has taken the initiatives to implement various projects and activities towards disaster prevention and mitigation in the country. The implementation of these projects are involving cooperation and collaboration from various agencies in the country. Most of these natural hazards are basically weather-driven hazards and many of these projects require input from the Malaysian Meteorological Department (MMD).

Monsoon Flood

The Northeast monsoon is the major rainy season in the country. Occasionally, the Northeast monsoon brings heavy rains which may cause severe floods to the east coast states of Peninsular Malaysia during the months November till January and January till early March over the western part of Sarawak and Sabah.

During the Northeast Monsoon, large-scale features such as the monsoon surges and the near-equatorial trough (and associated monsoon lows and cyclonic vortex) strongly influence the rainfall amounts and patterns. The cold surges or monsoon surges come in phase with the westward moving cyclonic vortex embedded in the near-equatorial trough will bring widespread torrential rain. The widespread heavy

monsoon rain normally lasts for 2 to 3 days. In severe cases, it can last for 3 to 8 days. Fig. 1 depicted the synoptic flow pattern for the onset of heavy rain.

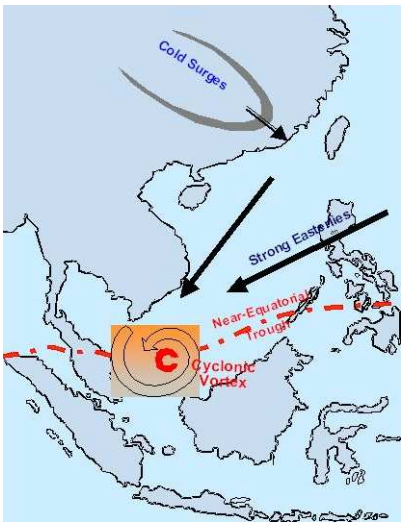


Fig.1 : Interaction of monsoon surges and westward moving cyclonic vortex.

Since this is more or less an annual occurrence, Disaster Preparedness Meetings on the flood preparation before the onset of the monsoon are normally held to ensure all preparations are done. The National Disaster Committee, State level Disaster Committee and even district level committee are briefed by the various agencies, including MMD on the amount of rainfall expected. MMD produces a booklet on Monsoon Outlook and distribute these booklets to all disaster relief agencies and other related agencies. These monsoon booklets contain the monsoon outlook for the coming monsoon and probable amount of precipitation each month, wind and sea state outlook, the monitoring and distribution system of forecast and severe weather warnings, some public education articles on the monsoon, ENSO and tropical storms as well as the phone numbers of every forecast centers and key personnel in the department.

In MMD, the Central Forecast Office (CFO) starts its preparation too from mid-October each year with more intensive monitoring and the issuance of special forecast to relevant agencies. Heavy rainfall, strong wind and rough sea advisories and warnings will be issued within 24 to 48 hours before the impact of these severe weather events on Malaysia.

Flash Flood

Due to intense development, flash flood occurrence in the country has been on the increase and it can happen several times each year leading to massive disruption in business activities with immense socio-economic and financial impacts. Flash flood is normally caused by severe storms such as squall-lines or thunderstorms which are localized with rainfall of high intensity and short durations (2 to 5 hours).

Due to the high intensity rainfall, low lying and poorly drained areas may be subjected to heavy flooding as the squall-line passes. In late 1996 Penang and Prai was affected by flash flood caused by squall-line which developed in the northern Malacca Straits moving rapidly inland in the early morning. These floods resulted in considerable damage of property and public facilities.

Thunderstorms occur throughout the year but are most likely to happen in the inter-monsoon periods, namely April to May and October to November. Over land, thunderstorms frequently develop in the afternoon and evening hours while over the sea, thunderstorms are more frequent at night. Sometimes the thunderstorm cells are small and localized but can be severe with intense lightning activities, heavy rainfall and strong wind gust. It is difficult to forecast the precipitation intensity, direction and the speed of the thunderstorms. The severe thunderstorms with high intensity rainfall and short duration may cause flash flood in major cities and towns.

The city of Kuala Lumpur, situated at the confluence of 2 rivers, has undergone rapid and drastic development. Flash flood occur several times a year. Traffic grinds to a standstill; cars are submerged in underground car parks. On the overloaded main roads, cars crawls for hours when a flash flood occurs.

