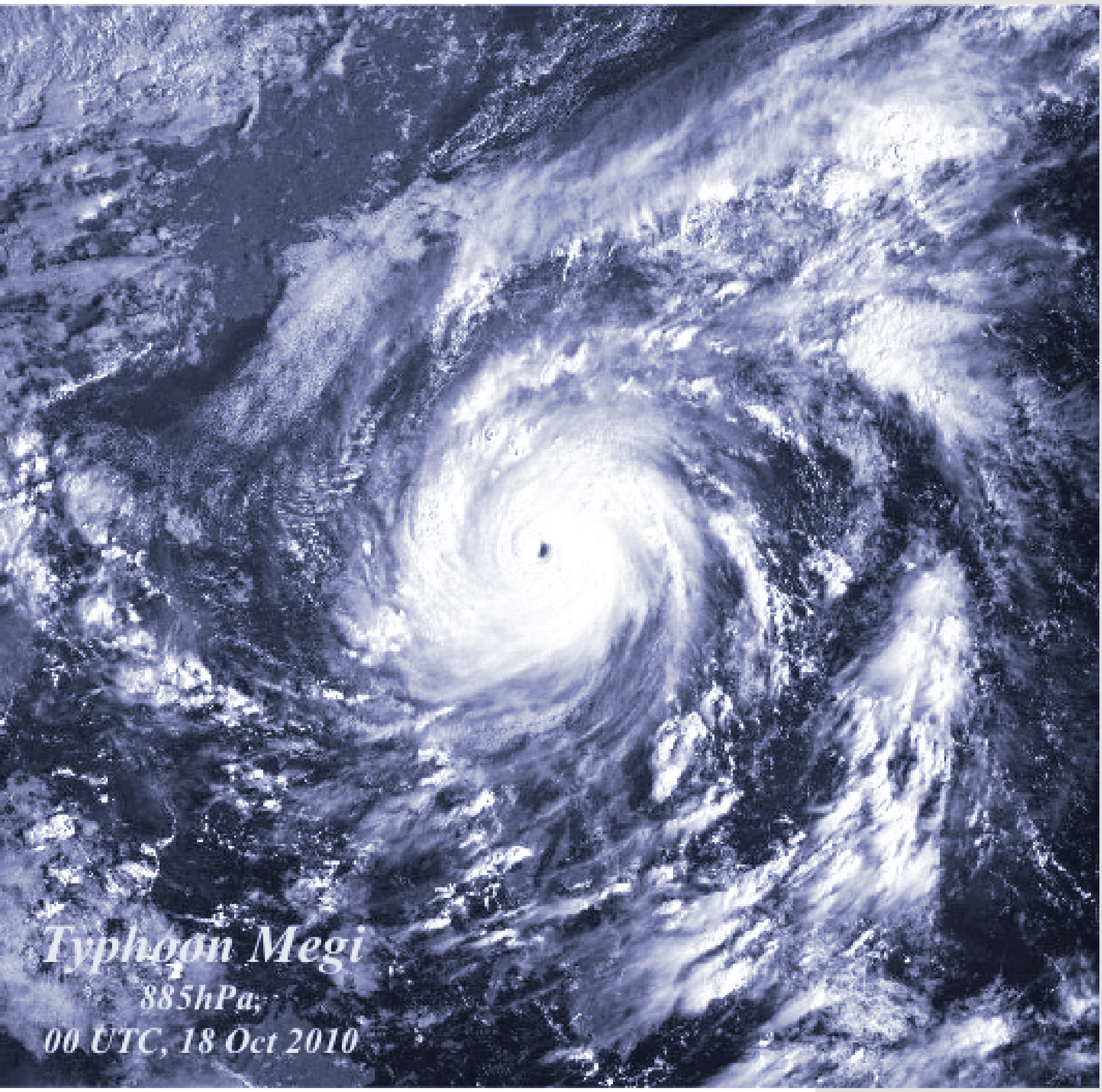
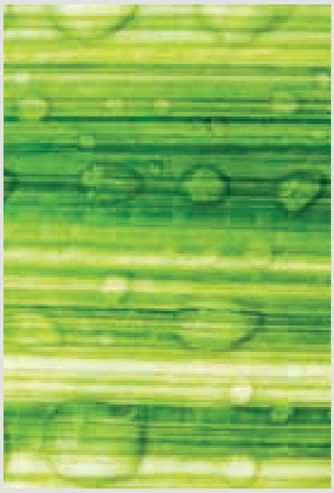
ESCAP/WMO
Typhoon Committee

2010
Annual Review
TCAR





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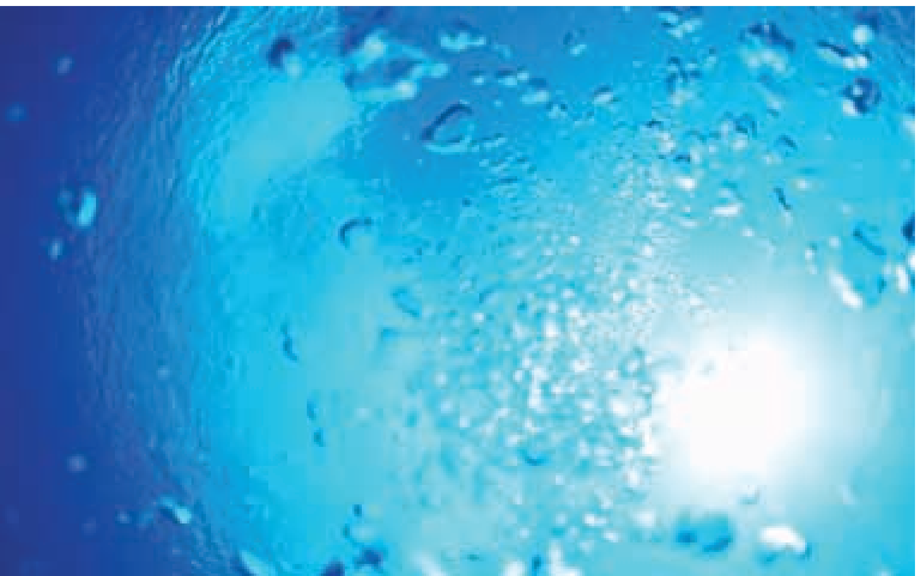

UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific
WMO

On the Cover:

MTSAT-1R VS imagery of MEJI (1013) at 00UTC, 18 October 2010.
(By courtesy of Japan Meteorological Agency)

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Chapter 3 CONTRIBUTED PAPERS

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ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC (ESCAP)

The Economic and Social Commission for Asia and the Pacific (ESCAP) aims to initiate and participate in measures for concerted action towards the development of Asia and the Pacific, including the social aspects of such development, with a view to raising the level of economic activity and standards of living and maintaining and strengthening the economic relations of countries and territories in the region, both among themselves and with other countries in the world. The Commission also:

- provides substantive services, secretariats and documentation for the Commission and its subsidiary bodies;
- undertakes studies, investigations and other activities within the Commission's terms of reference;
- provides advisory services to Governments at their request;
- contributes to the planning and organization of programmes of technical cooperation and acts as executing agency for those regional projects decentralized to it.

WORLD METEOROLOGICAL ORGANIZATION (WMO)

The World Meteorological Organization (WMO), a specialized agency of the United Nations, serves:

- to facilitate international cooperation in the establishment of networks of stations and centres to provide meteorological and hydrological services and observations;
- to promote the establishment and maintenance of systems for rapid exchange of meteorological and related information;
- to promote standardization of meteorological and related observations and ensure the uniform publication of observations and statistics;
- to further the application of meteorology to aviation, shipping, water problems, agriculture and other human activities;
- to promote activities in operational hydrology and to further close cooperation between Meteorological and Hydrological Services;
- to encourage research and training in meteorology and, as appropriate, in related fields.

ESCAP/WMO TYPHOON COMMITTEE (TC)

Under the auspices of ESCAP and WMO, the Typhoon Committee was constituted with a view to promoting and coordinating efforts for minimizing tropical cyclone damage in the ESCAP region. The incipient stage of the Typhoon Committee dated back to 1964 when the United Nations Economic Commission for Asia and the Far East (ECAFE) 11 at its twentieth session recommended that the Secretariat, in cooperation with WMO, should study the practical means of initiating a joint programme of investigations of tropical cyclones in the ECAFE region. Accordingly, a meeting of the Working Group of Experts on Typhoon was organized by ECAFE and WMO with financial assistance from the United Nations Development Programme (UNDP) in Manila in December 1965.

Noting the extensive damage caused by tropical cyclones in the region, the meeting recommended that a Preparatory Mission on Typhoons be organized to visit the countries in the ECAFE region and neighbouring countries affected by tropical cyclones, in order to formulate an action programme to mitigate tropical cyclone damage. It also recommended that a second meeting of experts be convened to examine the report of the Mission. Consequently, the ECAFE/WMO Preparatory Mission on Typhoons was organized during the period from December 1966 to February 1967, with financial assistance from UNDP. Broadly, the report of the Mission provided recommendations to improve meteorological observing networks, telecommunication facilities, tropical cyclone forecasting and arrangements for warnings. It also described requirements for the improvement or establishment of new pilot flood forecasting and warning systems on a key river basin in each of the countries visited.

The establishment of a Regional Typhoon Centre was also dealt with in the report. The second meeting of the Working Group of Experts on Typhoon was held in Bangkok in October 1967 and the meeting endorsed the report of the Preparatory Mission and reiterated the need for early action to mitigate tropical cyclone damage as a means of speeding economic development in the region. It also re-affirmed that national as well as joint efforts were necessary to combat effectively the detrimental effect of tropical cyclones.
Accordingly, the meeting recommended that a

Typhoon Committee with a Regional Typhoon Centre as its executive body be established under the auspices of ECAFE in cooperation with WMO; and the ECAFE and WMO secretariats were requested to draft jointly the statute and rules of procedure of the proposed Typhoon Committee and to convene an ad hoc meeting of government representatives to consider and finalize the drafts. The ad hoc meeting on the statute of the Typhoon Committee was held in Bangkok from 29 February to 2 March 1968. The meeting, besides finalizing and adopting the statute and rules of procedure of the Typhoon Committee, recommended that the statute of the Typhoon Committee be submitted to the twenty-fourth session of ECAFE and the appropriate body of WMO for consideration. It also recommended that ECAFE and WMO should provide a small staff to undertake the preparatory work required for the implementation of the programme recommended by the Mission.

At its twenty-fourth session in April 1968, ECAFE endorsed the establishment of the Typhoon Committee in accordance with the statute as adopted by the ad hoc meeting. In a parallel action, the WMO Executive Committee, at its twentieth session in 1968, endorsed the establishment of the Typhoon Committee. The inaugural session of the Typhoon Committee was convened in Bangkok in December 1968. The functions of the Committee are to:

- review regularly the progress made in the various fields of tropical cyclone damage prevention;
- recommend to the participating Government plans and measures for the improvement of meteorological and hydrological facilities needed for tropical cyclone damage prevention;
- recommend to the participating Government plans and measures for the improvement of community preparedness and disaster prevention;
- promote the establishment of programmes and facilities for training personnel from countries of the region in tropical cyclone forecasting and warning, flood hydrology and control within the region and arrange for training outside the region, as necessary;
- promote, prepare and submit to participating Governments and other interested organizations plans for coordination of research programmes and activities concerning tropical cyclones;
- consider, upon request, possible sources of financial and technical support for such plans and programmes;
- prepare and submit, at the request and on behalf of the participating Governments, requests for technical, financial and other assistance offered under the UNDP and by other organizations and contributors.

In carrying out these functions, the Typhoon Committee maintains and implements action programmes under the five components, namely meteorology, hydrology, disaster prevention and preparedness, training, and research with contributions and cooperation from its Members and assistance by the UNDP, ESCAP, WMO and other agencies. The Typhoon Committee is currently composed of 14 Members: Cambodia, China, Democratic People's Republic of Korea (DPRK), Hong Kong-China, Japan, Lao PDR, Macau-China, Malaysia, the Philippines, Republic of Korea, Singapore, Thailand, Viet Nam and the United States of America.

TYPHOON COMMITTEE (2011)

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Mr. Cho Seok Joon (Republic of Korea)

Typhoon Committee Secretariat

Secretary
Mr. Olavo Rasquinho

Meteorologist
Mr. Derek Leong

Hydrologist
Mr. Liu Jinping

Administrative Staff
Ms. Denise Lau
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ESCAP/WMO TYPHOON COMMITTEE ANNUAL REVIEW 2010

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FOREWORD

The first four-year cycle, during which the Typhoon Committee Secretariat has been installed in Macao, China, is finishing. During this period the Committee has strengthened its identity with the creation of a logo and the composition of the song “Typhoon! Typhoon!”, a kind of anthem of the Committee. The beginning of a new series of technical publications, the first of which consists of an extensive study of the impact of climate change on tropical cyclone frequency and intensity in the Typhoon Committee region, has also contributed to enhance this identity.

In terms of natural disasters, the year 2010 was marked by the magnitude 7 earthquake that occurred in Haiti, which caused a huge number of victims, about 230,000 dead and 300,000 wounded. Pakistan was victim of intense monsoon rains which caused about 1600 fatalities, and around twenty million people were affected due to loss of livelihoods and property, and nearly one million damaged or destroyed houses. These two natural disasters, the most significant in 2010, occurred in other countries than Typhoon Committee area; nevertheless some Members of the Committee were also severely affected by hydro-meteorological hazards. The central and southern parts of China suffered intense floods which have caused the evacuation of thousands of people. Also in Viet Nam, the Philippines and Thailand the intense rain caused frequent landslides and flashfloods and destroyed dykes and other structures. With regard to the formation and development of tropical cyclones, the most significant was the super typhoon Megi, one of the most intense typhoons on record, in whose center the pressure reached values around 885 hPa, causing huge damages in Luzon, Philippines and eastern China.

Thousands of lives were saved in 2010 thanks to the coordinated action of the meteorological, hydrological and civil protection services, due to the issuance of timely early warnings and evacuation of populations.

Although a large number of people have been saved from the action of hydro-meteorological phenomena, and we have done our best to avoid more serious damage, we will not be satisfied as long as there are lives lost that could be saved. That is why the Committee has been increasingly striving towards a better coordination of efforts to improve the joint action of the three components of the Committee, either holding meetings whose participants are meteorological, hydrological and DRR experts, or developing actions and projects involving the three components. This is the case of the crosscutting project on urban flood risk management (UFRM), whose main objective is to establish guidelines based on which the entities who deal with flood risk management can take action so that the consequences of flooding can be mitigated.

In 2010 fellowships were offered by China (CMA); Hong Kong, China (Hong Kong Observatory) and Republic of Korea (KMA). Workshops, training courses and seminars have also been carried out by the TC in collaboration ESCAP, WMO, IDI, NEMA, and other organizations such as Macao Foundation, ICHARM and JAXA. Another important issue which was addressed in 2010 was undoubtedly the preparation and discussion of the Strategic Plan for the period 2012-2016.

All progress in 2010 was certainly due to the joint efforts of Members and also to the harmonious collaboration between the Working Groups on Meteorology, Hydrology, DRR, the Training and Research Coordination Group and the TC Secretariat, all working under the guidance of the Advisory Working Group, ESCAP and WMO.

Although the Committee is to tread the right path, our ambition is to enhance our performance so that we can more efficiently perform the functions of which we were commissioned.

Mr. Cho Seok Joon
Chairman of Typhoon Committee

Introduction

The Typhoon Committee Annual Review (TCAR) has been published since 1985. From 1985 to 1994, the Royal Observatory of Hong Kong provided a chief editor for the preparation and publication of the annual review. In 1995, the Typhoon Committee Secretariat (TCS) took over the task of the publication of TCAR. The Typhoon
Committee, in its 39th Session held in Manila, Philippines, from 4 to 9 December 2006, appointed the Typhoon Committee Secretary as the Chief Editor.

Chapter 1 provides an overview of the activities of the Typhoon Committee in 2010. It contains detailed information of its Members' respective national programmes and
activities related to meteorology, hydrology, disaster risk reduction, training and research, as well as the achievements of ESCAP and WMO related to water resources management and disaster risk reduction. It also includes summary of the activities of TCS undertaken in 2010.

Chapter 2 includes a summary of the 14 tropical cyclones with tropical storm intensity or higher, in 2010. A new method of assigning Asian names to tropical cyclones in the Western North Pacific and South China Sea was implemented on 1 January 2000. Each tropical cyclone is identified by a four-digit code assigned by the Japan Meteorological Agency (JMA). In accordance with the WMO Guide to Marine Meteorological Sciences (WMO No. 471) and WMO Manual on Marine Meteorological Services (WMO-No. 558), the intensity of a tropical cyclone is classified following the table below.

As the classification of tropical cyclones is not the same in all TC Members, a table1 comparing this classification in several Members, which also includes the USA classification in North Atlantic, is also presented below.

This chapter also includes the narrative accounts of tropical cyclones in 2010 based on post analyses submitted by Members. Each report includes an account of the movement and intensity change of the tropical cyclone. The extent of damage caused by the tropical cyclone is documented as accurately as possible utilizing available data supplied by the national editors.

Sustained winds as referred to are wind speeds averaged over a period of 10 minutes. The velocity unit of kilometers per hour (kph) is used for wind speed as well as speed of movement of tropical cyclones and other weather systems. The SI unit of hectopascal (hPa) is used for atmospheric pressure. Reference times used in this Chapter are primarily in Coordinated Universal Time (UTC). Whenever possible, station names and numbers contained in WMO Weather Reporting-Observing Stations (WMO-No. 9, Volume A) are used for geographical references. Composite tracks and satellite images of the tropical cyclones are provided as well. Are also provided 00 UTC Sea Level Synoptic Analysis Charts on the day, a day before and a day after peak intensity was attained and upper air charts referring to the day when maximum strength was reached.

Chapter 3 consists of contributed papers, which were presented at the 43rd TC Session. Chapter 4, the final chapter, provides the 2010 activities of the WMO Tropical Cyclone Programme.

The TCAR has been published through the joint support of ESCAP and WMO. It would have not been made possible without the contributions of the National Editors of Members of the Typhoon Committee.

Special thanks to TCS staff Mr. Leong Kai Hong (Derek), meteorologist, Mr. Liu Jinping, hydrologist, Ms. Denise Lau, senior administrative secretary and Ms. Lisa Kou senior finance clerk , for assisting in the editorial work and layout.

Chief Editor
December 2011, Macao

1 This table is the Annex I to the "Assessment Report on impacts of Climate Change on Tropical Cyclone Frequency and Intensity in the Typhoon Committee Region" to be published by Typhoon Committee in 2010.

CLASSIFICATION MAXIMUM SUSTAINED WINDS

CLASSIFICATION	MAXIMUM SUSTAINED WINDS		
	Mps	Knots	Kph
(a) Tropical Depression	up to 17.2	Up to 34	up to 62
(b) Tropical Storm	17.2 - 24.4	34 – 47	62 – 88
(c) Severe Tropical Storm	24.5 - 32.6	48 – 63	89 – 117
(d) Typhoon	32.7 or more	64 or more	118 or more

Comparison of the Tropical Cyclone Classification

Maximum Sustained Wind Speed at the centre of the tropical cyclones			Hong Kong (10-minute average)	Mainland China (2-minute average)	Japan (10-minute average)	US Pacific (1-minute average)	US Atlantic (1-minute average)
kts	km/h	m/s					
< 34	< 63	<17.1	Tropical Depression (TD)	Tropical Depression	Tropical Depression	Tropical Depression	Tropical Depression
34 – 47	63 – 87	17.2-24.4	Tropical Storm (TS)	Tropical Storm	Tropical Storm	Tropical Storm	Tropical Storm
48 – 63	88 – 117	24.5-32.6	Severe Tropical Storm (STS)	Severe Tropical Storm	Severe Tropical Storm		
64 – 80	118 – 149	32.7-41.4	Typhoon (T)	Typhoon	Typhoon 64 – 84 kts	Typhoon 64-129kts	Hurricane categories 1: 64 – 82 kts
81 – 99	150 – 184	41.5-50.9	Severe Typhoon (ST)	Severe Typhoon	Very Strong Typhoon 85 – 104 kts		2: 83 – 95 kts
>=100	>=185	>=51	Super Typhoon (SuperT)	Super Typhoon	Violent Typhoon >=105 kts	Super Typhoon >= 130 kts	3: 96 – 113 kts; 4: 114 – 135 kts; 5: >135 kts

Note : the conversion between kts to km/h and kts to m/s may vary slightly subject to rounding practices and conversion factor decimal places.

II. Summary of Progress in Key Result Areas

2.1 Progress on Key Result Area 1: Reduced Loss of Life from Typhoon-related Disasters.

2.1.1 Meteorological Achievements/Results

1) Typhoon-related Disaster Emergency Response initiated by CMA

By the end of 2010, 7 named TCs landed on China's coastal areas. China Meteorological Administrator (CMA) launched different categories of Typhoon-related Meteorological Disaster Emergency Responses respectively (Table 2.1). About 1.23 million people were evacuated from typhoon impacted areas.

For Super Typhoon *Fanapi* (1011), two working groups from CMA were dispatched to Guangdong and Fujian provinces to inspect the typhoon forecasts and services. For Super Typhoon *Megi* (1013), Mr. Shen Xiaonong, Deputy Administrator of CMA, visited coastal provinces and supervised the typhoon forecasting and meteorological service. Several special video conferences for typhoon forecasting were held among National Meteorological Center of CMA, Guangdong and Fujian Meteorological Bureaus.

Table 2.1 Meteorological Disaster Emergency Actions initiated by CMA in 2010 in response to 7 landing TCs.

TCs' Name (Number)	Emergency Response Actions		Landing Time/Date	Warning Lead-time
	Category	Action Time		
Conson (1002)	IV III	06:20 UTC 14 Jul. 10:00 UTC 15 Jul.	11:50 UTC 16 Jul.	53h & 30min.
Chanthu (1003)	IV III	02:20 UTC 20 Jul. 10:00 UTC 21 Jul.	05:45 UTC 22 Jul.	51h & 25min.
Lionrock (1006)	IV III	01:00 UTC 29 Aug. 06:00 UTC 31 Aug.	22:50 UTC 01 Sep.	93h & 50min.
Namtheun (1008)	IV III	01:00 UTC 29 Aug. 06:00 UTC 31 Aug.	15:50 UTC 31 Aug.	62h & 50min
Meranti (1010)	IV	00:30 UTC 08 Sep.	19:30 UTC 09 Sep.	43h
Fanapi (1011)	III II	00:30 UTC 18 Sep. 08:00 UTC 19 Sep.	01:00 UTC 19 Sep. 23:00 UTC 19 Sep.	24h & 30min.
Megi (1013)	III II	00:30 UTC 19 Oct. 01:00 UTC 20 Oct.	04:55 UTC 23 Oct.	100h & 25min.

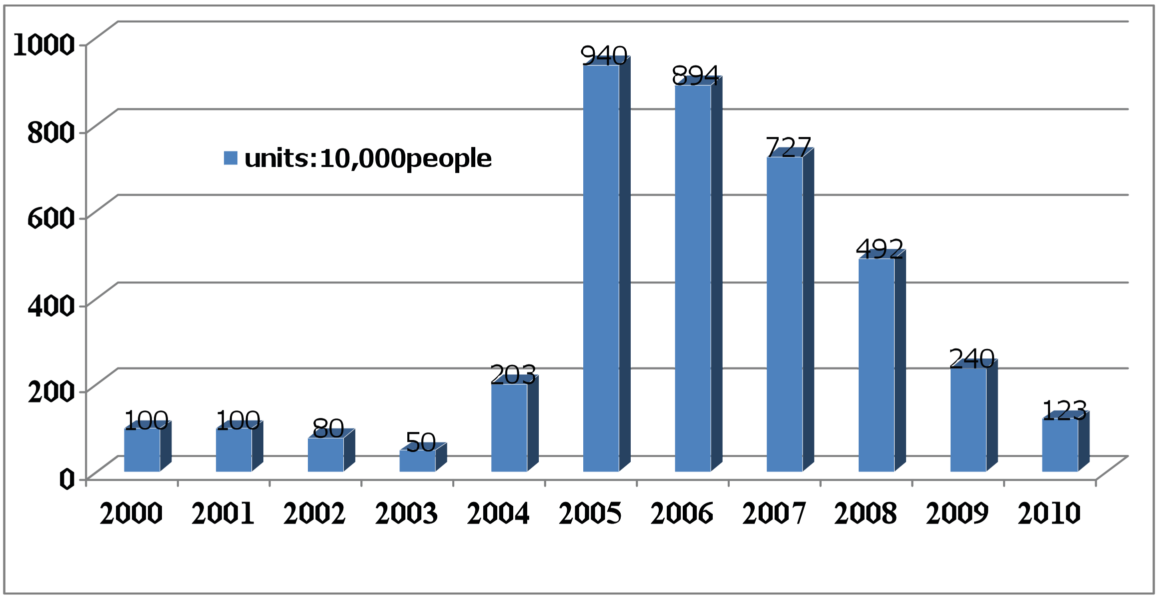

Fig 2.1 Evacuated population exposed to TC threats in 2000-2010

2) Promulgated *Regulations on Prevention of and Preparedness for Meteorological Disasters* by Chinese government

To better prevent and prepare for natural disasters induced by typhoon and other events, the State Council considered and adopted the *Regulations on Prevention of and Preparedness for Meteorological Disasters* at its 98th Executive Meeting on 20 January 2010, which was promulgated on 27 January 2010 through its directive No. 570 and became effective as of 1 April 2010.

The term "meteorological disaster" used in these *Regulations* refers to a disaster caused by typhoon, rainstorm (snowstorm), cold spell, heavy wind (sandstorm), low temperature, high temperature, drought, thunderstorm and lightning, hail, frost, heavy fog, etc.

This legal document clearly spells out that the work for prevention of and preparedness for meteorological disasters shall follow the principle of putting people first, taking scientific measures, joint efforts by governmental agencies, and participation of social entities. The implementation of these *Regulations* will help increase awareness and capacities of local governments and general public about disaster prevention and mitigation.

3) Revision of Typhoon Operation and Service Regulation by CMA

In order to further improve typhoon monitoring and forecasting service, China Meteorological Administration organized experts to revise Typhoon Operation and Service Regulation which had been implemented since 2001, the revised main contents are as the follows:

- **Extension of Typhoon Warning Zone**

In the latest revision of Typhoon Operation and Service Regulation, NMC's 48-hour TC warning zone will cover the entire South China Sea, this will be implemented from 2011.

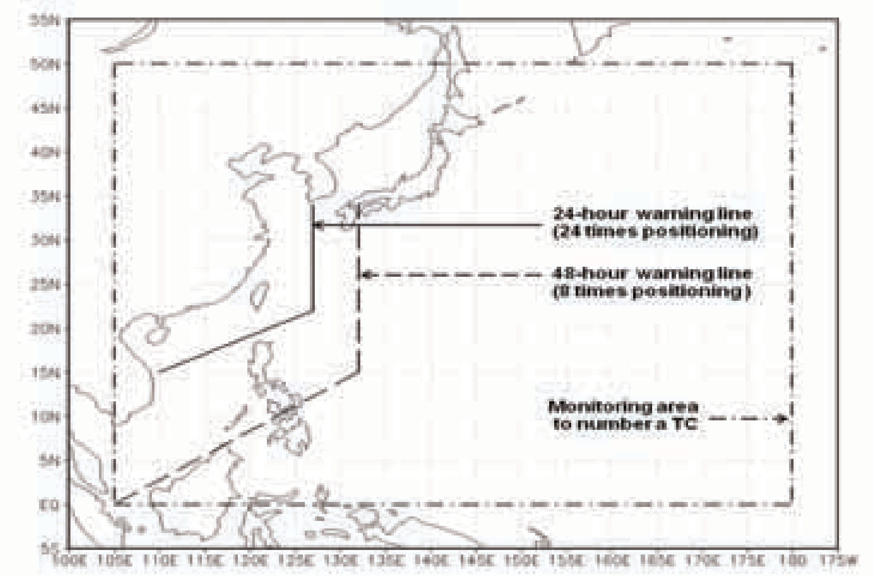

Fig 2.2 Revised typhoon warning zone of CMA

- **Extension of Tropical Depression Positioning Zone**

In the latest revision of Typhoon Operation and Service Regulation, NMC will number all tropical depressions (maximum sustained wind speed near center from 10.8 to 17.1m/s) which form over sea west of 180°E and north of the equator in western North Pacific Ocean and South China Sea. It will be implemented from 2011.

- **More Frequency for Tropical Depression Positioning**

In the latest revision of Typhoon Operation and Service Regulation, NMC will increase the frequency of positioning for tropical depressions formed over or moving into 48-hour warning zone. When a tropical depression is located outside of 48-hour warning zone, NMC only makes 4 times positioning at 00, 06, 12, and 18 UTC per day. If it moves into 48-hour warning zone, NMC will increase 4 additional positioning at 03, 09, 15, and 21 UTC. It will be implemented in 2011.

4) Issuance of 120H Official TC Forecast by CMA

Based on the experiment of 120-hour TC forecasting in 2009, NMC/CMA officially issued 120-hour TC track and intensity forecast via GTS from October 2010.

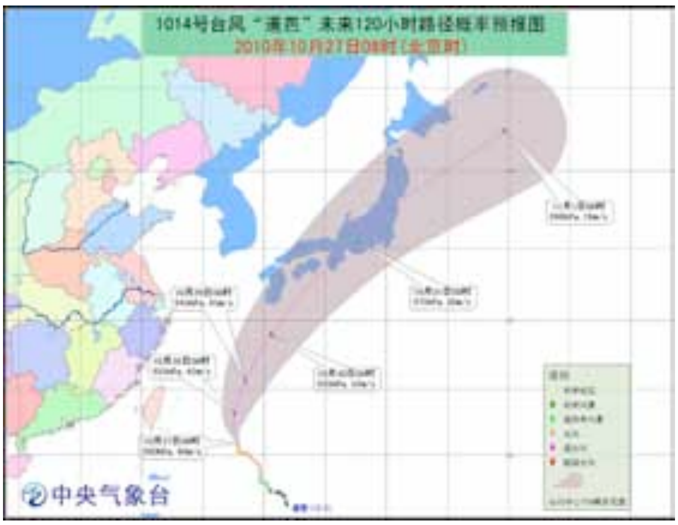

Fig 2.3 120h TC Track Probability Forecast, initial time at 00UTC on 27 Oct. 2010

5) Improvement in TC Refined Forecast by CMA

NMC/CMA has started its operational TC forecasting at 12-hour interval within 72-hour prediction based on NMC's multi-models consensus prediction system of typhoon track and intensity since October 2010. At present, this forecast is only issued as guidance material to local met. office via NMC's intranet website.

Fig 2.4 TC forecasting advisory at 12-hour interval on NMC guidance website

2.1.2 Hydrological Achievements/Results

In 2010, the departments of the Ministry of Water Resources (MWR) focused on the work for flood controls and drought relieves, and intensified their monitoring and forecasting of hydrological conditions to provide better services against floods and droughts. They also enhanced the basic research in an effort to promote technical advances in hydrological monitoring and forecasting. They also targeted to in-depth processing of hydrological information and expansion of their service products, and intensified their efforts to upgrade the operational hydrological systems, to continuously facilitate applications of flood risk mapping techniques in China.

1) Enhanced monitoring and forecasting

The Bureau of Hydrology (BOH) under MWR began its routine duty shifts as from mid March, and 24-hour duty shifts as from May 2010, to closely watch both weather and hydrological conditions, to enhance monitoring forces, to increase the frequency of measurements and forecasts, and to report or deliver meteorological and hydrological information (including rainfall and water levels of rivers) on a timely basis. In addition, BOH also enhanced weather monitoring and hydrological analysis, intensified hydrological forecasts and predictions, increased the number of discussions for joint forecasts between the hydrological departments at ministerial, basin-wide and provincial levels, and provided timely and accurate heavy-rain induced flood forecasts and predictions, which were updated continuously. Up to mid December 2010, BOH altogether issued 142 hydrological reports, 166 meteorological information, 126 hydrological analysis by stages, 96931 meteorological and hydrological SMS messages, 200 multi-station based real time flood forecasts, all serving as scientific basis for decision-making by the national flood-control headquarters. Especially, for flood controls in the Yangtze River and Songhua River, through discussions and consultations with basin-wide and provincial hydrological bureaus, BOH issued timely and accurate forecasts, making positive contributions to scientific water controls for the Three Gorges Reservoir of the Yangtze River and the Danjiangkou Reservoir of the Han River, as well as coordinated water controls between the upper-stream of Baishan reservoir and lower-stream of Fengman Reservoir all built along the Second Songhua River.

2) Enhanced basic research on hydrological environment to make technological advances

BOH/MWR has accomplished investigations on standards for hydrological information coding and database, with 2 revised drafts (one for data coding and the other for database itself) be proposed. BOH also developed a real-time hydrological information exchange system, which ran on a trial basis in 10 provinces (or autonomous regions) in June 2010, to ensure its implementation in 2011.

3) Greater efforts to upgrade the current hydrological operational systems

BOH organized the R&D of flood forecasting schemes for 77 flood sections of 66 rivers across 8 provinces (or municipalities) along the China's coastal regions which are subject to typhoon impacts. BOH held a meeting on exchanging flash flood forecasting techniques and experiences targeted to medium- or small-river basins in 14 provinces, which are prone to flash floods, to intensify the process for building up a flash flood forecasting and warning platform, and to proactively expand the service area.

4) Accomplishment of pilot flash flood control projects

In April 2009, MWR established 103 pilot projects for taking non-engineering measures to control flash floods in 103 counties of 29 provinces (ARs or Municipalities) and in the Xinjiang Production and Construction Corps. The Ministry of Finance approved 200 million Yuan as subsidies from the central government in support of these projects. So far, all these projects were completed, and these measures were effective. According to preliminary surveys, 329 flash floods in total occurred in 61 (out of the 103 counties). Through improved system monitoring and timely warnings, 930,000 people under threats were moved to safety in advance, with about 44,000 potential casualties being avoided. Some other counties where the pilot programs were implemented witnessed less casualties relative to the aftermaths of similar floods in the past, although excessively heavy rain took place in the year. In July 2010, non-engineering measures to control flash floods were launched at county levels, and it is planned that about 500 such measures will be completed (in next 3 years).

Fig 2.5 Pilot counties in which measures were taken for flash flood disaster prevention

5) Promoting wider applications of flood risk mapping techniques

BOH formulated "*Guidelines for Flood Risk Mapping*" and "*Technical Rules for Flood Risk Mapping*" and it specified the classification of flood risk maps, scopes, methods, requirements and updates. BOH also developed "*Indicators Based on Flood Risk Mapping*" and "*Approaches for Flood Risk Mapping Management*"， and it also made administrative provisions for preparation, issuance, application and management of various risk maps. Using GIS, database and other tools, BOH developed a software system for flood diversion and retarding analysis, a Software Package for Flood Analysis for the Protected Zones, an Urban Flood Analysis Software System", a Reservoir Overflow Analysis Software System, a Flood Risk Mapping Platform and a Flood Risk Mapping Management System, etc., which provided strong technical supports to risk mapping and its management. These software are based on hydrodynamic models， with independently developed front-end graphic processing, display and analysis systems. The flood risk maps were prepared including those for 9 flood protection zones, 6 flood detention zone, 2 reservoirs and 2 key cities. For more details, see Fig 2.6 and 2.7. Currently, these projects have been concluded, with second phase projects are being prepared.

Fig 2.6 Inundation depth in Dujiatai flood diversion & retarding zone in the Yangtze River basin

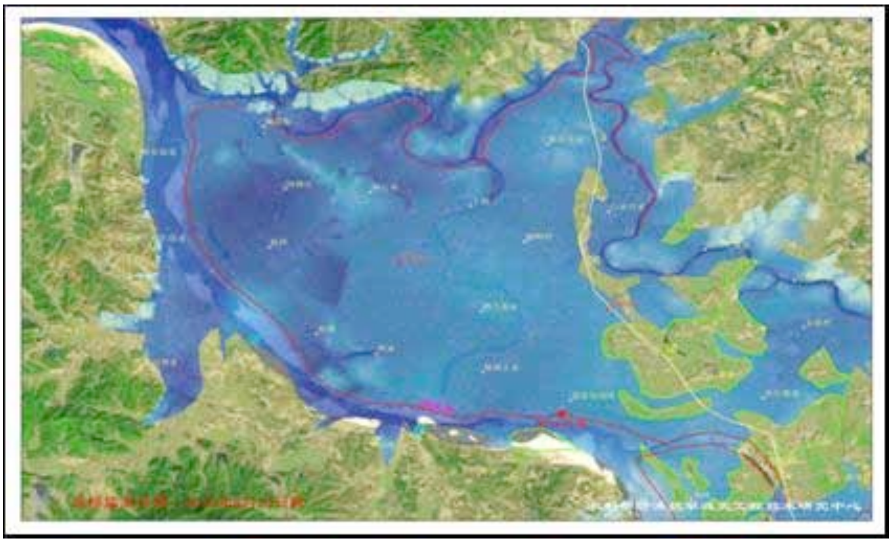

Fig 2.7 Observed status after collapse of Changkai dyke of the Wuhe River (2010)

2.1.3 Achievements/Results in Disaster Prevention and Preparedness

1) Emergency responses were initiated and people evacuated

According to the forecasts issued by meteorological departments about tracks, landing time and landing places of typhoons, local departments of civil affairs at different levels launched emergency responses in a timely manner by emergently evacuating and temporarily resettling 1.23 million people, effectively reducing casualties. At the central level, the National Committee for Disaster Reduction and the Ministry of Civil Affairs initiated 6 pre-warning responses, and dispatched working groups twice to the potential disaster-affected regions, to supervise the reservation of disaster relief materials and the disaster shelters, and to guide the local governments on responses to the possible impacts of typhoons.

2) The buildup of model communities for comprehensive disaster reduction enhanced communities' capability in disaster prevention, reduction and emergency response.

The Ministry of Civil Affairs has actively met the requirements of the National Eleventh Five-year

Plan on Comprehensive Disaster Reduction in the Period, promoted the widespread building of national model communities for comprehensive disaster reduction, and formulated the Standards for National Model Communities for Comprehensive Disaster Reduction. The Standards further specified the requirements for the model communities in terms of the institutional buildup for disaster reduction, emergency plan formulation and implementation, construction of disaster reduction facilities including shelters, and public outreach. 875 model communities were built up in 2010. They are of great significance for enhancing communities' capabilities in disaster prevention, reduction and emergent management, to ensure the safety of the people and their properties, and to facilitate creation of a harmonious society.

3) Various public outreaches for disaster prevention and reduction were made to increase public awareness of disaster reduction.

To further increase public knowledge about disaster prevention and reduction, to effectively enhance the urban and rural residents' awareness and capabilities of disaster prevention and reduction, and to mobilize the whole society for participating in the disaster prevention and reduction, the Ministry of Civil Affairs, the Ministry of Education and the Central Committee of the China Communist Youth League, Red Cross of China co-sponsored a "Nationwide Knowledge Competition on Disaster Prevention and Reduction". Various groups actively attended it, such as community residents, students, young volunteers, Red Cross members and disaster insurance, making widespread positive social impacts. This event fully mobilized the society to attend the efforts for disaster prevention and reduction, increased public knowledge, and enhanced their capabilities at different levels in this aspect.

Fig 2.8 Opening of the nationwide competition for better knowledge about disaster prevention and reduction.

Fig 2.9 An exercise for saving lives under debris

2.1.4 Research, Training, and Other Achievements/Results

1) Typhoon-associated Heavy Rainfall Risk Reduction in Asian Countries

Based on analysis of typhoon rainfall events, a standard for classification of typhoon-induced heavy rain in terms of disaster severity was developed. Advanced methods and techniques for Asia Typhoon rainfall risk assessment were being prepared and risk assessment models were also under development. Criteria and warning signals were used for public typhoon warning.

2) Torrential Rain-induced Flood Prevention System

Based on monitoring of small- and mesoscale synoptic severe weather and quantitative precipitation now-casting, a refined analysis and monitoring system on heavy rain-induced flood was established at the 3 levels: province, region and county. The major facilities includes real-time monitoring system at the 3 levels, heavy rain now-casting system, a forecasting platform and small- and mesoscale weather analysis system, development of numerical system for mesoscale heavy rainfall prediction.

2.1.5 Regional Cooperation Achievements/Results

On 13-15 October 2010, an International Workshop on Sharing Experience on Disaster Risk Reduction in Asian Countries was held in Japan. A range of research topics was extensively discussed, including definitions of the classification standard of typhoon heavy rain in terms of disaster severity, case studies of major typhoon-induced heavy rain disasters in recent 60 years, analysis of major typhoon heavy rain events, etc.

2.1.6 Identified Opportunities/Challenges for Future Achievements/Results

1) Accuracies of Typhoon track and intensity forecasts need to be further improved

Compared with typhoon track forecasts which have been improved substantively, TC intensity forecasts still pose challenges to the world typhoon forecasting community. In recent years, although China has improved significantly its capability in typhoon monitoring, forecasting, warning and service delivery, China still faces many difficulties in making accurate forecasts of typhoon track, intensity, associated wind and rainfall distributions as well as potential secondary disasters, due to the complexity and abnormal behaviors of typhoons proper. In 2011,research work on typhoon NWP and comprehensive forecasting techniques will be further enhanced; typhoon monitoring will be improved for better applications of various quantitative observational data; typhoon disaster assessment (including pre-assessment) regime will be set up to make analytical studies on distribution of wind, rainfall and secondary disasters induced by typhoons from various prospective; modalities and channels for issuing relevant products will be continuously improved, to expand TC forecasting, warning and service coverage. Attention will not only be given to typhoon track and intensity forecasts, but also to refined forecasts of wind, rainfall and potential impacts of secondary disasters all associated with typhoons.

2) Governments at various levels should play a leading role in prevention of and preparedness for typhoon disasters

China will actively push forward the mechanism that “governments take a leading role, with active interactions among the departments concerned and social participation” in typhoon disaster prevention, preparedness, rescue and relief work in a concerted effort to enhance meteorological disaster risk management. Further efforts will be made to implement ”*Interpretation and Action Plan for Meteorological Disaster Prevention and Preparedness Mechanism*” and the “*Notification on Learning about, Outreach and Implementation of the ‘National Meteorological Disaster Prevention and Preparedness – 2009-2020’”* More effective measures will be taken, so that governments at various levels will formulate their plans and policies, increase inputs and incorporate into their annual performance appraisals, to let governments at different levels play a leading role in typhoon prevention and preparedness. In 2010, local preliminary plans for typhoon disaster prevention and preparedness were issued. In 2011, efforts will be continued to push forward the work on formulations of specific work plans for typhoon disaster prevention and preparedness at provincial, prefectural and county levels.

3) Enhancing departmental collaboration to create a joint force for typhoon disaster prevention and mitigation

In 2011, the China Meteorological Administration (CMA) will further improve the time validity of meteorological disaster forecasts and warnings, create channels for issuing joint early warnings through interactions with other relevant agencies, and issue most timely and accurate forecasts, warnings and relevant information to general public, all aimed at minimizing loss of lives and property damages.

Currently, CMA has established the practice of meetings of inter-department focal points for early warning of meteorological disasters, and a team of focal points from 25 governmental departments. Similarly, the provincial (AR or municipal) meteorological bureaus also set up a practice of same nature at provincial level. CMA has dedicated transmissions lines with more than 10 ministries or commissions for information delivery, and CMA has created the mechanisms for advisory discussions on potential impacts of typhoon-induced disasters, interactions for jointly issuing disaster forecasts, and information sharing, in collaboration with other departments concerned. With all these, they demonstrate on a preliminary basis the role of the "Information Tree" of meteorological forecasts, warnings and relevant products. In 2011, CMA will continue to facilitate its collaborations with other ministries and agencies including those responsible for land resources, civil affairs, water resources, safety supervision, information industry, mobile telecommunication, professional cooperative and supply entities, etc., to build up the means for jointly issuing typhoon forecasts and warnings, and websites for typhoon information and service delivery, as well as the certification process in emergency response to typhoon disasters. CMA will promote the training of local managers on typhoon disaster prevention, preparedness and reduction in Fujian, Zhejiang, Guangdong, Hainan and other regions in China, which are vulnerable to typhoon impacts. In collaboration with other agencies of agriculture and water resources among others, the provincial (municipal) meteorological bureaus will build up joint typhoon information service stations. Along the southeastern coastal areas, they will collaborate with other agencies and telecom entities to incorporate CMA's Weather TV channel into local TV networks to achieve much wider publicity of the weather channel down to townships and villages.

4) Enhancing the grass-root typhoon prevention and preparedness regime to let voluntary weather messengers play a full role in information delivery

Targeted to individual communities, and oriented to general public, enterprises and civil bodies, a new modality is being created for grass-roots communities and entities to participate in meteorological disaster prevention and preparedness, which is mainly composed of volunteers and weather messengers, all aimed at actively promoting social participation as a whole in typhoon disaster prevention and mitigation.

From the prospective of building up a system for typhoon disaster prevention and preparedness in rural areas, a priority will be given to establish a demonstrative loud-speaker network and a full range of display screens (or posters) in villages; efforts will be made to push forward the building of the steering mechanisms for rural meteorological service delivery bodies at county and township levels, establishing a joint grass-root structure composing all relevant entities at county level for delivering meteorological information service, and providing leaderships at both county and township levels. Wearing more than one hats, teams of the rural weather messengers will be built up and be given relevant training, focusing on appointments of township and village heads as weather messengers and their training. Setups of township and village weather service posts and their certifications will be organized, to collect and upgrade information about risks of meteorological disasters on a regular basis, to map risk sites in counties, and to prepare plans for meteorological disaster prevention and preparedness within counties. Public knowledge outreach activities on rural disaster prevention and preparedness will be conducted in multiple modalities in rural areas, to enhance farmers' awareness and capabilities of disaster prevention, preparedness and self-rescue and relief. Emergency response plans will be prepared for rural areas to prevent or prepare for meteorological disasters, and emergency response exercises will be conducted in rural areas on a regular basis.

2.2 Progress on Key Result Area 2: Minimized Typhoon-related Social and Economic Impacts.

2.2.1 Meteorological Achievements/Results

1) General Office of the State Council issued the National Meteorological Disaster Emergency Plan

To formulate or improve national emergency response mechanism for meteorological disasters, to increase capabilities for their prevention, preparedness and responses, to minimize or avoid casualties and losses of meteorological disasters, and to provide meteorological support to economic and social developments, the General Office of the State Council launched the 'National Meteorological Disaster Emergency Plan' in December 2009. This plan is applicable to the following 14 meteorological disastrous events related to typhoon, rainstorm, snowstorm, cold wave, high wind, sand/dust storm, low-temperature, high-temperature (heat wave), drought, thunderstorm and lightning hail stone, frost, icing, heavy fog, haze, etc. It is based o the following principles:

- **Being people-centered and to minimize risks.** The primary task is to provide meteorological support for safety of people and their properties, and its starting point is for initiating emergency responses, to comprehensively strengthen the build-up of a system for emergency response to meteorological disasters, and to minimize their damages and losses;
- **Being mainly preventative, science-based, efficient and effective.** Engineering measures are combined with non-engineering measures, to improve capabilities for monitoring, forecasting and warning of meteorological disasters, as well as standards for disaster prevention and preparedness. Modern scientific and technological means should be fully used to well prepare for various emergency responses, and to improve capabilities in emergency response.
- **Regulating by laws and to be well coordinated.** By laws, regulations, and relevant responsibilities, good work should be done in meteorological disaster prevention and preparedness. Information exchanges should be enhanced between different regions, and departments to ensure resource sharing, and collaboration and coordination mechanisms should be established to enable the work in response to meteorological disasters to operate in a well-coordinated manner.
- **Managing by levels and be mainly based on administrative jurisdictions.** According to potential risks and impacts of the disasters, the meteorological disasters should be managed by levels. The local people's government should be responsible for the work in handling meteorological disasters that occurred in their own jurisdictions.

2) Adjustment of typhoon warning categories by CMA

According to the National Meteorological Disaster Emergency Plan, CMA adjusted the typhoon warning categories at the beginning of 2010 as follows:

- Typhoon Warning Red Symbol: When a severe typhoon (maximum sustained winds near the center is up to 41.5-50.9m/s) or a super typhoon (maximum sustained winds up to or above 51.0m/s) will make landfall or affect China coastal areas in the next 48 hours.
- Typhoon Warning Orange Symbol: When a typhoon (maximum sustained winds near center is up to 32.7-41.4m/s) will make landfall over or affect China coastal areas in the next 48 hours.
- Typhoon Warning Yellow Symbol: When a severe tropical storm (maximum sustained winds near center is up to 24.5-32.6 m/s) will land on or affect China coastal areas in the next 48 hours.
- Typhoon Warning Blue Symbol: When a tropical storm (maximum sustained winds near center is up to 17.2-24.4m/s) will make landfall on or affect China coastal areas in the next 48 hours.

2.2.2 Hydrological Achievements/Results

1) Active organization and participation in the relevant work of the project – 'Urban Flood Risk Management', in which China is responsible for implementation

At the 41st Session of the Typhoon Committee held in 2009, a new project – the 'Urban Flood Risk Management within the Region of Committee Members', which was responsible by China, was launched. It was targeted to exchange and share experience in urban flood management within the Committee Members, including the techniques used for urban flood monitoring, forecasts, and early warnings, to their capabilities in urban flood management. At its 42nd Session, the Typhoon Committee defined it as a cross-cutting collaborative project among the three working groups on meteorological, hydrological and disaster prevention and mitigation.

In 2010, the project made progress mainly in the following aspects: (1) ESCAP and the Typhoon Committee held a joint thematic workshop on urban flood management in Bangkok Thailand in July. At this meeting, a special expert panel was set up, which was mainly responsible for providing technical guidance for the cross-cutting project, including sum-up of experience, preparation implementation plan and a manual on urban flood management, filed tours in pilot cities, as well as provision of relevant advisories and guidance. The meeting also identified the mechanism for the next step and follow-up work plan of the project. (2) The Bureau of Hydrology under the Ministry of Water Resources fulfilled the tasks allocated to China according to the plan of the project, i.e. completion of a survey on urban flood management in three pilot cities (Shanghai/China, Yokohama/Japan, and Ngee Ann City/ROK) and summary on experience in this aspect; in April 2010, a questionnaire was prepared in both Chinese and English, which were distributed to the pilot cities. At the same time, the work units in Shanghai was organized to complete the questionnaire and translated into English. In July, the completed questionnaire was received from Yokohama, and exchanges were made at the meeting in Bangkok. In August, the completed questionnaire was received from Ngee Ann City, later on a preliminary summary report on urban flood management was prepared on the basis of the 3 questionnaires. At the request of the meeting, it was submitted to the Typhoon Committee workshop held in Macao, China in September.

2) Participation in the work related to the project – 'Hazard Mapping for Sediment-related Disaster'

This project was taken charge by Japan under the hydrological working group. On 4-5 Sept 2010, an outfield training and relevant workshop were held in Zhuhai, Guangdong under the project. This site was used as an application case, and Zhuhai City prepared a risk map for the region in line with methods learnt from the training event, which was submitted to the project manager.

2.2.3 Disaster Prevention and Preparedness Achievements/Results

1) Emergency responses had been launched for a number of times and emergency relief work was effectively carried out.

The National Committee for Disaster Reduction (NCSR) and the Ministry of Civil Affairs (MCA) had consecutively launched three natural disaster emergency responses for the three typhoons (i.e. *Fanapi, Chanthu* and *Megi*), by timely dispatching working teams to the disaster-affected regions, by providing assistance and guidance to the local governments in carrying out emergent relief work, and by having actively consulted with the Ministry of Finance for the allocation of central government disaster relief funds and materials. In 2010, the Ministry of Civil Affairs consulted with the Ministry of Finance for the allocation of 79 batches of disaster relief funds up to 11.344 billion Yuan, out of which 4.486 billion Yuan was allocated to address the floods, typhoon, landslides and mud-rock flows.

2) The dynamics of typhoons are closely tracked for the timely monitoring and assessment.

NCSR and MCA closely kept close eyes on motions of typhoons, by making comprehensive uses of ground data and satellite remote-sensing data, and depending on the unified operational platform incorporating "sky-ground-field". They had successfully carried out timely assessments of risks, losses and disaster reduction efforts and compiled and distributed several early warnings, assessment information and products, providing substantial support for the decision-making in disaster reduction and relief.

Fig 2.10 Distribution of severity (Disaster Index) of typhoon *Fanapi* in the affected areas

3) The build-up of disaster messenger teams has greatly enhanced the disaster management capabilities of the grass-root governments.

To enhance the management capabilities in responding to various natural disasters including typhoon, the Ministry of Civil Affairs had actively promoted the build-up of the system for disaster messengers, further improved the management system for disaster messengers and set up a certification system for disaster messengers. In 2010, the Ministry of Civil Affairs provided training for over 2,000 disaster messenger candidates above the county level and conducted the relevant examinations and certifications. The build-up of disaster messenger teams allowed effective outreach of the early warning against typhoons and assessments on the relevant disaster losses.

Fig 2.11 Teaching materials for voluntary disaster messengers were officially published in 2010.

2.2.4 Research, Training, and Other Achievements/Results

See also 2.1.4 in KRA 1

2.2.5 Regional Cooperation Achievements/Results

1) China participated in the summary of the On-Job-Training (OJT) project presided by Malaysia, which was a priority project launched by the Working Group on Hydrology in 2008

It mainly focused on OJT in flood forecasting for trainees from the Committee Members. Since the launch of the project, 4 training seminars had been held, with 3 trainees from China attending the 2nd, 3rd and 4th training events. By the end of 2010 when the project was complete, China contributed a partial summary on what had learnt from the training as a participating Member of the project to the concluding summary report prepared by Malaysia. The report was submitted to the Secretariat of the Typhoon Committee by the end of 2010.

2) CMA meteorological experts gave lectures for a one-week training course in Hanoi from 29 March to 2 April 2010

Invited by the Ministry of Natural Resources and Environment of Socialist Republic of Viet Nam, CMA meteorological experts gave lectures at a one-week training course in Hanoi from 29 March to 2 April 2010, including the application of satellite images to typhoon forecasting and warning, the typhoon warning system and numerical model in NMC/CMA and landfall typhoon precipitation classification and theory.

2.2.6 Regional Cooperation Achievements/Results

See also 2.1.6 in KRA 1

2.3 Progress on Key Result Area 3: Enhanced Beneficial Typhoon-related Effects for the Better Quality of life.

2.3.1 Meteorological Achievements/Results

Before each typhoon landfall, CMA establishments initiated in a timely manner any level of emergency response orders by issuing typhoon early warnings, and providing timely information and services for decision makers at various levels. In return, governments attached great importance to the warnings, followed by active interactions between the departments concerned and enforced measures. At the time to effectively reduce typhoon disasters, efforts were also made to maximize benefits of typhoons if any. Especially, just within 40 hours on 29-30 August three *TCs* (i.e. *Lionrock, Kompasu* and *Namtheun*) were generated, their interactions led to complex and changeable tracks, all making their wind and rainfall forecasts difficult. The wind and rainfall process mainly affected southeastern coast of China and some inland areas. Based on accurate and timely forecasts and proactive services, some local reservoirs increased their water storage accordingly, and the typhoon damages were relatively lighter than normal, with their advantages generally being greater than disadvantages.

2.3.2 Hydrological Achievements/Results

For typhoon prevention and preparedness in 2010, through enhanced leadership, thoughtful deployments, scientific directives and clear-cut responsibilities, the Ministry of Water Resources made good preparations for possible floods induced by typhoons, by displacing people under risks to safe areas and minimizing damages and losses. On condition that preventative work was well made to prevent and reduce typhoon-induced disasters, every opportunity was taken based on effective and timely forecasts to increase water storages for reservoirs and bonds in dry areas from rainfall accompanying with landing typhoons. In 2010, on the basis of flood forecasting schemes for 77 sections of 66 rivers in 8 provinces along the China's coastal regions, the Bureau of Hydrology under MWR provided hydrological forecasts and early warnings for the regions that were most likely affected by landfall typhoons, by enhancing forecasts/warnings on the one hand, and improving accuracy and quality of the forecasts on the other. Such information not only reduced damages to a greater extent, but also provided effective guidance to coastal provinces in making full use of favorable rainfall brought by typhoons for drought relief and water storages. For example, when super typhoon *Megi* was landing on the coast of the Zhangpu County, Fujian Province on 23 October 2010, with maximum wind force at 38m/s, no single casualty was reported due to science-based forecasts and warnings as well as careful deployments. Compared with water levels before its landfall, about 44 million m^3 water was improved into large reservoirs alone on 21-23 October.

2.3.3 Disaster Prevention and Preparedness Achievements/Results

1) Predictions and Assessment of Typhoons

National Disaster Reduction Center of China (NDRCC) kept close watch on typhoons, by using ground observations and satellite remote-sensing data and relying on the unified operational platform of "sky-ground-field", made timely assessments on risks, losses, relief work, and compiled many issues of Gazette on Disaster Assessment, providing support for the decision-making in disaster reduction and relief.

2) Disaster management Information

In order to improve timeliness, normalization and truth of disaster information, NDRCC has upgraded the National Natural Disaster Information System. Relying on the system, NDRCC adopts a webpage management, which is more convenient for reporting and managing disaster information like typhoon. At present, it collects and reports new disaster information and the amassed disaster information of different stages above county level under the Ministry of Civil Affairs. In addition, the subsystem for real-time disaster monitoring and disaster-information-sharing and the subsystem of

SMS messages can help the grass-root disaster information managers to learn about the reported disaster information and progress of the disaster relief effort at anytime anywhere, and the disaster information managers at and above the county level can communicate in real-time on a universal platform.

NDRCC has signed protocols on collection of annual disaster data from 27 counties on different disaster types with many provinces, and it has completed the inspection of the yearly and monthly data on natural disaster types such as typhoons in the last 20 years. These efforts provide substantial support to the correct analysis of the trends of disasters such as typhoon and the timely implementation of disaster relief.

3) Information sharing

The cooperation among the relevant membership units of the National Committee for Disaster Reduction has been strengthened, regular consultation meetings are held, on average 10 conferences are held monthly, trend forecast conference is held yearly; information on various disasters and disaster relief efforts are reported in a timely fashion, and the various products on disaster information, such as the *Disaster Reduction Bulletin*, *Yesterday's Disaster Information*, are timely released, to ensure the disaster reduction information applied for society widely.

4) The Construction of Disaster Reduction Emergency Equipment

NDRCC has paid much attention to equipment management and construction, and it has built up a preliminary guaranteeing capacity for emergent disaster relief incorporating information collection, emergent communication and office assistance, which has been applied effectively in disaster assessments. The system for information and service delivery by hand-held PDA terminals has been improved, various testing and application functions of the PDA terminals have been conducted, and a highly-efficient mechanism for the on-the-spot disaster information collection has been formed which combines sky and ground operations and collaborates with different departments.

5) The Construction of Disaster Information Manager

To improve the management of natural disaster such as typhoon, the Ministry of Civil Affairs has carried out the system construction of disaster information manager, become more proficient with position management system, and establishes position assessment system. In 2010, NDRCC trained and authenticated nearly 2,000 county-level disaster information managers. This made a difference for typhoon predictions and assessments.

2.3.4 Research, Training, and Other Achievements/Results

NIL

2.3.5 Regional Cooperation Achievements/Results

NIL

2.3.6 Identified Opportunities/Challenges for Future Achievements/Results

See also 2.1.6 in KRA 1

2.4 Progress on Key Result Area 4: Improved Typhoon-related Disaster Risk Management in Various Sectors.

2.4.1 Meteorological Achievements/Results

See also 2.1.1 in KRA 1
See also 2.2.1 in KRA 2

2.4.2 Hydrological Achievements/Results

In 2010, in developing "flood disaster risk index" under the Working Group on Hydrology, the Ministry of Water Resources continued to actively collect and compile relevant data based on the work initiated in 2009. The questionnaire was completed and submitted to Japan.

Regarding typhoon disaster risk management, the Ministry of Water Resources mainly conducted the following work:

- Infrastructure risk management has been enhanced with comprehensive measures being enforced.

- Legal system for disaster prevention and mitigation has been improved.

- A sound organizational framework for disaster prevention and reduction is being built up, with the commanding body has been strengthened for disaster prevention, preparedness and mitigation with clear-cut responsibilities and improved work efficiency.

- According to regional characteristics of natural disasters, an engineering system is being set up for disaster prevention and reduction system with plausible layout, proper standards, appropriate maintenance and safe operations.

- A supporting system has been strengthened for disaster prevention and mitigation with hydrological forecast accuracy being improved, with lead-time extended; the means of communication, commanding and control have been enhanced for disaster prevention and reduction; a sound emergency response mechanism has been set up for disaster prevention and mitigation, with inter-agency collaborative and coordinative mechanism being improved for joint actions.

- The preparatory plans for disaster prevention and reduction need to be further made or improved, with clear emergency response procedures, with training of professional skills being enhanced, and capabilities for disaster prevention & reduction improved.

- Better publicity & outreach of knowledge about disaster preparedness to improve public awareness & capability for disaster avoidance & mutual rescues, to reduce casualties and damages

Fig 2.12 A ceremony for publicizing outreach materials.

On 11 May 2009, the National Headquarters for Flood Control and Drought Relief together with the Ministry of Water Resources held a ceremony in Beijing for publicizing a video footage to outreach knowledge about typhoon prevention, preparedness, rescue and relief. At the same time, the organizers of the event also delivered posters – *How to Prevent and Prepare for Typhoon Disaster,* and booklets – *Knowledge about Typhoon Prevention and Avoidance* to relevant ministries, provinces and municipalities. This event was one of the 7-day outreach activities organized by MWR, all aimed at raising communities' interests in and awareness of typhoon prevention or preparedness, increasing public capabilities for mutual and self rescues, and minimizing loss and damages caused by typhoons.

2.4.3 Disaster Prevention and Preparedness Achievements/Results

1) Regulations on Natural Disaster Relief was officially promulgated, filling a legal gap in natural disaster relief.

On 8 July, Premier Wen Jiabao signed the Decree No.577 of the State Council, promulgating the *Regulations on Natural Disaster Relief*, for implementation as of 1 September 2010. The promulgation and implementation of the Regulations filled a legal gap in natural disaster relief. The document provided a legal basis for carrying out natural disaster relief, legally confirmed the working principles, systems and methods that were practiced for years in disaster relief, described the status of disaster relief in the national legal system for emergency relief, marking a new stage of normalization, institutionalization and legalization of disaster relief work. With it, administration of disaster relief activities can be exercised according to written regulations. The *Regulations* has specified the rights and obligations of the government, society and individuals in terms of natural disaster relief, improved the systems and mechanisms for natural disaster relief and laid a solid foundation for further enhancing the effectiveness of the natural disaster relief work, China's resilience against various natural disasters, maximum alleviation of the potential losses and impacts caused by natural disasters, and for safeguarding the society's stability and the economic development.

2) Many projects targeted to comprehensive risk governance were successfully accomplished, and a national technological framework for comprehensive risk governance was build up. "Research and Demonstration of the Key Technologies for Comprehensive Risk Governance", as a major project of the national science and technology supporting program in the Eleventh Five-year Period (2006-2010), was successfully accomplished in 2010. Through recognition and simulation of disaster risks, based on a platform and its relevant demonstrations, a national technological framework for comprehensive risk governance has been established in response to major disaster risks that pose threats to the national public safety and securities. "Research on Comprehensive Assessment Technology for Catastrophe Risks in Asia and its Application ", another project under the national science and technology supporting program in the Eleventh Five-year Period, will be accomplished soon. This project establishes a system of catastrophe standards which applies to Asian countries, compiles single-disaster and comprehensive high-risk distribution maps for earthquake and typhoon-rainstorm in Asia in the next decade, constructs a database of comprehensive catastrophe risks in Asia, and successfully develops a comprehensive assessment and demonstration system for the catastrophe risks in Asia.

2.4.4 Research, Training, and Other Achievements/Results

See 2.1.4 for KRA 1

2.4.5 Regional Cooperation Achievements/Results

See 2.1.5 for KRA 1

2.4.6 Identified Opportunities/Challenges for Future Achievements/Results

See 2.1.6 for KRA 1

2.5 Progress on Key Result Area 5: Strengthened Resilience of Communities in Response to Typhoon-related Disasters.

2.5.1 Meteorological Achievements/Results

The China Meteorological Administration (CMA) accomplished a nationwide risk analysis on the typhoon factors leading to disasters, an analysis of environmental sensitivity causing potential disasters, a vulnerability diagnosis of hazard-affected areas, an analysis on capabilities in disaster prevention and reduction, and typhoon risk assessments and mapping. The local meteorological bureaus accomplished the typhoon risk mapping for Shanghai, Zhejiang, Fujian, Guangxi, Guangdong and Hainan provinces as well as research work on typhoon-induced disaster factors in correlation of with hazardous situations respectively. Additionally, by analyzing both spatial distribution and historical evolution characteristics of the potential TC destruction index, and by investigating the correlation between TC destruction index and disastrous situation, an assessment model has been developed based on the index and true disaster aftermaths (direct economic loss, death toll, total affected areas, number of houses ruined).

The next step will focus on establishment of an operational system for typhoon risk assessments, so as to incorporate it in to operational applications.

2.5.2 Hydrological Achievements/Results

In October 2006, the State Council officially approved the *"Plan for National Flash Flood Prevention and Control*". In November 2007, the Ministry of Water Resources (MWR) completed the "*National Report on Implementation Schemes for the Pilot Counties in Flash Flood Prevention and Control*" . In April 2009, MWR launched, on a pilot basis, the so-called non-engineering flash flood prevention and control measures in 103 counties in 29 provinces (ARs or municipalities) including Xinjiang AR production corps. So far, all these projects have been accomplished, and put into operations on a trial basis. In July 2010, the non-engineering measures began fully expanding to other counties exposed to flash floods. It is planned that in the next 3 years, these measures will be implemented in additional 500 counties. The main elements of the measures include a survey on flash flood disasters, risk mapping, identifications of threshold rainfall and early warning indicators for river water levels, build-up of the flood monitoring, forecasting and warning system, accountability system, preparation and improvement of emergency flood prevention and preparedness plans, as well as public outreach, training and exercises, among others. The rainfall thresholds and water level alarming indicators will be defined by using empirical analysis approach, hydrological and hydraulic models. The flood monitoring, forecasting and warning system will be based on GIS platform, including information acquisition, discovery, analysis for forecasts and warnings, their issuances and other functions. The forecasts, warnings and other information will be disseminated through its transmission network and telecommunication facilities.

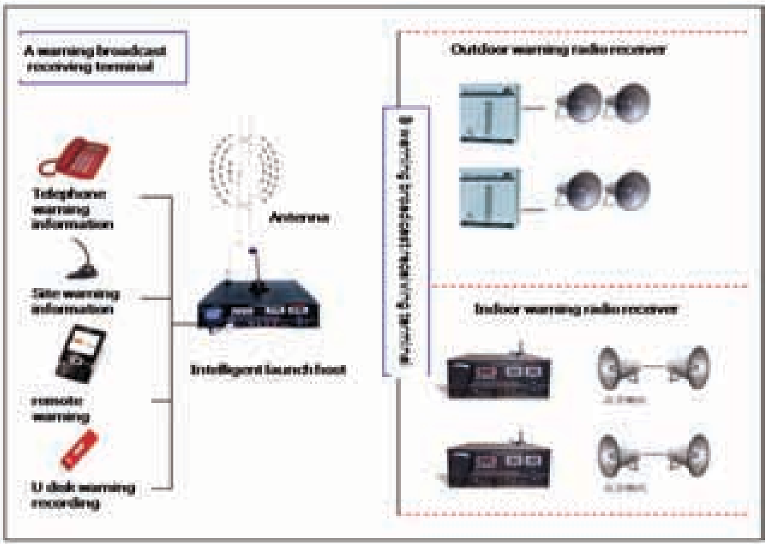

Fig 2.13 The development of preparedness and warning system for flash flood

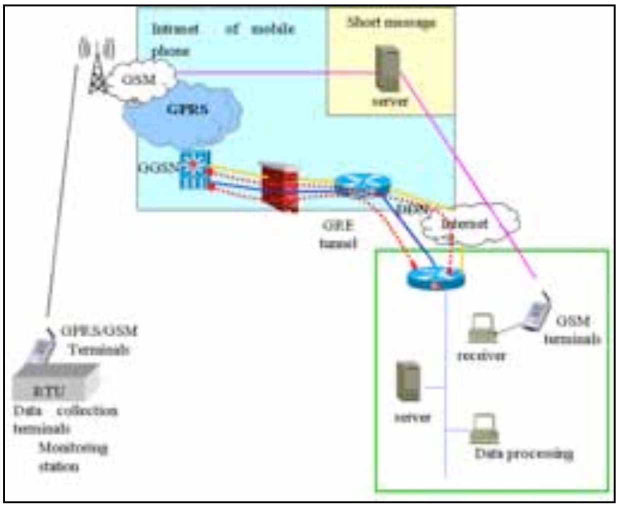

Fig 2.14 Telecommunication system based on GPRS flash flood warning system

2.5.3 Disaster Prevention and Preparedness Achievements/Results

NDRCC keeps close watch on typhoon, applying ground data and satellite remote-sensing data and relying on the unified operational platform of “sky-ground-field”, makes timely assessments on risk, loss, relief, and complies many issues of *Gazette on Disaster Assessment,* providing support for the decision-making in disaster reduction and relief.

The National Committee for Disaster Reduction and the Ministry of Civil Affairs takes active measures to promote post-disaster rehabilitation and reconstruction. The reconstruction of houses in the five typhoon-affected provinces (or Autonomous Regions) of Zhejiang, Fujian, Guangdong, Guangxi and Hainan in 2010 started, and to date, in Zhejiang and Jiangxi provinces, the completion rate of reconstruction projects was over 95%, and in Fujian and Guangdong, this rate stood over 50%.

2.5.4 Research, Training, and Other Achievements/Results
NIL

2.5.5 Regional Cooperation Achievements/Results
NIL

2.5.6 Identified Opportunities/Challenges for Future Achievements/Results
NIL

2.6 Progress on Key Result Area 6: Improved Capacity to Generate and Provide Accurate, Timely, and understandable Information on Typhoon-related Threats.

2.6.1 Meteorological Achievements/Results

1) Improvement in Satellite Observation System

A new polar orbiting meteorological satellite (FY-3B) was launched from Taiyuan Satellite Launch Center on 5 November 2010. This is the second of China's Fengyun-3 (FY-3) series. The satellite would form a network with the first FY-3 satellite (FY-3A), launched 27 May 2008, to improve China's meteorological observation and medium-range weather forecast capabilities. The FY-3 series would continue to play an important role in monitoring natural disasters and environment, and researching environment and climate change and disaster prevention and reduction.

Fig 2.15 A new polar orbiting meteorological satellite (FY-3B) launched on 5 November 2010.

In 2010, NSMC also continued to monitoring TCs at Polar Orbiting satellite platform by using of

FY-3A satellite,. Comprehensive utilization of FY-3A visible-infrared channels images, 250m high spatial resolution images and microwave channels images, the fine structure of the TCs eye and the location of severe precipitation were achieved. Furthermore, FY-3A meteorological satellite attached importance to global analysis of TCs. For example, Atlantic TCs (*Danielle, Earl, Fiona, Igor, Julia, Karl, Lisa, Matthew* and *Otto*), Eastern Pacific TCs (*Frank* and *Georgett*) and Indian Ocean TCs (*Laila*, *Phet* and *Bandu*). NSMC used FY-3A multi channels data to track these TCs and get preferable monitoring results.

During this typhoon season, National Satellite Meteorological Center (NSMC) switched on the multi-temporal twin satellite observational-mode. Everyday 96 photographs (once quarter an hour) were obtained from FY-2D and FY-2E satellites. Through these higher temporal resolution satellite data, the occurrences and evolvement characteristic of TCs could be better catched. During Sept. to Oct., the twin satellite observational-mode was suspended, but NSMC rapidly switched on this mode for two Super Typhoons weather service, one was for *Fanapi* (1011) at 11:00 on 19 September 2010 (BJT)，and the other was for *Megi* (1013) at 1:30 on 20 October 2010 (BJT). And it played important role in monitoring and forecasting TCs.

2) Improvement in Marine Observation System

By the end of 2010, 191 shore-based stations, 84 AWSs on islands, 18 buoys, 1 storm surge stations, 6 oil drilling platform-based stations and 4 ship stations have become operational, which have greatly enhanced the ability of coastal ocean observing ability.

Fig 2.16 The distribution of 18 buoys stations along China coasts.

3) Improvement in Radar Observation System

In 2010, 8 CINRAD radars have been set up on mainland China. It further increased capability for monitoring typhoon along the Chinese southeast coasts, among others. This has contributed to the disastrous weather prevention and reduction in many provinces.

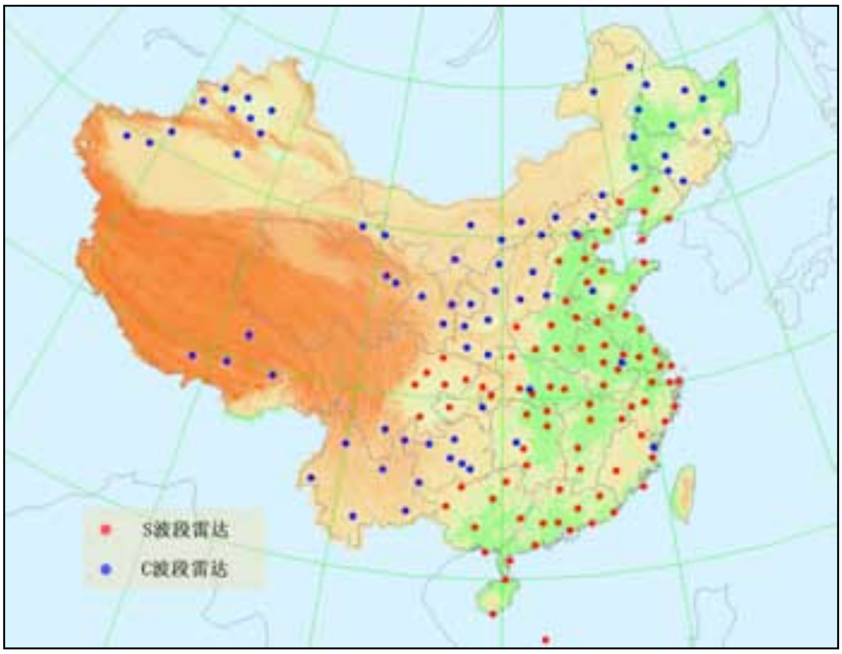

Fig 2.17 The 164 radars covered China

CINRAD/SA radars (red spot); CINRAD/SC radars (blue spot)

4) Improvement in Upper Air Observing System

In 2010, three upper air stations were up-graded by L-band radar-based upper air observing systems.

5) Improvement of Tele-Communication System

CMA started development of the next generation data broadcast system (CMACast) in 2010. CMACast is a multimedia dissemination system based on second-generation Digital Video Broadcast (DVB-S2) technology with both file and multimedia transmission capability. Figure 2.18 shows the system architecture of CMACast. It uses a whole 36MHz C-band transponder of AsiaSat-4 to disseminate meteorological data to users, including global exchanged observations and products, CMA's NWP products, as well as FY-2 and FY-3 satellite products, etc.. Currently, the daily broadcasting data volume is over 200GB. CMACast will be operational by the end of 2010 and will replace FENGYUNCast as CMA's contribution to GEONETCast. Figure 2.19 Shows the global view of the GEONETCast satellite coverage.

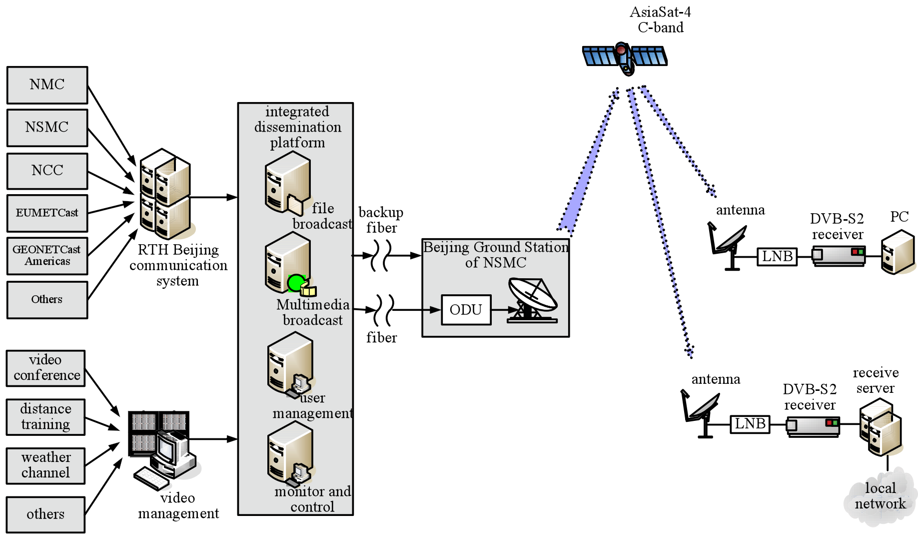

Fig 2.18 CMA cast System Architecture

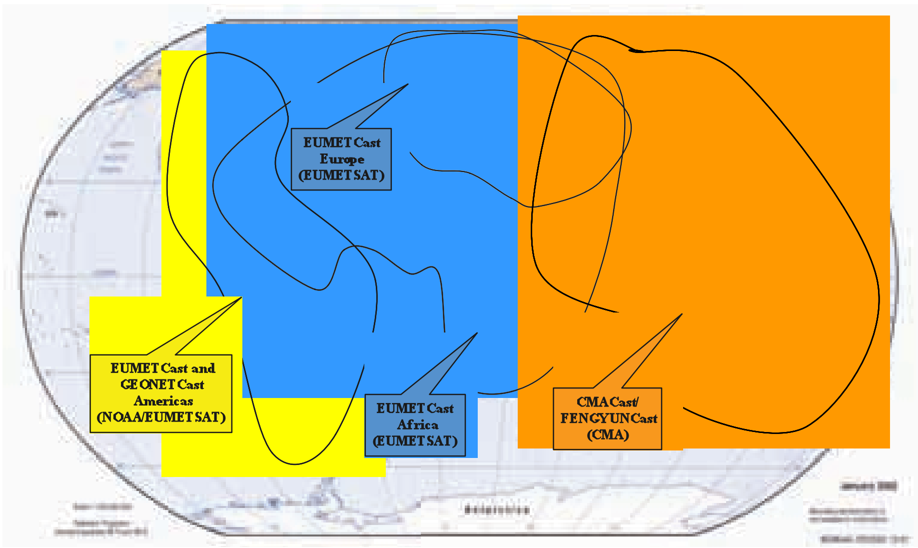

Fig 2.19 Global GEONET Cast Coverage

To support the typhoon-related services, CMA has made the following data and products available in its real-time database, and established the quality control system for the automatic precipitation observations obtained from regional stations. To ensure the high reliability for the data, automatic quality control and manually checked are being made for precipitation observations in real-time.

- METOP-A ATOVS products
- FY3A L1C products

6) Establishment of TC Analysis and Nowcasting System Based on Radar Observation

National Meteorological Center (NMC) of CMA has developed operational objective analysis for landing TCs by using the wind and precipitation retrievals from the new generation weather radar since July 2010, The products include TCs center positioning, 3-D wind retrieval, wind radius of 30kts and 50kts and quantitative precipitation estimation (QPE). These products provide objective references for operational TC forecasting and warning service, including center positioning, intensity estimation, precipitation now-casting and wind radius of 30kts and 50kts. Figure 2.20 gives some objective analysis products from radar observation for Super Typhoon *Megi* (1013)

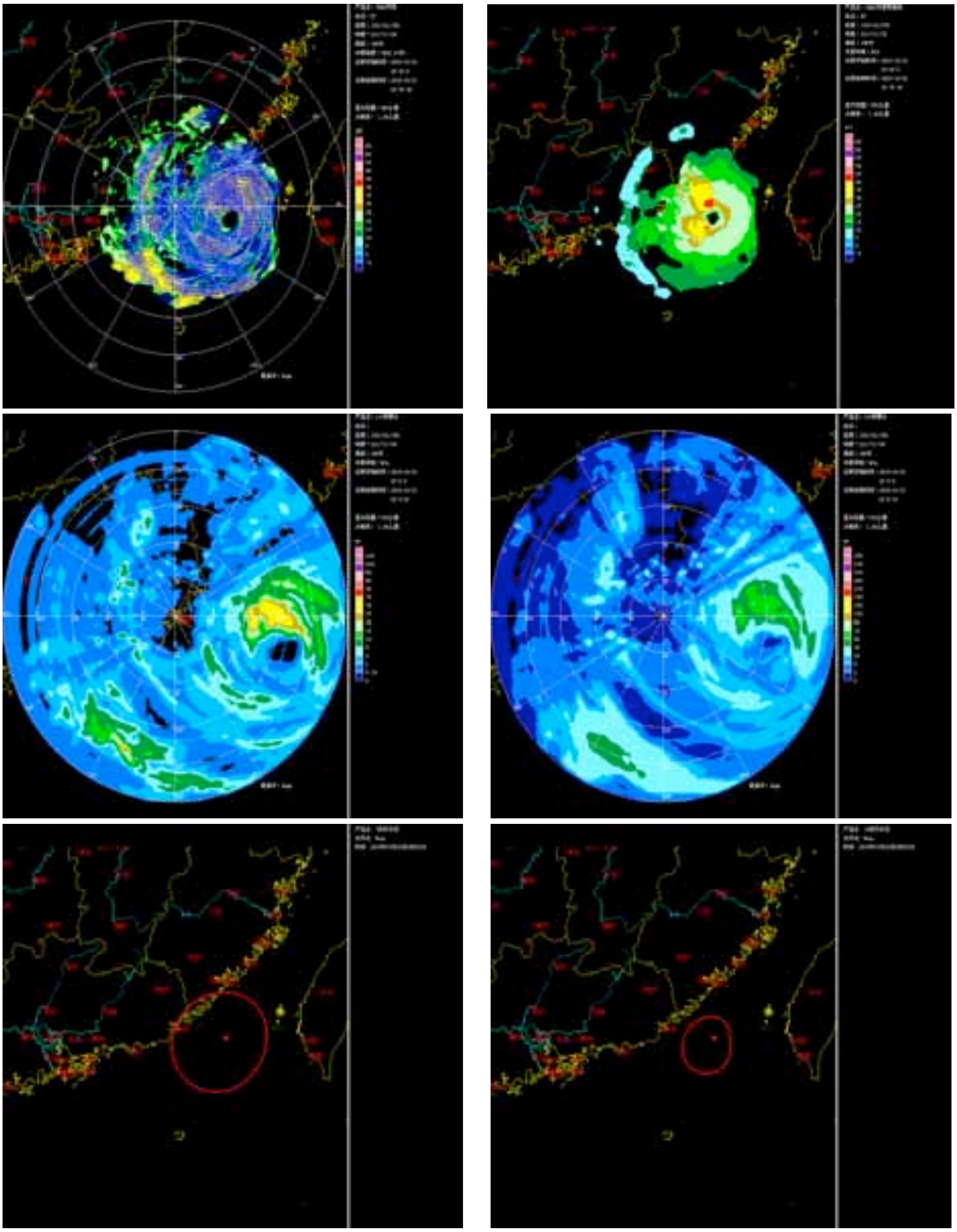

Fig 2.20 Objective analysis products from radar for Super Typhoon *Megi* (1013) at 04:30UTC, 23 Oct., 2010 (top: wind, middle: precipitation, Bottom: wind radius of 30kts and 50kts)

In 2010, NMC had set up a 0-2 hour nowcasting and extrapolated prediction system for wind and rainfall based on wind retrieval and quantitative precipitation estimation (QPE) by using radar observation. The system has been put into operational forecasting this year. Figure 2.21 shows some nowcasting forecast products for Super Typhoon *Megi* (1013).

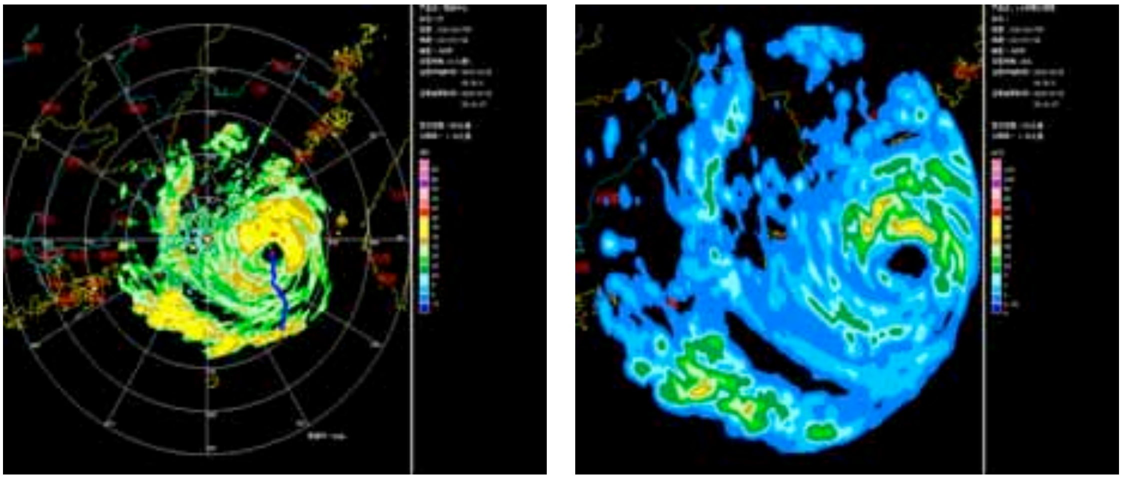

Fig.2.21 Nowcasting products based on radar observations of super typhoon *Megi* (1013) at 04:30UTC, 23 Oct., 2010 (Left: TC center positioning (red dot) and 1h extrapolated forecast for TC center (green dot); Right: 1h extrapolated rainfall forecast)

7) Establishment of Multi-model Consensus Prediction System of TC Track and Intensity

Based on best linear unbiased error (BLUE) method, NMC established a multi-model consensus prediction system of typhoon track and intensity by using six operational global models such as CMA-T213-ATOVS, CMA-T639, ECMWF, JMA and UKMO. The consensus principle is to calculate the weights by using typhoon real-time track forecasting error and historical error of each model. This system has been applied to operational forecasting since July 2010.

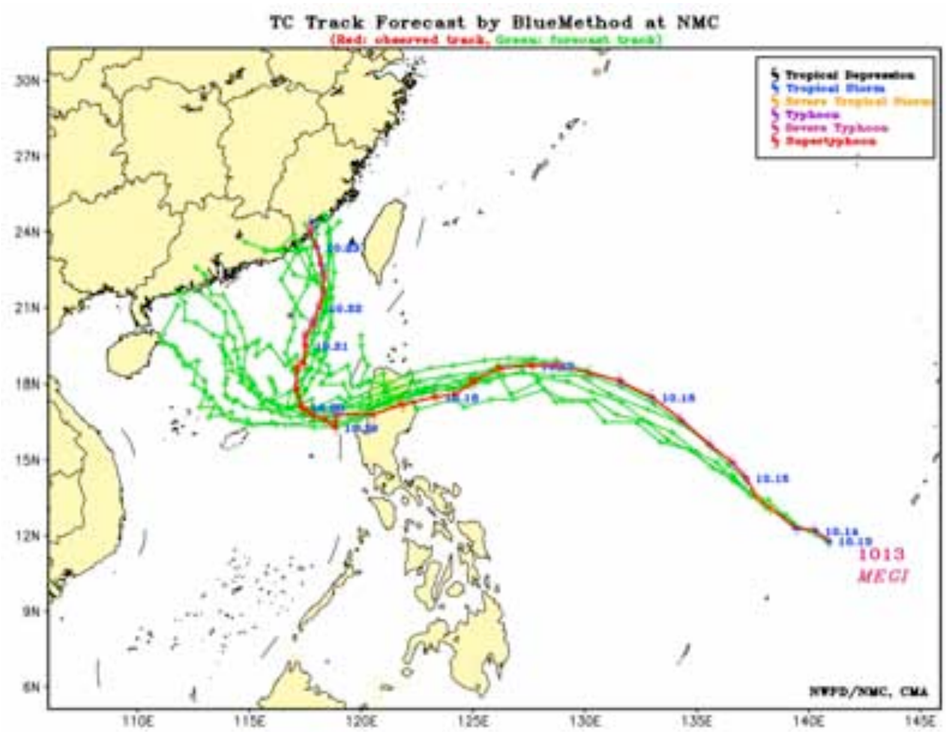

Fig 2.22 The consensus forecast (green) and observation (red) of super typhoon *Megi* (1013)

8) Super Ensemble Prediction of Typhoon Track Based on TIGGE Data

Based on TIGGE data, National Meteorological Centre (NMC) of CMA establish a super ensemble typhoon track prediction system including 139 members from CMA, ECMWF, NCEP, JMA, KMA and UK Met Office. The system has been put into operation since July 2010.

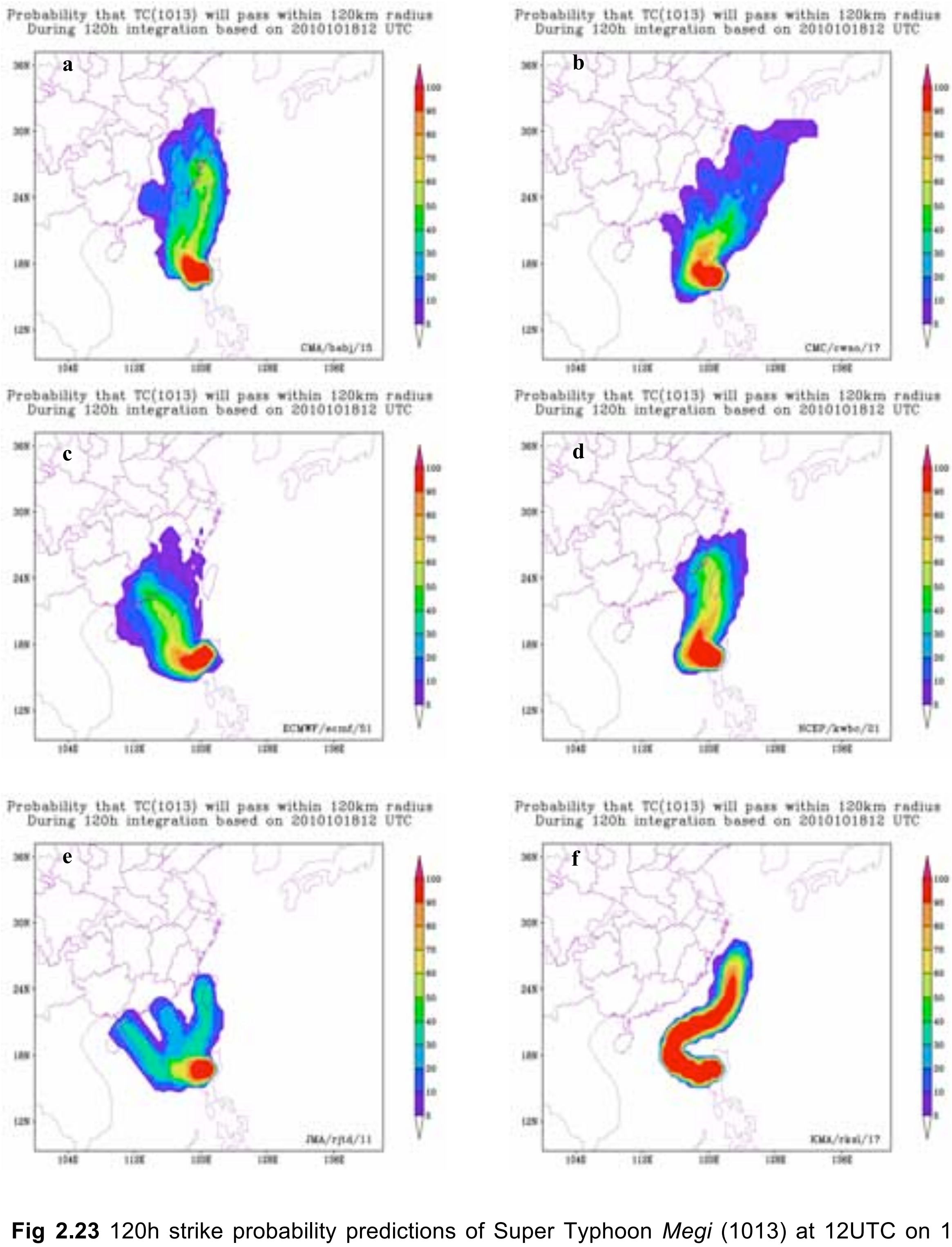

Fig 2.23 120h strike probability predictions of Super Typhoon *Megi* (1013) at 12UTC on 18 Oct., 2010(a, b, c, d, e, and f are from CMA, CMC, ECMWF, NCEP, JMA and KMA respectively.)