Figures 2 and 3 below depicted flash flood occurred in Kuala Lumpur, June 2003, after a three hours of heavy rainfall caused by severe thunderstorms. The maximum rainfall of 136 mm was recorded at the Gombak rainfall station. Some 1,200 families were evacuated from four areas in the city at the height of the massive flash flood in the Klang Valley.

Fig.2 : Flash flood in Kuala Lumpur

Fig.3 : Basement car park was flooded

The government has implemented flood mitigation measures to mitigate the impacts of flash floods in Kuala Lumpur. The conventional means to flood mitigation are no longer effective. The Department of Drainage and Irrigation Malaysia and the Highway Authority of Malaysia have been jointly appointed for the implementation of the project, SMART, an acronym for Stormwater Management and Road Tunnel, to alleviate the flooding problem in Kuala Lumpur.

The objective of SMART Tunnel is to reduce the floodwaters entering the city by diverting the water through a tunnel and releasing it into the river downstream of the

city. The SMART Tunnel is made up of 11.8m inner diameter, 9.7km long tunnel to store and divert the floodwater. The unique feature of SMART as shown in Fig.4 is the 3 km double-deck motorway which will be used for dual purpose, i.e. used for traffic flow when the flood diversion is not in operation to ease the congestion of traffic and used for floodwater drainage when the need arises.

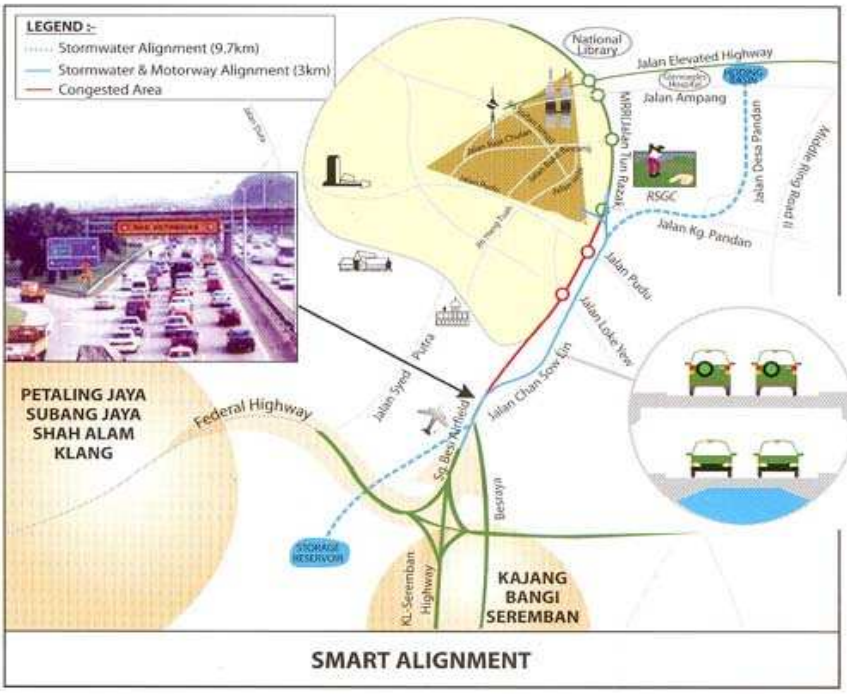


Fig.4 : The SMART Project

The challenge for MMD is the ability to provide early warning for short duration, very heavy precipitation thunderstorm in and around Kuala Lumpur with sufficient lead time to enable timely closure of the two upper-decks of the tunnel to traffic.

With this project are carefully mapped distribution of telemetric rainfall stations and the possible installation of new radar which would provide the necessary observational data for monitoring and input to a rainfall/flood model. MMD is working closely together with the Department of Drainage and Irrigation to provide accurate forecast input.

Wind Gust from Severe Thunderstorm

Thunderstorms are a common phenomenon occurring frequently during the afternoon and early evening during the periods of April to May and October to November. Thunderstorms are capable of producing hail, heavy rain, frequent lightning and strong gusty winds. The strong winds can reach very high speeds causing significant damage along its path and is extremely dangerous to aviation. The strong winds uprooted trees, blew off roofs toppled over lampposts and caused

chaos. Some of the most severe weather occurs when a cluster of thunderstorms affect an area for a prolonged period of time.

All meteorological forecast offices at principal airports in the country are equipped with conventional weather radars which can detect development of thunderstorms and monitor their movement. The meteorological office at the Kuala Lumpur International Airport at Sepang has a Doppler Radar capable of detecting wind shear in thunderstorms.