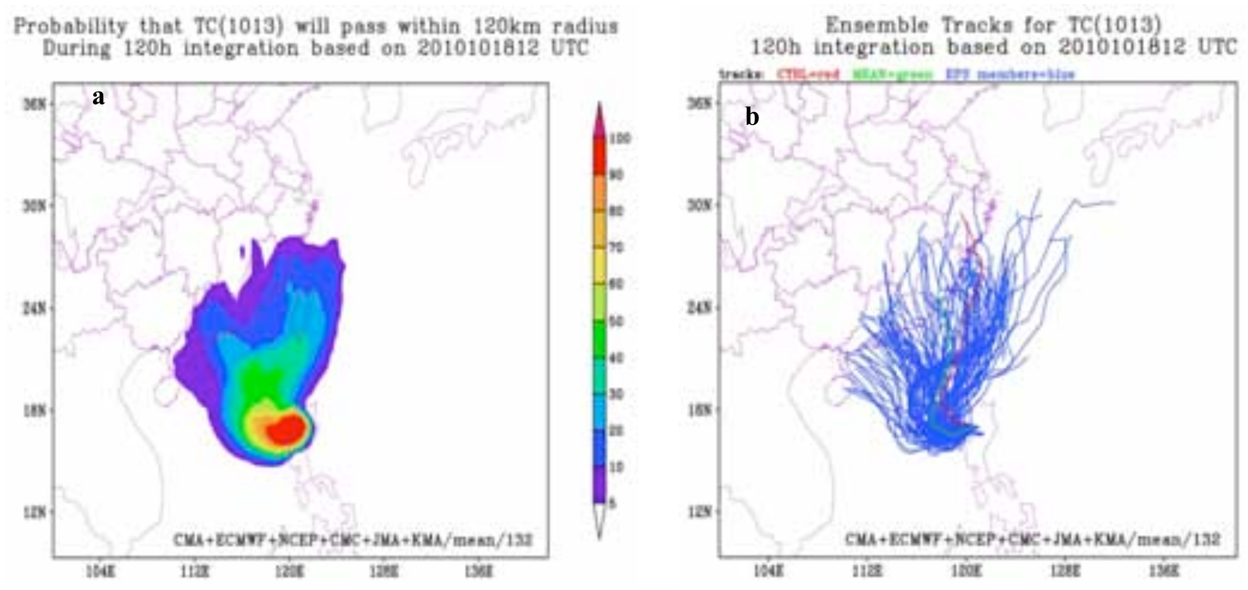

Fig 2.24 120h spaghetti probability (a) and track (b) prediction of Super Typhoon *Megi* (1013)

9) Improvement in TC Prediction System in NMC

For improving the accuracy and refining operational TC forecasts, two regional typhoon forecast systems based on GRAPES-Meso model or ARW WRF model have been put into operational test in NMC since July 2010. These systems provide some products such as TC track, intensity, accumulated precipitation, 10m wind, wind field and vertical distributions of latent heat, temperature anomaly and potential vorticity, etc.

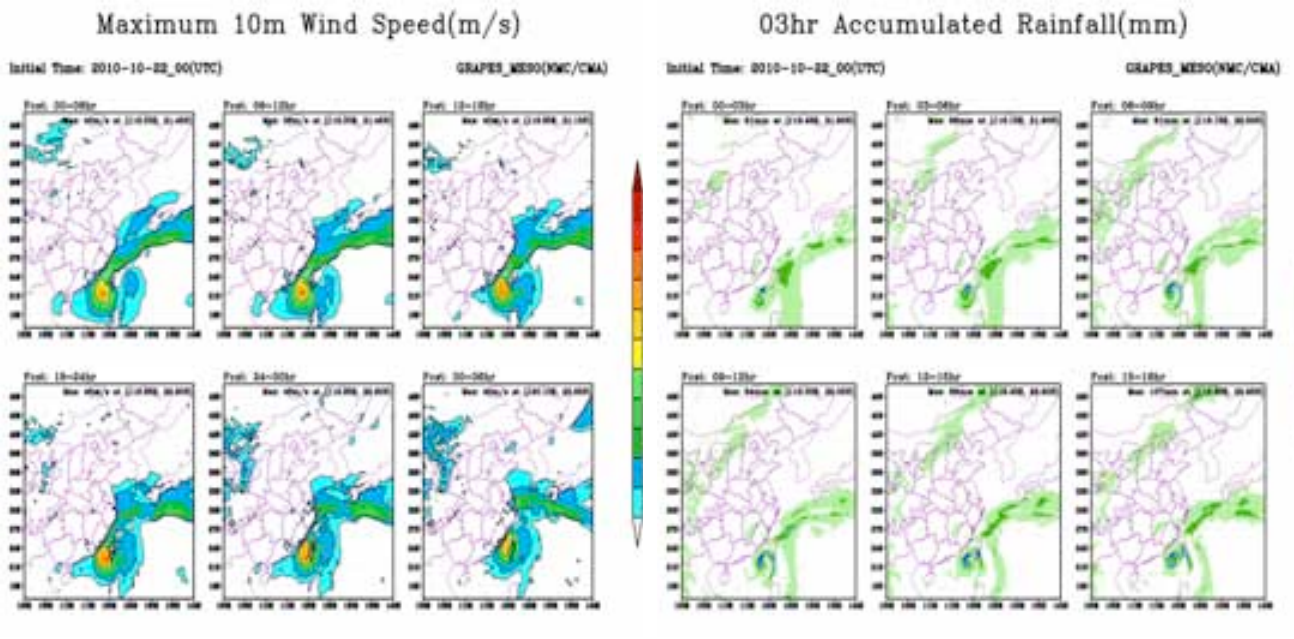

Fig 2.25 Wind and rainfall forecasts for Super Typhoon *Megi* (1013) by GRAPES-Meso scale model (left: 10m gale, right: accumulated rainfall, Initial time: 00UTC 22 Oct. 2010)

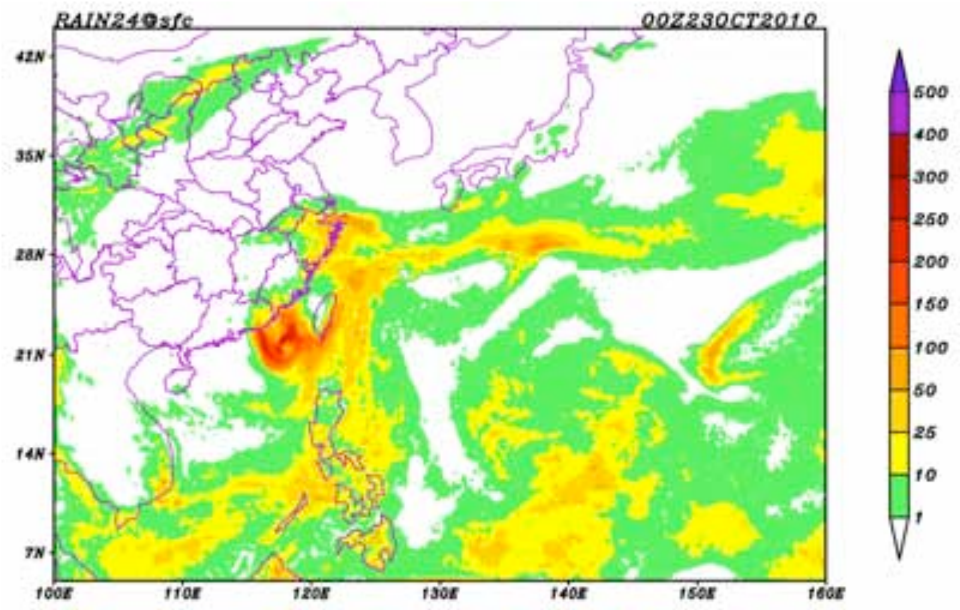

Fig 2.26 24h accumulated rainfall forecast for Super Typhoon *Megi* (1013) by ARW WRF system (Initial time: 00UTC 22 Oct. 2010)

Besides, NMC has also developed short-range TC gale products at 3-hour interval based on high resolution model of ECMWF and JMA for operational TC wind forecasting (Fig.2.27).

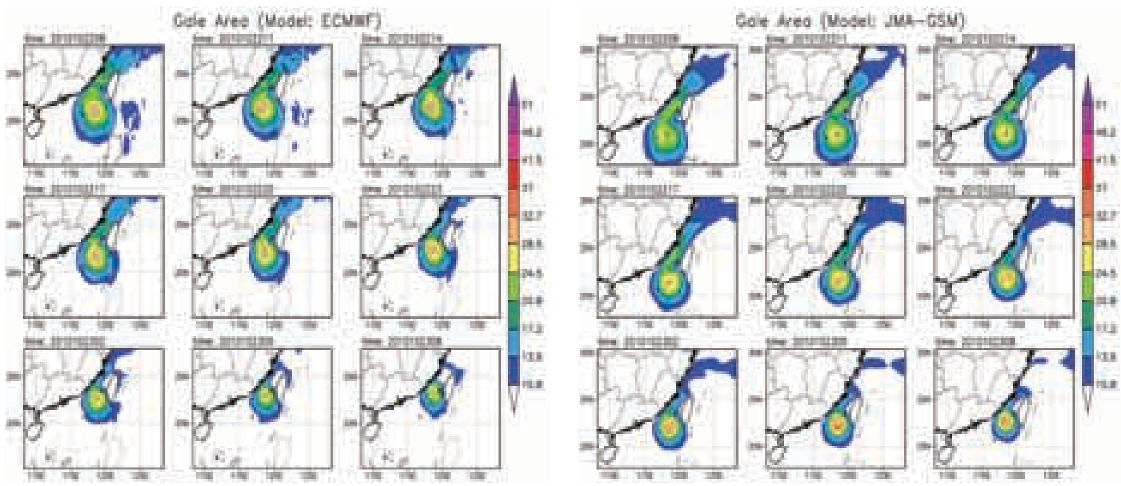

Fig 2.27 3-hour gale forecast for super typhoon *Megi* (1013)
(Left: ECMWF; Right: JMA, Initial time: 00UTC 22 Oct. 2010)

10) Improvement in Shanghai GRAPES-TCM Model System

Upgrade of the GRAPES-TCM (Global Regional Assimilation and Prediction System-Tropical Cyclone Model) to a high-resolution version with the improvement of TC initialization scheme and model physics. Major advances of the new version compared to the old one are:

- Increasing of the model horizontal resolution from 0.25°to 0.15°degree;
- Replacement of the original cycled vortex relocation (CVR) scheme with a cycled vortex data assimilation (CDA) scheme developed by Shanghai Typhoon Institute (STI);
- Implementation of a new Kain-Fritsch scheme with the modification of trigger function (Ma and

Tan, 2009) in the high-resolution GRAPES-TCM model;

- Parameterization of the surface drag coefficient in terms of strong surface wind. The high-resolution GRAPES-TCM model was put into quasi-operation in the 2010 TC season. Preliminary verification on TC track forecast shows the overall advantage of the upgraded model over the old version.

11) Improvement in South China Sea Typhoon Model (SCS-TYM)

SCS-TYM at the Guangzhou Institute of Tropical and Marine Meteorology was in stable operational run in 2010. The SCS-TYM is non-geotropic model with latitude-longitude grid points and a resolution of 0.36º and 31 vertical layers. It issues five-day forecasts of tropical oceans and typhoons. Artificial bogus and typhoon re-positioning techniques were used for the initial typhoon values of SCS-TYM and 3-dimensional variation assimilation (GRAPES_3D-Var) were adopted for data assimilation. On the basis of the original operational system, the scheme of water vapor advection was further improved and schemes of processing grid-point physics in the model upper reach and of convection parameterization were studied and improved. Improvements were also made to the formation of initial typhoon values. SCS-TYM has improved the forecasts of path and intensity of typhoons and also is capable of forecasting the formation of typhoons to some degree.

12) Operational Run of GRAPES Regional TC Ensemble Prediction System

Regional GRAPES-Ensemble TC Model (GRAPES-EnTCM) developed from GRAPES-TCM has been put into operation in 2010 based on quasi-operational run in 2009. Different with GRAPES-TCM, this system employs 12 ensemble members to take into account the uncertainties of model initial condition, physics and growth rate of model error. These ensemble members were constructed with breeding-based method, vortex bogus, vortex structure perturbation, and various schemes for model physics. Products such as ensemble track prediction, hitting probability, have been developed for use in national TC forecast discussion, TC special report, etc. Verification on retrospective numerical prediction of plenty of typhoon cases shows that the averaged ensemble track prediction error is less than that of deterministic prediction from GRAPES-TCM.

13) Improvement in Objective Forecasting Method for Typhoon Intensity

A statistical interpretation prediction method for TC intensity developed by NMC and Shanghai Typhoon Institute has been put into operation since 2009. The method is based on T213 global typhoon prediction system of NMC by using some predictors such as climatology persistence, SST, temperature and height at pressure level. The method is run twice at 00 and 12UTC each day for 72hr forecasting by using two different background fields of T213 global model (IPMG) and T213 global model with bogus (IPTY). By making comparison with subjective forecasting of NMC (BABJ) during the operational period from 2009 to 2010, IPMG and IPTY are helpful for operational TC intensity forecasting, but IPMG is better than IPTY.

14) Improvement in Operational TC Forecasting Platform

Typhoon version of MICAPSV3 on PC platform has formally been put into operation in NMC since July 2010. It is a platform combined by visualization of observation data, interactive making and sending of advisory and graphics for operational TC forecasting such as track, intensity, wind and rainfall etc. (Fig 2.28). The platform frees forecaster from hand work, greatly shortens the time for making and sending advisory and graphics of TC products.

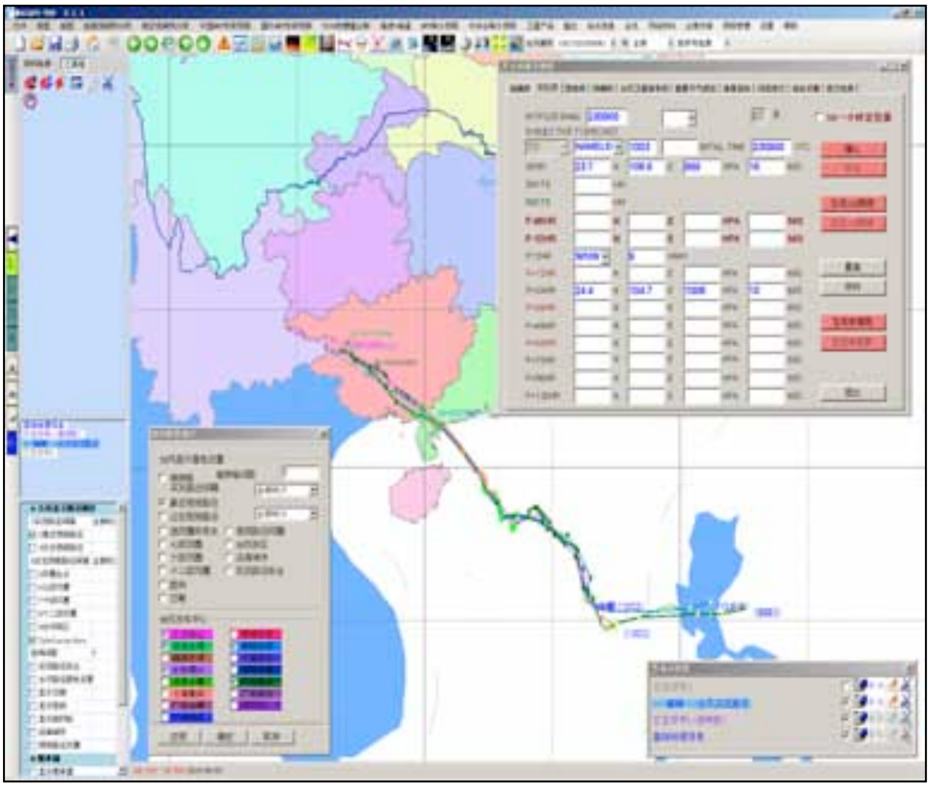

Fig 2.28 Operational typhoon forecasting platform in NMC

15) Integration Platform for TC Resources from Global Website

In July 2010, NMC built an integration platform from which forecaster can get real-time global TC resources. These resources include real-time global TC advisory, satellite, radar and marine observation data, NWP products and data download.

16) Field Experiments for Landing TCs

In 2010, some special field experiments have been carried out for Severe TY *Kompasu* (1007) and Super TY *Fanapi* (1011) by Sonic Anemometer/Thermometer, GPS, mobile wind profiler and AWSs. And real time scenes were provided consecutively to weather forecast centers.

In Guangdong, some field experiments were made on vertical structure of the boundary layer of some landing TCs by using wind profilers and microwave radiometers. Additionally, GPS sounding and tethered sounding systems were also deployed to conduct observation based on actual needs.

For the near-surface observation, four-component radiometers, AWSs and visibility devices were mainly used. The measurements include visibility, shortwave and long wave radiation fluxes, wind direction/speed, temperature/pressure, humidity and precipitation. And wave radars were also used to obtain waves and ocean surface currents.

The marine observation platform covers part of the ocean that is 6.5km from coast and 17m high. It is equipped with vorticity covariance and gradients observation systems for measuring air-sea momentum, heat and moisture exchanges and getting data of air-sea interactions. Submarine devices consist of temperature/salinity profiler, Doppler current speed profiler, and gravity-based wave instruments for measuring marine boundary layer, ocean currents and waves.

2.6.2 Hydrological Achievements/Results

To further improve supporting capability of water regime service, in 2010, the Bureau of Hydrology (BOH) under the Ministry of Water Resources (MWR) upgraded its operational national river regime forecasting system, accomplished the Phase-II project for creation of a dedicated national database for flood control and drought relief. BOH improved the consultation function of the hydrological information display system in response to emergency public water events, and functions of flash flood early warning module and feedback module. BOH upgraded and improved the functions of hand-held GIS system, adding functions to overlap rainfall amounts on top of a regime distribution chart, and to overlap with soil moisture pattern. BOH also improved river regime analysis functions and retrieval of water level warning information.

In aspect of typhoon service, BOH/MWR accomplished the development of flood forecasting schemes for 77 flood sections of 66 rivers across 8 provinces (or municipalities) along the China's coastal regions which are exposed to typhoon impacts. The accomplishments according to the timelines in 2010 included: 1) in its flood/drought notification issued in the beginning of 2010, typhoon prevention tasks for 77 forecasting sites were assigned in advance; 2) BOH completed the R&D of schemes for river typhoon-induced flood forecasts. According the work plan, forecasting scheme preparation was completed by the end of March 2010, tested and accepted in April, put into operational run in May; 3) BIH established work mechanism for water regime forecasts in response to typhoon, which was initiated as soon as a typhoon developed and it was numbered for close watch for possible impacts on China; the hydrological departments within a potential impact region should make continuously updated hydrological forecasts based on NWP and other weather products according to specific situation, and they should also up-post their forecasts according to the reporting procedures; when video consultation conference is called from elsewhere, up-delivery of forecast results must be ensured for needs in the conference;4) BIH has established a performance assessment mechanism targeted to the river regime forecasts in response to typhoons, and after the flood-prone season each year, BOH conducts such assessment on the hydrological forecasts, which is ended with a summary report, in order to enhance management of its forecasting work.

According to historical typhoon impacts, on the one hand, the specific technical R&D of flood forecast schemes within the typhoon impact regions are targeted to the 78 selected river sections in Shanghai, Zhejiang, Fujian, Hunan, Jiangxi, Guangdong, Guangxi and Hainan. On the other hand, in collaboration with the Hohai University, the major sea tide gauges along the China's coast are chosen from making tide forecasts. Then BOH/MWR integrates sea tide forecasts from the University together with other products to provide coastal tide forecasts and services in response to typhoon invasion.

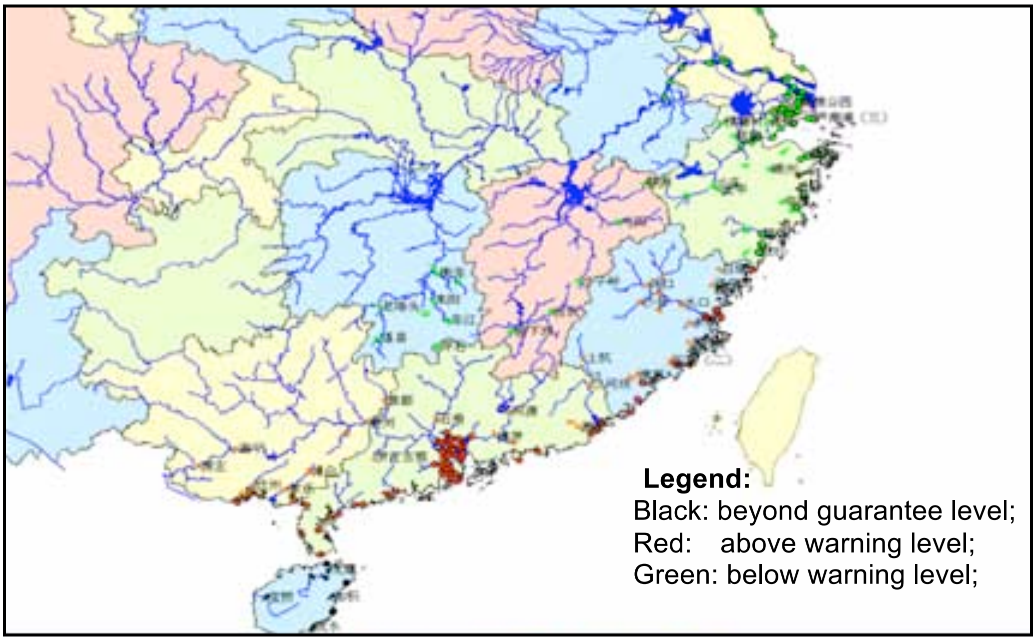

Fig 2.29 A sketch map of a typhoon-induced flood forecast

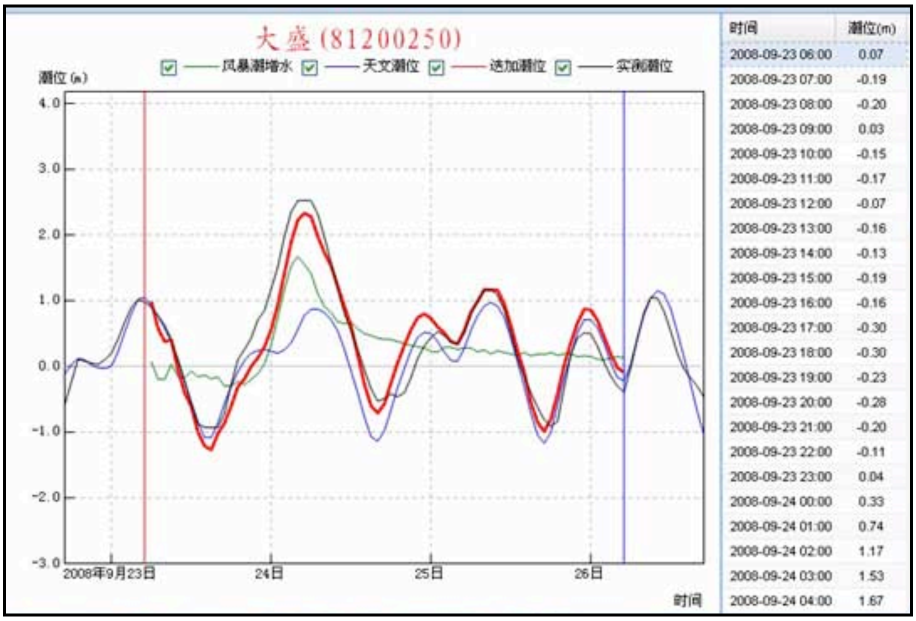

Fig 2.30 A coastal sea tide forecast chart

2.6.3 Disaster Prevention and Preparedness Achievements/Results

1) The national system for natural disaster management has been set up, enhancing the grass-root disaster management.

The national system for natural disaster management that integrates the central, provincial, prefectural and county governments has been accomplished, which have multiple functions such as direct reporting of disasters, real-time disaster monitoring, information sharing, dissemination of SMS messages and statistical analysis. This system has become an indispensable operational platform for departments of civil affairs above the county level to pool together, analyze and report information on disasters and disaster relief. As a result, there is a significant boost in the timeliness, normalization, completeness and processing efficiency of the disaster information reporting of local governments at various levels.

Fig 2.31 A sketch of the National Natural Disaster Management System

2) The mobile data collection system has been set up for real-time data transmission and sharing between disaster spots and control centers.

The real-time mobile disaster data collection system based on hand-held PDA terminals has been put into operation, preliminarily realizing the real-time data transmission and sharing, such as tables, videos, audios and images between disaster management departments at different levels and in disaster spots.

Fig 2.32 An interface of the Mobile Data Collection System.

Fig 2.33 An interface of the operational platform for comprehensive management of disaster reduction activities.

3) An operational system for comprehensive management of disaster reduction activities has been set up, enabling operations for disaster reduction, rescue and relief.

The operational system for comprehensive management of disaster reduction activities has been set up, incorporating such operations as remote-sensing data processing and applications, disaster monitoring and early warning, disaster emergency response, disaster loss assessment, support of decision-making, user service, information delivery and database management.

2.6.4 Research, Training, and Other Achievements/Results

1) The National Basic Research Program (973 Program) for Landing TCs

Research on abnormal changes of TCs and their mechanism before and after landfall over China – a project supported by the National Basic Research Program (973 Program) has been launched since 2009. This research is being conducted by CMA in collaboration with some universities and research institutions until 2013. The main research contents are as follows:

- The filed experiments on TC landfalls on China.
- Researches on theories and methods for TC micro-structures and integrated observation analysis based on multi-source data.
- The sea-land-air boundary layer structure and evolution characteristics for landing TCs.
- The influence mechanism of sea-land-air interaction for TC abnormal changes before and after TC landing on China.
- The activities of mesoscale system in TC circulation and its influence mechanism on TCs' abnormal changes before and after TC landing on China.
- Research and application on NWP methods for landing TCs.

2) Upgrade of Typhoon Initialization Scheme

A new vortex assimilation scheme was designed and implemented in GRAPES-TCM, which incorporated a modified bogus data assimilation (BDA) scheme, vortex relocation scheme and

MC-3DVAR scheme. In this scheme, within the assimilation cycle of MC-3DVAR, observed vortex information, model-controlled 3-D vortex structure forecasted by the dynamical model, as well as large-scale background forcing are jointly introduced into the model initial field in GRAPES-TCM. 22 numerical experiments for super typhoon *Jangmi* (2008) show that, 24h/48h track error reduces from 121/187km to 89/179km with the new scheme. Moreover, intensity forecast is also improved significantly.

3) Vortex Initialization with the Assimilation of Retrieved Variables (VIRV)

A new scheme - Vortex Initialization with the Assimilation of Retrieved Variables (VIRV) - was used to improve the initialization of regional numerical TC prediction model. In this scheme, the horizontal winds in planetary boundary layer (PBL) and sea level pressure (SLP), derived from QuikSCAT data with a modified UWPBL model are assimilated with 3DVAR approach to make initial analysis. The procedures of retrieval are implemented under the joint dynamical constraints of gradient wind, secondary circulation and thermal stratification. Moreover, in order to improve TC intensity analysis, the roughness parameterization in the UWPBL model was modified for the case of strong surface wind. The sensitivities of TC structure, intensity and track to the VIRV are then examined through two numerical experiments targeted to TC Bilis (2006) and TC Fung-Wong (2008). The maximum wind speed (MWS) and minimum sea level pressure (MSLP) derived from the QuikSCAT data show better agreement with the observations, relative to those derived from the National Center for Environmental Prediction (NCEP). The TC intensity analysis in the VIRV is increased by modifying the low-level (upper-level) convergence (divergence), vertical shear of horizontal wind, transportation of moisture. Significant improvement in 48-hours TC simulation is found in the MWS, with 22.8% error reduced. In particular, the modification of roughness parameterization (MRP) enhanced the simulation of MWS by 6.9%. Finally, the VIRV also reduces the simulation error in TC track affecting the steering flow in the troposphere.

4) Ocean-Atmosphere Coupled Model System

A regional Ocean-Atmosphere coupled model system for use of typhoon landfall forecast was developed by Shanghai Typhoon Institute based on the GRAPES-TCM atmospheric model and ECOM ocean model. The dynamical and thermo-dynamical variables considered in the coupled model includes: SST, short wave radiance flux, surface heating flux, moisture flux, stress, etc. Retrospective numerical experiments on TC *Rananim* (2004) were performed. The results show that TC intensity is sensitive to couple effect. The TC intensity produced by the atmospheric model GRAPES-TCM is more intensive than its coupled counterpart and observations. The ocean feedback reduces overestimation of TC intensity by GRAPES-TCM. Especially, it is found that the SST variation along the TC track simulated by the coupled model shows more consistency with the derived SST from TRMM/TMI compared to that of GRAPES-TCM. The TC track forecast changes little under the coupling effect.

5) Study of Formation and Quasi-Periodic Behavior of Outer Spiral Rain bands

The outer spiral rain bands simulated in the cloud-resolving model TCM4 are preferably initiated near a 60-km radius, or roughly about three times over the radius of maximum wind (RMW). They are reinitiated quasi-periodically with a period between 22-h and 26-h in the simulation. It is shown that outer spiral rain bands are triggered by local symmetric instability in the upper troposphere just outside the rapid filamentation zone. The preferred radial location of initiation of outer spiral rain bands is understood as a balance between the suppression of deep convection by rapid filamentation and the favorable dynamical and thermodynamic conditions for initiation of deep convection.

The quasi-periodic occurrence of outer spiral rain bands is found to be associated with the boundary layer recovery from the effect of convective downdrafts and the consumption of convective available potential energy (CAPE) by convection in the previous outer spiral rain bands. Specifically, once convection is initiated and organized in the form of outer spiral rain bands, it will produce strong downdrafts, consume CAPE, and remove symmetric instability. These effects weaken convection near its initiation location, leading to an outward propagation of the outer rain band since CAPE is much higher outside than inside the rain band. As the rain band propagates outward further, the boundary layer air near the original location of convection initiation takes about 10 hours to be recovered by subtracting energy from the underlying ocean. Convection and thus new outer spiral rain bands will be initiated near a radius of about three times the RMW. This will be followed by a similar outward propagation and the subsequent boundary layer recovery, leading to a quasi-periodic (nearly a diurnal) occurrence of outer spiral rain bands.

6) Study of Landing TC Extratropical Transition Process

Statistics show that TCs in the region (34~48°N) Extratropical Transition (ET) event takes place with a 50% probability. ET events are mainly regional, in nature with the highest probability of 65% near 42°N. TCs to the south of 42°N show a general trend, in which degeneration rate increases gradually with higher latitude. Those to the north of 42°N gradually decreases (except near 48°N), and those to the north 50°N rapidly reduced to 0%. ET occurrence point (referred to as degeneration point) changes with the seasons, showing north-to-south down trend (reaching North from August to September). The higher the latitude variability is, the weaker, the cyclone intensity will be, modifying the latitude point.

7) Verification of Tropical Cyclones-Related Satellite Precipitation Estimates

Accurate precipitation estimates with both high temporal and spatial resolutions are required for many applications, such as numerical model verification and data assimilation. To evaluate the abilities of satellite retrievals in reflecting precipitation features related to TCs affecting Mainland China, four years of 6-h and 24-h precipitation retrievals from three datasets, namely Tropical Rainfall Measuring Mission satellite algorithm 3B42 version 6 (3B42), Climate Prediction Center MORPHed (CMORPH) product and precipitation retrieval based on Geostationary Meteorological Satellite-5 infrared brightness temperature (GMS5-TBB), are compared statistically with direct measurements from surface rainfall gauges in the TC periods. The GMS5-TBB dataset was set up by a method of considering the GMS5-TBB characteristics, hourly precipitation intensity and horizontal distribution for landfall TCs. The results show that for the heavy rainfall events, the GMS5-TBB data perform much better than the 3B42 and CMORPH with almost halved bias, which should owe to the fact that the GMS5-TBB method adopted the adjustment of the convective rain rate by considering TBB characteristics of landfall TCs and using hourly gauge rainfall in the setting-up process. Since the heavy rainfall events associated with landfall TCs are the most concern, the compared GMS5-TBB data can be used as operational/research reference. Since 2008, GMS5-TBB method has been applied operationally in Shanghai Typhoon Institute.

8) Typhoon Track Forecast Error Analysis

Through the detail analysis based on the subject forecast information of CMA, JMA and JTWC, operational track forecast has been improved largely during last 12 years (1997-2008). And more process is gained in 48h forecast than the 24 hour forecast. But most of the improvement of track forecast happened in the early years of this century (2000-2004), few progresses are made in recent years (2005-2008). Further analysis shows that 24h track forecast error of weak TCs (STS and TS) is 40-50km larger than that of the strong TCs (TY, severe TY and super TY), and the forecasts of TCs over the region from the Yellow Sea and the waters to the east of Japan are less trustful than TCs in other regions. For TCs over the South China Sea, the forecasts from CMA and JTWC are more accurate than other centers in 24 hour forecast and JTWC is most reliable in 48 hour forecast.

9) TC Genesis

Using TC data from CMA and the ERA re-analysis data for the period of 1958~2001, a possible mechanism for the role of latent heat flux variation on TC activities over the western North Pacific (WNP, including South China Sea) has been proposed. There exist significant decreasing trends in both TC frequency over WNP and the latent heat flux in the key region - central subtropical North Pacific. It can be concluded at least tentatively that during the past more than 40 years the decreasing trend in the latent heat flux in central subtropical North Pacific is one of the main reasons that cause the decreasing trend in TC frequency over WNP. Intra-seasonal oscillation also has effect on typhoon genesis over the western north pacific. This indicated that the ISO strongly affects the typhoon genesis. In the years of more typhoon genesis, the ISO was weak in the area to the west of the Philippines; at the same time, the ISO was strong in the area to the east of it, with significant northwestward propagation. Moreover, in the years of less typhoon genesis, the ISO gradually became stronger with a significant eastward propagation from the eastern Indian Ocean to the area around 120 °E.

10) Training Course on Satellite Data Application in Weather Analysis and Forecast

From January to October, 2010, China Meteorological Administration Training Center (CMATC) organized one training course on satellite data application in weather analysis and forecast with 25 participants, course contents mainly covered: fundamental principle of satellite meteorology, multi-channel observation application in weather and climate analysis and forecasting, satellite monitoring and application of mesoscale system, formation and application of TOVS data, derived gust products of geostationary satellite, TC positioning and intensity estimation by satellite image, precipitation estimation techniques by satellite data, analysis application of water vapor imagery, analysis application of TBB, generation and application of OLR data, monitoring dust storms by using polar-orbiting and geostationary meteorological satellite, large scale cloud system analysis.

11) Training Course on Application of New Generation Doppler Weather radar

In January-October 2010, CMATC organized two training events on applications of the new generation Doppler weather radar and 98 trainees attended, the training focused on principles of Doppler radar, velocity identification, data quality control, the characteristics of radar echoes in a convective storm, radar products and algorithms, severe convective weather now-casting.

12) Advanced Training Courses on Numerical Weather Prediction

In January-October 2010, CMATC organized an advanced training courses on NWP models for 47 trainees, the course mainly included numerical discretion methods, model output analysis, convective cumulus parameterization, radiation parameterization, boundary layer physical processes parameterization, microphysics processes parameterization, briefing GRAPES model.

13) Summer School on Numerical Weather Prediction Model

A summer school for advanced training course for NWP Models was successfully held in July 2010 in Beijing. The lecturers were from America and China. The training course included basic numerical discretion methods and analysis theories, parameterization schemes of physical processes and their applications in numerical prediction models, and the GRAPES model and its recent advances, aiming at improving trainees' comprehensive knowledge of and abilities for numerical prediction model development.

14) National Training Courses on Hydrological Forecasting

To enhance local hydrological service capabilities, the Bureau of Hydrology/MWR organized a number of training workshops on river regime forecasts at different levels. For example, in October 2010, a training seminar on hydrological forecasts of China's river regimes was held in Nanjing, and more than 100 trainees from regime forecasting establishments nationwide attended the event, in which they learnt how to prepare water regime reports, methods used in flood forecasting, hydrological database components, water regime data exchange and dissemination, and other operational knowledge.

Fig 2.34 A national training event on hydrological forecasting

2.6.5 Regional Cooperation Achievements/Results

NIL

2.6.6 Identified Opportunities/Challenges for Future Achievements/Results

1) WMO TC Landfall Forecast Demonstration Project (WMO-TLFDP)

The World Expo 2010 was held in Shanghai from May to October 2010, during the peak months of the rainy season in Shanghai and East China. Climatologically, during this period, about five TCs landed on the coastal regions of the East China. It is almost certain that these landing TCs will have tremendous impact on the World Expo and related activities.

To provide a better TC landfall forecast service for World Expo 2010, and to enhance the ability of forecasters and decision-makers to effectively use products of the most advanced TC forecasting techniques in the world, "WMO TC Landfall Forecast Demonstration Project (WMO-TLFDP)" was proposed by the East China Regional Meteorological Centre/CMA during the IWTCLP-II held in Shanghai, China, 19-23 Oct. 2009. The proposal was subsequently adopted by CAS-XV held in

Incheon, ROK, 18-25 November 2009.

The WMO-TLFDP is a component of the Shanghai MHEWS project, to be implemented starting in May 2010 in conjunction with the start of the World Expo 2010. The TLFDP is a three-year project which will end in December 2012. It is jointly supported and guided by WWRP, TCP, and PWS of WMO. The leading institution is Shanghai TC Institute/CMA, with full involvement of East China Regional Meteorological Centre and RSMC Tokyo TC Centre. The participation of other National & Regional Centers is also envisioned. It will work closely with the NW Pacific Tropical Cyclone Ensemble Forecast Experiment for TC Committee members.

The WMO-TLFDP will:

- Develop a system to collect, integrate and display real-time forecasting results for landing TCs, including track, intensity, gale extent and rainstorm distributions, from various institutions;
- Develop and integrate techniques to evaluate accuracy of forecast for landfall location and time, gale distribution, and torrential rain;
- Make comprehensive analyses of the forecasts and evaluate their reliability;
- Assess their social and economic impacts.

Through close international collaboration, the WMO-TLFDP will demonstrate and quantify the benefits of an end-to-end forecast system for landing TCs using the latest advances in the science of tropical cyclone forecasting. The WMO-TLFDP, as a means of exchanging forecast experiences, a platform for the application of the latest TC forecast technology, and a bridge to connect forecast and public service, is expected to promote the implementation of the most advanced landfall TC forecast techniques in the East China which ultimately will be of benefit to WMO Members as well.

2) Challenges for Future Achievements

Tropical cyclone intensity forecasting remains a challenge. Of all intensity forecasting, rapid intensification (RI) is a particularly thorny problem. Some investigators propose that there a nonlinear response of TC vortex to environmental forcing in cases of RI. Research in understanding the mechanisms associated with intensification or weakening of tropical cyclone, especially just prior to landfall should continue. In addition, the size of tropical cyclone is the most difficult operational forecasts to produce. The lack of appropriate data for validation is a stumbling block to forecast improvement. Greater efforts should be put into intensity and structure research and prediction of tropical cyclone.

The continued development of high resolution models needs to be accompanied by improved specification of initial conditions and modeling of inner core processes and air-sea interactions. Further improvements in microphysical and boundary layer parameterization are also required. More research on multi-model consensus and single -model ensemble approaches should be encouraged in operational forecasting of tropical cyclone.

Although substantial progress was made in the past decade, track forecasting still remains a high priority. Efforts should continue to further reduce track forecast error. All potential sources of track errors (model physics, initial conditions, etc) should be examined. On the other hand, it is very difficult to make an accurate prediction for the sharp turning track of tropical cyclone. It is a significant need for further studies into the mechanism of sharp turning of tropical cyclone motion.

Heavy rainfall and flooding caused by landfall tropical cyclones (LTCs) are recognized as extreme weather events, but the science behind the behaviors of LTC rainfall is not currently understood to a great enough extent.

One of the major reasons for the slow pace of improvement in TC QPFs may be deficiencies in the collection and assimilation of real-time inner core data into numerical weather prediction models. Due to cloud and rain effect, satellite retrieved products usually have large uncertainties under cloudy and precipitating areas, thus most of the cloudy and rain-effected data are rejected during the quality control procedures in data assimilation.

2.7 Progress on Key Result Area 7: Enhanced Typhoon Committee's Effectiveness and International Collaboration.

2.7.1 Meteorological Achievements/Results

1) Typhoon Forum

To provide a real time communication platform for forecaster and researcher in the Asia and Pacific Typhoon committee, and to improve the TC forecasts, and to reduce the damage of TC, a website was set up as a Typhoon Forum (http://www.typhoon.gov.cn/en/bbs/) by STI/CMA. The forum is designed to discuss TC motion, intensity, and rainfall distribution, which may have impacts on the Asia and Pacific Area. Up to November 2010, 59 members from 11 countries in Asia and the Pacific Area as well as Officials from TCS and Scientists in TC research attended the forum. Right now, the website covers 33 topics, 57 posters and 39 attachment files.

2) WMO Typhoon Committee Member attending WMO International Conference on QPE/QPF and Hydrology in Nanjing

The Third WMO International Conference on Quantitative Precipitation Estimation (QPE) and Quantitative Precipitation Forecasting (QPF) and Hydrology was convened at the WMO Regional Training Centre in Nanjing, China in 18-22 October 2010. 8 WMO/ESCAP Typhoon Committee Members (76 people) attended the Conference. The overarching objective of this conference is to improve QPF capabilities and advance the use of these fields in hydrological predictions with an emphasis on high impact events. The conference covered a wide range of issues relating to QPF including new observational approaches and technique development for Quantitative Precipitation Estimation (QPE), advances in data assimilation, modeling and verification for QPF, user needs and the challenges to operational QPF.

3) TC Research Fellowship

TC Research Fellowship offered by CMA (China Meteorological Administration) was awarded to Mr. Nguyen Manh Linh from Thailand and Ms. KAMOLRAT SARINGKARNPHASIT from Viet Nam to work on the project Typhoon Information Processing System at National Meteorological Center of CMA during the period from 8 October to 8 December 2010.

Mr. Huang Yiwu from NMC/CMA also received the TC Research Fellowship offered by Hong Kong Observatory to make experiments on *Morakot*'s rainfall, including experimenting with different terrain, topography and monsoon strength. The purpose of this work is trying to answer the questions as what would happen if *Morakot* hits Hong Kong and what would the rainfall amount be like as a result of the changes in terrain, monsoon intensity and TC weakening after landfall.

4) Lecturer for Typhoon Committee Roving Seminar

The TYPHOON COMMITTEE Roving Seminar 2010 was held at the Sunee Grand Hotel and Convention Center in Ubon Ratchathani, Thailand on 30 Nov – 3 Dec. It was attended by 10 participants from Cambodia; Hong Kong, China; Lao PDR; Macao, China; Malaysia, Philippines, Singapore and Viet Nam; plus 15 local participants from Thailand. Professor Zhang Qinghong (Peking University of China) presented Topic on "Effects of tropical cyclone interaction with monsoon, with emphasis on enhanced rainfall". The participants expressed a warm appreciation of the outstanding presentations, which provided them with new insight on the topics discussed.

5) WIS Development at CMA

CMA started developing WIS/GISC system for data collection, DAR services and data request/reply to the authorized users, as well as metadata exchange and synchronization with other WIS centers from 2008. It adopts J2EE framework and a layered modular design, with simple structure and easily scalable components, a user-friendly web interface for accessing, monitoring and managing data services. It is fully compliant with WIS technical specifications and standards, and endorsed by ET-GDDP. Now, CMA WIS/GISC system has synchronized metadata with JMA and DWD, harvesting metadata from HKO, providing data access to global data, CMA NWP products, FY satellite data and TIGEE products to users.

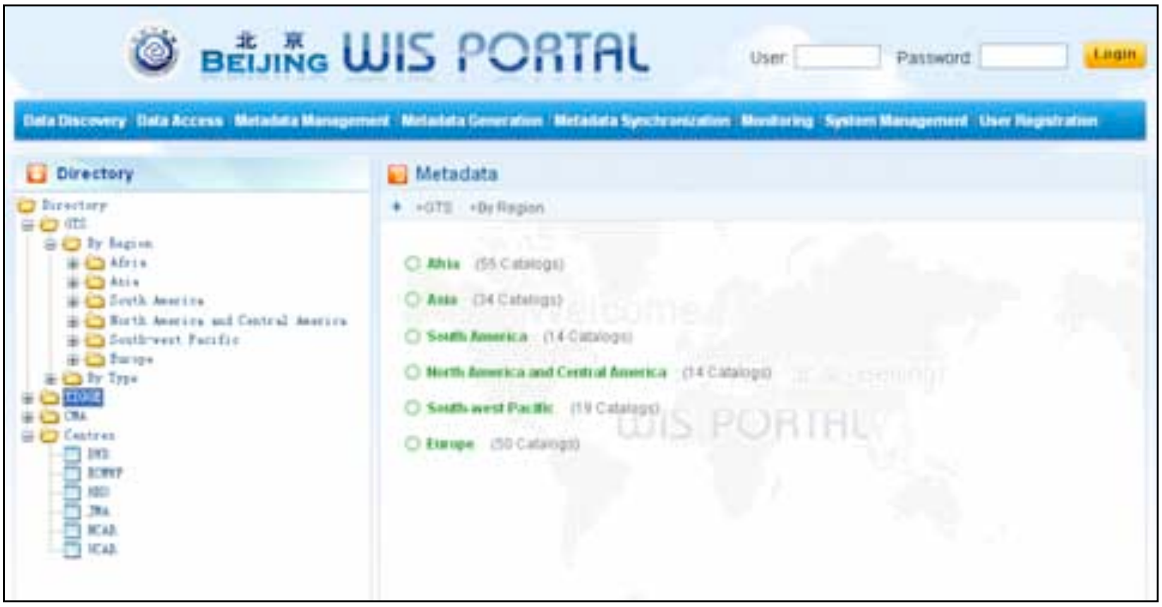

Fig 2.35 CMA's WIS portal

6) Upgrading of CMA's data broadcasting system

Currently, 18 WMO Members, including Bangladesh, DPRK, Indonesia, Iran, Kyrghyz, Lao P.D.R, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Peru, Philippines, Sri Lanka, Tajikistan, Thailand, Uzbekistan, and Viet Nam are equipped with FENGYUNCast system. As CMA's next generation data broadcast system - CMACast - will operate and function in parallel with FENGYUNCast in 2011. All FENGYUNCast receivers outside China will be upgraded to CMACast receivers.

2.7.2 Hydrological Achievements/Results

In 2000, the Typhoon Committee decided to launch the Regional Cooperation Program Implementation Project (RCPIP), in which 9 projects were related to hydrology. In January 2008, Malaysia as a Member country proposed an international training program on hydrological forecasting based on a Tank model, and the proposal was adopted at the 39th Session of the Typhoon Committee.

The Ministry of Water Resources sent a hydrological forecaster to attend the training seminar on flood forecasting (OJB) held in Malaysia in 2010. It was the fourth training event on hydrological prediction based on a Tank model sponsored by WMO/ESCAP Typhoon Committee and hosted by Malaysia. The training mainly included studies on Tank-model-based hydrological forecasting system plus on-line practices, which was designed to further improve flood forecasters' knowledge, operational skills and experience. By using the Tank model, trainees may acquire enough knowledge, understanding and experience for development and use of flood forecasting models in home countries. The 26-day training event was held from 12 July to 6 August 2010, and more than 20 participants attended it, including Ms. Chen Hongyu from the Bureau of Hydrology under the Huaihe River Commission (China), Sengduanduan Phouthanoxay from Lao PDR, Nguyen Thuy Thi from Viet Nam and staff from the Department of Irrigation and Drainage (DID) of Malaysia. During the training, apart from the lectures given by experts, trainees also made case studies targeted to a selected area within their home countries for application use of the Tank model. The Tank was developed with VBA computer language, parameter calibration was made according to the hydrological data in history, aimed at improving Tank-model based forecasts. By the end of training, trainees submitted the individual Tank models they developed in VBA for their home region, they also summarized the case studies and delivered a paper. Finally, a certificate was presented to each trainee. During the training, they also visited the Malaysian Meteorological Service, SMART Tunnel, DID flood monitoring facilities and demonstration of its hydrological forecasting system, etc.

2.7.3 Disaster Prevention and Preparedness Achievements/Results

In 2010 China was actively involved in international cooperation concerning disaster prevention and reduction. National Disaster Reduction Center of China has successively dispatched 28 person-times to attend the relevant international meetings and training programs in 15 countries, among which is the 42nd Conference of the Commission for Typhoons of the World Meteorological Organization. In the meantime, China cooperated with the International Civil Defence Organization, the Secretariat of ASEAN, and APEC Secretariat respectively in holding the International Workshop on Space Technology Application in Disaster Reduction, ASEAN 10 plus Three Seminar on Urban Disaster Emergency Management, Seminar on Integrating Disaster Risk Reduction into Post-disaster Recovery and Reconstruction. Many delegates from membership countries of the World Meteorological Organization took part in these workshops. Through communication, the mutual understanding between China and other countries and international organizations is strengthened, and experience and practices are exchanged and shared, laying a solid foundation for future cooperation in the relevant fields.

2.7.4 Research, Training, and Other Achievements/Results

International Training Course on Meteorological Satellite

From January to October, 2010, the CMATC organized an international training courses on Meteorological Satellite, the 18 international participants in this course are from Asia, Africa and Latin American countries. The training contents covered: To retrieve and analysis cloud properties by satellite data, Image interpretation-synoptic scale system, Monitoring and analysis techniques for the tropical weather systems based on satellite observation, Progress and future development on satellite sounding technology, Fire and flood monitoring, Pre-processing of FY satellite data, satellite precipitation estimate, Remote sensing aerosol with MODIS and the application of MODIS aerosol products, Meteorological satellites and space weather operations, Assimilation of ATOVS/VASS data from meteorological satellite in NWP model.

Fig 2.36 International Training Courses on Satellite Meteorology in Beijing

2.7.5 Regional Cooperation Achievements/Results

2.7.6 Identified Opportunities/Challenges for Future Achievements/Results

See 2.6.6 for KRA 6

III. Resource Mobilization Activities

3.1 To enhance typhoon scientific studies, and to provide better scientific and technical support to real-time operational work, the Ministry of Finance launched the following 2 typhoon-related research projects in 2010

- *Research on Nowcasting Techniques for Landing Typhoon-induced Winds and Rainfall*, with a fund of 2.14 million RMB Yuan, mainly includes development of inversion technique of Doppler radar data for landing TCs, assimilation technique for integration of multi-source data, development and improvement of nowcasting techniques on precipitation and winds.
- Key Techniques for Typhoon Forecast Confidence Estimation and Its Operational Applications, with funding up to 3.68 million RMB Yuan, mainly focuses on (a) development of an objective estimation method for real-time TC forecasting performance, and establishment of a comprehensive estimation analysis system; (b) development of some techniques for estimating prediction errors, and some models and schemes for estimating prediction errors; (c) development of some methods and techniques for estimating confidence of all results from different prediction models and schemes, including estimation, application and verifications of confidence of predicted results based on the characteristics of the probability distribution of the estimated and historical prediction errors.

3.2 In 2011, the Ministry of Finance will continue to support a research project (meteorology)

- *Studies on Offshore Typhoon Structure and Intensity and Forecasting Techniques*, with a supporting fund of 2.5 million RMB Yuan, mainly includes (a) analytic study on the characteristics of TC boundary layer, mesoscale structural variation, intensity change mechanism by using observational data, numerical simulation and diagnostic analysis for some typical TC cases; (b) studies on various factors that affect TC bogus and model physic schemes TC structure and intensity change based on the above analysis and research; (c) establishment of a regional TC model for operational TC intensity prediction based on NCAR/ARW-WRF model.

IV. Update of Members' Working Groups representatives

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4.5 Resource Mobilization Group

There were at least 10 reports of fallen trees in Hong Kong during the approach of Megi, affecting the traffic in various parts of the territory. A 50-metre crane on a construction site in Tsing Yi collapsed, fortunately with no one injured.

4. Regional Cooperation Assessment (highlighting regional cooperation successes and challenges)
   Nil.

II. Summary of progress in Key Result Areas (For achievements/results which apply to more than one Key Result Area, please describe them under the most applicable Key Result Area. Then, at the end of the description, place in parentheses ( ) the other applicable Key Result Areas)

1. **Progress on Key Result Area 1**: Reduced Loss of Life from Typhoon-related Disasters. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

   a. Meteorological Achievements/Results

The Tropical Cyclone Information Display and Processing System (TIPS), the major system for TC forecast operations, was enhanced with incorporation of the Observatory‟s mesoscale non-hydrostatic model (meso-NHM), the ensemble mean track of China Meteorological Administration, UK Met. Office and Korea Meteorological Administration based on data available from the THORPEX GIFS-TIGGE project, and the overlay of tropical cyclone strike probability information derived from the CMA EPS, in addition to ECMWF EPS and JMA One-week EPS, to facilitate the formulation of the subjective warning track.

The new generation numerical weather prediction (NWP) system of the Observatory has been put into operation since June 2010. The system, named as the Atmospheric Integrated Rapid cycle (AIR) forecast model, was developed with the kind support of JMA based on their Non-hydrostatic Model (NHM). It provides 72 hours and 15 hours of forecasts at horizontal resolution of 10 km and 2 km respectively. With the improved model physics and higher horizontal resolution comparing to the previous NWP system, AIR forecast model shows improvement in the weather forecasts on both surface and upper levels. To support the prediction of high-impact weather due to tropical cyclones, new products like distribution of surface wind and gusts have been developed for reference by forecasters to assess the change of wind intensity over coastal areas of southern China (Figure 7).

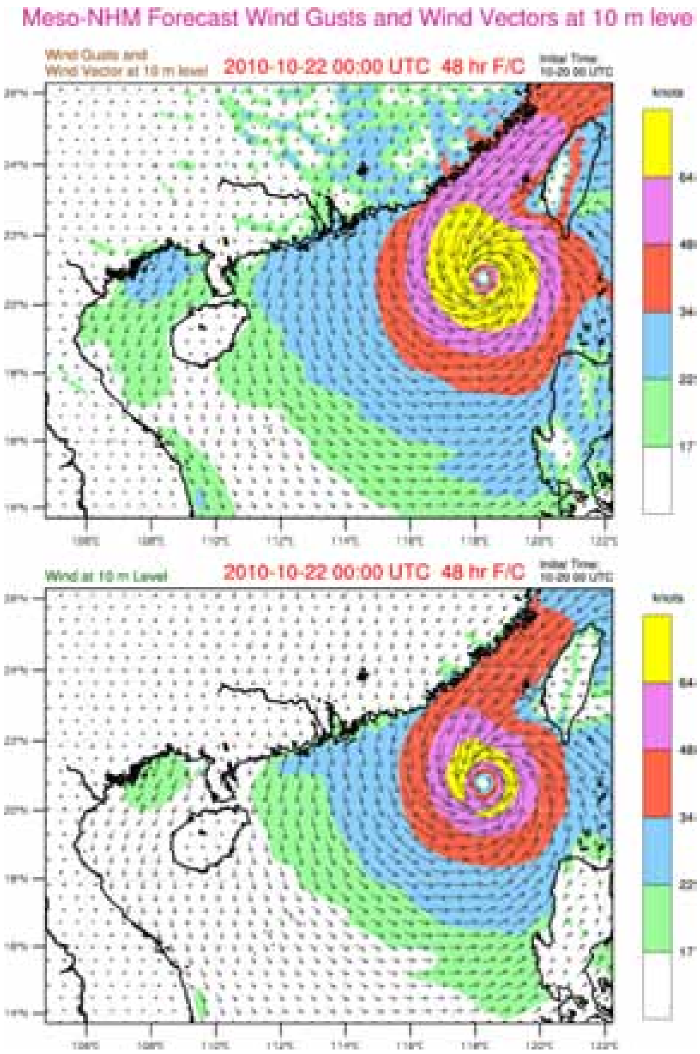


Figure 7. 48 hr forecast of surface wind gusts (upper panel) and winds at 10 m level (lower panel) from 10 km NHM for Super Typhoon Megi (1013) at 00 UTC, 22 October 2010. Wind speeds (in knots) are represented by color shading and areas of strong force wind (blue) are forecast to cover the coastal waters in the vicinity of Hong Kong.

b. Hydrological Achievements/Results

The radar tracking algorithm of the SWIRLS (Short-range Warning of Intense Rainstorms in Localized Systems) nowcasting system was upgraded from correlation-based to optical flow-based. The verification results for 2010 showed that the optical flow-based quantitative precipitation forecasts (QPF) were more skilful in general. A grid-based real-time QPF verification system was set up for effective performance monitoring and algorithm tuning. For better rainfall analysis in support of hydrological applications, especially over gauge sparse areas, a new quantitative precipitation estimation (QPE) technique based on radar-rain gauge co-Kriging was under development. The same QPE technique was also being explored for application to quality control of rain gauge data.

The Observatory provided support to the Drainage Service Department in their review of the Drainage Master Plans in Yuen Long & North Districts and feasibility study of applying integrated water resources management system in real-time flood forecasting. Results showed that direct output from SWIRLS nowcasting system agreed reasonably well with the measurement at the nearest rain gauge but did not serve as a good predictor of flooding over a small catchment due to spatial variation and time fluctuation. Further studies would be conducted where opportunities arise.

The Observatory provided the Drainage Service Department with a forecast guidance on the likelihood of having rainstorms (widespread and persistent heavy rain with hourly rainfall at 30 mm or higher) in Hong Kong in the next couple of hours to facilitate their flood control operations. It was presented in iconic form, with intuitive graphical content flipping between two possible states: “(80%” or “<80%” (meaning high chance or not). The probability guidance was based on the rainfall forecasts generated by the SWIRLS (Short-range Warning of Intense Rainstorms in Localized Systems) nowcasting system and historical rainstorm data.

c. Disaster Prevention and Preparedness Achievements/Results

In order to facilitate the flood related operations of relevant government departments, Short Message Service (SMS) was arranged to alert key operational personnel upon the real-time regional rainfall exceeding the thresholds of 50 mm/hr and 70 mm/hr.

With the successful implementation of a localized alert system on storm surge flooding for a small rural village community in 2009, similar early alert system was implemented for five more vulnerable areas in Hong Kong in 2010. Early alerts would be communicated to key operational personnel using the Short Message Service (SMS). Super Typhoon Megi (1013) posed severe threats to countries along its path in October 2010. In Hong Kong, localized storm surge alerts were activated during the approach of Megi. Necessary precautions were taken in time for preventing flooding caused by possible storm surge (Figure 8).

Figure 8. Precautions taken at one of the flood-prone locations during the passage of Severe Typhoon Megi

d. Research, Training, and Other Achievements/Results

An Observatory‟s officer lectured on tropical cyclone wind and rainfall forecasting in a training workshop at Shanghai organized under the WMO Typhoon Landfall Forecast Demonstration Project. The objective of the workshop is to enhance the ability of weather forecasters in tropical cyclone forecasting, especially the provision of better forecast services for the World Expo 2010.

A training course on "Automated Weather Station Network" was provided to 11 meteorologists from 11 WMO Members by the Observatory from 29 November to 3 December 2010. It covered, amongst other topics, applications of automated weather station network in monitoring weather situation during the passage of tropical cyclones. Data on wind, rain, water levels, etc. gathered from local automatic weather stations is made available in real-time on the Internet, providing detailed and timely weather information to government personnel and the public for mitigation of damage and casualties caused by tropical cyclones.

e. Regional Cooperation Achievements/Results

Please refer to Key Result Area 2(e).

f. Identified Opportunities/Challenges for Future Achievements/Results

Nil.

2. **Progress on Key Result Area 2**: Minimized Typhoon-related Social and Economic Impacts. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

Please refer to Key Result Area 1(a).

b. Hydrological Achievements/Results

The Drainage Service Department liaised closely with other relevant Government departments and persons in charge of construction sites to avoid flooding due to blockage of roadside gullies, drains or watercourses by garbage or construction waste. Television announcements were broadcast from time to time soliciting the support of the public to keep the drainage system from blockage.

The Drainage Service Department provided a 24-hour hotline to facilitate reception of flooding complaints and to mobilize their labour force and contractors. Complaints received by the department were recorded by a computerized Drainage Complaints Information System so that data could be retrieved and analyzed later. When the situation warranted, an Emergency Control Centre under the charge of senior professionals would be activated.

Please also refer to Key Result Area 5(b).

c. Disaster Prevention and Preparedness Achievements/Results

Typhoon related information on Hagupit (2008) and Koppu (2009) were prepared and provided to NIDP, Republic of Korea for the production of brochures. The information highlights the impact of the storm surge during the passage of Hagupit and the new alerting system on storm surge during the passage of Koppu.

Damage figures brought about by tropical cyclones and rainstorms were collected from selected Government departments and public utility companies for the compilation of damage statistics. The results were provided in the annual tropical cyclone publication of the Observatory.

d. Research, Training, and Other Achievements/Results

Nil.

e. Regional Cooperation Achievements/Results

As one of the contributions to the WMO Typhoon Landfall Forecast Demonstration Project in assessing the social and economic impacts of an improved tropical cyclone forecast service, the Observatory shared the experience of conducting public and customer opinion surveys with the Shanghai Typhoon Institute.

f. Identified Opportunities/Challenges for Future Achievements/Results
   Nil.

3. **Progress on Key Result Area 3**: Enhanced Beneficial Typhoon-related Effects for the Betterment of Quality of life. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results
   Nil.

b. Hydrological Achievements/Results
   Nil.

c. Disaster Prevention and Preparedness Achievements/Results
   Nil.

d. Research, Training, and Other Achievements/Results
   Nil.

A paper on the benefits of typhoons from the Hong Kong perspective was presented in the 5th ESCAP/WMO Typhoon Committee‟s Integrated Workshop "Urban Flood Risk Management in a Changing Climate: Sustainable and Adaptation Challenges" held in September 2010. The study revealed that the rainfall associated with tropical cyclones accounted for a significant portion of Hong Kong‟s annual total rainfall and would help alleviate the prevailing drought. Furthermore, based on data in 2007-2009, tropical cyclones provided a net cooling effect in Hong Kong. Tropical cyclones could also enhance potential wind energy in Hong Kong.

e. Regional Cooperation Achievements/Results
   Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results
   Nil.

4. **Progress on Key Result Area 4**: Improved Typhoon-related Disaster Risk Management in Various Sectors. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

The convective weather associated with a tropical cyclone may have adverse effects on flight operations, with implications on both aviation safety and efficiency. In support of air traffic management (ATM), an Aviation Thunderstorm Nowcasting System (ATNS) was developed and put into trial operation since May 2010 to forecast the location of thunderstorms in the next 60 minutes by extrapolation based on artificial intelligence technique. ATNS automatically determines the movement of thunderstorms from the radar image sequence every 6 minutes and forecasts their future locations at 6-minute time steps. It is found to be useful in forecasting the thunderstorms in the outer rain bands of tropical cyclones. Alerts on severity of thunderstorms affecting the vicinity of HKIA (Figure 9) are generated for reference by aviation weather forecasters and air traffic controllers. Based on 5 tropical cyclone cases in 2010, ATNS demonstrates a 30-minute nowcasting skill with probability of detection (POD) larger than 70% and false alarm rate (FAR) under 30%.

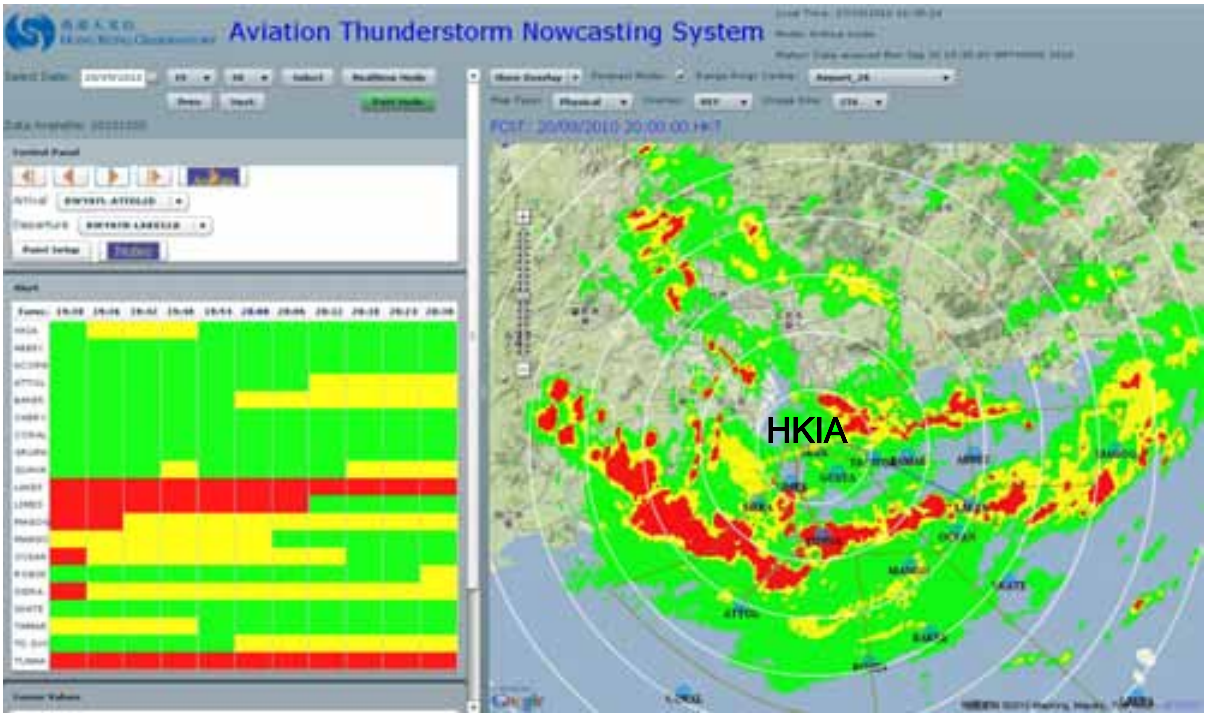
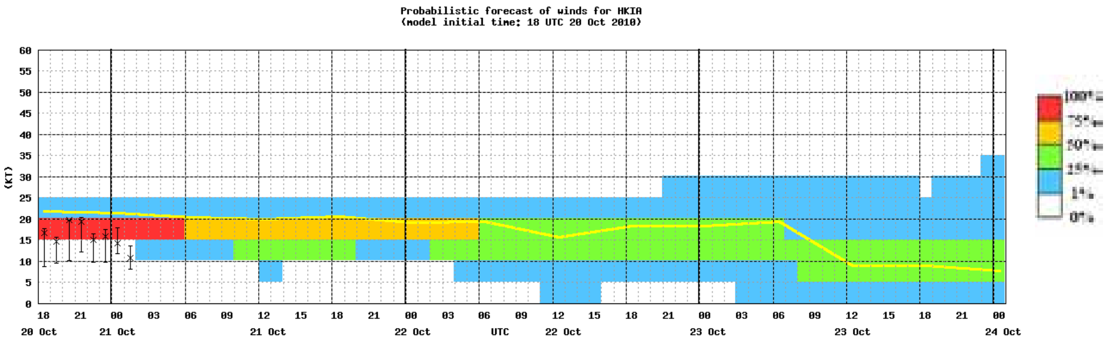


Figure 9. A web-based interface showing the forecast locations of thunderstorms around HKIA (right panel with different colors indicating the intensity of forecast radar reflectivity) and the corresponding alerts at selected locations (left panel) for the case of Severe Typhoon Fanapi (1011) at 12:00 UTC on 20 September 2010.

High crosswind may have adverse impact on flight operations. To support the forecasting of high crosswinds, objective probabilistic wind speed and crosswind forecasts for the Hong Kong International Airport (HKIA) were generated based on ECMWF EPS outputs for reference by aviation users and forecasters on a trial basis. Figure 10 shows the probabilistic products during the passage of Severe Typhoon Megi in October 2010. To facilitate near real-time verification, 10-minute mean wind observations ending on the hour from the anemometers on the runways of HKIA are overlaid and denoted by vertical black segments spanning the range of wind speed observations from various anemometers. The wind observation in METAR report is marked with a cross in the figure. New products of probabilistic forecast of tropical cyclone distance from HKIA and probability map of tropical cyclone positions would also be generated and put on trial in 2011 with a view to facilitating users‟ understanding of the spread in the probabilistic wind forecasts.

(a)



(b)

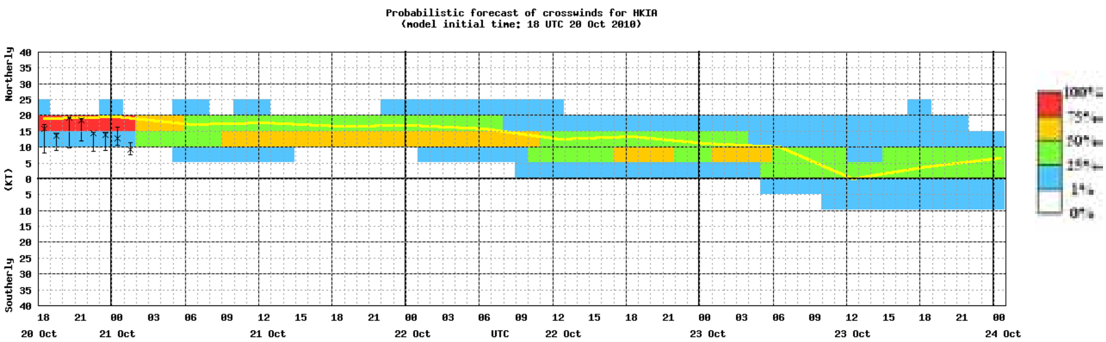


Figure 10 Objective probabilistic forecast of (a) wind speed; (b) crosswind for HKIA during the passage of Severe Typhoon Megi in October 2010.

b. Hydrological Achievements/Results

Dynamic hydrological and hydraulic computer models for the drainage systems in Hong Kong managed by the Drainage Service Department were developed to provide quantitative information on the risk of flooding, impacts of development and the performance of various flood loss mitigation options. In particular, all the trunk and major branch river channels in the most flood-prone river basins in the northern part of Hong Kong had been digitized into the computational hydraulic model which was used for the review of the hydrological criteria for the release of basin-wide flood warning in the region. A computerized stormwater drainage asset inventory and maintenance system had been developed. In the past year, the Drainage Service Department had completed several research studies including a review on the triggering criteria for the Special Announcement on Flooding in the northern New Territories, a sensitivity analysis of the hydraulic effect of mangrove growth in river estuary, an analysis of effects of climate change on stormwater drainage system, the use of local rainfall forecasts to mobilize maintenance staff to deal with flooding, and a study to identify the critical input parameters of the MIKE11 model and to quantify their uncertainties and sensitivities on the flood risk assessment.

A study to estimate extreme rainfall intensities for various locations over the whole territory using a regional frequency analysis approach was being carried out and would be completed in early 2012.

c. Disaster Prevention and Preparedness Achievements/Results

Nil.

d. Research, Training, and Other Achievements/Results

An Observatory‟s officer attended the Workshop on “Space Application to Reduce Water-related Disaster Risk in Asia” organized by ESCAP and supported by WMO Typhoon Committee and Japan Space Exploration (JAXA) in Bangkok from 7 to 9 December 2010.

Please also refer to Key Result Area 2 (d).

e. Regional Cooperation Achievements/Results

A pilot project on "Aviation Weather Disaster Risk Reduction" (ADRR) in RA II was established in the WMO Commission for Aeronautical Meteorology session in 2006 with a focus on tropical cyclone hazards.

Under the project, dedicated website (http://adrr.weather.gov.hk) for the pilot project developed by the Observatory was being extended to cover the Bay of Bengal and the Arabian Sea (see Figure 11) with the official tropical cyclone forecasts, advisories (TCAC New Delhi), numerical weather prediction products and satellite imageries of that area provided by India Meteorological Department.

Noting the success of the pilot project, it is planned that the ADRR website would become operational in early 2011. Training will also be organized for sharing best practice with Members.

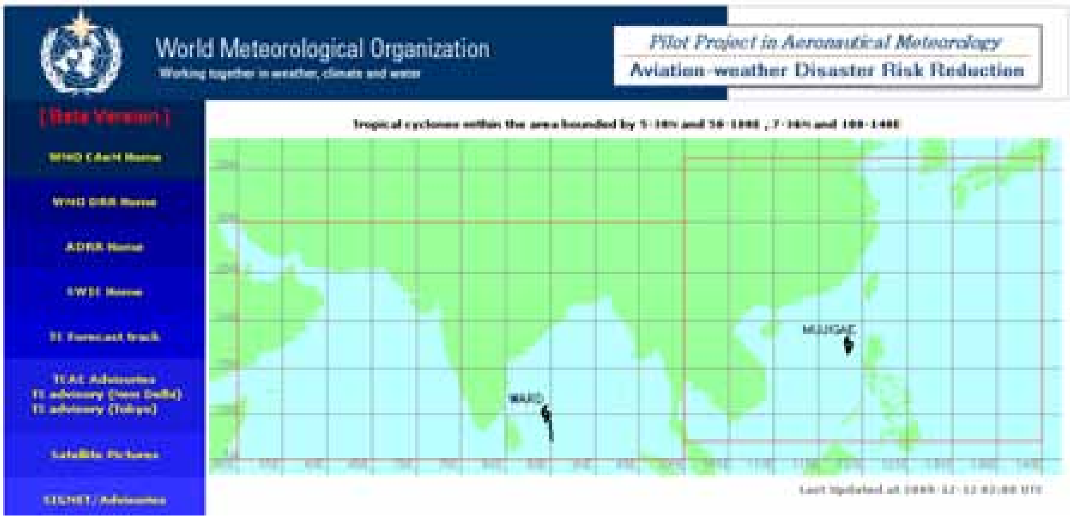


Figure 11 Coverage of ADRR website will be extended to the Bay of Bengal and the Arabian Sea.

f. Identified Opportunities/Challenges for Future Achievements/Results

Nil.

5. **Progress on Key Result Area 5**: Strengthened Resilience of Communities to Typhoon-related Disasters. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

To enable the public to identify more easily the areas affected by tropical cyclones, the Observatory enhanced its tropical cyclone track information webpage employing Google Map. The track is displayed on a base map with detailed geographic information. Information on the tropical cyclone is provided when the user mouses over the analysed and forecast positions.

Real-time weather photos from three more strategic sites in Hong Kong were launched on the Observatory website in June 2010, making the total of such sites to 15. These weather photos allowed the public to better appreciate the weather conditions in real time. Among these sites, some were located near the seaside to monitor the sea conditions. A new pan-tilt-zoom camera was also installed at the southeastern part of Hong Kong Island in mid-2010 to assist forecasters to monitor the high waves and swells arising from approaching tropical cyclones.

Exposure information of the reference wind stations of the Observatory‟s Tropical Cyclone Warning System was provided on the Observatory website starting from July 2010. The information could help the public to learn more about the geographical characteristics of the wind stations so that they could make sensible interpretation of the wind information at these sites.

Two new products were launched on the Observatory"s web page based on the outputs of the new suite of high-resolution NWP models that came into operation in mid-2010. The new products are, namely, "Computer Forecast Weather Map" and "Wind Forecast for Water Sport Activities". The former provides prediction up to three days ahead of the evolution of weather patterns over East Asia and the western North Pacific; and the latter provides detailed site- and time-specific forecasts for a number of water sport hotspots in Hong Kong. The new products will enable the public to gain more insight into the possible development of hazardous weather such as tropical cyclones affecting Hong Kong and the driving mechanisms behind them.

To publicize the Observatory's warning systems, a video series introducing the severe weather warnings (including tropical cyclone) in Hong Kong, was launched on YouTube (http://www.youtube.com/watch?v=5ZO2wTTS6Po) from May to July in 2010. Apart from providing the definitions and factors affecting the issuance of our warnings, the videos also demonstrate the possible disasters brought by severe weather. Members of the public are reminded on the suitable precautions to take to minimize damage when severe weather warnings are in force.

With the rapid increasing popularity of smartphones in the market, the Observatory developed an iPhone application (named as MyObservatory, Figure 12) in 2010 to provide individuals with a comprehensive and personalized weather service any time and anywhere. MyObservatory automatically provides the latest location-specific information, e.g. temperature, wind and weather photos from the weather stations closest to the user. In addition, the application also provides the latest tropical cyclone warnings as well as the forecast track, which is implemented on Google map with rich geographical information. "MyObservatory" has been well received by the public, and its visit figures exceeded 100 million in three months. Plans are underway for this popular application to be extended to other mobile platforms.

Fig. 12 Sample displays of “MyObservatory” showing the current weather, 7-day forecasts and tropical cyclone forecast track.

To reach out to the younger generation, the Observatory started experimenting with the use of social networking services for the dissemination of weather warnings and information. The Hong Kong Observatory Twitter service was launched in September 2010. Tropical cyclone warnings, in a form of „tweets‟, are published on the Observatory‟s Twitter profile “HKObservatory” and distributed to all „followers‟, viz. users subscribing to the tweets of HKObservatory. The advantages of using these popular social networking platforms include its cost-effectiveness for implementation and maintenance as well as the ability to reach out to international travelers to Hong Kong.

b. Hydrological Achievements/Results

Since 1997, about HK$8 billion worth of major river-training works and flood-control projects had been completed in the New Territories over the northern part of Hong Kong. As a result, the flooding in the New Territories had reduced.

To alleviate flooding in low-lying villages, the Government completed 27 village flood pumping stations to protect 35 villages where river-training works could not be effectively undertaken due to topography.

For the rural areas, the construction of 25 km of drainage channels and 3 km of stormwater drains were in progress. For the urban area, the construction of 32 km of stormwater drains and 14 km of drainage tunnels were underway.

Data from rain gauges operated by the Drainage Service Department and Geotechnical Engineering Office were relayed to the Observatory to support the operation of the Rainstorm Warning System, the Special Announcement on Flooding in the northern New Territories and the Landslip Warning System. Savings in operational cost were achieved by using the government data network instead of commercial leased lines. General Packet Radio Services (GPRS) mobile networks and solar panels were used for data acquisition in some out-stations where land-based telemetry and electricity supply were unreliable. Over 80 automated gauging stations were installed at major river channels in the territory to provide round-the-clock real-time monitoring of water depth, rainfall and video surveillance.

Over 1600 km of drains and watercourses were inspected and about $109 million was spent on such maintenance works in 2008-2009. At locations where flooding might cause high risks to local residents, local flood warning systems were installed to monitor the flooding situations and to alert them about the arrival of floodwater. A list of flooding blackspots was also compiled to facilitate the deployment of resources to carry out immediate relief measures during adverse weather situations. Also refer to Key Result Areas 2(b) and 4(b)

Staff of the Drainage Service Department attended various training classes, workshops and conferences (both local and overseas) to acquire the latest knowledge on advanced technology relating to flood prevention, including flooding caused by tropical cyclones. Overseas experts were also invited to Hong Kong to provide in-house training to staff of the department on advanced hydraulic modelling techniques for the drainage systems.

c. Disaster Prevention and Preparedness Achievements/Results

Seminars to promote public understanding of severe weather warnings and proper response actions were conducted by the Hong Kong Observatory for government bureaux/departments as well as the education, transport and other sectors.

The "Safer Slopes Safer Living Fiesta 2010" was jointly organized by the Civil Engineering and Development Department, Hong Kong Observatory, Hong Kong Red Cross and the Hong Kong Association of Property Management Companies (Figure 13). It was the first carnival event in Hong Kong featuring slope safety and reducing natural disasters. It aimed to enhance public knowledge and awareness on slope safety and disaster. Apart from quizzes, booth games, performances and exhibitions, a „Disaster Adventure Pavilion‟ was set up for people to experience the power of various natural disasters such as landslides and typhoons. The Fiesta attracted more than 5,000 people.

Figure 13 Honourable guests officiating the opening ceremony of the Fiesta

To enhance public awareness of mountaineering safety, the Civil Aid Service joined hands with 16 government departments and non-governmental organizations to hold the "Mountaineering Safety Promotion Day" on 31 October 2010. As in the past years, the Observatory rendered full support to the activity by setting up booth and delivering talks to introduce weather phenomena including tropical cyclones which would affect mountaineering and hiking. Precautions under various severe weather conditions were also highlighted.

The “Hong Kong Community Weather Information Network” started in 2007 in collaboration with the Hong Kong Polytechnic University and the Hong Kong Joint-school Meteorological Association saw further expansion in the number of community weather stations to a total of 92, with relevant weather data made available to the public via the Internet. Weather data obtained through the Network was applied by school children in various educational projects and studies. The network also helped raise awareness of severe weather, including tropical cyclones.

To celebrate the World Meteorological Day on March 23, the Hong Kong Observatory was open to the public on 27 and 28 March, 2010. Around 10,000 people of all ages visited the Observatory headquarters. The theme of the Open Day was "Braving the storm together for over a hundred years". Through words, pictures and various exhibits, it introduced how the Observatory had evolved to cope with societal changes, protect the safety of the public with science and technology, and contribute towards the well-being of Hong Kong, its neighbouring areas and the international community.

d. Research, Training, and Other Achievements/Results

A series of public talks on "Weather and Everyday Life" was held at various districts in Hong Kong in April 2010. The talks elaborated on weather phenomena affecting daily life and the precautionary measures to be taken during tropical cyclones and severe weather situations. Similar talks on different topics were held in April, May and August 2010 to cater for the needs of specific clients. Please also refer to Key Result Areas 4(d)

e. Regional Cooperation Achievements/Results
Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results
Nil.

6. **Progress on Key Result Area 6**: Improved Capacity to Generate and Provide Accurate, Timely, and understandable Information on Typhoon-related Threats. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

Tropical cyclone predictions encoded in CXML format made available under the THORPEX/TIGGE project were routinely acquired and processed. Maps of the ensemble tracks (Figure 14) and strike probability derived from such data were generated in real time for reference of the forecasters.

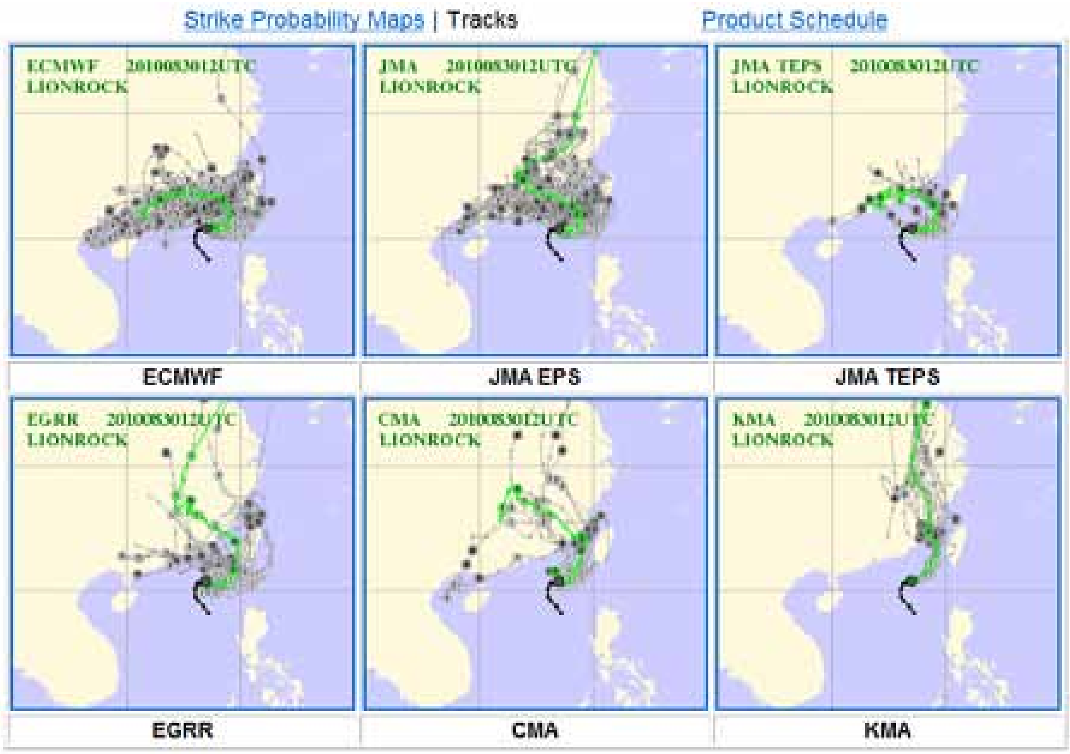
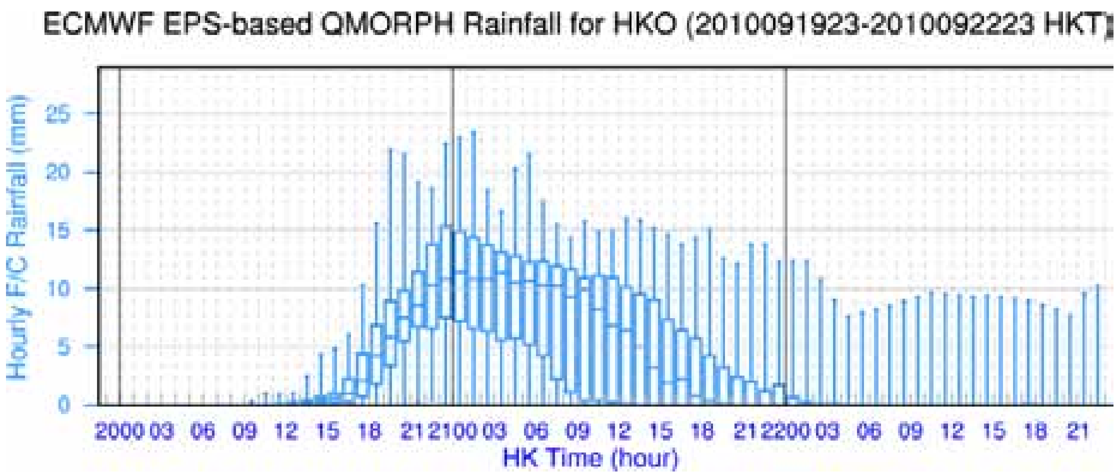


Figure 14. EPS predictions from various centres generated from CXML data during Severe Tropical Storm Lionrock (1006).

The satellite-based tropical cyclone rainfall forecast tool combining the QMORPH precipitation analysis from the Climate Prediction Center of NOAA and subjective tropical cyclone forecast track was enhanced prior to the start of the typhoon season in 2010. Perturbed tropical cyclone tracks output from the EPS of ECMWF were employed to generate probabilistic rainfall predictions with respect to various rainfall thresholds using the same technique. Figure 15 shows a sample of the new product during the passage of Severe Typhoon Fanapi in September 2010.



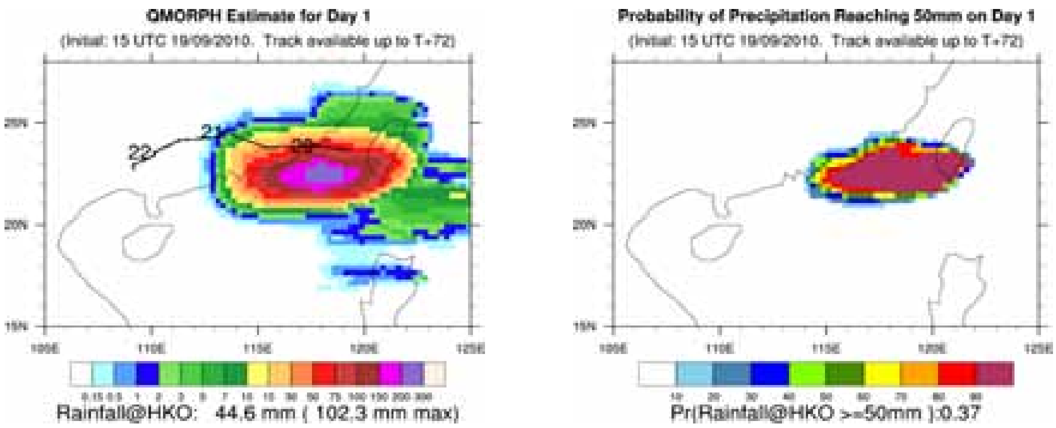


Figure 15 Predictions of rainfall associated with Severe Typhoon Fanapi (1011).

b. Hydrological Achievements/Results

Nil.

c. Disaster Prevention and Preparedness Achievements/Results

Nil.

d. Research, Training, and Other Achievements/Results

Verification of the track predictions from the multi-model ensemble (MMC) and each of the member models, namely ECMWF, JMA, UKMO and NCEP, was conducted using all cases of tropical cyclones at or above tropical depression strength within the western North Pacific during 2008-2009. The results showed that ECMWF outperformed all other members from 24-hour forecasts to 120-hour forecasts with a wide margin (at 0.05 level of significance and serial correlation removed). The ECMWF track position errors were even smaller than those of MMC for 72-hour forecasts, 96-hour forecasts and 120 hour forecasts. However, the differences were not statistically significant.

A method using principal components of dynamical climate model data as predictors to forecast the monthly/seasonal number of tropical cyclones coming within a certain range of a city has been developed. A keynote lecture on the subject was given by a member staff of the Observatory at the 5th ESCAP/WMO Typhoon Committee Integrated Workshop “Urban Flood Risk Management in a Changing Climate: Sustainable and Adaptation Challenges”.

An officer of the Observatory attended the 10th Training attachment to RSMC Tokyo Typhoon Centre in Japan from 21 to 30 July 2010 under one of the capacity building initiatives of the 33rd Session of ESCAP/WMO Typhoon Committee.

Three officers of the Observatory separately attended (1) the International Training Course on "Multi-hazard Early Warning" at WMO Regional Training Centre at Nanjing, China from 10 to 28 May 2010; (2) the International Training Course on "Satellite Meteorology" at WMO Regional Training Centre at Beijing, China from 22 June to 2 July 2010; (3) the International Training Course on "Numerical Weather Prediction" at WMO Regional Training Centre at Nanjing, China from 13 to 24 Sep 2010.

e. Regional Cooperation Achievements/Results

An officer of the Observatory served as a member in the Typhoon Committee"s Expert Team on the Assessment of Change of Frequency and Intensity of Tropical Cyclones in the Typhoon Committee Region. Observatory"s input of providing reference material and assessments had been communicated to the focal point of the Expert Team.

f. Identified Opportunities/Challenges for Future Achievements/Results

Nil.

7. **Progress on Key Result Area 7**: Enhanced Typhoon Committee"s Effectiveness and International Collaboration. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results
Please refer to Key Result Area 2(e).

b. Hydrological Achievements/Results
Nil.

c. Disaster Prevention and Preparedness Achievements/Results
Nil.

d. Research, Training, and Other Achievements/Results

An Observatory staff served as a resource person and delivered lectures on tropical cyclone genesis and seasonal tropical cyclone forecasting in the Typhoon Committee Roving Seminar in 2010.

Please also refer to Key Result Area 4 (d).

e. Regional Cooperation Achievements/Results

As part of the Observatory"s contribution to the WMO Landfall Typhoon Forecast Demonstration Project (WMO-LTFDP), the in-house developed satellite-based tropical cyclone rainfall forecast tool was adapted to the eastern China region and being supplied in real-time to the Shanghai Typhoon Institute for evaluation since September 2010.

A forecaster from the National Meteorological Centre of CMA attached to the Observatory under the Typhoon Committee Research Fellowship 2010 for 2 months starting from late October 2010. The research topic was, "Can the extreme rainfall associated with Typhoon Morakot (0908) happen in Hong Kong?". The study involved the conduct of numerical experiments by transplanting the storm vortex of Morakot and the associated environmental conditions to the South China Sea in order to estimate the amount of rainfall that would thus fall in Hong Kong.

The Severe Weather Information Centre (SWIC) website, operated by Hong Kong, China for WMO, continues to serve as a popular channel for dissemination of real-time official tropical cyclone warnings and information worldwide. To facilitate the dissemination of severe weather warnings within the local community and to enhance their availability to interested parties anywhere on the globe, the ESCAP/Typhoon Committee recommended in 2009 a feasibility study of employing an Internet web based platform for real-time transmission of severe weather warnings. Hong Kong, China coordinated the project and undertook necessary software development. In June 2010, a new service known as SWIdget was successfully launched by the Observatory. With this SWIdget service, local as well as international users can obtain severe weather warnings issued by participating official weather services in near realtime in SWIC platform. Up to October 2010, warnings of the three participating weather services, namely, Hong Kong, China; Macao, China; and Guam, the USA, are available. Development was underway to disseminate warnings from two Typhoon Committee members, viz Singapore and Republic of Korea with target completion date in Jan 2011. Plans are in hand to invite more official weather services to participate.

The WMO RA II Pilot Project on the Provision of City-Specific Numerical Weather Prediction (NWP) Products to Developing Countries was making steady progress. Up to October 2010, 19 RA II Members, 8 of which were Typhoon Committee Members, participated in the project. In addition to the forecast time series for the existing 160 cities, arrangement is being made to generate forecast products to Pakistan and Thailand.

f. Identified Opportunities/Challenges for Future Achievements/Results

Two meteorologists from the Observatory attended the Seventh WMO International Workshop on Tropical Cyclones (IWTC-VII) held in La Reunion, France from 15-20 November 2010 and presented a rapporteur report on

"Operational Warning Strategies". Apart from presenting a review of the latest developments on the topic, a number of recommendations had been put forward for discussion at the workshop.

III. Resource Mobilization Activities

Nil.