The challenge for MMD is the lack of capability for the provision of timely and accurate early warning on strong winds to the users with sufficient lead time.

Landslides

Landslides in Malaysia are largely triggered by heavy rain due to either a single heavy thunderstorm/rain or successive days of moderate rain especially during the rainy season. Although soil type and structure also contributes towards landslide risks, currently it is felt that monitoring the rainfall amount and rainfall intensity over hilly terrain could serve as a useful indicator of the risk levels of landslides. In recent years, the incidences of landslides are on the increase, and this could be attributed to the rapid development and land clearing.

The landslide that was occurred at Taman Hillview in Kuala Llumpur which destroyed a home built on a slope with eight people died and five survived as shown in Fig. 5. The Department of Drainage and Irrigation's rainfall records showed that it has been raining everyday for almost 15 days with rainfall amounting to 250 mm before this tragedy occurred.

Fig.5 : An aerial view of the house in Taman Hillview that was destroyed in the landslide

Fig. 6: Landslide along the North- South Expressway

Due to the increased landslides occurrence over hilly terrain, a special Landslide Committee has been set up to address this issue. This Committee is headed by Public Work Department with members from various agencies such as National Security Division, MMD, Mineral and Geoscience Department, Drainage and Irrigation Department, Malaysian Center for Remote Sensing, Malaysia Highway

Authority, Local government, Survey and Mapping Department. The Committee is in the process of identifying the high risk areas of landslide in the country and working towards the ability to provide more accurate risk level indicator to road users and people staying in higher terrain.

Existing Capacities and Major Gaps in Monitoring and Prediction of Hydrometeorological and Landslide Hazards

MMD has established 8 regional forecast offices, 39 strategically located automatic weather stations (AWS), 10 conventional weather radars, 1 Doppler weather radar and 1 wind profiler. The Doppler weather radar and the wind profiler are located at the KLIA airport.

In Malaysia the capacities in the monitoring and prediction of hazards vary considerably from one hazard to another. MMD's capacity to monitor and predict heavy monsoon rain during the Northeast monsoon is relatively more developed than for other types of weather related hazards such as flash flood, strong gust from severe thunderstorm and landslides. MMD has the warning capability for the issuance of heavy rainfall, strong wind and rough sea advisories and warnings within 24 to 48 hours before the impact of these severe weather events on Malaysia.

The forecasting of severe thunderstorms is challenging as the hazards affect localized areas. The technical warning capabilities utilizing diverse nowcasting techniques for the prediction of precipitation intensity from severe thunderstorms that may cause flash flood and landslides as well as wind gust from severe thunderstorms has not been developed. The operational warning systems for predicting speed and direction of severe thunderstorms, accuracy of quantitative precipitation and accuracy of wind gust nowcasting are still lacking.

While significant progress has been made on the technical aspects of monitoring and forecasting heavy rainfall during the Northeast monsoon, many major gaps and shortcomings exist for the applications of nowcasting techniques for short range forecasting throughout the whole country.

The key issues include :

- Inadequate coverage of observing systems such as high resolution three-dimensional Doppler radar data , real-time AWS rainfall stations for monitoring of hydro-meteorological hazards,

- Inadequate level of technical capabilities (resources, expertise and operational warning services) for monitoring and nowcasting of severe events in MMD

- Insufficient multi-disciplinary, multi-agency coordination and collaboration for improving the nowcasting techniques on weather related hazards.

THE WAY FORWARD

Improve Infrastructure And Capacity Building

MMD is focusing on capacity building and installation of essential equipments and infrastructures in order to be able to provide meaningful and accurate meteorological information based on sound scientific basis and up-to-date technology. Under the Ninth Malaysia Development Plan which would take effect from 2006 till 2010, budget has been allocated for training, attachments to specialized meteorological centers or universities, further degrees and participating in international seminars, conferences, symposiums.

Under the same development plan, additional 120 automatic weather stations (AWS) will be installed nationwide between the year 2007 and 2009. The Drainage and Irrigation Department (DID) has installed rain gauges nationwide for monitoring and prediction of flood. MMD will work closely with DID for the sharing of rainfall data to improve the data coverage and to strengthen MMD's warning capabilities on weather related hazards.

Some of the existing conventional weather radars will be upgraded to Doppler radar. Telecommunication network and NWP will be upgraded and enhanced. The delivery systems will further strengthen to allow meteorological information and warnings to be disseminated to the users in a timely manner.