IV. Update of Members' Working Groups representatives

1. Working Group on Meteorology –
   Mr. C.M. Shun – email: cmshun@hko.gov.hk
   Facsimile: 852 23119448
   Telephone: 852 29268232

2. Working Group on Hydrology –
   Mr. H.Y. Mok – email: hymok@hko.gov.hk
   Facsimile: 852 23119448
   Telephone: 852 29268451

3. Working Group on Disaster Prevention and Preparedness –
   Ms. Hilda Lam - email: hildlam@hko.gov.hk
   Facsimile: 852 23119448
   Telephone: 852 29268222

4. Training and Research Coordinating Group –
   Mr. Edwin S.T. Lai - email: stlai@hko.gov.hk
   Facsimile: 852 23119448
   Telephone: 852 29268371

5. Resource Mobilization Group
   Nil.

II. Summary of progress in Key Result Areas

1. Progress on Key Result Area 1: Reduced Loss of Life from Typhoon-related Disasters.

a. Meteorological Achievements/Results

a-1. Establishment of a regional storm surge watch scheme

RSMC Tokyo is developing a regional storm surge watch scheme to allow forecasting of storm surges in the TYC region. In 2010, the TYC members (Hong Kong, the Philippines, Vietnam, Macao, Malaysia and Singapore) provided tidal and bathymetric data to RSMC Tokyo, which subsequently developed a prototype storm surge model using the bathymetric data. RSMC Tokyo plans to verify the accuracy of the model using the tidal data provided, with a view to supplying distribution maps and time-series charts of storm surges in the future.

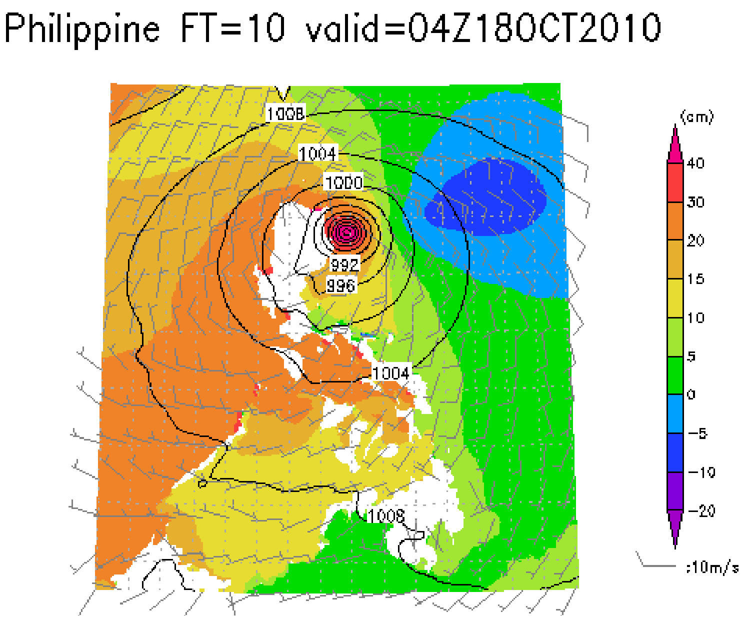


Figure 3. Example of a forecasted storm surge (Typhoon Megi, 2010)
The colors indicate storm surge height (cm), and the contours show surface pressure (hPa). The barbs represent wind strength.

(KRA 7)

b. Hydrological Achievements/Results

b-1. Hazard Mapping for Sediment-related Disasters Project

From 2002 to 2008, the Sediment-related Disaster Forecasting Warning System Project was executed with the aim of sharing the Japanese method of setting the critical rainfall levels that trigger warnings and evacuation in the event of sediment-related disasters from the viewpoint of identifying dangerous situations. The project involved eight TC members (China, Malaysia, Vietnam, the Philippines, Thailand, the United States and Japan), and its final report was published in the form of technical guidelines and case studies for the 42nd TC session in Singapore. (http://www.typhooncommittee.org/docs/publications/book2_SEDIMENT.pdf).

Currently, the Hazard Mapping for Sediment-related Disasters Project, led by the Sabo Department of MLIT and NILIM, is being executed by six TC members (China, Hong Kong, the

Philippines, Thailand, the United States and Japan) to share Japanese methods of setting hazardous areas, making hazard maps for warning/evacuation and land use restriction from the viewpoint of identifying dangerous areas.

Before the TC 5th Integrated Workshop in Macao on Sept. 4 and 5, a collaboration meeting between WGDRR and WGH and field training for the Hazard Mapping for Sediment-related Disasters Project was held. On Sept. 4, an indoor lecture was given at the Macao Science Center to explain the Japanese method of setting hazardous areas and how to make and use hazard maps. On Sept. 5, field training was held for TC members and locals (engineers and residents) on setting hazardous areas and improving local awareness of risk for sediment-related disasters at a model site in Zhuhai City, China. The meeting and field training were attended by 20 people from nine TC member countries (Cambodia, China, D.P.R. Korea, Hong Kong China, the Republic of Korea, Macao China, Thailand, the Philippines and Japan) and 15 local staff from Zhuhai City Office and local residents, respectively.

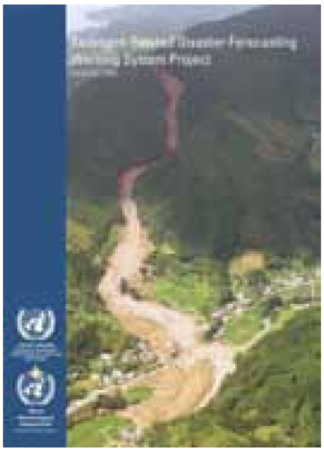


Figure 4. The final report of the Sediment-related Disaster Forecasting Warning System Project

Figure 5. Field training for the Hazard Mapping for Sediment-related Disasters Project in Zhuhai City, China

Figure 6. Example of a hazard map for sediment-related disasters

(KRA2, 4, 5, 6, 7)

c. Disaster Prevention and Preparedness Achievements/Results

c-1. Major Disaster and Response Measures since January 2010

In 2010, Japan was affected by a number of bouts of torrential rain. In particular, heavy downpours during the rainy season from mid-June to mid-July resulted in 16 fatalities and caused inundation above floor level in as many as 1,786 houses throughout Japan.

Heavy rains from 18 to 30 September in Amami Oshima, Kagoshima Prefecture, reaching up to 130 millimeters per hour resulted in three fatalities, caused inundation above floor level in 123 houses and damaged about 500 houses. The national government's response included early warning reports from the Japan Meteorological Agency (JMA) and inter-ministerial meetings for response coordination.

The Prime Minister visited affected sites in Gifu Prefecture in July, and the Minister of State for Disaster Management visited Amami Oshima in October as part of related investigations. .

c-2. Technical Investigation on Large-Scale Flood Countermeasures

There has been a significant reduction in the total area inundated by flood disasters thanks to weather forecasting system improvement and the promotion of land conservation and flood control projects over a period of many years. However, in terms of general assets, the amount of damage in flooded areas has greatly increased in recent years. Additionally, the frequency of downpours depositing more than 100 mm of rain per hour has seen an increasing trend throughout the country over the last 30 years (Figure 7, 8).

This increasing trend necessitates strengthened countermeasures to ensure quick and smooth evacuation and relief activities in the event of large-scale flooding. The Central Disaster Management Council established the Committee for Technical Investigation on Large-Scale Flood Countermeasures to analyze anticipated situations. As an example of related activities, it reviews measures against large-scale flood disasters that are expected to cause immense damage to the capital region.

The Central Disaster Management Council, chaired by the Prime Minister and manned by other Ministers of State, focuses on the promotion of comprehensive disaster countermeasures.

The study was started in 2006, and some interesting cases of analysis have been made. One such example is the simulation of a potential flood area in the Tone River basin (the largest river basin in Tokyo). A map of the flood area was simulated, assuming river dike breach caused by hypothetically fatal rainfall with an occurrence likelihood of once every 200 years. In the worst-case scenario, more than two million people could be affected by such a flood, and nearly a million houses could be damaged. Although this was only a simulation, it is important that the potential magnitude of related damage is properly understood by the government and residents alike (Figure 9).

After 20 rounds of discussions over a period of four years, the committee recommended the following countermeasures March 2010:

1. Damage reduction by ensuring timely and effective evacuation
2. Enhancement of disaster response capabilities and securement of important functions by public institutions
3. Strengthening of disaster response capability among residents and private firms in relation to large-scale flooding and other disaster conditions in March 2010
4. Disaster mitigation through the implementation of flood control measures and land use Control
5. Countermeasures against other damage events associated with large-scale floods

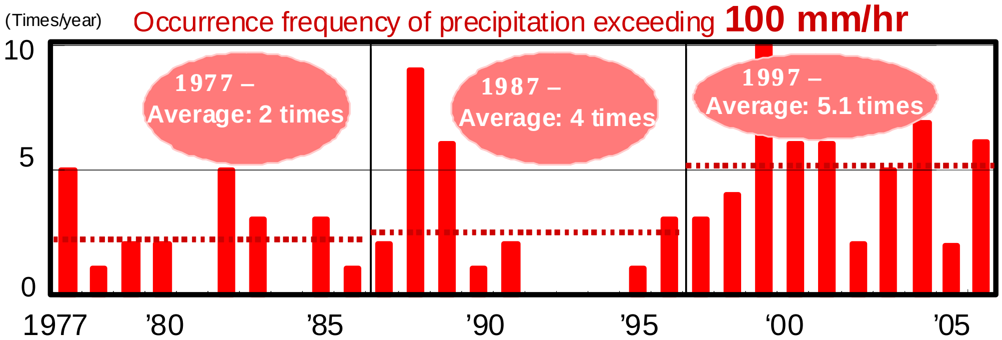


Figure7. Tendency of downpours as of 2006 (over 100 mm/hr)

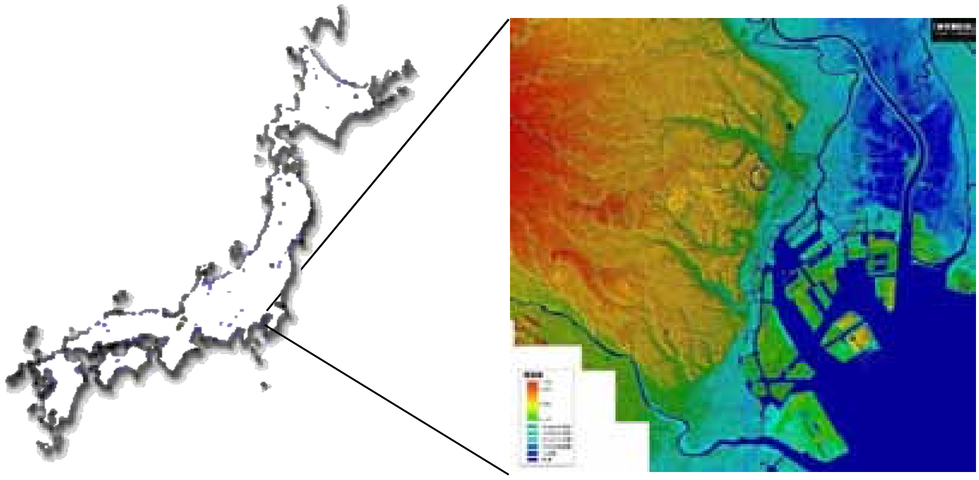
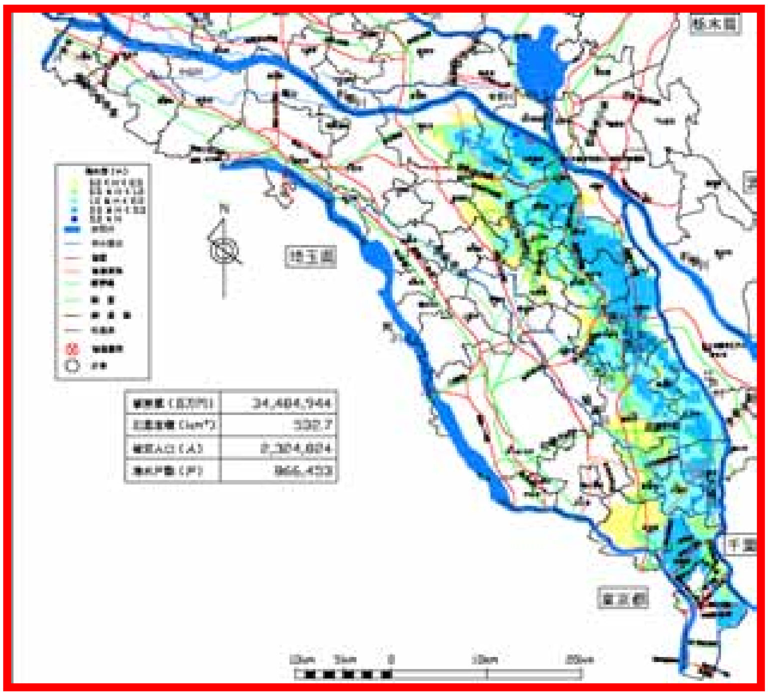


Figure8. Zero-meter altitude area in the metropolitan area



Flood area (hectares)	53,000
Affected population	2,300,000 people
Flooding above floor level	690,000 houses
Flood below floor level	170,000 houses

Figure 9. Flood area simulation for the Tone River basin in Tokyo

c-3 Technical Investigation on Disaster Evacuation

In April 2010, the Central Disaster Management Council established the Committee for Technical Investigation on Disaster Evacuation to investigate various challenges relating to disaster evacuation, such as setting up evacuation centers and preparing for issuance of evacuation information.

d. Research, Training, and Other Achievements/Results

d-1. Technical Emergency Control Force for Disaster Assistance

The Technical Emergency Control Force (TEC-FORCE) was established in 2008. It consists of teams of experts for different purposes formed by different agencies in the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), such as the River Bureau, the National Institute for Land and Infrastructure Management, the Japan Meteorological Agency, the Geographical Survey Institute, and regional branch bureaus. When a large-scale disaster occurs or is likely to occur due to a typhoon or earthquake, TEC-FORCE teams will be dispatched to provide technical assistance by swiftly collecting information on disaster situations and carrying out duties to prevent or contain damage. They will assist municipalities in affected areas in early recovery and smooth, swift implementation of emergency measures.

Immediately after the occurrence of a large-scale disaster, damage to elements of infrastructure supporting local livelihoods such as roads will often interrupt life-saving work and the stable daily activities of residents. However, municipalities originally responsible for such infrastructure are very likely to be overwhelmed in responding to residents' emergency needs, making them unable to fully perform the tasks needed to assess infrastructure damage and start recovery efforts. Composed of national government employees with expertise in infrastructure management and experience in disaster response, TEC-FORCE aims to provide professional support in order to assist municipalities across Japan in the event of such circumstances.

In 2010, TEC-FORCE teams were dispatched to different areas on three occasions: to Hiroshima Prefecture on 16 July during a Baiu-front heavy rainfall event, to affected areas on 8 September in relation to Typhoon No. 9, and to the Amami area on 20 October during a heavy rainfall event. Over 400 TEC-FORCE members were sent to these affected areas for investigations from the air by helicopter as well as on the ground. They also provided guidance to local task forces on restoration work to assist early recovery.

Figure 10. Damage assessment on the ground

Figure 11. Damage assessment by helicopter

Figure 12. Technical assistance team (advising on recovery works)

(KRA2, 4)

e. Regional Cooperation Achievements/Results

e-1. Publication of a Deep Rapid Landslide Frequency Map of Japan

The Sabo Department of Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and Public Works Research Institute (PWRI) have implemented studies on deep rapid landslides in response to several instances of the phenomenon in recent years that have caused fatalities among residents. In such landslides, both the soil layer and the underlying deep weathered/fractured bedrock collapse simultaneously. Although they occur less frequently than shallow landslides, they are capable of causing large-scale disasters.

According to recent findings by PWRI, deep rapid landslides occurring since the Meiji era (i.e., since 1868) in Japan have been seen in areas with a high rock uplift rate and specific types of geology. Accordingly, based on spatial patterns of rock uplift rates and on a geological map of Japan, the Deep Rapid Landslide Frequency Map – a resource showing estimated occurrence frequencies of the phenomenon all over Japan – has been created. The Sabo Department of MLIT and PWRI have officially announced the publication of this map, and will execute the measures outlined below.

(a) For a period of around three years, focused investigation of areas deemed to have especially high frequencies of deep rapid landslide occurrence will be carried out, and susceptibility to occurrence in individual small mountain catchment areas will be evaluated. The results of this investigation will be sequentially published once the related work is complete. Research is also under way to develop a simplified investigation method that can be applied to other large areas where deep rapid landslide occurrence is relatively frequent.

(b) For small mountain catchment areas deemed as a result of evaluation to be highly susceptible, the risk of landslide dam occurrence will be investigated, and warning/evacuation systems will be established in cooperation with the local governments responsible for neighborhood and downstream areas.

The Sabo Department of MLIT and PWRI will collaborate with the Japan Society of Erosion Control Engineering to clarify the processes and mechanisms behind deep rapid landslides in further detail and to develop effective countermeasures for the phenomenon.

Figure 13. Example of a natural dam – a sediment-related disaster caused by a deep rapid landslide (Mimikawa River, Miyazaki Pref.)

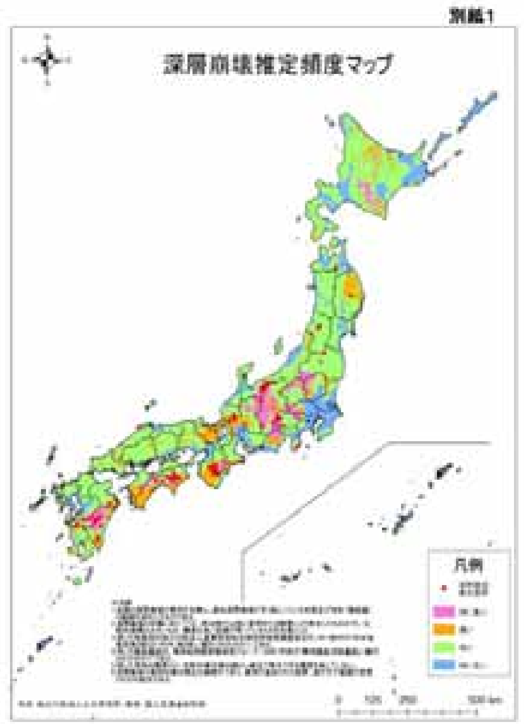


Figure 14. Deep Rapid Landslide Frequency Map of Japan (Red dots indicate locations where deep rapid landslides have occurred. Purple shading indicates areas with an especially high frequency of deep rapid landslide occurrence, and orange shading indicates areas with a high frequency.)

(KRA2, 5, 6, 7)

f. Identified Opportunities/Challenges for Future Achievements/Results

2. Progress on Key Result Area 2: Minimized Typhoon-related Social and Economic Impacts.

a. Meteorological Achievements/Results

b. Hydrological Achievements/Results

c. Disaster Prevention and Preparedness Achievements/Results

d. Research, Training, and Other Achievements/Results

e. Regional Cooperation Achievements/Results

f. Identified Opportunities/Challenges for Future Achievements/Results

3. Progress on Key Result Area 3: Enhanced Beneficial Typhoon-related Effects for the Betterment of Quality of life.

a. Meteorological Achievements/Results

b. Hydrological Achievements/Results

c. Disaster Prevention and Preparedness Achievements/Results

d. Research, Training, and Other Achievements/Results

e. Regional Cooperation Achievements/Results

f. Identified Opportunities/Challenges for Future Achievements/Results

4. Progress on Key Result Area 4: Improved Typhoon-related Disaster Risk Management in Various Sectors.

a. Meteorological Achievements/Results

a-1. JMA's Climate Change Monitoring Report

JMA describes inter-annual variability and long-term trends regarding typhoon activity in its Climate Change Monitoring Report every year. This is distributed to the Japanese public as well as to NHMSs via the Tokyo Climate Center's website (http://ds.data.jma.go.jp/gmd/tcc/tcc/products/gwp/gwp.html).

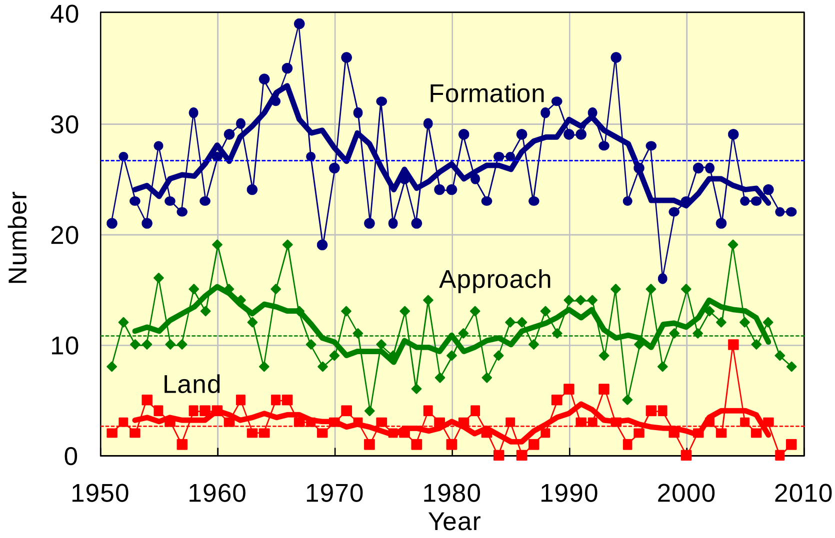


Figure 15. The number of tropical cyclones (TS intensity or higher) forming in the western North Pacific (top), those that approached Japan (middle) and those that hit Japan (bottom). The thin, solid and dashed lines represent annual/five-year running means and normal values (1971 – 2000 averages), respectively.

(KRA1, 2, 5, 6)

b. Hydrological Achievements/Results

c. Disaster Prevention and Preparedness Achievements/Results

c-1. Visiting Researchers from ADRC Member Countries

The ADRC receives visiting researchers from member countries, and 50 have taken part in this program to date. Below is a list of the visiting researchers in the network.

	Name	Country	ADRC attendance in VR role		
1	Shim Kee-Oh	Republic of Korea	1999/07/23	-	1999/10/11
2	Ngo Van Sinh	Vietnam	1999/12/10	-	2000/03/17
3	Lek Nath Pokharel	Nepal	2000/01/12	-	2000/05/07
4	Nimal D. Hettiarachchi	Sri Lanka	2000/04/13	-	2000/10/12
5	M. Babul Aknter	Bangladesh	2000/05/12	-	2000/11/16
6	W. A. Chulananda Perera	Sri Lanka	2000/11/13	-	2001/04/05
7	Hiripsime Vardanyan	Armenia	2001/03/09	-	2001/06/04
8	Philomena Miria	Papua New Guinea	2001/06/04	-	2001/12/03
9	So Ban Heang	Cambodia	2001/06/04	-	2001/12/04
10	Md. Atikuzzaman	Bangladesh	2002/01/09	-	2002/06/30
11	Tigran Sayiyan	Armenia	2002/02/23	-	2002/08/22
12	Khun Sokha	Cambodia	2002/07/29	-	2002/12/25
13	V. P. Pasrija	India	2002/10/05	-	2002/12/25
14	Dilli Pd. Shiwakoti	Nepal	2003/01/08	-	2003/07/02

15	Bolormaa Borkhuu	Mongolia	2003/01/08	-	2003/07/05
16	Vilayphong Sisomvang	Lao PDR	2003/07/08	-	2003/12/25
17	Rachman Sobarna	Indonesia	2003/07/09	-	2003/09/30
18	Om Prakash	India	2003/10/08	-	2003/12/24
19	Rahmonov Suhrobsho	Tajikistan	2004/01/14	-	2004/06/10
20	Nguyen Thanh Phuong	Vietnam	2004/01/27	-	2004/06/29
21	Yuan Yi	China	2004/07/19	-	2004/10/15
22	Bouasy Thammasack	Lao PDR	2004/07/21	-	2004/12/24
23	Shyam Sunder	India	2005/10/02	-	2005/12/25
24	Ross Sovann	Cambodia	2005/01/23	-	2006/06/30
25	Bal Bahadur Malla	Nepal	2005/01/30	-	2006/06/29
26	Maria Matilde Limpahan Go	Philippines	2005/07/13	-	2005/12/27
27	Diloro Mirzovatanovna Mirova	Tajikistan	2005/07/15	-	2005/12/21
28	Lyudmila Harutyunyan	Armenia	2006/01/11	-	2006/04/10
29	G. M. J. K. Gunawardana	Sri Lanka	2006/03/01	-	2006/06/30
30	San-Hyeok Kang	Republic of Korea	2006/07/01	-	2006/12/15
31	Altanchimeg Shaazan	Mongolia	2007/01/09	-	2007/06/30
32	Arun Pinta	Thailand	2007/01/14	-	2007/06/30
33	Nwet Yin Aye	Myanmar	2007/07/06	-	2007/12/31
34	Karybai Uulu Kanat	Kyrgyz Republic	2007/07/04	-	2007/12/31
35	Zhang Yunxia	China	2008/01/01	-	2008/05/28
36	Zafar Waqar Taj	Pakistan	2008/02/23	-	2008/06/24
37	Vu Thanh Liem	Vietnam	2008/07/11	-	2008/12/17
38	Shambhu Prasad Marasini	Nepal	2008/07/11	-	2008/12/19
39	Muhammad Khalil Bin Aziz	Malaysia	2009/1/15	-	2009/06/24
40	Areerat Wijitpatchraphon	Thailand	2009/1/15	-	2009/06/24
41	Predeep Kodippili	Sri Lanka	2009/8/6	-	2009/10/17
42	Porcil Josefina Tan	Philippines	2009/8/5	-	2010/12/10
43	Mishra Sagar	Nepal	2009/8/6	-	2010/12/10
44	Shahid Hussain Malik	Pakistan	2009/8/7	-	2010/12/10
45	Phurimon Puneam	Thailand	2010/1/6	-	2010/4/30
46	Amirzudi bin Hashim	Malaysia	2010/1/15	-	2010/4/30
47	Aziz Ali Nasser	Yemen	2010/1/1	-	2010/6/13
48	Nguyen Ngoc Huy	Vietnam	2010/6/1	-	2010/6/30
49	Carmelita A. Laverinto	Philippines	2010/7/21	-	2010/11/20
50	Chinthaka Dinesh Hemachandra	Sri Lanka	2010/7/21	-	2010/11/20

Figure 16. Visiting Researchers

d. Research, Training, and Other Achievements/Results

d-1. Disaster Management Policy Program: Water-related Risk Management Course

In response to the growing threat of water-related disasters around the world, there is an urgent need to build a community of experts and professionals to deal with them, particularly in developing countries. To meet this need, ICHARM offers a master's degree program called the Water-related Disaster Management Course of Disaster Management Policy Program, which started in October 2007. This is a one-year program jointly organized by ICHARM and the National Graduate Institute for Policy Studies (GRIPS) with the support of the Japan International Cooperation Agency (JICA).

As of the beginning of 2011, 12 masters students are enrolled on the course. Two of these were selected from a TC member region (China).

Figure 17. Management course students for the year 2009-2010

(KRA1, 2, 5, 7)

d-2. Implementation of JICA's Comprehensive Management of Rivers and Dams group training program

The River Bureau of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), the

National Institute for Land and Infrastructure Management, PWRI and JICA serve as implementing agencies for JICA's Comprehensive Management of Rivers and Dams group training program, which began in 1973.

Engineering officers working on flood control and water resource management from Asia and elsewhere are invited to attend the program. Lectures are given on water management measures taken by the Japanese Government, presentations/exercises are organized in relation to aspects of engineering technology (such as river management systems, riparian structures, hydrological analysis and dam design/operation), and field visits to relevant facilities are arranged. In 2010, officers from Indonesia, Iraq, the Philippines, Myanmar, Syria and Vietnam participated in the training from September to December.

The program is coordinated by Infrastructure Development Institute-Japan.

Figure 18. Trainees of the program

(KRA1, 2, 5, 7)

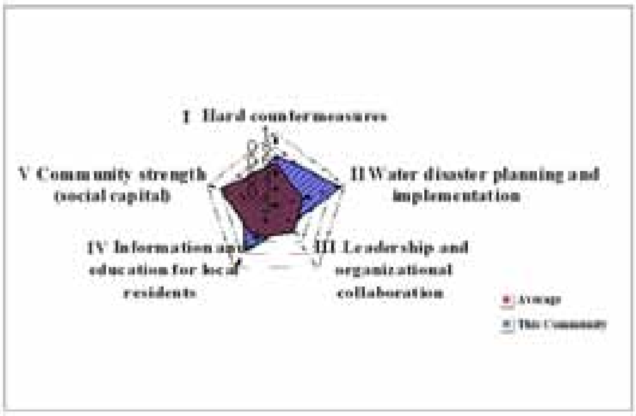
e. Regional Cooperation Achievements/Results

e-1. Project for the Development of Flood Disaster Preparedness Indices

Strengthening disaster preparedness for effective response at all levels and identifying, assessing and monitoring disaster risks are issues stressed in the Priorities for Action section of the Hyogo Framework for Action adopted in January 2005. However, despite these recognized priorities, central governments in many countries often provide inadequate assistance or fail to implement it in a timely manner when disasters happen. It is also well understood that when a disaster occurs, the most effective actors are local residents themselves. Accordingly, raising disaster preparedness levels to ensure effective response by local communities/governments is a critical factor in disaster management. As a further consideration, there is no widely recognized indicator that can be utilized for periodical self-assessment in localities. In this regard, a common operational overview is needed by which communities can be encouraged, directed and allowed to learn from each other to take rational procedures toward ensuring an adequate state of preparation.

Against such a background, the current project was proposed to fill these gaps and adopted for implementation. Its objective is to establish indices to improve flood disaster preparedness levels of local governments and communities.

Establishing FDPI



In order to develop a well-organized set of indicators, it was agreed that they should be based on the disaster management cycle. However, they should also be localized and enriched by feedback from TC members. To this end, ICHARM developed a rudimentary set of indicators for model trial/evaluation and launched a website exclusively for the task at hand (www.fdpi.jp/fdpi) in September 2010. Currently, TC members are being encouraged to provide this information to their communities and local municipalities so that they can model-test the proposed set of indicators in a questionnaire style. The list of questions is also expected to serve as a resource providing instruction on how to develop local disaster response capacity.

(KRA1, 2, 5, 6, 7)

f. Identified Opportunities/Challenges for Future Achievements/Results

5. Progress on Key Result Area 5: Strengthened Resilience of Communities to Typhoon-related Disasters.

a. Meteorological Achievements/Results

a-1. JMA Mobile Observation Team

In October 2008, JMA named its disaster survey team the Mobile Observation Team (JMA-MOT). Survey teams from JMA carry out field surveys to ascertain actual conditions and provide scientific explanations of events after natural disasters such as severe storms, earthquakes, tsunamis, volcanic eruptions and storm surges. JMA gave a unified name to the survey team to familiarize the public with its activities and contribute to the reinforcement of community resilience and risk management authorities after disasters. Once a disaster occurs, the relevant local meteorological observatory organizes and dispatches the Mobile Observation Team based on agreement with the local government. Another mission of this Team involves public relations; the local meteorological observatory issues an official announcement on the dispatch of JMA-MOT just after the decision to send them out, and releases the field survey report as soon as possible, which is expected to reduce anxiety among the public.

(KRA4, 6)

b. Hydrological Achievements/Results

c. Disaster Prevention and Preparedness Achievements/Results

d. Research, Training, and Other Achievements/Results

d-1. Training Course on Local Disaster Management Planning with Flood Hazard Maps

ICHARM conducted the Flood Hazard Map (FHM) training course from 2004 to 2008, thereby significantly contributing to the promotion of the TC project of the same title. To build on past achievements and further promote the establishment of solid local disaster management plans in developing countries, this new training course was launched and run over a period of three weeks in November 2009 in collaboration with JICA. The overall goal is to reduce flood damage in the target countries by formulating local disaster management plans combined with FHMs and flood forecasting/warning systems and by strengthening local resilience against floods. The program aims to give trainees the skills required to develop direction and schedules for the creation of local disaster management plans combined with flood hazard maps and flood forecasting/warning systems. The second-year (Jan. 2011) part of this three-year systematic training course is currently under implementation, and is attended by nine trainees, two of whom are from TC member regions (Lao PDR and Thailand).

Figure 19. Opening ceremony of the training course

(KRA1, 2, 6, 7)

e. Regional Cooperation Achievements/Results

f. Identified Opportunities/Challenges for Future Achievements/Results

6. Progress on Key Result Area 6: Improved Capacity to Generate and Provide Accurate, Timely, and understandable Information on Typhoon-related Threats.

a. Meteorological Achievements/Results

a-1. Improvement of Observation Systems

Satellite observation

Switchover of Meteorological Mission from MTSAT-1R to MTSAT-2

As detailed in the previous country report for Japan, on 1 July, 2010, JMA switched over imaging satellite operations to the Multi-functional Transport Satellite-2 (MTSAT-2, also known as Himawari-7), which is located at 145 degrees east, from MTSAT-1R (Himawari-6), which is located at 140 degrees east and now operates as an in-orbit stand-by for MTSAT-2.

MTSAT-2 captures cloud imagery, observing with one visible and four infrared channels in the same way as MTSAT-1R. The spatial and quantization resolutions of the images are also identical. The observation timetable of MTSAT-2 has no changes from that of MTSAT-1R; it observes the Northern Hemisphere every 30 minutes and the Southern Hemisphere hourly. Overall, MTSAT-2 continuously provides the same information on typhoon observation.

Regarding the satellite's HRIT/LRIT (High/Low Rate Information Transmission) image dissemination service for MDUS/SDUS (Medium/Small scale Data Utilization Station) users, MTSAT-1R continuously provides MTSAT-2's images even at the post-switchover stage, meaning that MDUS and SDUS users do not need to reconfigure the orientation of their receiving antennas. Since the switchover, full-disk visible images have been additionally disseminated by LRIT.

(KRA1, 2, 4, 5)

a-2. Improvement of the Initialization Scheme for Tropical Cyclones in JMA's NWP

In JMA's global and meso-scale NWP systems, a typhoon-bogus scheme is applied to initialization for tropical cyclones (TCs) over the western North Pacific. In this scheme, a typical TC structure is generated based on real-time TC analysis at RSMC Tokyo, and pseudo-observation data (i.e., bogus data) extracted from this structure are deployed around the TC. The bogus data are assimilated in each NWP system.

In recent years, the accuracy of the first-guess fields in operational analysis has been improved by the introduction of new satellite data and a sophisticated data assimilation system. This has reduced the relative accuracy of the bogus data, and the assimilation of too many bogus data could impair the accuracy of analysis. To deal with this issue, a bogus data adjustment function has been introduced. With this function, the number of bogus data can be adjusted according to the distance from the TC's central position in the TC analysis to the one in the first guess. In many cases, the number of bogus data is greatly reduced as a result, and these data are deployed only in the vicinity of the TC center.

For the global NWP system, data assimilation and forecast experiments were conducted prior to actual operation. The level of TC track prediction error was clearly reduced as a result of using the improved typhoon-bogus scheme (Figure 20). The new scheme was incorporated into the operational global NWP system in April 2010.

An almost-identical scheme was incorporated into the operational meso-scale NWP system in September 2010. One additional change for the meso-scale system is the timing of bogus data generation. Previously, these data were prepared for the start of the assimilation window (at a point three hours before the analysis time). In the new scheme, the data are prepared for the end of the assimilation window (at the analysis time). This allows the system to use the latest TC analysis data. However, since the meso-scale data assimilation process is started only 50 minutes after the analysis time, the bogus data generation schedule is very tight and the process sometimes cannot be completed in time. Any data delivered late will be used in the next data assimilation process three hours later.

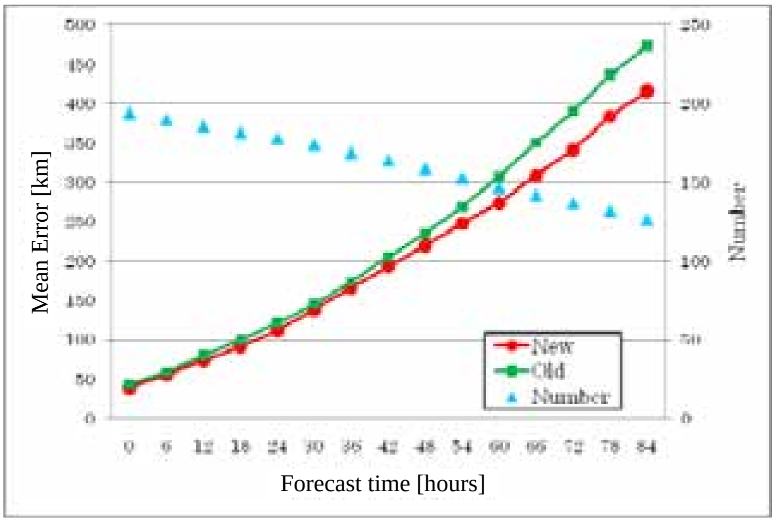


Figure 20. Mean track forecast errors (km) for TCs in RSMC Tokyo's area of responsibility from 25 September to 25 October, 2009, according to the global NWP system. The red line shows errors of TC track prediction with the improved typhoon-bogus scheme, and the green line shows those with the old one. The level of error is clearly lower with the improved scheme. The blue triangles denote the number of verification samples.

(KRA1, 2, 4, 5, 7)

a-3. Improvement of the RSMC Data Serving System

JMA's RSMC Data Serving System (DSS) has provided TDCF (Table-driven Code Form) observational data types such as SYNOP BUFR since July 2010, also has provided TAC (Traditional Alphanumeric Code) observational data including SYNOP, SHIP, BUOY, TEMP and PILOT since 1995. In recent years, the number of WMO members providing TDCF observational data through the Global Telecommunication System (GTS) has increased in line with national migration plans. In this regard, JMA has expanded the content of the RSMC DSS to include TDCF surface and upper observational data. It will continue to provide TAC and TDCF observational data in parallel until further notice.

(KRA1, 2, 4, 5, 7)

a-4. Improvements to the initial perturbation of JMA's Typhoon Ensemble Prediction System

Since February 2008, JMA has operated the Typhoon Ensemble Prediction System (TEPS) with the aim of contributing to operational five-day TC forecasts at the RSMC Tokyo-Typhoon Center.

The forecast model of TEPS is a low-resolution version (TL319L60) of JMA’s Global Spectral Model (GSM). It runs four times a day when TCs of TS/STS/TY intensity are present or expected to appear in the Typhoon Center’s area of responsibility (0˚N – 60˚N, 100˚E – 180˚E) with 11 members (1 control member + 10 perturbed members) and a forecast time of up to 132 hours.

The initial perturbations of TEPS are created using the singular vector (SV) method. Two types of SV spatial target area are defined to capture the uncertainty of TC track forecasts. One is the Northwestern Pacific (20°N – 60°N, 100˚E – 180˚E), and the other is a group of areas around the central positions of TC forecasts (three at maximum: TC target area). To further improve the performance of TEPS, JMA revised the method used to make initial perturbations. First, TC target areas are set as circular regions with a 750-km radius from the TC’s central position, in contrast to the previous rectangular-area settings (10 degrees in the meridional direction and 20 degrees in the zonal direction). Second, the amplitude of the initial perturbation is normalized using the moist total energy value, in contrast to the previous normalization using the maximum meridional or zonal wind speed.

Figure 21 shows ensemble mean track forecast errors classified according to the reliability index. A, B and C represent the highest, mid-level and lowest levels of forecast reliability. The index is determined by the six-hourly accumulated ensemble spread at each forecast time. In the new system, the mean track forecast errors of A, B and C remain in the same order as the reliability indices throughout the forecast time, which was not the case with the previous system. This result indicates that the revisions contribute to appropriate distribution of initial perturbations and improve the spread-skill relationship of TC track forecasts, thereby ensuring that TEPS products can provide information on operational TC forecasts with a higher level of confidence.

The revisions were incorporated into TEPS in May 2010.

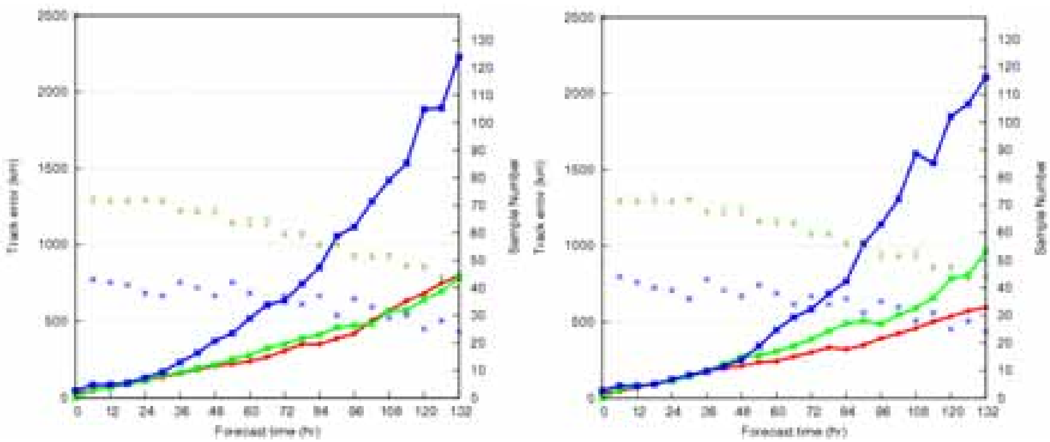


Figure 21. Ensemble mean track forecast errors for TCs in the Typhoon Center’s area of responsibility from 25 September to 25 October, 2009. The figure on the left is for the old system, and that on the right is for the new system. The red, green and blue lines show the mean track errors with reliability index A, B and C, respectively. The colored marks indicate the number of samples for each class.

(KRA1, 2, 4, 5, 7)

a-5. Weekly report on extreme climate events

JMA issues weekly reports on extreme climate events around the world, including extremely heavy precipitation and/or weather-related disasters caused by tropical cyclones. These reports are distributed to NMHSs via the TCC website in near-real time (http://ds.data.jma.go.jp/gmd/tcc/tcc/products/climate/).

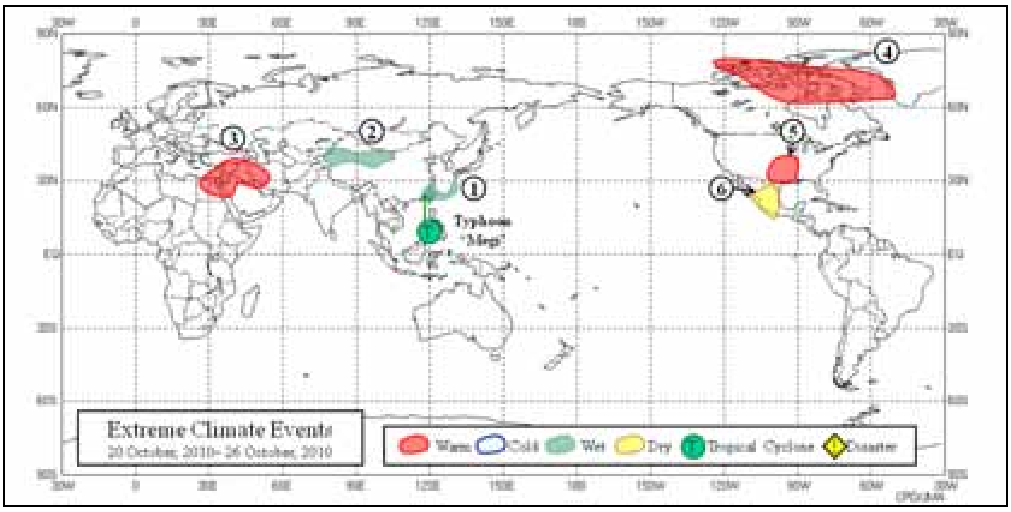


Figure 22 Distribution of global extreme climate events (7 Oct 2009 - 13 Oct 2009); The figure indicates areas where extreme climate events were identified from SYNOP messages, and also shows the tracks of tropical cyclones based on preliminary data from Tropical Cyclone Centers worldwide.

(KRA 1, 2, 4, 5, 7)

a-6. Tropical Cyclone Ensemble Forecast Information Website

1. Introduction

As a five-year initiative starting from 2009, the World Weather Research Program (WWRP) RDP project entitled North Western Pacific Tropical Cyclone (TC) Ensemble Forecast (NWP-TCEF) aims to build on the THORPEX Interactive Grand Global Ensemble (TIGGE) concept and take advantage of the TIGGE Cyclone XML (CXML) data provided by multiple organizations to improve TC track forecast skill over the Northwestern Pacific. Since May 2010, the Meteorological Research Institute has operated a website for ESCAP/WMO Typhoon Committee members and interested researchers around the world to allow visualization, comparison and verification of ensemble forecasts provided by the multiple organizations using CXML data. The site's URL is http://tparc.mri-jma.go.jp/cyclone, but password protection is used to ensure exclusive access to operational forecasters and researchers.

2. CXML data

CXML data consist of XML formatted text files containing information including the TC center location, maximum wind speed and sea level pressure in real-time analysis and deterministic/ensemble forecasts. A detailed description of the CXML format is provided on the CXML website at http://www.bom.gov.au/cyclone/cxmlinfo/index.shtml.

Such files are provided by JMA, ECMWF, NCEP, UKMO, MSC (Canada), KMA, CMA and STI (China). JMA provides two different forecasts: the weekly ensemble forecast (WEPS) and the typhoon ensemble forecast (TEPS).

3. Website overview

The site provides TC forecast tracks and information on strike probabilities, i.e., the chances of a TC coming within 120 km of certain points. These probabilities are plotted on a map for each forecast time and for a period of four days. Time series representations of distances to the TC center and strike probabilities are also shown for major or coastal cities and islands.

Figure 23 shows the main view of the site. Users can choose a TC from the menu on the left, the initial time of the forecast from the menu to the top right, and the image type (tracks or strike probabilities) from the menu in the top center. Forecasts provided by individual centers can be viewed and compared at a glance, and large images can also be seen (see Figure 24). For verification purposes, the TC track analyzed in real time by JMA is also shown with a black line.

Figure 25 shows a screenshot of a time series view (accessible via the Strike Prob. menu option). Blue circles on the map indicate the cities from which the time series of distances to the TC center and strike probabilities are calculated. The city names are also listed below the map to enable selection using either method. The selected city is highlighted with a red circle on the map, and its name and location are indicated in the time series image. Figure 26 shows a sample time series plot for an individual center. The bars represent strike probabilities, and the red box plots represent distances to the TC center based on all ensemble forecasts. The blue line is the distance based on deterministic forecasting (if available), and the black line represents the distance based on the TC track analyzed in real time by JMA for verification purposes.

4. Further use

To access the site and the CXML data for further research purposes, email a request including your name, country, and affiliation to thorpex@mri-jma.go.jp to receive a user ID and password.

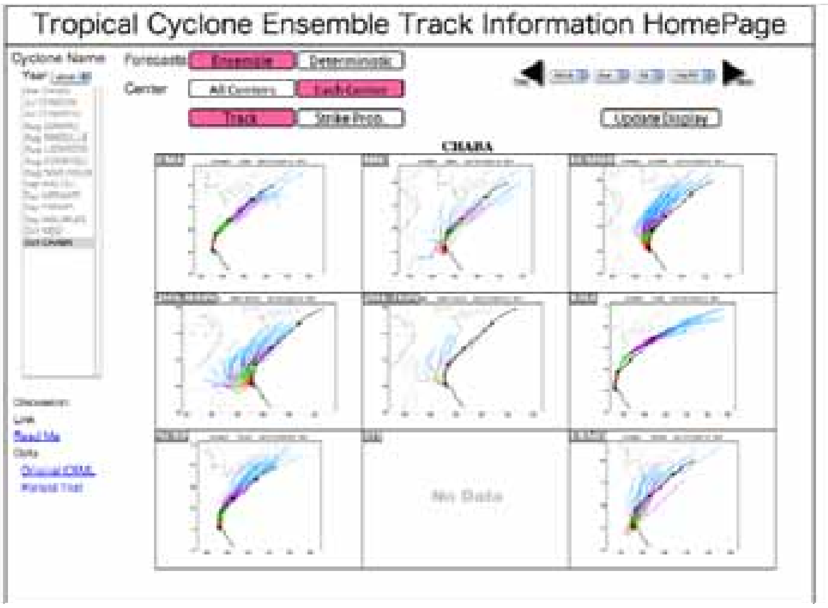


Figure 23. A screenshot showing the main view of the website (displaying data from 12 UTC on 26th October, 2010, for Typhoon Chaba). The user can choose the TC from the menu on the left, the initial time from the menu to the top right, and the image type from the menu in the top center.

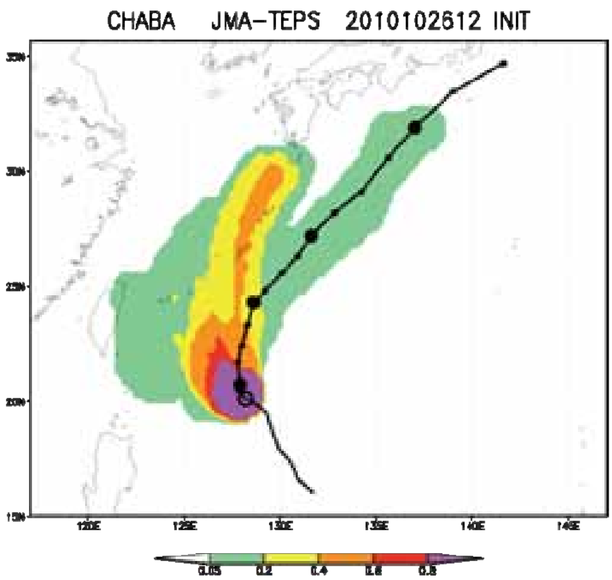


Figure 24. A sample strike probability map (created using JMA typhoon ensemble forecasts from the case shown in Fig. 1). Colored shading indicates the probability that the TC center will come within 120 km of certain points within four days based on ensemble TC track forecasts. The black line with dots represents the TC track analyzed in real time by JMA.

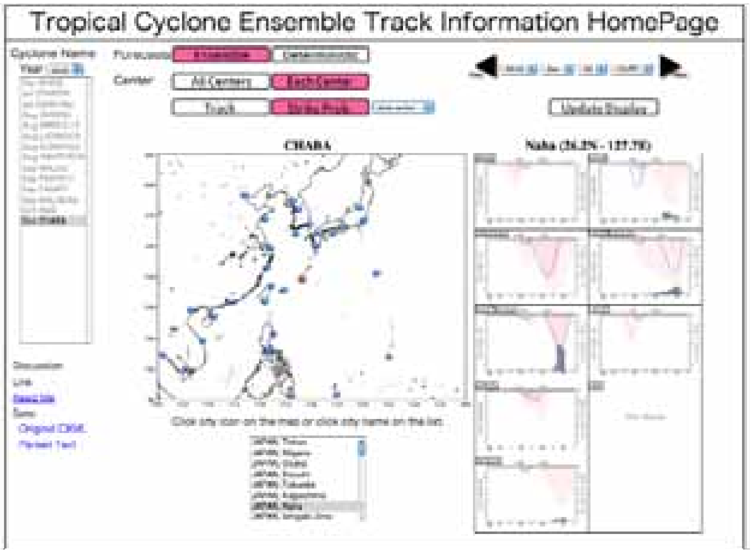


Figure 25. A screen shot of the time series view (the same case as that shown in Fig. 23). When the user selects a city by clicking on the map (available cities are marked with blue circles, and the selected city is marked with a red circle) or the list, the time series of the distance to the TC center and the strike

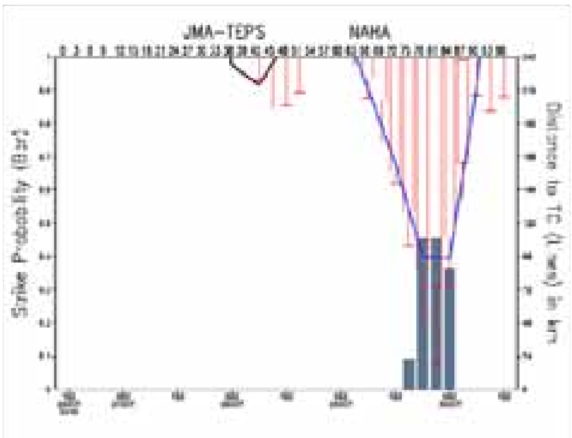


Figure 26. A sample time series display (the same case as that shown in Fig. 23 for Naha, Japan). The bars represent strike probabilities, and the red box plots represent the distances between the city and the TC center based on ensemble forecasting. The blue line is the distance based on deterministic forecasting, and

b. Hydrological Achievements/Results

b-1. Approaches of the International Flood Network (IFNet) and the Global Flood Alert System (GFAS)

(1) IFNet

IFNet was established to promote international sharing of knowledge, technology and information related to flood countermeasures and international cooperation in flood management.

The first statement was expressed at the 3rd World Water Forum in Kyoto in March 2003. IFNet is an open network for parties in charge of flood risk reduction, including government/nongovernment organizations, international bodies, public corporations, private companies and educational institutions. It had 617 registered participants from 81 countries as of 31 March, 2010. In its role as the network's secretariat, Infrastructure Development Institute-Japan manages the IFNet website at http://www.internationalfloodnetwork.org/.

(2) GFAS

GFAS is a project offering the information needed to rank the risk of flood occurrence utilizing satellite observation of rainfall amounts, and related information has been provided through the IFNet website since 2006. Automatic distribution of information on the project was introduced in June 2006. GFAS supplies rainfall data and flood occurrence probability (flood possibility) information based on global rainfall measured every three hours by multiple earth observation satellites. This is intended to act as a valuable resource for flood forecasting and the issuance of warnings in areas along large rivers where it takes several days for data on rainfall in upstream areas to reach downstream areas, in regions where telemeter systems have not been developed, or in international river zones where it is difficult to transmit information on upstream areas to downstream areas. GFAS offers two types of services – one providing basic information and the other providing customized information.

GFAS is currently implementing upgrades to add GSMaP data for analysis of hourly rainfall and to serve as a more usable interface for residents living in areas at risk of flooding.

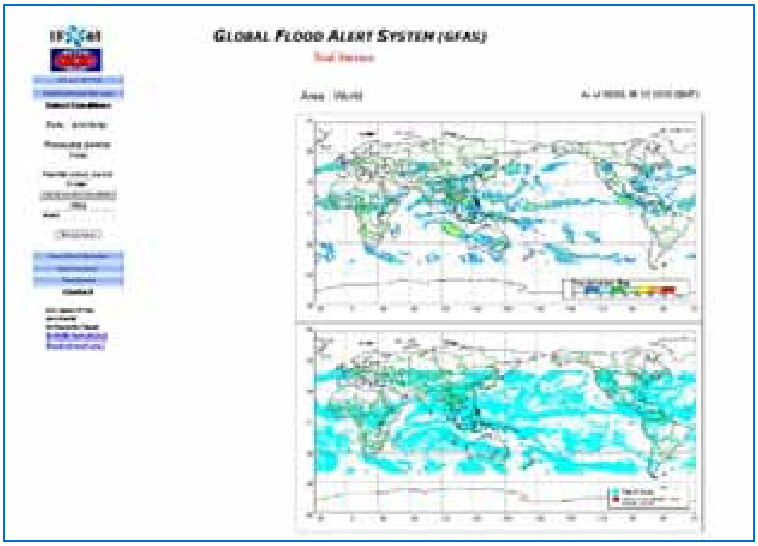


Figure 27. Global Flood Alert System (GFAS)

(KRA1, 2, 4, 5)

<u>b-2. Enhancement of Countermeasures for Localized Heavy Rainfall and Extremely Intensified Rainfall – Test operation of X-band MP radars –</u>

In recent years, localized heavy rainfall and extremely intensified rainfall have become more frequent throughout Japan. To implement adequate countermeasures for such high-risk water hazards in flood fighting and river management, MLIT had installed 11 X-band MP (multi-parameter) radars in three metropolitan areas and other regions (Kanto, Hokuriku, Chubu and Kinki) by the end of March 2010, and began distributing rainfall information via web images for public use in July 2010.

1) Observation with X-band MP radars

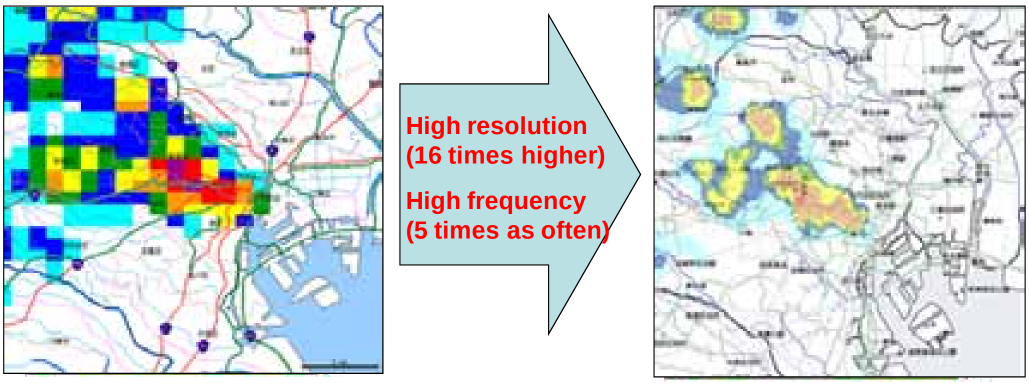
X-band MP radars now enable rainfall observation with a level of detail that was previously difficult to capture with conventional C-band radars. The new radar system allows real-time observation of rainfall events on a much finer scale than before.

X-band MP radars and C-band radars

	X-band MP radars	C-band radars
Observation interval	1 minute	5 minutes
Minimum observation area	250-m mesh	1-km mesh

【C-band radars】
- Minimum observation area: 1-km mesh
- observation interval: 5 minutes
- observation to data delivery: 5 – 10 minutes

【X-band MP radars】
- Minimum observation area : 250-m mesh
- observation interval : 1 minute
- observation to data delivery : 1 – 2 minutes



C-band radars (quantitative observation coverage: 120-km radius) are better suited for wide-area rainfall observation. On the other hand, X-band MP radars (quantitative observation coverage: 60-km radius) enable real-time, detailed observation even for localized heavy rainfall, although they are capable of covering only smaller areas.

Figure. 28

2) Use of observation information in river management

Detailed information including rainfall data from X-band MP radars can be put to a wide variety of uses toward adequate efforts in flood fighting and river management to cope with localized heavy rainfall and extremely intensified rainfall – phenomena that have become more frequent in recent years. Detailed information from this advanced system is expected to improve the accuracy of risk assessment for rising river water levels and subsequent flooding caused by extreme rainfall events.

In addition to providing real-time images, the new radar system is also designed to output images observed during the previous 30-minute period so that users can check rainfall area movement. This is expected to facilitate appropriate evacuation during heavy rainfall events as well as to support the preparation and implementation of better countermeasures for possible disasters in flood-prone structures and areas such as underground shopping malls.

(KRA1, 2, 4)

c. Disaster Prevention and Preparedness Achievements/Results

d. Research, Training, and Other Achievements/Results

e. Regional Cooperation Achievements/Results

f. Identified Opportunities/Challenges for Future Achievements/Results

7. Progress on Key Result Area 7: Enhanced Typhoon Committee's Effectiveness and International Collaboration.

a. Meteorological Achievements/Results

a-1. TCC News

TCC issues a quarterly newsletter called TCC News, which is available on the TCC website. It covers various climate-related topics including the El Niño outlook, JMA's seasonal numerical prediction for the coming summer/winter, summaries of Asian summer/winter monsoons, reports on extreme climate events around the world, and introductions to new TCC services. The latest issue, TCC News No. 22, covers the reduced frequency seen in the formation of tropical cyclones of tropical storm (TS) intensity or higher over the western North Pacific and discusses two tropical cyclones that caused fatalities in the Philippines, the Republic of Korea and the Democratic People's Republic of Korea. (http://ds.data.jma.go.jp/tcc/tcc/news/tccnews22.pdf).

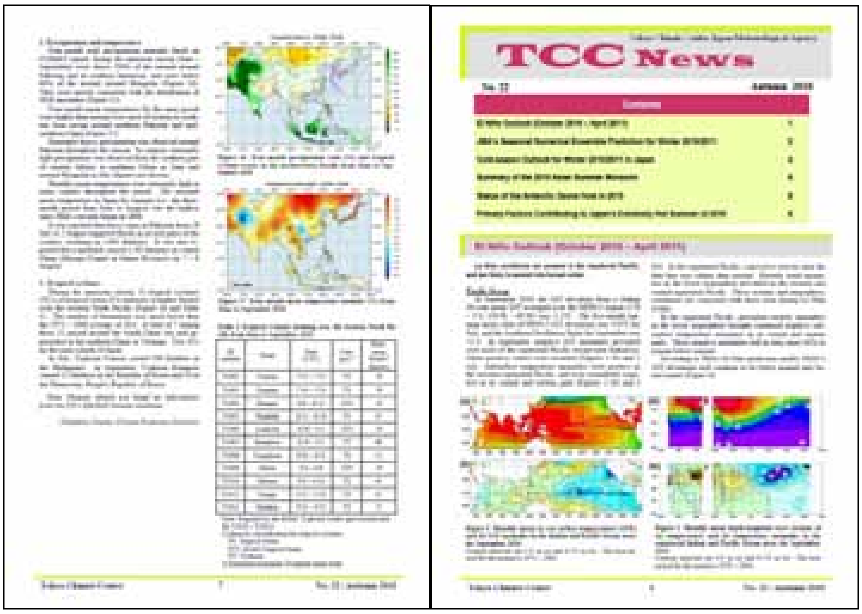


Figure 29. TCC News

(KRA1, 2, 4, 5)

b. Hydrological Achievements/Results

b-1. 5th International Conference on Flood Management (ICFM5)

The International Conference on Flood Management (ICFM) is the only recurring international conference wholly focused on flood-related issues. It is designed to bring together practitioners and researchers alike, including engineers, planners, social specialists, disaster managers, decision makers and policy makers engaged in various aspects of floodplain management. It provides a unique opportunity for these various specialists to come together to exchange ideas and experiences.

ICFM5 will be held in Tsukuba, Japan, from 27 to 29 September, 2011. It will consist of 5 plenary sessions and more than 20 parallel sessions for oral presentations, as well as poster sessions, special events and technical and cultural tours. Attendees will have the opportunity to participate in various sessions, including the following:

- Flood Risk Management (Prevention, Mitigation and Adaptation)
- Flood Disaster Management (Preparedness, Emergency Response and Recovery)
- Flood Forecasting and Early Warning Systems
- Flood Management in Different Climate Conditions and Geographic Zones
- Cross-cutting and other topics

http://www.ifi-home.info/icfm-icharm/icfm5.html

ICFM5: Important Dates

Abstracts Submission　Deadline: 1st April, 2011

Acceptance notification due: 30 April, 2011

Online registration: March to June, 2011

Your proactive participation is very much appreciated.

We look forward to seeing you in September 2011 in Tsukuba, Japan.

(KRA1, 2, 4, 5,6）

b-2. The 8th Ministers' Forum on Infrastructure Development in the Asia-Pacific Region

The 8th Ministers' Forum on Infrastructure Development in the Asia-Pacific Region was held in Tokyo, Japan, on Saturday 9 October, 2010. Ministers in charge of infrastructure development from 15 member states and territories attended the forum for a high-level meeting on social infrastructure in the region. This year, the forum was hosted by Japan and chaired by H.E. Mr. Sumio Mabuchi, the Minister of Land Infrastructure, Transport and Tourism (MLIT).

The general meeting of the forum started with a keynote address entitled An End-to-End Approach for Climate Change by Dr. Toshio Koike, who is a professor at Tokyo University's Civil Engineering Department and chair of the Steering Group on Water and Climate Change of the Asia-Pacific Water Forum. The speech was followed by a series of presentations by the heads of the participating delegations reporting on issues they currently face and efforts to solve them along the line of the forum's theme – the adaptation of infrastructure to increasing water-related risks under the influence of climate change. The presentations provided a great opportunity for the ministers and other participants to share local knowledge and experience. MLIT Vice-Minister Mr. Wakio Mitsui spoke on behalf of the Japanese delegation and introduced water-related efforts made in Japan, such as flood control, water resource development, adaptation to climate change and other international contributions.

The forum finally adopted a Ministers' Declaration stating a common understanding of the current situations and outlining future efforts to be made by the member states and territories regarding the forum's theme. Some of the understandings shared were as follows:

- Resolving water-related issues, such as floods, droughts and water quality deterioration, is essential for sustainable development and preservation of the environment and the ecosystem.
- It is important that the governments of the member states and territories acknowledge and promote the implementation of appropriate measures for water-related risks as a political priority issue through cooperation at all levels.

Based on these and other common understandings, the forum issued a joint statement on future efforts, including the following:

- The member states and territories will strongly promote mitigation and adaptation measures for water-related risks, which are expected to increase due to the effects of climate change.
- The member states and territories will promote integrated adaptation measures combining physical and non-physical action.
- The member states and territories will strengthen their network and promote international cooperation toward the resolution of water issues around the world.

Figure 30. The ministers pose for photos at the 8th Ministers' Forum on Infrastructure Development in the Asia-Pacific Region

(KRA1, 2, 4, 5, 6)

c. Disaster Prevention and Preparedness Achievements/Results

c-1. Asian Conference on Disaster Reduction 2010

The Asian Conference on Disaster Reduction (ACDR) 2010 was held in Kobe, Hyogo Prefecture, Japan from 17 to 19 January, 2010. The event was organized jointly by the government of Japan, the Secretariat of the United Nations International Strategy for Disaster Reduction (UNISDR) and the Asian Disaster Reduction Center (ADRC). It was attended by as many as 238 participants, including high-level government officials from 28 countries and representatives of 53 international and regional organizations, the academic community, the private sector and civil society organizations.

The conference facilitated the sharing of experiences and lessons learned during the process of implementing the Hyogo Framework for Action 2005 – 2015 (HFA), thereby providing important insights for the Mid-Term Review of the HFA as well as for ongoing preparations toward the 4th Asian Ministerial Conference on Disaster Risk Reduction held in October 2010 in Incheon, Republic of Korea.

The key topics addressed at ACDR 2010 were as follows:

1. Lessons to be learned from recent disasters in Asia
2. Progress and shortcomings in implementing the Hyogo Framework for Action 2005 – 2015
3. Expansion of applications for space technologies and other technological innovations in disaster risk reduction
4. Strengthening of sub-regional cooperation for disaster risk reduction

Among those delivering initial remarks at the opening ceremony on the first day of the conference were H.E. Mr. Hiroshi Nakai (Minister of State for Disaster Management of the government of Japan and Conference Chair), Mr. Kenzo Oshima (Senior Vice-President of the Japan International Cooperation Agency (JICA)), who emphasized the necessity of further promoting international cooperation on disaster risk reduction for the potential impacts of global climate change, and ADRC Chairman Prof. Shigeru Ito, who expressed high expectations for ACDR 2010.

The keynote speech was given by Ms. Margareta Wahlstrom, Assistant Secretary-General for Disaster Reduction and Special Representative of the Secretary-General for the Hyogo Framework for Action in the Secretariat for the International Strategy for Disaster Reduction. In her presentation, entitled "Five Years of Implementation of the Hyogo Framework for Action: Mid-Term Review," Ms. Wahlstrom invited all attendees to make further commitments toward achieving the goals of the HFA. She also stressed the importance of integrating disaster risk reduction considerations into economic and territorial development efforts.

During active discussions in the public forum and during breakout sessions, participants concluded that the following points should be further explored in a consistent manner in individual countries and organizations:

- Action to address climate-related natural disaster risks
- Action to address disaster risks in cities
- Transfer of experiences and lessons to the next generation in order to preserve such knowledge
- Enhancement of efforts to strengthen the capacity to respond to and deal with natural disasters not only at national level, but more importantly at local and community levels
- Facilitation of better use for space technologies in achieving disaster risk reduction objectives by raising awareness of their effectiveness among related institutions, and enhancement of capacity building and human resource development in the field
- Further promotion of institutionalization for disaster risk reduction activities by enabling cooperation at regional or sub-regional levels.

Figure 31. Group photo of participants

<u>c-2. Urban Search-and-Rescue Training in Singapore as an ADRC activity for disaster reduction</u>

The Singaporean Government holds a training course every year for search and rescue officers. The course has been receiving trainees from outside Singapore for the past nine years and providing training on the search-and-rescue expertise required in urban disaster situations. The training facility complex of the Civil Defence Academy (CDA) run by the Singapore Civil Defence Force (SCDF) is one of the highest-level facilities of its kind in Asia. In an effort to utilize their expertise and facilities, ADRC has been inviting relevant officers from member countries to the training course since 2001. Officers from Armenia and Sri Lanka attended the course from 11 to 22 January, and officers from Mongolia, Bhutan and the Maldives participated from 18 to 29 October, 2010 (two weeks).

Figure 32. Urban search-and-rescue training in Singapore

d. Research, Training, and Other Achievements/Results

d-1. Tenth Typhoon Committee Training Seminar at the RSMC Tokyo - Typhoon Center

One responsibility of the RSMC Tokyo - Typhoon Center is to assist members of the ESCAP/WMO Typhoon Committee in tropical cyclone forecasting services. A related activity of the Center is to hold on-the-job training in tropical cyclone operations for forecasters in the region with the aim of improving analysis and forecast skills by exchanging views and sharing experiences in the field.

Two forecasters – Ms. Wong Sau Ha (Hong Kong Observatory) and Ms. Hu Yihong (National Environment Agency of Singapore) – visited the Japan Meteorological Agency (JMA) from 21 to 30 July, 2010, to participate in the tenth Typhoon Committee Training Seminar. On the course, the two forecasters learned about tropical cyclone analysis and forecasting, and in particular analysis using SATAID software (a satellite viewer program). The sessions provided were intended to give detailed information on RSMC products, including JMA's operational tropical cyclone forecast. The course also featured practical training to estimate tropical cyclone center position and intensity using the Dvorak and the early-stage Dvorak techniques.

Figure 33. Ms. Hu Yihong (left), Mr. Kunio Sakurai (middle), Director-General of JMA, and Ms. Wong Sau Ha (right), with staff members from the National Typhoon Center (JMA's Director-General's Office)

Figure 34. Discussion in the operation room (JMA's Forecast Division)

(KRA1, 2, 4, 5, 6)

d-2. *The Reinforcement of Meteorological Services* group training course

JMA conducted the Reinforcement of Meteorological Services group training course as one of the Training and Dialogue Programmes of the Japan International Cooperation Agency (JICA) from 14 September to 18 December 2010. The session was one of a series of JICA group training courses in meteorology that have been provided since 1973 to support capacity building among National Meteorological Services. On the course, eight participants from eight countries (including Cambodia, Lao PDR, and Myanmar from among the TC members) acquired skills in the utilization of satellite data including nephanalysis and tropical-cyclone analysis, and learned about the application of numerical weather prediction products and radar data. The course also included technical tours to research institutes, private weather companies, airlines, meteorological instrument manufacturers, and mass media in charge of disaster prevention/mitigation and risk management to highlight state-of-the-art application and communication of meteorological information.

(KRA1, 2, 4, 5, 6)

d-3. International Centre for Water Hazard and Risk Management (ICHARM) – an organization operated under the auspices of UNESCO

ICHARM, established on 3 March, 2006, under an agreement involving the Japanese Government, UNESCO and the Public Works Research Institute, actively promotes various activities for better water-related disaster management. Although ICHARM's scope is global, many of its activities target the Asia-Pacific region, including TC members' areas of responsibility.

Training, research and information networking are the three pillars of ICHARM's activities to produce the best practicable strategies for a range of localities worldwide and to assist in their implementation. ICHARM primarily places priority on risk management in relation to flood-related disasters, including those induced by typhoons.

Some of ICHARM's notable activities over the past year are outlined below.

Update on ICHARM's progress

1) Training

i) Water-related Disaster Management Course of Disaster Management Policy Program (a one-year master's degree program offered since October 2007 in collaboration with GRIPS and JICA)

ii) Local Emergency Operation Plans with Flood Hazard Maps training course (launched in 2009 as successor to the flood hazard mapping training course in collaboration with JICA)

2) Research

i) Development of IFAS (the Integrated Flood Analysis System)

ii) Research on water-related risk assessment and other issues

3) Information Networking

i) Service as secretariat of the International Flood Initiative (IFI) – a joint project of UNESCO, WMO, UN/ISDR and UNU

ii) Service as topic coordinator on water-related disaster issues at the Asia-Pacific Water Summit and the World Water Forum

iii) Extension of technical assistance to selected Asian countries in collaboration with ADB (launched in November 2009) and other activities

Many of these activities are expected to be beneficial in enhancing social, economic, environmental and institutional aspects of disaster risk reduction in TC member regions. ICHARM also makes related information available on its website at http://www.icharm.pwri.go.jp/.

(KRA1, 2, 3, 4, 5, 6)

e. Regional Cooperation Achievements/Results

e-1. Expert services of the Japan Meteorological Agency (JMA)

- Two experts from JMA and MRI visited the Malaysian Meteorological Department in September 2010 to provide training at a workshop on marine forecasting models for waves and oil spills and on an ocean data assimilation model.
- A JMA expert visited the Korea Meteorological Administration in December 2010 for sharing experience on radar operation systems to help improve the systems in the Republic of Korea.
- A JMA expert visited Thailand in December 2010, to give a lecture on QPE/QPF technique at a workshop on "Space Application to Reduce Water-related Disaster Risk in Asia". The workshop was attended by participants from China, Viet Nam and Macau.

e-2. Technical visits to JMA

- A numerical weather prediction expert from the Hong Kong Observatory visited JMA for technical exchange on JMA's non-hydrostatic model and its 3D variational data assimilation system in January 2010.

f. Identified Opportunities/Challenges for Future Achievements/Results

III. Resource Mobilization Activities

1. A basic design study for the project to upgrade the radar system in the Philippines

The government of Japan has exchanged a letter with the government of Philippines about an agreement on the project named Improvement of the Meteorological Radar System in the Philippines. This is a project for sponsorship by Japan’s Grant Aid program, and is implemented by The Japan International Cooperation Agency (JICA) to support the upgrading of the radar observation system run by the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). In this project, three Doppler radars and VSAT system will be installed.

IV. Update of Member's Working Groups Representatives

1. Working Group on Meteorology

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2. Working Group on Hydrology

3. Working Group on Disaster Prevention and Preparedness

4. Training and Research Coordinating Group

5. Resource Mobilization Group

Several rainstorm warnings were issued in 2010. Referring to the damages shown in Table 2 below, flooding and landslips were the major impacts of heavy rainfall in Macao.

Date	Duration	Incidents (cases)									
		Flooding	**Fallen Trees**	**Buildings collapsed/ Concrete fallen**	**Billboards collapsed or tottering**	**Scaffoldings collapsed or tottering**	**Windows collapsed or tottering**	**Awnings collapsed or tottering**	**Landslips**	**Casualties**	**Others**
19-05-10	16H00-17H30	0	0	0	0	0	0	0	1	0	0
30-05-10	14H50-16H50	0	0	0	0	0	0	0	2	0	0
09-06-10	09H05-11H00	24	0	0	0	0	0	0	1	0	5
10-06-10	02H20-04H00	19	0	0	0	0	0	0	5	0	1
28-07-10	17H40-19H45	20	0	1	0	0	0	0	0	0	0
11-09-10	01H10-02H15	8	0	0	0	0	0	0	0	0	4
12-09-10	13H48-15H00	2	0	0	0	0	0	0	0	0	1
20-09-10 to 21-09-10	22H00 to 00H50	13	0	0	0	0	0	0	0	0	0

Table 2: Damages caused by rainstorms during 2010

II. Summary of progress in Key Result Areas (For achievements/results which apply to more than one Key Result Area, please describe them under the most applicable Key Result Area. Then, at the end of the description, place in parentheses ( ) the other applicable Key Result Areas)

1. Progress on Key Result Area 1: Reduced Loss of Life from Typhoon-related Disasters. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

Remote sensing has been considered as a helpful means for monitoring strength and moving direction of typhoons. For obtaining satellite images from FY-2E, a FY-2E receiving system was purchased in order to replace the existing FY-2C receiving system.

b. Hydrological Achievements/Results

Please refer to Key Result Area 2(b) and 2(c)

c. Disaster Prevention and Preparedness Achievements/Results

The Slope Safety Panel formed by Land, Public Works and Transport Bureau (DSSOPT), Civic and Municipal Affairs Bureau (IACM) and the Civil Engineering Laboratory, has continued to inspect the 188 slopes in Macao. All with immediate danger have been reinforced. Other reinforcement and related works have been completed or are undertaken on the slopes with high landslide risk.

Slopes inspection and reinforcement

Aside from sending a special team to repair the damaged trees immediately after the typhoons, IACM has also created an identification card for more than 21,000 trees. The database includes the height, trunk diameter, location, growth and health problems of the trees. The database does not only serve as an important base for future tree plantation strategies, but also enables IACM staff to reinforce the maintenance of the trees and prevent accidents during heavy storms.

Repairing damaged trees

To improve safety during poor weather, IACM is also strengthening the control of illegal installation of business and advertising signs and its removal.

A tottering billboard after typhoon

When typhoon signal is hoisted, DSSOPT will send sms message to construction sector warning them to adopt precautionary measures such as securing and fastening the works, scaffoldings, and working platforms etc. in order to prevent the occurrence of accidents. In addition, the Bureau will also delegate representatives to inspect construction sites and old buildings, as well as urge the residents to check if their air conditioner stands and flower racks are safe prior to the hoisting of typhoon signals.

d. Research, Training, and Other Achievements/Results

One forecaster participated in the TC Roving Seminar held in Thailand on November 30- December 03, 2010, focusing on topics of microwave satellite images analysis, effects of tropical cyclone interaction with monsoon and seasonal prediction of cyclone activities.

e. Regional Cooperation Achievements/Results

Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

Nil.

2. Progress on Key Result Area 2: Minimized Typhoon-related Social and Economic Impacts. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plangoals)

a. Meteorological Achievements/Results

Please refer to Key Result Area 1(a)

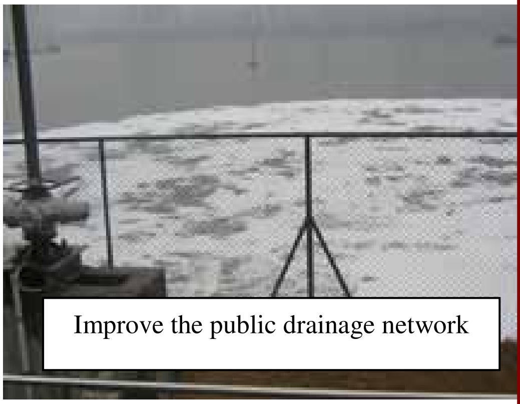
b. Hydrological Achievements/Results

Please refer to Key Result Area 2(c) and 7(b)

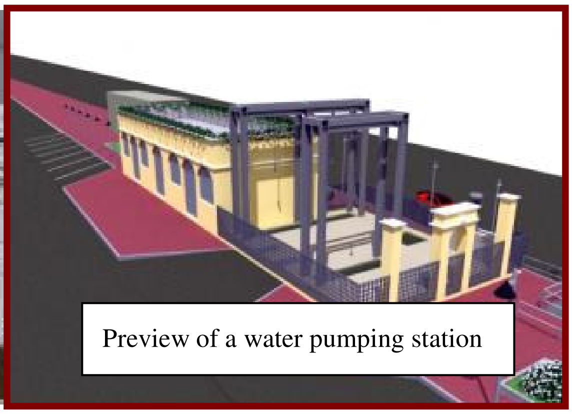
SMS alerting service for rainstorm-induced flooding is now under testing and that disseminates instant flooding information as well as the trend of precipitation to registered merchants for them to take necessary precautions against flooding.

c. Disaster Prevention and Preparedness Achievements/Results

According to the Fourth Assessment on Climate Change, the United Nations Intergovernmental Panel on Climate Change (IPCC) estimates that the water level in the Pearl River Estuary, which is adjacent to Macao, will rise between 40 and 60 centimeters by 2050. In response to such threat, IACM will construct three storm water pumping stations (two in Macau Peninsula whereas one in Taipa) to improve the public drainage network and prevent flooding problems during the rainy season.



Improve the public drainage network



Preview of a water pumping station

DSSOPT plans to commence a major sewer upgrade project in “Kou Si Tak” area, one of the vulnerable flooding areas during the rainy season. Moreover, DSSOPT plans to renew all the existing pipes and divide them into two separate systems to handle rain water and sewage respectively, with an aim to enhance the drainage capacity and thereby alleviate the flooding problem.

Sewer upgrade project

d. Research, Training, and Other Achievements/Results

In order to let citizens have a better understanding our operations as well as the meaning of different warnings, 836 students and citizens were recorded visiting the SMG headquarters in the year 2010.

e. Regional Cooperation Achievements/Results

Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

Nil.

3. Progress on Key Result Area 3: Enhanced Beneficial Typhoon-related Effects for the Betterment of Quality of life. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

Nil.

b. Hydrological Achievements/Results

Nil.

c. Disaster Prevention and Preparedness Achievements/Results

Nil.

d. Research, Training, and Other Achievements/Results

Nil.

e. Regional Cooperation Achievements/Results

Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

Nil.

4. Progress on Key Result Area 4: Improved Typhoon-related Disaster Risk Management in Various Sectors. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

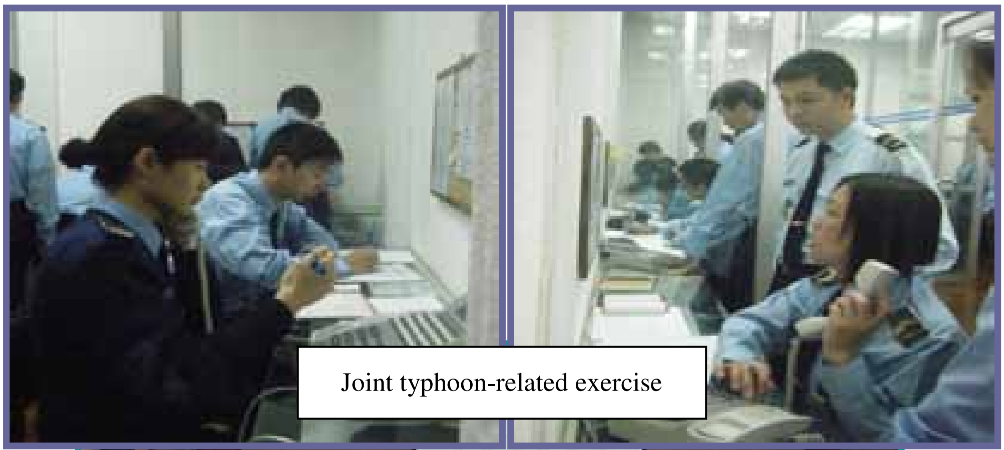
Nil.

b. Hydrological Achievements/Results

Please refer to Key Result Area 7(b).

c. Disaster Prevention and Preparedness Achievements/Results

As for enhancing the disaster response capabilities of the members of Civil Protection System, Macao Security Forces Coordination Office held an annual joint exercise involving all the members of the System in early April this year. The exercise simulated the hoisting of typhoon signal no. 8 to test the system's capability in cooperation, crisis management, information dissemination and communication. After that, a conference was held to review the civil protection mechanism and solve the problems found in the said typhoon exercise.



Joint typhoon-related exercise

Civil Protection Annual Meeting

d. Research, Training, and Other Achievements/Results

Nil.

e. Regional Cooperation Achievements/Results

Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

Nil.

5. Progress on Key Result Area 5: Strengthened Resilience of Communities to Typhoon-related Disasters. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

Nil.

b. Hydrological Achievements/Results

Nil.

c. Disaster Prevention and Preparedness Achievements/Results

Government officials and representatives of community associations took the proactive approach by visiting residents and shop owners in the low-lying areas. Besides, Chief Executive Mr. Chui Sai On recently visited those districts where often suffer from flooding in heavy rain in order to hear the residents' grievances and discuss possible solutions to their problems.

Visits to the flooding affected districts

d. Research, Training, and Other Achievements/Results

Nil.

e. Regional Cooperation Achievements/Results

Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

Nil.

6. Progress on Key Result Area 6: Improved Capacity to Generate and Provide Accurate, Timely, and understandable Information on Typhoon-related Threats. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

Please refer to Key Result Area 1(a)

b. Hydrological Achievements/Results

Please refer to Key Result Area 2(b)

c. Disaster Prevention and Preparedness Achievements/Results

In order to provide the public with natural disasters-related information hoping to draw their awareness on the impacts of typhoons and other natural disasters, Macao Security Forces Coordination Office launched a civil protection related website (www.gcseg.gov.mo) in April this year. The office is also keen on promoting typhoon prevention via the media or through distribution of brochures and pamphlets.

Civil protection website


Brochures and pamphlets

In order to enhance citizens' recognition of the safety of Macao's slopes and provide them a more convenient and effective way to obtain relevant information, a website about slopes safety (http://slope.dssopt.gov.mo/zh_HANT/sites/slope/id/1) that was jointly established by DSSOPT and Cartography and Cadastre Bureau (DSCC) was launched in November 2010.

Slopes safety website

d. Research, Training, and Other Achievements/Results

Please refer to Key Result Area 2(b)

e. Regional Cooperation Achievements/Results

Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

Nil.

7. Progress on Key Result Area 7: Enhanced Typhoon Committee's Effectiveness and International Collaboration. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

The ESCAP/WMO Typhoon Committee (TC) Integrated Workshop was again hosted by the Macao, China since 2006. The Workshop with the theme of "Urban Flood Risk Management in a Changing Climate" was held at the Convention Center of the Macao Science Center on 6 -10 September 2010 with the attendance of more than 70 experts from 14 TC Members. The Workshop was intended to provide the opportunity not only for the exchange of ideas among experts from the various fields covered by the Committee, but also to assess the progress in the various activities endorsed by the Committee at its 42nd Annual Session.

b. Hydrological Achievements/Results

Please refer to Key Result Area 7(a)

The Chief of Meteorological Watch Centre of SMG participated in an ESCAP/WMO Typhoon Committee Expert meeting on Urban Flood Risk Management Expert Meeting held in Bangkok, Thailand on 19-20 July 2010 with the scope of strengthening regional cooperation towards flood resilient cities.

c. Disaster Prevention and Preparedness Achievements/Results

In order to share typhoon-related information with fellow members of Typhoon Committee and learn from their experiences as well as disaster management skills, Macao Security Forces Coordination Office has continued to participate actively in the meetings organized by Typhoon Committee as well as the TC Working Groups. The followings are the meetings that the representatives of the office attended over the year.

- 25 to 29 January 2010, 42nd Session of Typhoon Committee
- 5 to 10 September 2010, Integrated Workshop
- 25 to 26 October 2010, 5th Meeting of WGDRR

Three of TC meetings

The office has also continued to provide supports to the WGDRR as well as its activities by presenting reports on the impacts of some critical typhoons and the works related to the disaster risk reduction in Macao.

d. Research, Training, and Other Achievements/Results

Nil.

e. Regional Cooperation Achievements/Results

Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

The Macao SAR Government continues contributing the Endowment Fund to support the operation of Typhoon Committee Secretary for another 4 years.

III. Resource Mobilization Activities

Nil

IV. Update of Members' Working Groups representatives

1. Working Group on Meteorology

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2. Working Group on Hydrology

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3. Working Group on Disaster Risk Reduction

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   Email: copc@fsm.gov.mo

4. Training and Research Coordinating Group

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   E-mail: wkleong@smg.gov.mo

5. Resource Mobilization Group

   Nil.

Table 3 Summary of flood events during 2009 North-East Monsoon season

State/River Basin	Period of Rainfall	Date of Peak Flood (2009)	Average Rainfall (mm)	Highest Recorded Daily Rainfall (mm)	Estimated Area of Flood Extent (Hectare)
Padang Terap River, Kedah	7 -12 Nov 2009	Nov 7 / 19.17m @ Kuala Nerang	101	125	14,000
Golok River, Kelantan	5 – 12 Nov 2009	Nov 7 / 18.06m @ Kusial	125	358	20,000
Besut River, Terengganu	21 – 28 Nov 2009	Nov 22 / 9.55m @ Jambatan Jerteh	316	339	18,000

The estimated cost of flood damages is RM 65 million. Approximately 50,000 people were evacuated and given shelter in flood relief centres in the states of Kedah, Perak, Pahang, Terengganu and Kelantan. The death toll during this monsoon season was nine persons. The worst affected areas were areas along the major rivers such as the Kelantan River, Golok River and Besut River.

II Summary of progress in Key Result Areas

1. Reduced Loss of Life from Typhoon-related Disasters.

1.1 Meteorological Achievements/Results

Radar System Upgrade

As part of the 9th Malaysia Plan, major upgrades were carried out to the radar station network operated by the Malaysian Meteorological Department (MMD). Up to 2009, only one (1) of the radar stations operated by the MMD is a Doppler radar. In 2010, the remaining ten (10) conventional radars were upgraded to Doppler radars. The RAPIC BOM systems of the conventional radars were replaced by the IRIS SIGNET VAISAL system. A new radar station was also constructed in Miri, Sarawak.

With the present upgraded radar stations, each of them will be able to function at two operation modes. One is the fixed operation mode, during which scans are done using 4 vertical levels and up to a range of 500km. The temporal resolution for this fixed mode is 10 minutes. The other mode is during which scans are done using 16 vertical levels and therefore of a lower range up to 300km. The temporal resolution of this higher horizontal resolution mode is 30 minutes.

1.2 Hydrological Achievements/Results

Improvement of Facilities

The Department of Irrigation and Drainage (DID) to date has installed and operated about 525 telemetric stations in 38 river basins. In addition to that, 670 manual river gauges, 1013 stick gauges and 182 flood warning boards have been set up in flood prone areas so as to provide additional information during the flood season. As part of the local flood warning system, about 395 automatic flood warning sirens are being operated.

An Integrated Flood Forecasting and River Monitoring System (iFFRM) for the Klang Valley are being developed. For this system, 88 new telemetric stations and infrastructure networks will be installed together with a flood modelling system that include both hydrometeorology and hydrodynamic. To date, infrastructure networks have been completed, while the progress for modelling has reached 90%.

An Integrated Flood Forecasting and Warning System for Muda River Basin are being developed. The objective is to develop a radar rainfall analyzer and integrator for Muda River and a real-time flood forecasting system. To date, the progress is 40%.

As reported previously, Stormwater Management and Road Tunnel Project (SMART), Kuala Lumpur had been completed in July 2007. Since then, SMART had successfully diverted flood water from entering Kuala Lumpur City Centre.

1.3 Research, Training, and Other Achievements/Results

Atmospheric Model-Based Rainfall & Flood Forecasting System (AMRFF)

To improve the efficiency of flood forecasting in Malaysia, DID has embarked on the Atmospheric Model-Based Rainfall & Flood Forecasting System (AMRFF) project. This project is to be completed by November 2010. At present, the progress of the project is 60%.

This project has two objectives:

1. To develop real-time flood forecasting based on Atmospheric Model-based Rainfall and Flood Forecasting (AMRFF) System for providing a real-time flood warning and emergency responses in a convenient lead-time to the Pahang, Kelantan and Johor River Basins.

2. To develop radar rainfall analyzer and integrator for Malaysia (RAIM) to estimate rainfall distribution and the rainfall magnitude forecast in the Pahang, Kelantan and Johor River Basins.

On The Job Training (OJT)

The fourth OJT was held from the 12 July until 6 August 2010 at the DID office (Hydrology and Water Resources Division), Kuala Lumpur, Malaysia. The programme was arranged for 20 days to cover all the modules that have been planned by the Department. Upon successful completion of the on-the-job training programme, participants would be able to:

i. Gain knowledge, appreciation and experience on the use of the Tank Model for flood forecasting

ii. Configure a flood forecasting model based on the Tank Model for a selected catchments in the participant’s country

iii. Calibrate the Tank Model and preparing the model for operational use in the participant’s respective organisation

iv. Develop an error correction module for the Tank Model to enhance forecast accuracy

v. Develop expertise in writing simple macros (Microsoft Excel) to automate model computations – a skill which can be used to customize the model and further enhance the model in the future

The fourth OJT was attended by 18 participants, comprising 15 engineers from the Department of Meteorology and Hydrology Lao PDR, Ministry of Water Resources of China and Ministry of Water Resources and Environment Vietnam and 3 Typhoon Committee (TC) representatives. This programme consists of 11 elements as shown in **Table 4**.

Table 4: The OJT programme schedule

No	***Training Programme***	***Type***	***Date***	***Week***	***No. of days***
1	Flood forecasting using the tank model	Lecture	12 July 2010	1	1
2	MS Excel Macros	Lecture			2
3	Configuring the Tank Model	OJT			2
4	Data quality checking and processing	OJT	19 July 2010	2	2
5	Catchment parameters – calibration of model (1)	OJT			1
6	Development of Excel macros for automating model computations	OJT		2	1
7	Fine tuning model – adjustment of flood simulation to improve forecasts – calibration of model (2)	OJT		2	1
8	Site visit to Malaysian Meteorological Department and SMART Tunnel	Site Visit	29 July 2010	3	1
9	Lecture on telemetry and SCADA, Integrating with SCADA/Telemetry System and preparing the model for real-time flood forecasting, dissemination of flood forecast	OJT	30 July 2010	3	1
10	Enhancements to model – adapting model to changes and additional modules (Fill-in Matrix/Rating Curve)	Lecture	2 August 2010	4	3
11	Reports/Discussion	-	5 August 2010	4	2
	Total No. of Days				20

2. Minimized Typhoon-related Social and Economic Impacts.

2.1 Meteorological Achievements/Results

Automatic Weather System Upgrade

Under the 9th Malaysia Plan, the Automatic Weather Station (AWS) project is expected to be completed in 2010. Under this project a further 108 AWS were added to the existing network of AWS. A higher density of AWS data made available through this system would help immensely in continuous monitoring of the weather conditions.