Promote Public Awareness And Education

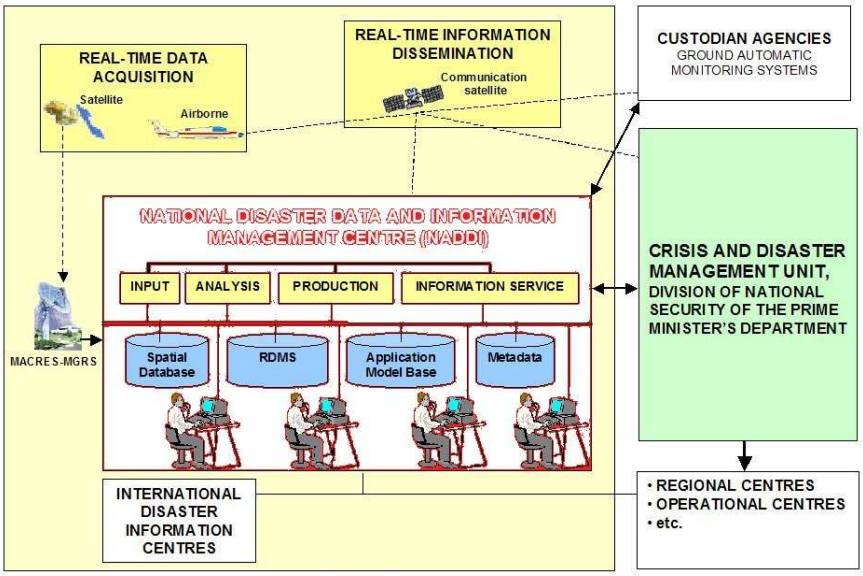
After the occurrence of the catastrophic tsunami on the 26 Dec 2004, the National Security Division, MMD and other government agencies, local universities and NGOs have organized numerous seminars, workshops, drills, exhibitions in various parts of the country to raise awareness of the public relating to earthquakes and tsunami.

Public awareness and understanding of other weather related disasters need to be promoted allowing individual to react in a proper manner to the warnings. Although in the past, MMD had participated in exhibitions and produced some useful pamphlets for distribution to the public, probably this effort had to be intensified to promote awareness regarding the implications and impacts of extreme weather event. It is essential to work closely with the mass media. The mass media is an important channel to educate the public in understanding and raise the level of awareness to weather related disaster.

NADDI

Malaysian Center for Remote Sensing (MACRES) is in the process of implementing the National Disaster Data and Information Management Centre (NADDI) to address the requirements for early warning, detection, monitoring, mitigation, and the requirements for managing the disasters effectively. NADDI comprises a central disaster database and an information management system that will focus on forest fires, flood, landslide, oil spill as well as other disasters involving petrochemical, refineries, toxic waste, etc. This system will serve as a central system for collecting,

storing, processing, analyzing and distributing value-added data and information on disaster to disaster management and relief agencies.



Components of NADDI

Improve Nowcasting Capability

With the advancement of science and technology, there is an urgent need to improve nowcasting capabilities so as to be able to provide more timely, accurate and meaningful forecasting on the prediction of speed and direction of convective thunderstorms, rainfall intensity, accuracy of severe thunderstorm wind gust. In Malaysia where the rainfall is basically convective in nature, NWP products need to be enhanced for predicting accurately the convective precipitation in the tropics.

International coordination and cooperation is important for the successful implementation of the nowcasting applications for MMD. WMO provides a vehicle to facilitate cross-cutting activities on technical issues, share and exchange of experience and support of capacity building for the nowcasting applications.

CONCLUSION

In the last decade, the occurrences of weather related hazards such as monsoon flood, flash flood in the cities, severe thunderstorms, storm surge and landslides have been on the increasing trend. While significant progress has been made on the technical aspects of monitoring and forecasting heavy rainfall during the Northeast monsoon, the operational warning systems for predicting the speed and direction of severe thunderstorms, accuracy of quantitative precipitation and wind gust are still lacking. Under the initiative of WMO, diverse nowcasting techniques will be introduced and the possible participating in a nowcasting project will certainly strengthen national warning capabilities on monsoon flood, flash flood, severe thunderstorms, storm surge and landslides.

There is need for continued development of operational nowcasting applications and warning systems within the MMD to provide more effective warnings of severe storms. Close cooperation between NMHSs must be enhanced. Best practices and experiences should also be shared among nations to expedite each nation's ability towards nowcasting applications and weather related hazards warning system.

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