2.2 Hydrological Achievements/Results

Flood Forecasting and Warning (Operation)

Flood forecasting operations were carried out during the flood seasons by the respective DID state offices with technical assistance from the National Flood Forecasting Centre at DID Head Quarters. The river basins which have been provided with forecasting models are summarized in **Table 5**.

Some of the flood forecasting models have been revised in order to improve their performance. Flood forecasting models for Johor River, Muar River and Batu Pahat River are currently being revised using the real-time computerized HEC-HMS model.

Table 5 The river basins with forecasting models.

River Basin	Catchments Area (km^2)	Number of Forecasting Point	Forecasting Model
1. Muda River	4,300	2	Stage Regression
2. Perak River	14,700	3	Stage Regression
3. Muar River	6,600	2	Linear Transfer Function
4. Batu Pahat River	2,600	2	Stage Correlation
5. Johor River	3,250	2	Regression Model
6. Pahang River	29,300	3	Linear Transfer Function and Stage Regression (back-up)
7. Kuantan River	2,025	1	Tank Model
8. Besut River	1,240	1	Stage Regression
9. Kelantan River	13,100	2	Tank Model and Stage Regression (back-up)
10. Golok River	2,175	1	Stage Regression
11. Sadong River	3,640	1	Linear Transfer Function
12. Kinabatangan River	17,000	1	Linear Transfer Function
13. Klang River	1280	5	Flood Watch

3. Improved Typhoon-related Disaster Risk Management in Various Sectors

3.1 Disaster Prevention and Preparedness Achievements/ Results

Malaysia is geographically located just outside the 'Pacific Rim of Fire" and is generally free from severe natural disasters such as earthquake and volcanic eruption. Although Malaysia is spared from the threats of severe natural disasters and calamities, Malaysia is nonetheless affected by other natural disasters especially monsoonal flood, landslide, severe haze, and strong storm surges during the monsoon season.

Hardware and/or Software Progress

3.1.1 Emergency Command Centre (ECC)

The Emergency Command Centre has been approved during the Mid-Term Review of the Ninth Malaysia Five-Year Plan. The Government of Malaysia through the National Security Council has agreed to start the development of the centre by early next year in 2011.

3.1.2 Malaysian Emergency Response System (MERS 999)

The establishment of a single emergency number "999" for the entire nation will make it easier for the public to contact emergency service providers, namely the police, ambulance, fire station and civil defence rescue units. With the new system, specially-trained service professionals form the 999 Emergency Call Service Centre would handle all emergency calls and reroute them to respective emergency service providers, complete with digital data on the type of emergency and location.

The 999 emergency number is free of charge and any emergency call will be answered and vetted within 10 seconds. All 999 call centres are connected to the agencies through a virtual private network. The telephone number and location of callers will be identified through automatic number identification and automatic location identification with the help and sharing of information between telecommunication service providers.

3.1.3 Government Integrated Radio Network (GIRN)

A Government Integrated Radio Network (GIRN) project was introduced to provide secure digital trunk radio system between the various Government agencies in Malaysia as a study showed that there are currently more than 12 radio networks used by the various agencies. The introduction of the GIRN project preserves the autonomy and freedom of the various agencies while providing a unified network of shared infrastructures.

GIRN will certify that every agency's network would be physically and virtually separated. Every agency would manage the equipments and assets on its own. It can utilise and manage the network using its own and unique command and control policy. The network is virtually separated by using different System Number for each agency. In case of emergency or disaster, all agencies communicate in one single radio channel. GIRN is targeted to cover 95% of Malaysia's populated land and areas extending 10 nautical miles from the shoreline.

3.1.4 **Fixed Line Alert System (FLAS)**

The Fixed Line Alert System (FLAS) or Disaster Alert System (DAS) will enable the Government, specifically the National Security Council and the Malaysian Meteorological Department to disseminate early warning messages to selected communities who subscribe to fixed line telephone when a disaster occurs. When the system is triggered, pre-recorded emergency voice messages on the early warning of potential catastrophic disasters such as tsunami will be broadcasted immediately to Telekom Malaysia's fixed line subscribers.

3.2 Implications on Operational Progress

3.2.1 **Disaster Management and Relief Committee**

For the year 2010, Minister at the Prime Minister's Department, as the Chairman of the National Disaster Management and Relief Committee, chaired two flood disaster preparation and mitigation meetings to assess the level of preparedness among disaster management agencies in emergency response, recovery and rehabilitation for the flood victims.

Similar preparation and mitigation meetings are also held at the respective state and district levels. The committee is responsible to evaluate a situation and to determine the level and scope of disaster; to formulate plan of action; to determine the capability in handling disaster and the need to request for assistance whether from within or outside the country.

3.2.2 Reviewing the Directive No. 20 of the National Security Council (NSC)

To facilitate the management of disasters, NSC is tasked to coordinate efforts among the various agencies involved in disaster management. The National Security Council Directive No. 20: *The Policy and Mechanism on National Disaster and Relief Management* was established on 11 May 1997 to provide inter-agency coordination in disaster management.

Due to the uncertainty and complexity of disasters, measures are taken to review and upgrade Directive No. 20 to ensure that it remains relevant and up to date in meeting these challenges. The NSC is taking steps by having meetings at regular intervals with related agencies to conduct the review exercise.

The Department of Social Welfare has 4 main tasks as stipulated in the Standard Operational Procedures (SOP) under the Directive as follows:

i. Management of evacuation centers;

ii. Assistance in the form of food, clothing and other necessities including family disaster kit;

iii. Registration of victim; and

iv. Guidance and counseling

The Department of Social Welfare which is in charge of preparing the relief centers, food supply and registration of disaster victims will identify suitable potential relief centers in the whole country. At the same time the department also has to establish good networking with food suppliers at strategic places. On top of that, the depots for food and other necessities storage at the zone level such as north, south, east and central of Peninsular Malaysia were established. For the year 2009, the department had identified 4,744 relief centres which can accommodate 1.3 millions disaster victims at a time.

In term of training for social workers and volunteers, the department had conducted 31 training sessions for 3,239 people (1,750 social workers and 1,489 volunteers) in 2009. The objectives of these trainings are to provide knowledge and skills for officers and volunteers to work professionally in helping the disaster victims. On top of that, the Department of Social Welfare also continued to assist the families who are seriously affected by disaster in order to help them to return to their normal daily life. This is considered as a long-term intervention or management process.

3.2.3 National Disaster Relief Trust Fund (NDRF)

National Disaster Relief Trust Fund was changed from a normal fund to a trust fund in 2005 to enable the general public and the private sector to contribute in assisting disaster victims. Financial sources for the fund comprise of both annual budget allocation from the government and contributions from the public and private sectors. The types of financial assistance provided are for the following eventualities:

i. loss of income;
ii. damaged/demolished house;
iii. agricultural damage;
iv. livestock and aquaculture damage; and
v. burial cost for fatalities due to disasters

The trust fund is administered in accordance with a letter of trust which is subjected to Section 10 of the Financial Procedure Act 1957. The letter allows the usage of the trust fund for extending financial aid and relief supplies to foreign countries affected by disasters.

In the year 2010, Malaysia has contributed more than USD 2 million in terms of cash money, medicines, medical equipments, tents and daily necessities to help victims of the great flood in Pakistan.

3.2.4 Central Store

During the National Disaster Management and Relief Committee Meeting No. 1/2006 on 5 January 2006, the Prime Minister of Malaysia, as chairman of the committee highlighted the need to relocate and deploy search and rescue (SAR) assets in a strategic location / storage facility.

At the National Disaster Management and Relief Committee meeting No. 1/2007, the Prime Minister requested that a centralised store for SAR utilities and equipments should be established. This storage facility is managed together by the National Security Council, the Armed Forces, the Welfare Department and the Royal Malaysia Police.

The establishment of this facility at the Defense Supplies Depot in Sungai Buloh allows centralised procurement of the much needed assets and equipments for disaster relief operations such as rescue boats, mobile toilets and heavy trucks as required at the local level all across Malaysia. These assets are managed by state offices of the National Security Council and coordinated in their deployment via the role of the NSC as secretariat for the Disaster Management and Relief Committee at the district and state levels respectively.

3.3 Regional Cooperation Achievements/Results

3.3.1 **Regional Cooperation**

At the regional level, Malaysia is an active member of the Association of South East Asia Nations (ASEAN) and is a member of the ASEAN Committee on Disaster Management (ACDM). In ensuring cooperation among Member States, the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) was signed on 26 July 2005. The agreement has entered into force on 24 December 2009.

In line with the Agreement, States are called upon to designate National Focal Points and competent authorities to coordinate regional Humanitarian Assistance and Disaster Relief Operations (HADR), to support the establishment of ASEAN Coordinating Centre for Humanitarian Assistance on Disaster Management (AHA Centre) as well the ASEAN Standby Arrangements for Disaster Relief and Emergency Response (SASOP). The standby arrangements require Malaysia to earmark assets on voluntary basis to be shared with other Member States who are in need of assistance.

3.3.2 Fourth Asian Ministerial Conference on Disaster Risk Reduction

Malaysia participated in the Fourth Asian Ministerial Conference on Disaster Risk Reduction (4th AMCDRR) which took place at Incheon, Republic of Korea from 25 – 28 October 2010 with the main theme “Climate Change Adaptation through Disaster Risk Reduction”. Malaysia’s participation in the said conference was deemed important to the country as it is a continuation of Malaysia’s initiatives through the hosting of the previous 3rd AMCDRR.

4. Strengthened Resilience of Communities to Typhoon-related Disasters.

4.1 Hydrological Achievements/Results

Technical Advancement

The Infobanjir website (http://infobanjir.water.gov.my) continues to be enhanced and improved in terms of IT technology, hardware, procurement and network expansion as well as its contents to meet the customer’s requirement. It has recently included rainfall isohyet maps where users can monitor and assess the severity of rainfall of the previous events. It has also included the improvement of on-line flood reporting in order to expedite the dissemination of the flood reports to the top management level.

The active on-going projects carried out by DID are as follows:

i. Flood Diversion (Keruh Diversion, Gombak Diversion etc.)
ii. Retention Pond (Sri Johor, Taman Desa, Batu, Jinjang etc.)
iii. 1.8 km stretch of Sg. Kerayong

4.2 Research, Training, and Other Achievements/Results

Enhancement of Public Education and Awareness

To instill disaster risk reduction awareness among the public, various initiatives were introduced. These include awareness programmes for disasters such as landslides, tsunami, and floods by the MMD, Ministry of Education and Ministry of Science, Technology and Inovation. These initiatives were conducted in schools, universities and hospitals.

MMD in collaboration with the Ministry of Education had organized a total of 95 awareness programmes in regard to extreme weather and its impact in various schools and universities throughout the country. Out of the 95 awareness programmes conducted by the MMD, 48 public education and awareness programmes were conducted by the Regional Offices, 44 by the Training Division and 3 by the Geophysics and Tsunami Division. The Ministry of Science, Technology and Innovation had also carried out 3 such awareness programmes at the national level.

5. Improved Capacity to Generate and Provide Accurate, Timely, and understandable Information on Typhoon-related Threats.

5.1 Meteorological Achievements/Results

The Shanghai Typhoon Institute's Bogus Data Assimilation (BDA) Typhoon Bogussing Scheme was successfully implemented on an operational basis in December 2009 to improve the cyclone vortex representation in the MM5 model at MMD. In the BDA scheme, bogus sea level pressure data are ingested as an observation field based on the Fujita's formula, and all model fields will be adjusted accordingly under the constraints of the MM5 model. Tropical cyclone analysis data from CMA are used to update the cyclone's central pressure, maximum wind speed and location. Currently, the bogussing scheme is configured for the Southeast Asian domain from 90°E to 130°E and 0°N to 20°N. The bogussing scheme will be turned on whenever a tropical cyclone with central pressure of less than 1000 hPa is located within the domain.

The MM5 with the BDA Typhoon Bogussing Scheme has performed well during the passages of Chantu, Dianmu, Mindulle and Megi over the South China Sea in 2010. The tracks of these tropical cyclones were more accurately predicted compared to the MM5 model without the bogussing scheme. More verification of track forecasts is being conducted and further research in cyclone intensity and structural changes, landfall processes, ensemble prediction techniques of cyclone tracks and assimilation of non-conventional data (radar and satellite) will be undertaken in the near future to improve the bogussing scheme's performance.

5.2 Research, Training, and Other Achievements/Results

Research and Training

An officer from MMD was sent to attend the Asia Pacific Typhoon Workshop in Manila, Philippines on 27 – 28 Jan and another officer attended the Typhoon Committee Roving Seminar in Ubon Ratchathani, Thailand on 30 Nov – 3 Dec 2010.

Current research activities at the MMD Research Division include three studies which are related directly to tropical cyclones. The three studies are:

i. The Impact of Tropical Cyclones in the Western Pacific Ocean and South China Sea on the Rainfall in Malaysia.

ii. The Impact of Tropical Cyclones in the Bay of Bengal on the Rainfall in Peninsular Malaysia.

iii. Influence of Tropical Cyclones in the Western Pacific Ocean and South China Sea on the Tropospheric Circulation and Weather Pattern over the Asian Monsoon Region during the Pre-monsoon, Monsoon and Post-monsoon Seasons.

The first two of the papers are completed and the third is in the drafting stage.

The courses, seminars and conferences related to flood and hydrology organized by DID during the year are as follows:

i. One-day Seminar on R&D in Hydrology, Kuala Lumpur, 18 January 2010

ii. Course on Hydrological Application, Sarawak, 5 May 2010

iii. Course on Flood Operation, Sarawak, 6 May 2010

iv. National Conference on Hydrology and Environment, Batu Pahat, 23-24 June 2010

v. “4th On The Job Training (OJT)”, DID Kuala Lumpur, 12 July – 6 August 2010

vi. Course on Flood Forecasting and Warning System, Kelantan, 20 - 22 July 2010

vii. Course on Flood Management, Sarawak, 27 – 29 July 2010

viii. 4^{th} International Course on Flood Mitigation and Storm water Management 2010, DID Kuala Lumpur, 4 – 22 Oct 2010

5.3 Information and Communication Technology (ICT)

The MMD ICT Division has upgraded the Computer Message Switching System (CMSS) and start using the new system from August 2010. This new system is used to manage transmission of meteorological data and information locally and internationally that include Global Telecommunication System (GTS) and Aeronautical Fixed Telecommunication Network (AFTN) messages.

The development of the Malaysian Integrated Forecasting System (MIFS) is expected to be completed by November 2010. This system comprises of visualization and product generation systems and internal web. The visualization and product generation systems are able to generate various meteorological and marine products including observations from the land surface stations, marine, upper air, radars, satellites and also the forecast products from various numerical weather prediction models. This system is capable to give an alert based on predefined criteria like maximum wind speed and position of tropical cyclone in certain area.

Most of these products are distributed through internal web to forecast offices to help MMD’s staff monitoring the weather and issuing weather forecasts and warnings to the public and clients. This internal web is also opened to external agencies that involved in disaster management to enable them to obtain information that are related to weather in real time.

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II. Summary of progress in Key Result Areas (For achievements/results which apply to more than one Key Result Area, please describe them under the most applicable Key Result Area. Then, at the end of the description, place in parentheses ( ) the other applicable Key Result Areas)

1. Progress on Key Result Area 1: **Reduced Loss of Life from Typhoon-related Disasters.** (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)

a. Meteorological achievement/result

- **A Campaign for the Prevention of Typhoons**

KMA (Korea Meteorological Administration) conducted a campaign for the prevention of typhoons and created a promotional video to attract public attention and to minimize damage-causing typhoons.

It was shown at approximately 1,100 locations from 1 August 2010 to 30 September 2010 on broadcast, web site and electronic display boards of government and public institutions all over Korea, raising public awareness of typhoon-related disasters.

- **Expert Meeting on Typhoon Activity and Disaster Prevention 2010**

The National Typhoon Center (NTC) of the Korea Meteorological Administration (KMA) held an expert meeting to establish prevention measures against typhoon-related disaster for this year on 5-6 April 2010 in Jeju, Korea. Over 40 experts on typhoon research and forecast and decision-makers from the Ministry of Public Administration and Security, the National Institute for Disaster Prevention, the Korea Water Resources Corporation, Seoul National University, Jeju Special Self-governing Province, etc. participated in this meeting, and discussed their typhoon outlooks for the year. There had been no injuries or damage from typhoon in the last two years. However, some studies showed that two or three typhoons may land on the Korea Peninsula this year (In fact, three typhoons (Dianmu (1004), Kompasu (1007), and Malou(1009) affected Korea). Also, methods were introduced to prepare against typhoons and minimize losses through organization. Participants agreed to reinforce their mutual cooperation and KMA outlined its plan to expand its typhoon forecast out to 5 days.

Fig. II-1-1. Participants in the expert meeting on typhoon activity and disaster prevention 2010 held on 5-6 April 2010, Jeju, Korea.

- **<u>Workshop on the Seasonal Prediction of Typhoon Activity</u>**

A workshop on the seasonal prediction of typhoon activity hosted by NTC/KMA was held on 23-24 August 2010, at Seogwipo KAL Hotel in Jeju, Korea. The main theme was “the current condition and autumn prediction of typhoons in 2010.” Experts from several fields such as meteorology, oceanography, hydrology, disaster prevention, and journalism participated in this workshop and presented their research findings about the frequency, track, strength, activity, etc. of typhoon and typhoon-related phenomena such as La Nina, Madden-Julian oscillation (MJO) and Arctic Oscillation (AO). Participants noted that typhoon generation frequency in the Northwest Pacific would be small in number and stronger than the normal year in intensity. In particular, many expected Korea to be directly affected by at least one or two more typhoons in the course of the year.

Fig.II-1-2. Typhoon expert workshop participants. 23-24 August 2010, Jeju, Korea

- 5-Day Typhoon Forecast (Experimental and Domestic version)

NTC/KMA plans to extend the typhoon forecast period from 3 days to 5 days in 2010, including for domestic service and its experimental version. This extension of forecasting time was expected to help prepare against typhoons approaching Korea, and to make a valuable contribution towards reducing typhoon damage. KMA's 5-day forecast was possible due to the improvement of numerical model predictions as well as intensified monitoring ability using satellite-based observations. Although this forecast system was operated on an trial basis in 2010, KMA plans to transition it to an operational system after 2011 following a thorough review of this year's forecast outputs.

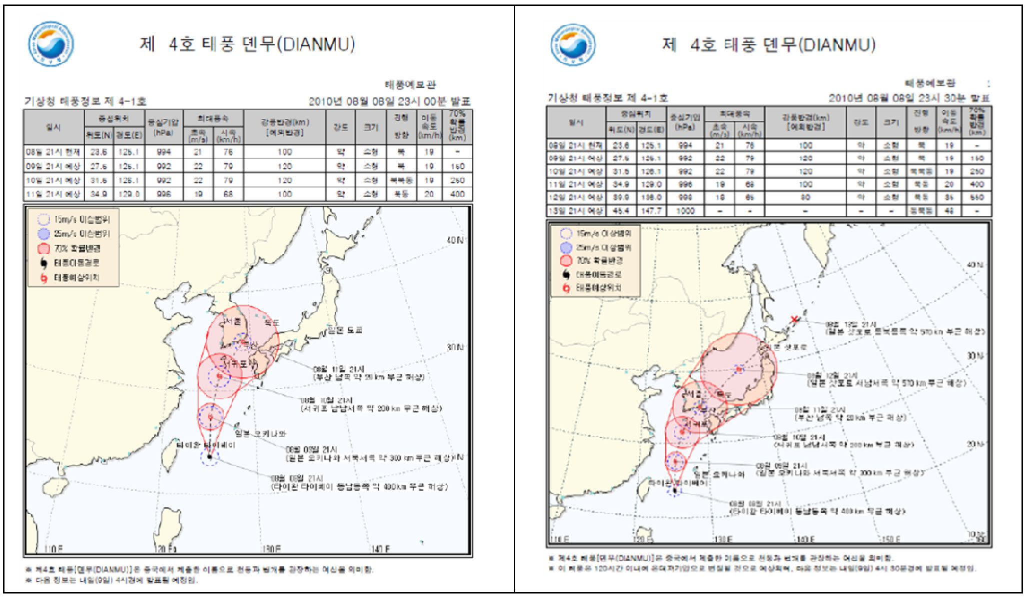


Fig. II-1-3. An example of 3-day (left) and 5-day (right) forecast of Typhoon Information

- Establishment of a "Special Typhoon Risk Management Team"

A "Special Typhoon Risk Management Team" was launched in 2010. The team is composed of experts from the National Meteorological Center, the National Satellite Meteorology Center, the Weather Radar Center, and the National Typhoon Center. The main objective of this team is timely and reliable typhoon information service to the public for mitigating typhoon damage. The team, located at the National Typhoon Center, is summoned when a typhoon is expected to affect Korea within 48 hours.

b. Hydrological achievement/result

- <u>Research Project on Next-Generation Flood Defense Technology</u>

As a possible effect of climate change and increased rainfall, life and property damage caused by floods is rapidly increasing in frequency, scale, and diversity.

Flood protection technology has strong regional characteristics. Simply introducing technology from abroad is not an option, and the technology is not the fruit of corporate R&D, but rather of government-level efforts.

■ The aim of this study is to:

Rebuild the system

Reduce the risk

Ready the nation against floods

■ The research contents are as follows:

1. Flood Forecasting using IT/ST

1-1 : Advanced Flood Monitoring Technology

1-2 : Improved Technology for Flood Forecasting by Applying Meteorological Information

1-3 : Diversified Technology for Spatial Flood Forecasting in River Basin

1-4 : Development and Application of Rainfall Radar System

1-5 : Development of Hand-held Flood Monitoring Assistants Based on LBS

2. Flood Defense Capacity

2-1 : Nationwide Flood Control Planning Assessment and Standardization

2-2 : Design Technology for Flood Control

2-3 : Improvement of Laws and Guidelines related to Flood Control

2-4 : Standardization for River Structure Certification

3. Watershed Flood Defense

3-1 : Optimized Technology for Watershed Flood Control

3-2 : Extreme Flood Management Resulting from Failure of Hydraulic Structure

3-3 : Flood Protection Considering the Change in Future Environment

3-4 : Non-structural Measures and Assessment Technology

3-5 : Emergency Action Planning System against Extreme Floods

4. Flood Management System

4-1 : Flood Information Visualization and Transmission Technology

4-2 : Real-time Flood Control System using Satellites

4-3 : Integrated Flood Disaster Management System

4-4 : Integrated National Flood Prevention System

Based on these research findings, the national flood defense and management system will be built so as to reduce human damage by 5% and property damage by 30%. Skill level is to increase by 80% relative to developed countries. The government should contribute to the prevention of flooding by maximizing land conservation and use efficiency. Flood disaster-safe construction aims to improve the quality of life.

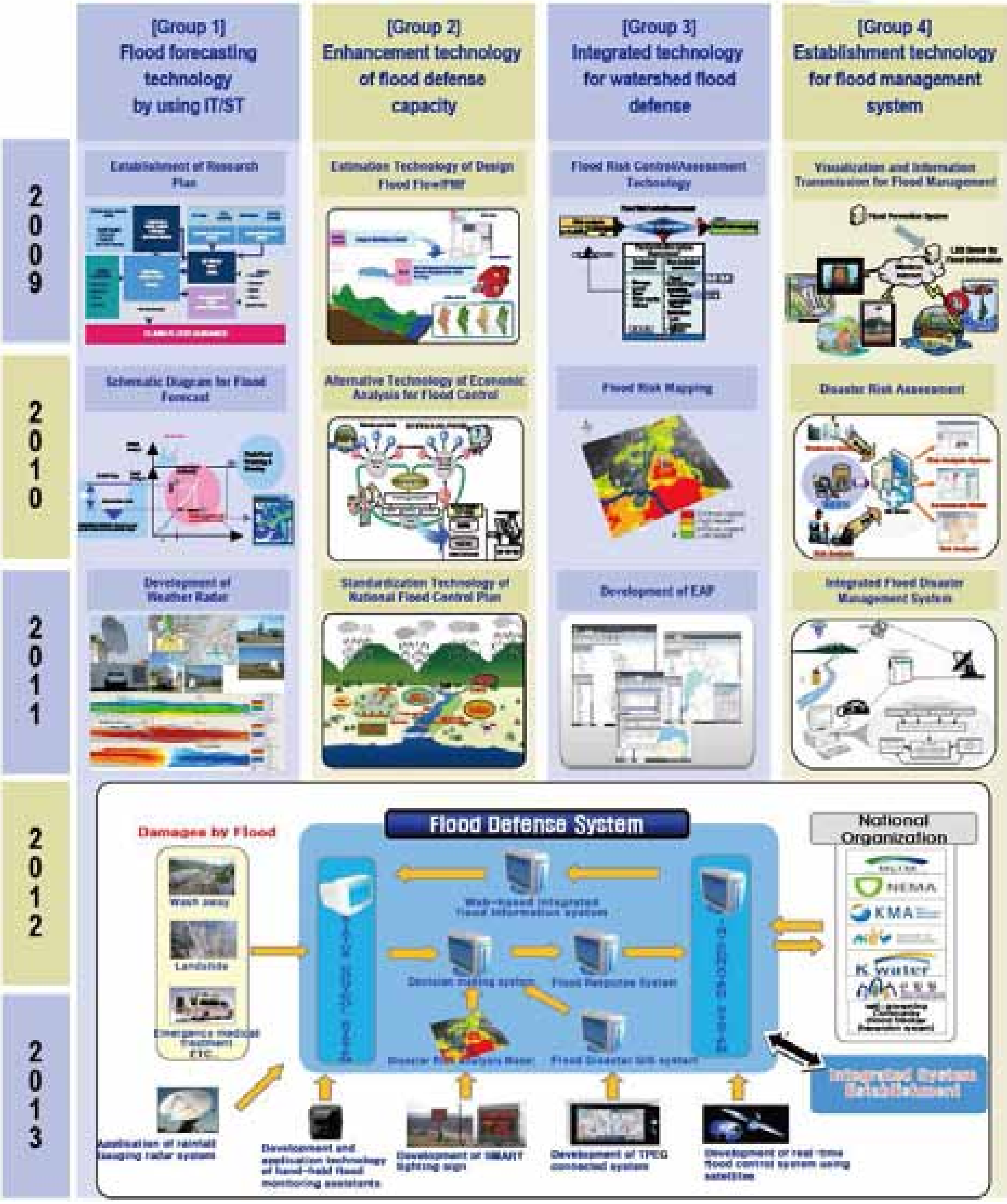


Fig. II-1-4 Research plan

- **Four Major Rivers Restoration Project**

At present, one of the most important policies promoted by the Korean Government is 'the Four Major Rivers Restoration Project'. This project's principal aim is to prevent 200-year return frequency flood and to offer a safer river environment. To improve safety from flood, existing small dams are reinforced and many small dams are constructed.

To strengthen river basins small- and middle-sized dams will be constructed. The yearly repeated flood can be reduced by the method of form dredging.

Main objectives by basin are as follows:

Han river	- Flood stage drop with dredging (0.4-3.9m) - Flood control capacity increase to settle retention reservoir - Flood safety increase with old levee reinforcement (131 km)
Geum river	- Flood defense measure: increasing flood control ability upto100 million m^3
Nakdong river	- Water security ability reinforcement through addition of eight small dams - Rapid flood defense and water-stage drop of drainage gate by increasing installation of estuary dam
Yeongsan river	- Flood defense measure: increasing flood control ability upto120 million m^3

The current progress is as follows:

- Ministry of Land, Transport and Maritime Affairs
  : 95 new constructions on schedule
  : Core contents such as small dams and dredging to be 60% complete by year end
- Ministry for Food, Agriculture, Forestry and Fisheries
  : Construction to raise 96 reservoir banks in progress
  : Yeongsan river estuary dam improvement construction began in March 2010 and will be complete in 2012
- Ministry of Environment
  : Facility reinforcement of total phosphorus treatment
  (Projects to improve water quality: 1,281 sites)

Fig. II-1-5 Epo small dam in Han river

Fig.II-1-6 Gumnam small dam in Gum river

(Sources; www.4rivers.go.kr/ www.mltm.go.kr)

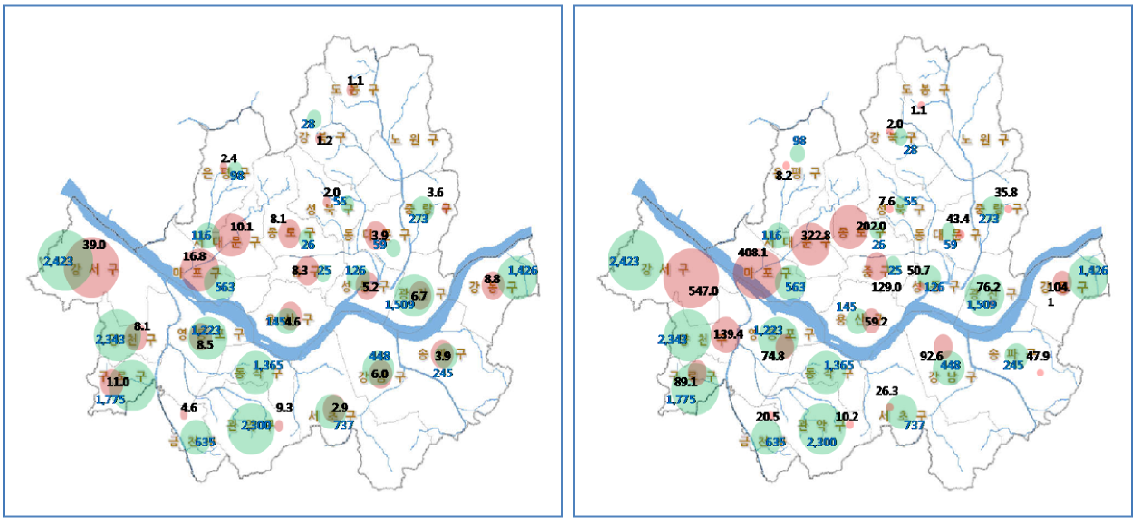
c. Disaster Risk Reduction (DRR) Achievements/results

- <u>Heavy rainfall in Seoul and Gyeonggi</u>

This year's Chuseok holiday was marked by heavy rainfall, which flooded roads and houses and caused power outages in Seoul. KMA posted a heavy rain warning for Seoul on Tuesday, September 21. KMA forecasted 30- to 100-mm rains in Seoul until Tuesday and most areas nearby recorded more than 177.8 mm. The western area near the Yellow Sea experienced scattered rains from Tuesday night to Thursday morning. Western Gangseo-gu in Seoul had precipitation reaching up to 222 mm/h as of 3:15 p.m. on Tuesday. The precipitation in Gimpo, Gyeonggi Province, and Incheon was expected to reach 50-150 mm/h.

Severe rains cut off sections of the 16 major roads in Seoul, and about 100 households in the western Seoul area experienced power outages. Fig. II-1-7 shows the total number of flooded homes within an hour and three hours. Statistics show that a total of 17,943 homes were damaged, including 2,423 in Gangseo-gu, 2,343 in Yangcheon-gu, and 2,300 in Gwanak-gu.

During the torrential rains, after the flooding of the homes and buildings, many requests for help with the water drainage systems were received. On September 21, heavy rains forced the evacuation of nearly 12,000 people and were blamed for at least one death in South Korea. It took the country by surprise when over-279.4-mm rains fell as millions of people were heading home for Chuseok, the Korean equivalent of Thanksgiving. One fisherman was killed, and at least one other person was injured when an apartment wall collapsed. The rains damaged about 15,000 homes, but the electricity was restored in almost 3,000 homes. Those affected by the storm received cash payments from the local government as assistance for their living expenses.



(a) One-hour period *(b) Three-hour period*

Fig. II-1-7. Distribution of flooded homes in the Seoul area.

Fig. II-1-8. Basement of a house flooded due to the heavy rains on 21 September 2010 in Seoul, South Korea.

Fig. II-1-9. Parking lot around buildings flooded due to the heavy rains on 21 September 2010 in Seoul, South Korea.

Fig. II-1-10. South Korean men pushing a stalled car during the heavy rains on 21 September 2010 in Seoul, South Korea.

Fig. II-1-11. A man steps across floodwater to board a passenger bus amidst the heavy rains on 21 September 2010 in Seoul, South Korea.

Fig. II-1-12. Motor vehicles braving the floods during the heavy rains on 21 September 2010 in Seoul, South Korea.

Fig. II-1-13. South Korean rescue team members searching for missing persons during the heavy rains on 21 September 2010 in Seoul, South Korea.

Fig. II-1-14. Motor vehicles braving the floods during the heavy rains on 21 September 2010 in Seoul, South Korea.

Fig. II-1-15. A subway station flooded due to the heavy rains on 21 September 2010 in Seoul, South Korea.

Fig. II-1-16. South Korean rescue team members search for missing persons during the heavy rains on 21 September 2010 in Seoul, South Korea.

The main issues that were raised after the damage from the severe rains were estimated were (i) drainage capacity problems; (ii) inflow of rain water into the lower-level areas and catchment basin capacity deficiency; and (iii) pumping capacity deficiency and inexperienced pumping station operation. The detailed causes of the damages, and the measures that were taken to address them, are listed in Table II-1-2.

Table II-1-2. Detailed causes of the damage, and the measures that were taken to address them

Main Issues	Detailed Causes of Damage	Measures
Drainage capacity problems	Flow capacity deficiency in the drainage channel	Reestablishment of a drainage design standard
	Drainage overflow by the continually rising channel stream surface	Strengthening of the strategies for reducing rainfall runoff
	Underground-space inundation by the overflowing sewage channel	Establishment of an integrated drainage basin operating system
	Decreased channel discharges due to sediments in the drainage channel	Provision of assistance for evacuation of lower-area residents
Inflow into lower areas and catchment basin capacity problems	Inflow of rainfall water into lower-area homes	Installation of a water pump to block inflow of water into homes
	Catchment basin capacity deficiency	Expansion of catchment basins, and reduction of debris flow, including sediments
Pumping capacity and operating problems	Drainage basin size and pumping capacity deficiency	Expansion of pumping capacity to a level matching 30 years' worth of rainfall
	Inexperienced pumping station operation	Development of an integrated operating system

d. Research, training, and other achievements/results

- <u>Development of a flashflood prediction system for DRR in mountainous areas</u>

"Guerrilla storms" and localized heavy rains have increased in frequency in recent years in South Korea, leading to serious disasters, especially in the mountainous areas. These rainfall patterns are the direct cause of flashfloods, which cause considerable damage in both urban and mountainous areas. Furthermore, the trend of the damages caused by flashfloods shows that their magnitude increases with time.

In the city regions, casualties from flashfloods are not serious, but property damage is considerable. On the contrary, flashfloods occurring in mountainous areas can give rise to many casualties. The National Institute for Disaster Prevention (NIDP) plans to minimize casualties in the valleys of mountainous areas by estimating the extent of a flashflood three hours before it occurs, and by issuing an early warning within 20-40 minutes of its occurrence.

To this end, the Flashflood Forecasting System (FFFS), shown in Fig. II-1-18, has been established. MAPLE can predict three-hour rainfall data in 4,272 unit basins. Although MAPLE can precisely forecast rainfall characteristics less than three hours before the event, it still needs to adjust its forecast results, which NIDP does via data integration between MAPLE and AWS in this study, as shown in Fig. II-1-19. Among the stations, 345 (including the existing stations) were selected for the issuance of warnings. In the existing stations, rainfall is monitored and checked by Flashflood Guidance Rainfall for warning issuance purposes. New warning stations estimate rainfall via AWS and MAPLE, and then issue a warning if the rainfall is expected to cross over the threshold. The accuracy is verified through a separate expert system, which predicts rainfall by comparing it with previous measurements, and the warning criteria are regularly checked.

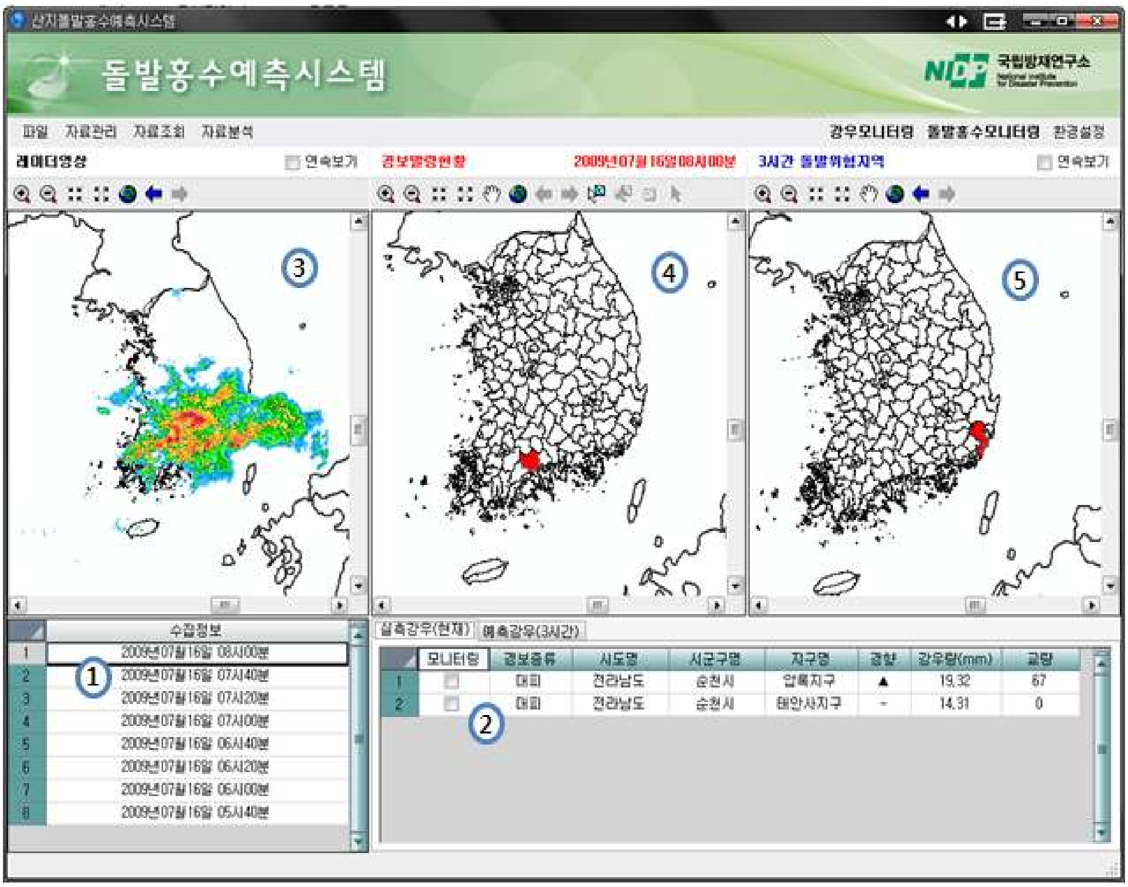


Fig. II-1-18. The main window of the system.

Fig. II-1-19. MAPLE data, AWS stations, and data integration.

When a flashflood risk area is identified, a warning message will be delivered to the pre-designated persons via SMS or e-mail, as shown in Fig. II-1-20. The warning information delivered via SMS will be concise and will include the warning time and the current situation in each district. More detailed information will be delivered via e-mail. Window ① is for SMS delivery (under installation), and window ② is the e-mail delivery window.

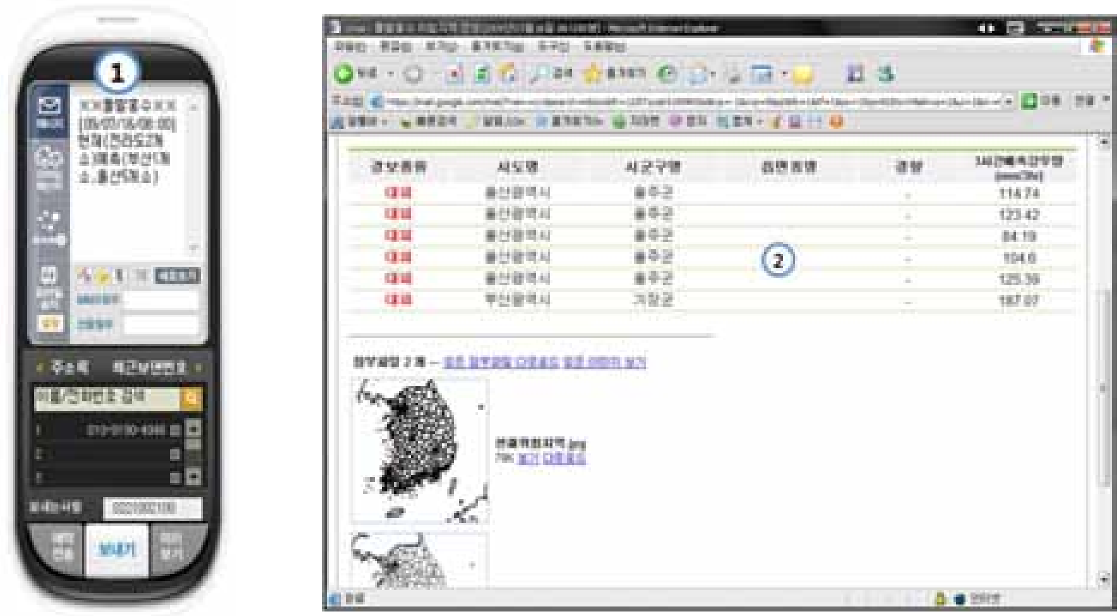


Fig. II-1-20. Dissemination of the warning degree via SMS or e-mail.

NIDP also published a manual for FFFS, through the Typhoon Committee (TC). This manual can be used for disaster risk reduction education and for international responses to climate change and related flashflood events, as it contains valuable examples and concrete system figures. This FFFS manual will help each country understand disaster behavior and the appropriate disaster mitigation strategy based on statistics and reports.

- <u>Domestic activities in wind-related DRR</u>

The wind code for buildings and other structures was renewed in 2009, after five years of study funded by the Ministry of Land, Transport, and Maritime Affairs (MLTM). Climate change and associated extreme-wind effects were studied to update the wind code, and the zonal classification based on the basic wind speed was slightly modified from the 2005 code. It is still based, however, on the 10-minute averaged value, and no special attention was directed to the coastal area of typhoon-prone regions. The recent wind damage wrought by Typhoon Kompasu shows that the revised wind code must take into account wind-borne debris.

The Natural Disaster Prevention Act of Korea specifies ten types of structures that require regulations and codes for wind-resistant design: buildings, airports, parks, roads and bridges, cables, cranes and lifts, bulletin boards, power lines, ports, and railways. The act also specifies two kinds of legal operations for local governments. The first consists of establishing a mitigation plan for natural disasters, including wind-related disasters, for all of the 234 local governments of South Korea. The plan should include a survey and evaluation of natural disasters in the region, and should summarize the risk with the corresponding mitigation measures. Each local government is required to renew the plan every five years. Since 2007, more than 100 local governments have established such plans, some of which are still under review by the central government. The second legal operation for local governments is to assess the natural-disaster risk of a planned development whenever a change in land cover or topography takes place.

The Natural Disaster Insurance Act of Korea has been in effect since 2004, and NEMA and three major insurance companies are involved with insurance matters. The act stipulates that the policyholder pays about half of the premium while NEMA pays the other half. Since it took effect in 2006, many policyholders have benefited from the insurance. One of the critical issues regarding the insurance act is the determination of insurance rates for insured properties, whose risks are never identical. As very little claims data has been accumulated and as natural disasters are caused by unforeseen meteorological phenomena, a statistical method has been developed [3], and a wind hazard map has been produced, as shown in Fig. II-1-21.

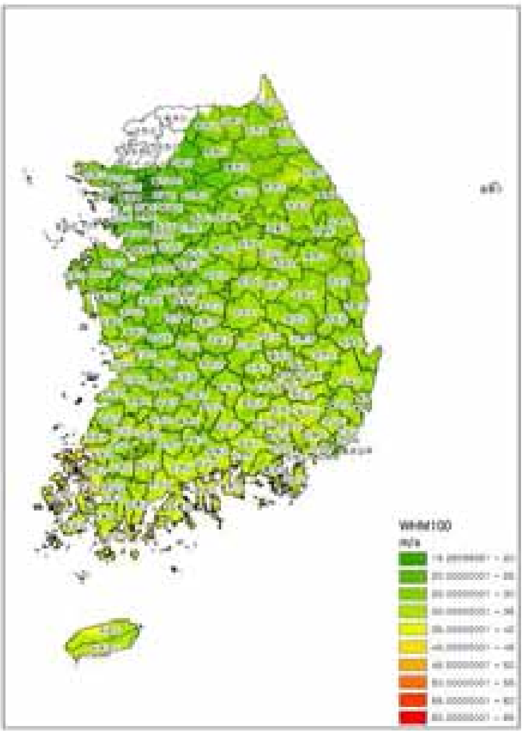


Fig. II-1-21. Wind hazard map.

As neither the local governments nor the insurance companies had a wind risk assessment methodology, such a method was developed through collaborative research by universities and IT companies, with funding from NEMA. As risk consists of hazard and vulnerability, extreme-wind-speed analysis and typhoon Monte Carlo simulation are carried out for the Korean peninsula while vulnerability has been studied using both the statistical and experimental approaches. The developed method was integrated into the Web-GIS code (Fig. II-1-22).

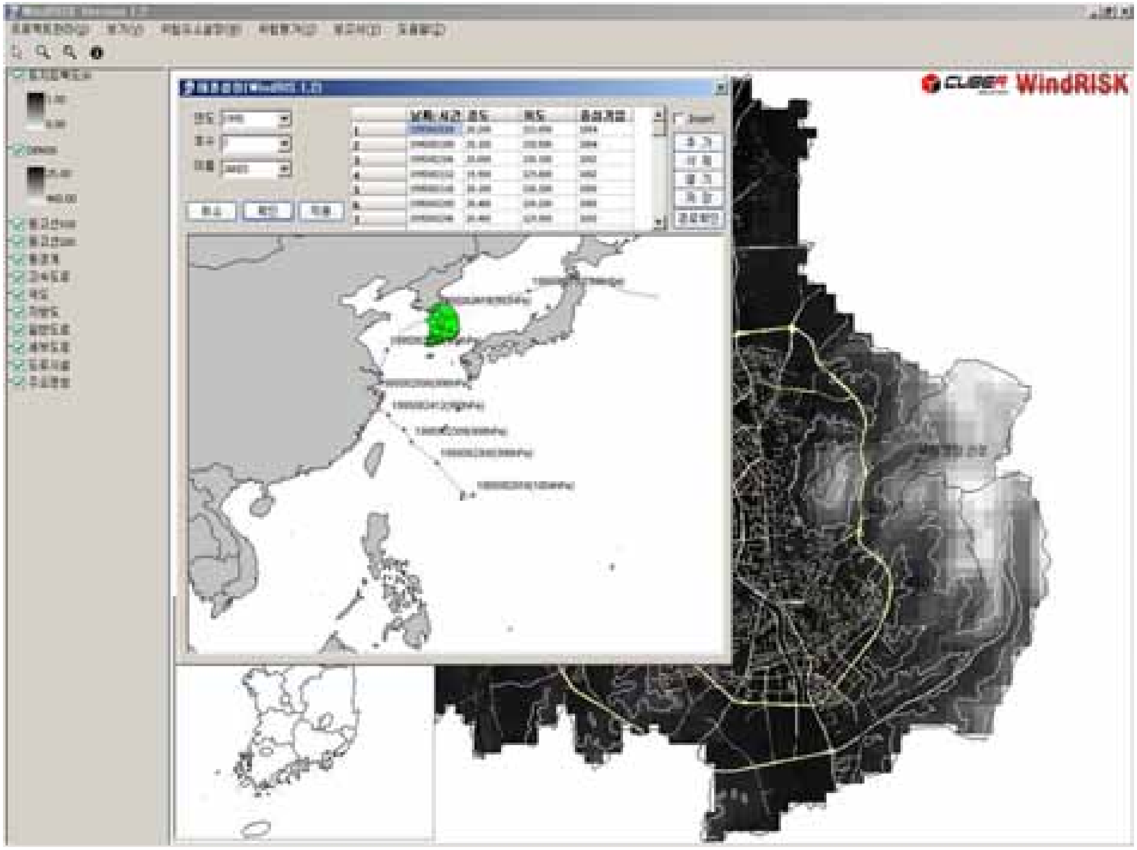


Fig. II-1-22. Web-GIS-based wind risk assessment.

In this regard, NEMA recently organized a collaborative research project on the effects of climate change on the resistant capabilities of structures. The study, which covers rainfall, strong wind, snowstorms, and sea level rise, started in 2008 and will continue until 2011. To estimate extreme winds in the future, researchers conducted downscaling of various GCMs and prediction of extreme winds. In addition, the intensity of a typhoon is postulated to be dependent on SST, and a model that takes this fact into consideration has been developed.

With the common interest in sharing information regarding typhoons and related damage, a committee on typhoons was organized in 2007-2009 to establish WGTCDIS, which appears on the TCDIS website (www.tcdis.org). WGTCDIS supplies information regarding the extent of damage from typhoons and tropical cyclones that affect the country, without any estimation of loss. With its representative chairing the Disaster Prevention Subcommittee, NIDP implemented an estimation system with Web-based GIS for the South Korean provinces, building a historic database on climate and disaster reporting, with some statistical models. Fig. II-1-23 shows WGTCDIS.

Fig. II-1-23. WGTCDIS shows the estimated trajectories of the other typhoons that affected South Korea, compared with that of Typhoon Kompasu.

e. Regional Cooperation Achievements/Results

- Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

- Nil.

1. Progress on Key Result Area 2: **Minimized Typhoon-related Social and Economic Impacts.** (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)

a. Meteorological achievement/result

- **<u>Monitoring of typhoon effect on the Changjiang Diluted Water Using an ocean forecasting system</u>**

The freshwater discharge of the Changjiang River is the third largest in the world after the Amazon River and the Congo River. In the coastal ocean, this massive amount of freshwater discharge influences not only the marine ecosystem and circulation in the East China Sea but also those in the Yellow Sea. The behavior of the Changjiang Diluted Water (CDW) shows a remarkable seasonal variation. In winter, the outflow of CDW extends southward along the coast, and northeast toward Jeju Island, Korea, in summer. As a result, the CDW with an isohaline of 30 psu in winter occasionally causes severe damage to the fishery industry, especially along the coast of Jeju Island.

Strong typhoons affect this low salinity field in summer. It is difficult to predict the behavior of CDW around Jeju Island because spatial and temporal variations of CDW vary from one summer to another. Therefore, the offshore extensions and pathway of CDW during the typhoon period are still poorly understood despite numerous numerical studies on the movement of the CDW plume. This study shows the influence of Typhoon Dianmu (1004) on CDW using a high-resolution operational ocean forecasting system and satellite observation data.

The ocean forecasting system of NIMR/KMA is based on ROMS (Regional Ocean Modeling System). ROMS is a free-surface, terrain-following, primitive equations ocean model widely used by the scientific community for a wide range of applications. The ROMS covers the northwestern Pacific Ocean from 115°E to 150°E and from 20°N to 52°N with an 8-km horizontal resolution including the Yellow Sea, the East China Sea and the East Sea, and marginal seas around Korea. The model has up to 20 vertical levels depending on the bottom topography. Open boundary data are obtained from a data assimilative global model (Estimating the Circulation and Climate of the Ocean: ECCO). Atmospheric boundary conditions such as sea winds and heat flux are obtained from RDAPS (Regional Data Assimilation and Prediction System), KMA's weather forecasting system. ROMS provides 48-hour ocean field predictions at 00UTC every day using RDAPS input data. Seasonal discharge amounts of the Chanjiang River are obtained from the RivDis 1.1 database.

The simulated CDW shows a patch structure of low-salinity water detached from the plume between the Changjiang and Jeju Island. The model simulation of this study clearly shows the differences in the CDW field before and after typhoon Dianmu's passage (1004). Before Dianmu's passage, the salinity of CDW was about 22-28 psu along the western part of Jeju Island. However, once the typhoon passed, the CDW salinity increased to 28-30 psu (Fig. II-2-1). Also, the sea temperature decreased from 28-29°C to 23-27°C. The effects of the typhoon lasted over 1 week. The model simulation results show a good agreement with satellite and hydrographic observation data. This study focuses on the effect of the typhoon on CDW using a 3-D high-resolution ocean forecasting system driven by real-time assimilated atmospheric conditions. According to our simulation results, we could identify rapid increase and decrease in CDW salinity and temperature, respectively. The ocean forecasting system used in this study can be applied to monitor and forecast CDW behavior in real time. The forecasted CDW fields would serve as useful information to the fishery industry.

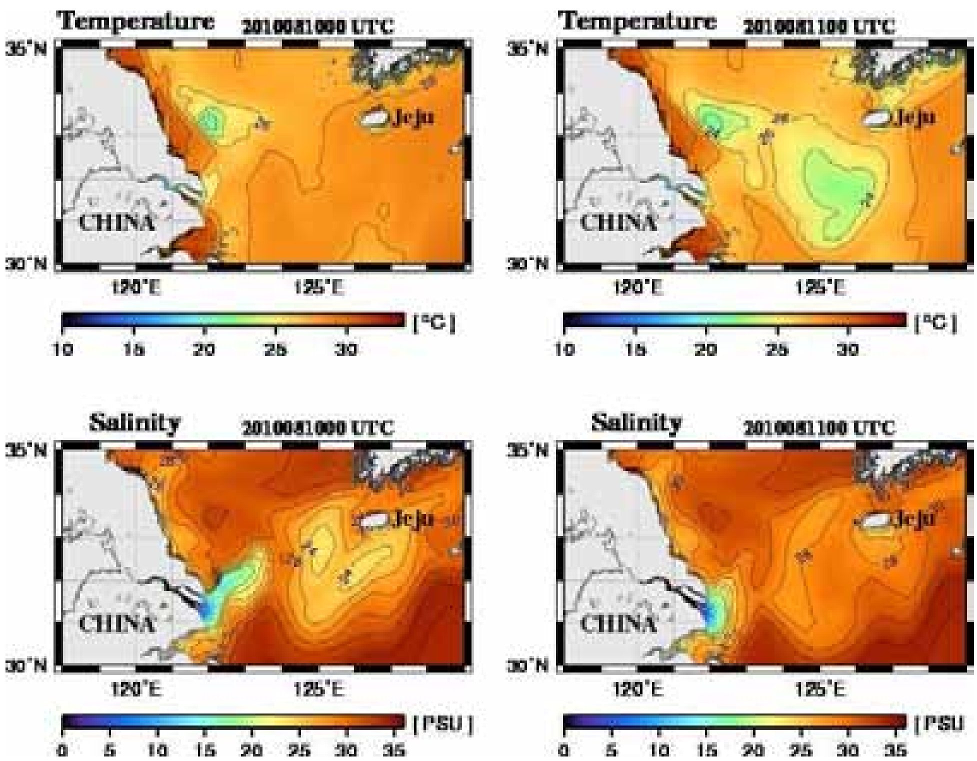


Fig. II-2-1. Simulated temperature (upper) and salinity (lower) fields before (00 UTC, 10 August 2010) and after (00 UTC, 11 August 2010) the passage of Typhoon Dianmu (1004)

b. Hydrological achievement/result

- Development of an Assessment System for Flood Control Measures

Currently, the frequency and intensity of typhoons and floods in the region including the south-east Asia region have increased due to accelerating urbanization, industries, highly dense land use, heavy construction of infrastructures and especially climate change impacts. This phenomenon threatens not only human lives but is also causing significant economic loss, which is gradually on the rise. Therefore, it is necessary to develop and build more advanced and standardized methods to judge the efficiency of flood control plans, and to establish a comprehensive and integrated system to evaluate optimal measures for flood control by eliminating uncertainties of socio-economic impacts. Economic loss due to floods in South Korea is continuously rising, recording an increase by a factory of 11 over 30 years. A similar trend is true of the rest of the world.

The project entitled 'Assessment System for Flood Control Measures on Socio-economic Impacts', led by the Ministry of Land, Transport and Maritime Affairs (MLTM), Republic of Korea, was launched in 2008. As shown in Fig. II-2-2, this long-term project will be completed by 2011.

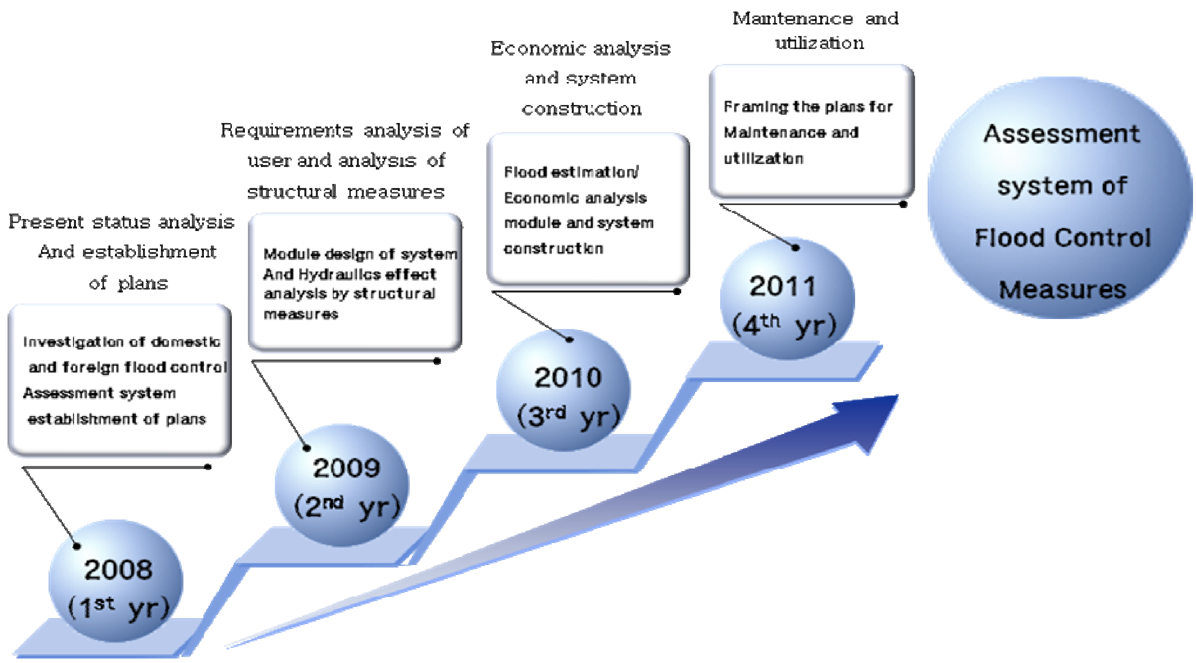


Fig. II-2-2. Annual Task Target (2008 to 2011)

The importance of basin-unit flood control measures is clearly recognized. To reduce loss and damage due to floods, it is necessary to develop basin-unit flood control measures, instead of general, long-term one-dimensional river-unit flood measures. However, current weaknesses of basin-unit flood control measures are as follows:

1) Deduction and selection of flood control measures relying on experts' experiences;
2) Absence of a unified procedure or system;
3) Estimation of the economical efficiency of flood control measures relying solely on structural damages

Moreover, standards for selecting flood control measures are not clear, and most of them are vague and confusing. Although basin-unit flood control became more important with the introduction of the basin integrated flood control project, there is no integrated process or system to assess and prepare basin-unit flood control plans.

The eventual purpose of this research is to establish a standardized and integrated assessment system of flood control measures and those flood control measures will eventually be put to practical use in member countries of the Typhoon Community to reduce socio-economic damage due to typhoons and floods in the region. An assessment system would make it possible to implement pre-assessment to select optimized economic flood control measures. As a result, member countries would be able to develop their own capacity against floods and strengthen international cooperation with other member countries as well.

1) Proposal of a scheme to construct an integrated assessment system for flood control measures
2) Establishment of a scheme to select optimal economic flood control measures
3) Construction of a viable assessment system for TC members

↓

- ***Construction of a reasonable and integrated assessment system for flood control measures***
- ***Use as a future pre-assessment system***

Research for the upcoming year will concentrate on the following:

: D/B construction for flood damage estimation;

: Module construction for flood damage cost estimation by flood frequency;

: Module construction for analysis of structural measures;

: System construction of flood area estimation and economic evaluation of flood damage

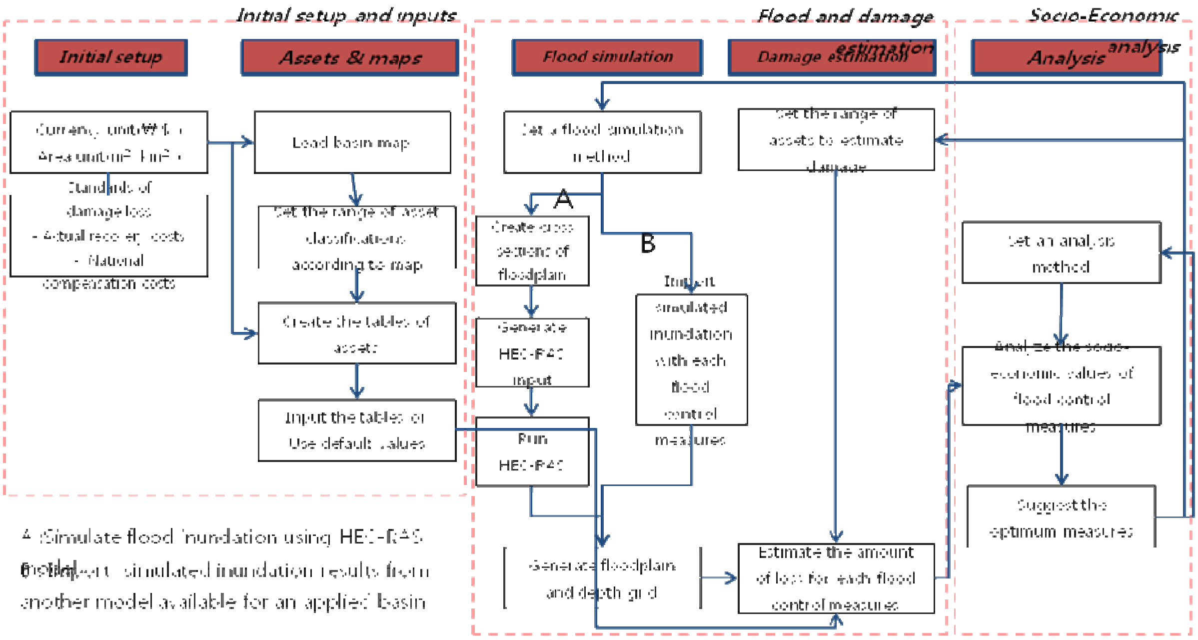
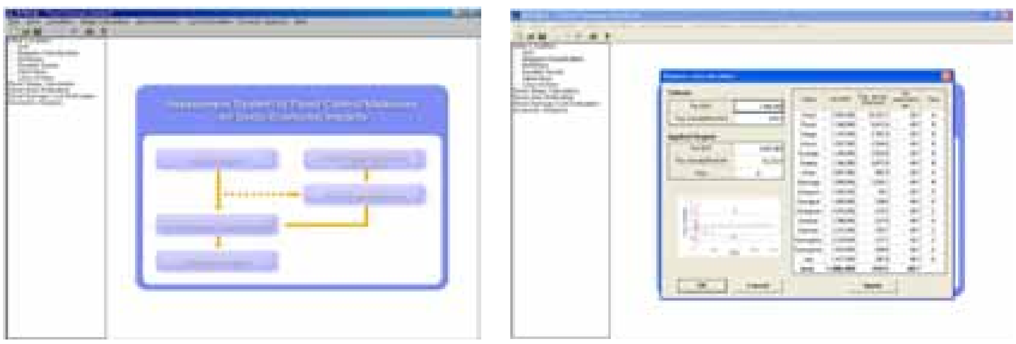


Fig. II-2-3. Flow chart

This project is to be completed in 2011 with the establishment of an integrated and comprehensive assessment system of flood control measures to minimize socio-economic damage from floods. Ultimately, the final assessment system will be utilized to establish more efficient flood control measures and to strengthen technical and information oriented cooperation among member countries in the region.



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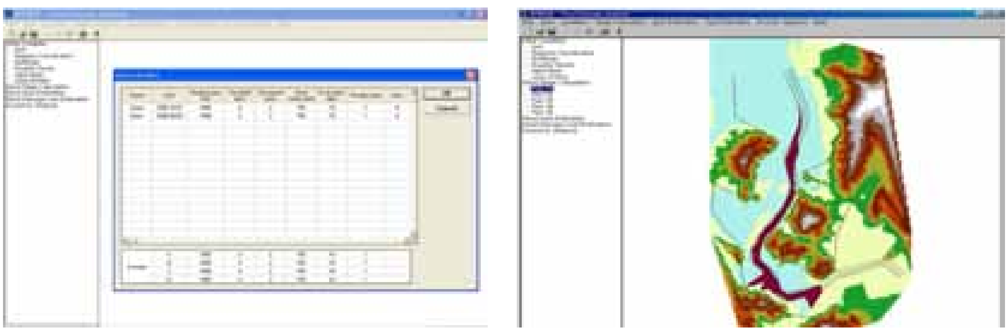

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Fig. II-2-4. Assessment System for Flood Control Measures

c. Disaster Risk Reduction (DRR) Achievements/results

- **Foundation of a promotion corps for reinforcing vulnerable zones**

NEMA established a promotion corps on 28 October 2009 to reinforce vulnerable zones and to activate the economies in the vulnerable zones. To strengthen disaster prevention in disaster-vulnerable zones, rural streams, and construction sites, the Korean government will allocate a USD 488 million budget for 2010. The promotion corps organized a technical support team consisting of NIDP employees and experts from the private sector to prevent budget wastage and to prepare countermeasures for vulnerable zones. This year, the improvement projects for 190 disaster-vulnerable zones is to be completed.

d. Research, training, and other achievements/results

- **Disaster Management Education Training Program**

NEMA's National Disaster Management Institute (NDMI) invites high-ranking officials from local governments to participate in a disaster management education training program. It offers a total of 75 courses every year: eight elementary courses, 48 expert courses, and 19 other courses. It also offers education programs for foreigners, with support from the Korea International Cooperation Agency (KOICA), where participants can learn South Korea′s experience with national disaster control including the country′s national disaster information and prediction/prevention systems. NDMI invited high-ranking officials from Bangladesh to participate in one such disaster management education training program, co-sponsored by NEMA and KOICA. The ten-member Bangladeshi delegation was also exposed to traditional Korean culture during the three-week program. Bangladesh, which suffers tremendous damage from floods every year, decided to send overseas ten high-ranking public officers responsible the country's disaster management, to learn about disaster preparedness from industrialized countries in an effort to advance the country's disaster control system. NDMI also ran a disaster management education program for government officials from Paraguay in May 2008 and plans to expand its cooperation with other countries by offering disaster management education to public servants from ten other countries, including China, Nicaragua, and Indonesia, in the second half of 2010.

To cope with disasters and to minimize loss of life and property, each local government implements full readiness and close coordination in disaster situations. The DRR staff members receive education during the Disaster Preparedness Period to enhance their ability to cope with natural disasters. The program includes planning, managing critical situations, applying damage investigation methods, and studying relevant legal mechanisms. To enhance prompt responsiveness to disasters, exercises under computer-simulated disaster conditions, a comprehensive disaster prevention exercise, and region-specific emergency drills are conducted in each district. The exercises under computer-simulated disaster conditions, hosted by all national and local disaster prevention headquarters, aim to develop the ability to manage disasters. For the region-specific emergency drills, the local governments carry out their own emergency drills to fit the local conditions. For the national-level comprehensive disaster management exercises, exercises focusing on strengthening close coordination between the related agencies and on developing disaster situation management ability are provided. The training program includes life saving, emergency relief, and recovery measures for lifeline facilities.

e. Regional Cooperation Achievements/Results

- Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

- Nil.

2. Progress on Key Result Area 3: **Enhanced Beneficial Typhoon-related Effects for the Betterment of Quality of life.** (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)

a. Meteorological achievement/result

- Nil.

b. Hydrological achievement/result

- Nil.

c. Disaster Risk Reduction (DRR) Achievements/results

- Nil.

d. Research, Training, and Other Achievements/Results

- Nil.

e. Regional Cooperation Achievements/Results

- Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

- Nil.

3. Progress on Key Result Area 4: **Improved Typhoon-related Disaster Risk Management in Various Sectors.** (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)

a. Meteorological achievement/result

- <u>Improvement of typhoon analysis, forecast, and validation system</u>

The National Typhoon Center continues to support typhoon forecasters by transitioning the upgraded TAPS-2 (Typhoon Analysis and Forecasting System - 2) to operations. The typhoon forecast period was tentatively extended from 3 days to 5 days from June of 2010. KMA's 5-day forecast could be realized because of increased numerical model predictability as well as intensified monitoring ability using satellite-based observations. There has been new typhoon database development for improving the integrated management of scattered typhoon-related data. The new searching engine of the typhoon database system can extract and arrange data by typhoon name, typhoon formation and extinction dates, and by typhoon intensity and size.

- <u>Patent registration of the Typhoon Information Search System</u>

The Typhoon Information Search System had its patent registered on 25 October 2010. This system provides an easy tool for searching past typhoons by track, typhoon formation location, etc. This system is currently limited to internal use but will be open to the public through the National Typhoon Center website within the next year. The algorithm of this system is also applied to TAPS-2 for use by forecasters for searching similar types in previous years.

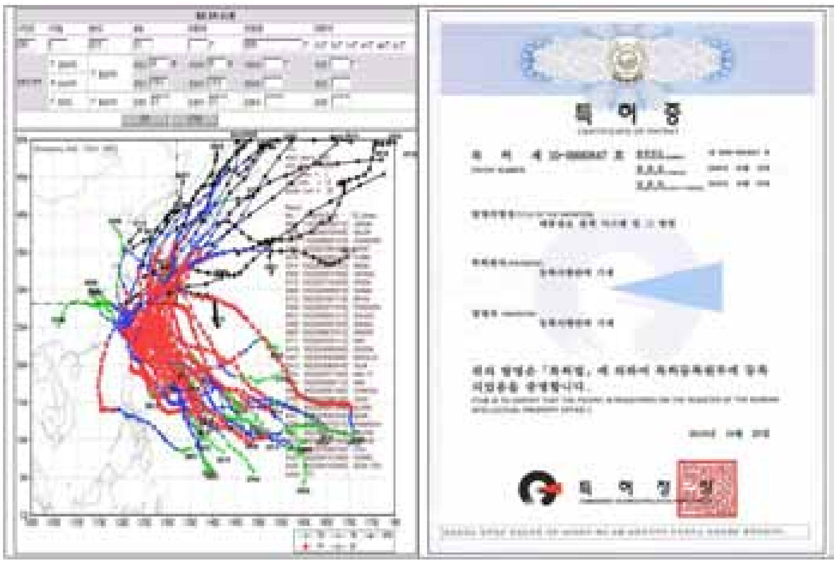


Fig. II-4-1. Typhoon Information Search System and its recently registered patent

b. Hydrological achievement/result

- <u>Central joint improvement task force for climate change</u>.

The aim of this task force is not limited to restoration in the wake of a typhoon, but permanent disaster preparation by installation of improved measure.

■ Basic course

: Establishment of advanced countermeasure system;

: Preparation of manual on abnormal climate disasters;

: Country reinforcement for disaster damage protection;

: System improvement of disaster management and countermeasures

■ Implementation strategy

: Expansion of protection investments;

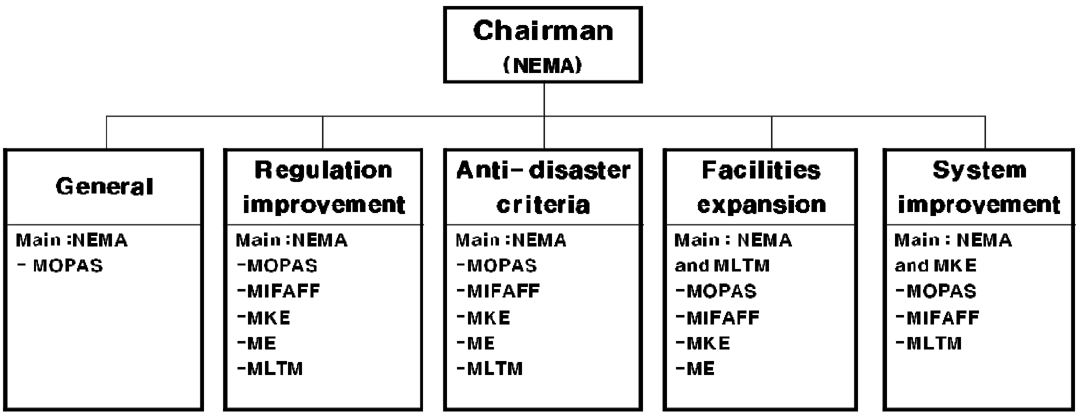
: Establishment of strong wind protection plans for urban areas;

: Heavy snow protection plan reinforcement based on voluntary and responsibility;

: Advanced disaster countermeasure system reinforcement;

: Common people support plan improvement based on self-support willingness;

■ Organization



■ Improvements (Flood, Wind, Snow)

: Adjustment of anti-disaster criteria in light of climate change;

: Expansion of rain discharge reducing facility;

: Dewater pump ability improvement;

: Sewage pipe and river maintenance improvement;

: Steep slope-land maintenance and criteria reinforcement

c. Disaster Risk Reduction (DRR) Achievements/results

- <u>Enhanced WGTCDIS</u>

NIDP formally opened WGTCDIS, which makes it possible to share TC member countries' disaster information (e.g., typhoon-related damage, disaster management system, early warning system) and to service various functions, such as tracking similar typhoons, retrieving information regarding damages wrought by previous disasters, providing meteorological information, and analyzing regional-weather risks.

Promotion of the value of WGTCDIS to the TC member countries, led by NIDP, will continue in 2011. The TC member countries, such as the Philippines, Lao PDR, Thailand, Cambodia, and the USA, provided GIS, metrological, and disaster information for WGTCDIS by the end of 2009, and NIDP sponsored an expert mission to set up WGTCDIS for the TC member countries, and to improve their usage of WGTCDIS. The enhancement of WGTCDIS and the establishment of a methodology for assessing the socioeconomic impacts of disasters, led by NEMA, will be continued in 2011. NIDP will continue to collect such information, to prepare brochures containing related information, and to present a report on these activites at the 6th WGDPP meeting to be held in Seoul, South Korea, in 2011. The review of the progress of the WGTCDIS project and the enhancement of TC's effectiveness and efficiency in accomplishing its purpose, as stated in the Statute of the Typhoon Committee, will also continue in 2011. WGDPP will participate in a focused, integrated WGM, WGH, WGDRR, TRCG, and AWG workshop, with the specific deliverables defined, to review the progress of the WGTCDIS project and to map out future activities of WGDRR.

For the extension of the ongoing WGTCDIS project, the validation of Vietnam's WGTCDIS is necessary, and the typhoon- and typhoon-damage-related data of the new members are needed. There were communications with Vietnam to identify joint activities and to inform the other TC member countries of the validation of its WGTCDIS. Thailand, Lao PDR, the Philippines, Cambodia, and the USA will prepare data for developing their respective WGTCDISs. After building WGTCDIS for five TC member countries, an expert mission must be formed and deployed, to which the members will supply information regarding their respective WGTCDISs and application thereof. The expert team will be organized during a TC session and will visit the TC member countries when their respective WGTCDISs have been established.

In 2011, WGTCDIS is expected to improve in convenience and user accessibility by integrating the two afore-mentioned services and by providing abundant and varied contents to TC members. Moreover, WGTCDIS will be applied to five other TC member countries: Thailand, Lao PDR, the Philippines, Cambodia, and the USA.

d. Research, Training, and Other Achievements/Results

- Nil.

e. Regional Cooperation Achievements/Results

- Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

- Nil.

4. Progress on Key Result Area 5: **Strengthened Resilience of Communities to Typhoon-related Disasters.** (List progress on the **Strategic** Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)

a. Meteorological achievement/result

- Nil.

b. Hydrological achievement/result

- Nil.

c. Disaster Risk Reduction (DRR) Achievements/results

- Nil.

d. Research, Training, and Other Achievements/Results

- Nil.

e. Regional Cooperation Achievements/Results

- Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

- Nil.

5. Progress on Key Result Area 6: **Improved Capacity to Generate and Provide Accurate, Timely, and understandable Information on Typhoon-related Threats.** (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)

a. Meteorological achievement/result

- <u>Improving Typhoon Initialization of Global Data Assimilation and Prediction System (GDAPS) in KMA</u>

The Global Data Assimilation and Prediction System (GDAPS) of KMA is composed of three systems: an observations processing system (OPS), a 4D-Var data assimilation system (DA), and a forecast system (FS). DA produces initial conditions for FS based on observations processed by OPS. To overcome data sparseness problems, artificially produced bogus winds data are added to observations. In the case of typhoons, initialized using bogus winds data, the location is corrected but the intensity is still too weak. Since the underestimated intensity forecast degrades the accuracy of track forecast, a new typhoon initialization method using both bogus winds and bogus sea level pressure is developed. Case experiments were performed for 2009 and 2010 typhoons to investigate the impact of bogus data on the track and the intensity forecasts. The results show that, in most cases, using both bogus wind and bogus SLP produces more accurate forecasts in track as well as in intensity. The new typhoon initialization scheme is implemented into the GDPAS in December 2010, and is expected to improve the track forecasts of GDPAS in the next typhoon season.

- <u>Successful launch of COMS and operational provision of satellite-based typhoon analyses</u>

Korea's first geostationary satellite, COMS (Communication, Ocean, and Meteorological Satellite), was successfully launched from the Arianespace launch site in Kourou, French Guiana, at 21:41 UTC on 26 June. Following its launch, COMS reached its nominal position at 128.2E on the geostationary orbit on 6 July and entered test mode on 10 July. The first MI visible image was acquired on 12 July, and the first IR image, on 11 August, after a successful outgassing period. COMS MI (Meteorological Imager) data service is expected to start in early 2011, following 6 months of In-Orbit Test, which will verify the performance of the satellite system and payloads.

The KMA has been providing satellite analyses about the typhoon's center and intensity since 2000 using data from the MTSAT-1R/2 satellite. KMA's typhoon analysis system is a user-friendly web-based system developed in 2006 based on the Advanced Objective Dvorak Technique (AODT) of SSEC/UW-Madison (Space Science Engineering Center/University of Wisconsin-Madison). In 2010, KMA upgraded version 6.3 of its web-based typhoon analysis system to 7.2.3, and improved the algorithm for estimating the 15 m/s radius of strong winds for the case of shear pattern using QuikSCAT and ASCAT data.

The KMA has also developed a system to produce satellite-based typhoon analysis reports (such as Fig. II-6-1). These reports will include essential typhoon information such as location of the center, maximum wind speed, central pressure, 15m/s radius of strong wind, mean wind speed/direction for 3 hours, typhoon pattern and accuracy of typhoon center estimations. Comments from satellite analysts on the location of the typhoon center will be also included. The analyses based on COMS data will be provided on an operational basis by satellite analysts to forecasters 4 times a day (or 8 times a day in the event of emergencies) via the KMA intranet after 2011.

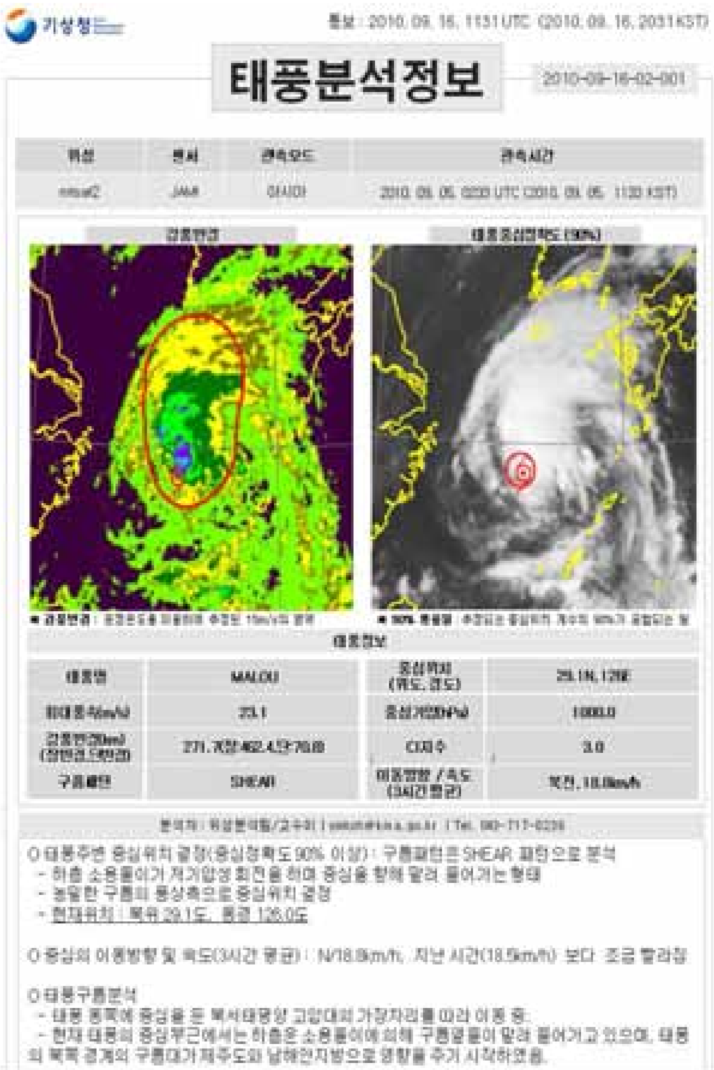


Fig. II-6-1. Sample of typhoon analysis report provided by satellite analysts on an operational basis

- **Change of KMA's Ensemble Prediction System**

KMA's Ensemble Prediction System was replaced by the one constructed based on the Unified Model (UM) in December 2010. The new Ensemble Prediction System has the same resolution as the deterministic global prediction system (N320L50), and is composed of 24 members. The method to generate initial perturbation is ETKF (Ensemble Transform Kalman Filter), and physical perturbations, such as RP (Random Parameter) and SKEB (Stochastic Kinetic Energy Backscatter), are added during model simulations. The UM-based Ensemble Prediction System products including typhoon track prediction data (Cyclonic XML) will be provided to TIGGE in the near future.

- **Completion of National Center for Meteorological Supercomputing (NCMS) / Installation of Supercomputer No. 3**

The center in Ochang, Chungcheongbuk-do, whose construction was completed on 29 March 2010, began operations with 26 staff members and 35 contract engineers. The computer system is the third supercomputer for KMA and consists of an interim component (Cray XT5), an initial component (Cray XT5) and a final component (Cray XE6). The new system is dedicated to NWP operations (data assimilation and prediction) and associated higher-priority application models as well as lower-priority R&D contributions. Seventeen different numerical models run on the machine to produce forecast products two to four times daily and deliver them to forecasters at the KMA headquarters.

The older computer system (Cray X1E) is dedicated to generating IPCC climate change scenarios for the next two years.

Fig. II-6-2. National Center for Meteorological Supercomputing

Supercomputer “Haeon"

Supercomputer XE6 "Haedam”

Installation Year	December 2010
System Name/System Model	Haeon, Haedam / Cray XE6
Theoretical peak performance	379TF x 2
Maximal LINPACK performance	316TF x 2
Total Memory	119.8TB
Disk (Shared File system)	2.5PB
Backup Library	800TB / 4PB

Fig. II-6-3. Specifications of KMA Supercomputer No. 3 (Cray XE6)

- **Establishment of the Weather Radar Center**

The increasing frequency of high-impact weather (HIW) events such as localized downpours and typhoons, possibly associated with global warming, has greatly stimulated the community’s need and demand for reliable weather information. As a result, there is a growing emphasis on radar data, which are used not only for real-time HIW monitoring but also as input data for numerical prediction and hydrological models. There is accordingly a particularly pressing need to have in place an optimal radar operation framework so as to maximize the accuracy of radar observations. The Weather Radar Center (WRC) was established in April 2010 to operate the weather radar system in Korea more effectively and to support sharing of radar data and develop technologies for data analysis including data quality control, QPE (Quantitative Precipitation Estimation) and QPF (Quantitative Precipitation Forecast). A primary goal of WRC is to become the nation’s radar data hub for coordinating all radar data available in Korea.

Fig. II-6-4. Signboard hanging ceremony for the Weather Radar Center

- **<u>Data assimilation using UM/VAR system for operations</u>**

KMA started to operate UK Met Office’s Unified Model (UM, N312, 50 levels) for global prediction in May 2010. At the same time, Regional UM (12km, 38 levels) was also adopted for operations. The global 4D-Var system with a 6-hour window is applied to the operation of global UM. KMA NWP centre has increased data usage in UM/VAR system for the first UM operation year. As planned, GPS-RO and SSMI/S were added to the data assimilation (DA) process at KMA. As a result, 5 types of satellite data including ATOVS, IASI and AIRS data are used for direct assimilation. AMV and Scatterometer sea wind from ASCAT and ERS are used for DA at present.

(i) Data Assimilation for operational UM

Currently, KMA’s global 4D-Var DA system processes approximately 80% of the observations used in the UK Met Office (UKMO) DA system (Fig. II-6-5) as well as local observations taken by KMA. Efforts to increase data acquisition for assimilation will be continued. KMA has also recently started to review specific technologies to apply to the pre-process stage for quality flagging in DA.

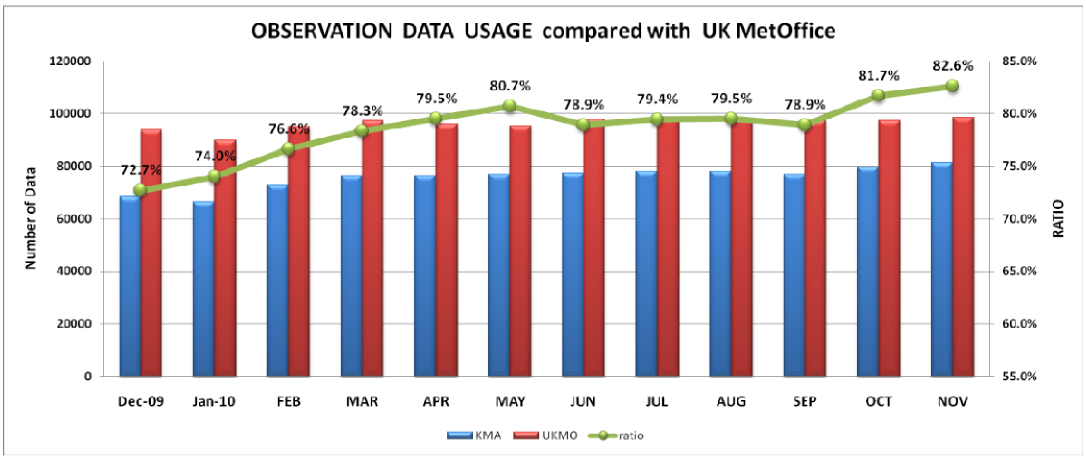


Fig. II-6-5. Increment of data amount in the data assimilation system from Dec 2009 to Nov 2010.

(ii) Improved use of AMV

KMA-AMV, produced using MTSAT-1R and KMA's updated algorithm[1] with UM background, was introduced in the UM cycle and its quality and impact on model forecast was evaluated. The performance of AMV extracted by using UM background was compared with that extracted by using GDAPS[2] background for two weeks from 16 to 31 Oct 2009. The RMSE and bias[3] of AMV whose QI exceeds 0.8 seem to have improved, when UM is used for background (after that UM-BG AMV). However, the impact of UM-BG AMV on forecast was not as pronounced, even though the quality of UM-BG AMV itself was improved relative to radiosonde wind. One of the main reasons why UM-BG AMV does not have much impact on the forecast is thought to be related to the experimental environment, where all other data are already being assimilated (Fig. II-6-6).

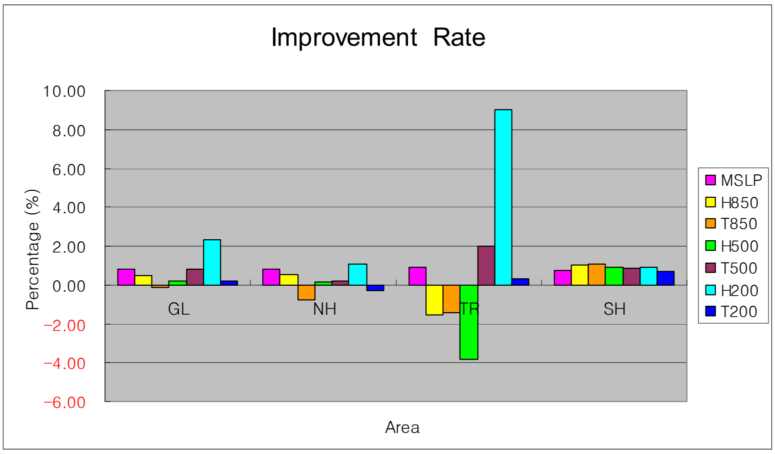


Fig. II-6-6. Improvement rate of UM-BG AMV cycle against GDAPS-BG AMV (averaged for whole forecast hours). UM-BG AMV and GDAPS-BG AMV refer to the AMV extracted with UM and GDAPS background, respectively.

- Plans for data assimilation of UM/VAR system at KMA

(i) The use of high-resolution of UM global and regional VAR

KMA is preparing operation of the UM global model at high resolution (N512, 70 levels) and the UM regional model (12-km, 70 levels) for East Asia. According to the UM application plan, the 4D-Var data assimilation system in the high-resolution global and regional UM is also being tested for operation.

(ii) Improved use of COMS product

COMS products will be released by March 2011 after testing in NMSC4. COMS AMV, clear-sky radiance and SST will be used for operational data assimilation at KMA. According to

[1] KMA has developed the AMV retrieval algorithm for the purpose of applying it to COMS.
[2] GDAPS: The previous global model which was in use since 1997 prior to adoption of UM
[3] Where RMSE and bias were compared with radiosonde wind
[4] National Meteorological Satellite Center of KMA

the science plan agreed with the U.K. Met Office, AMV will be used in operations by August 2011 and clear-sky radiance will be introduced to operations in 2012.

The AMV based on the further updated KMA algorithm and UM background will be tested continuously. KMA will also start to run regional data assimilation over East Asia. KMA-AMV will also be applied to regional data assimilation. At present, the full-disk AMV is being used for data assimilation at 6-hour intervals. Hourly AMV of the northern hemispheric half disk is being tested for operational use. KMA expects to improve regional prediction of its operational models.

- **<u>New charts for typhoon forecast</u>**

Typhoon-exclusive charts have been added to KMA's typhoon information pool. Most typhoons that affect the Korean territory are born in the northwest Pacific region, which was not fully covered by the previous analysis and prognostic charts. The typhoon information in this area is very important for monitoring the early stages of typhoons or tropical cyclones. All existing typhoon-relative charts have expanded to include the Northwest Pacific region reaching over the equator and the integrated numerical model charts displaying JMA, ECMWF, KMA UM and UK MetOffice UM numerical prediction, have been newly added. The new charts have been helping typhoon forecasters make the best decision since the summer of 2010.

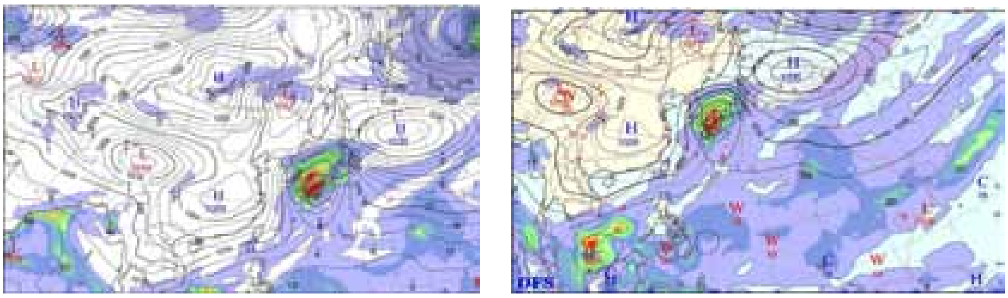


Fig. II-6-7. Previous prognostic chart (left) and typhoon-exclusive prognostic chart (right). The latter chart now includes the Northwest Pacific.

Additionally, the typhoon messages issued at Japan typhoon center was also no more used in weather analysis chart and the typhoon messages issued at KMA are replaced to make weather charts. The small change could contribute to more independent typhoon operations at KMA.

- **<u>KOICA Project –Establishment of an Early Warning and Monitoring System for Disaster Mitigation in Metro Manila</u>**

The Republic of Korea has been conducting a three-year (2009-2012) project "*Establishment of an Early Warning and Monitoring System for Disaster Mitigation in Metro Manila*" under the sponsorship of the Korea International Cooperation Agency (KOICA), aiming at establishing a weather and flood forecasting model for an early warning and monitoring system at the Pasig-

Marikina River basin, mitigating the impact of natural hazards through accurate analysis of real-time data collected from the early warning system, and strengthening the relationship between the Republic of Korea and the Philippines in the field of weather forecast and disaster management.

The $3-million project was initiated by KOICA and the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) in the wake of the high-impact by Typhoon Ketsana, the most devastating typhoon to hit Manila in September 2009. The Korea Meteorological Administration (KMA) contributes to this project by providing consultation on the project management. KMA also shares expertise in the fields of information and communication, meteorology and hydrology by dispatching experts and providing training.

The early warning and monitoring system will include an observation network of 4 AWSs, 7 rain gauges and 10 water level gauges; and a warning network linking the PAGASA headquarters, 7 local governmental offices and 20 warning posts with a wireless communication system (see Fig. II-6-8).

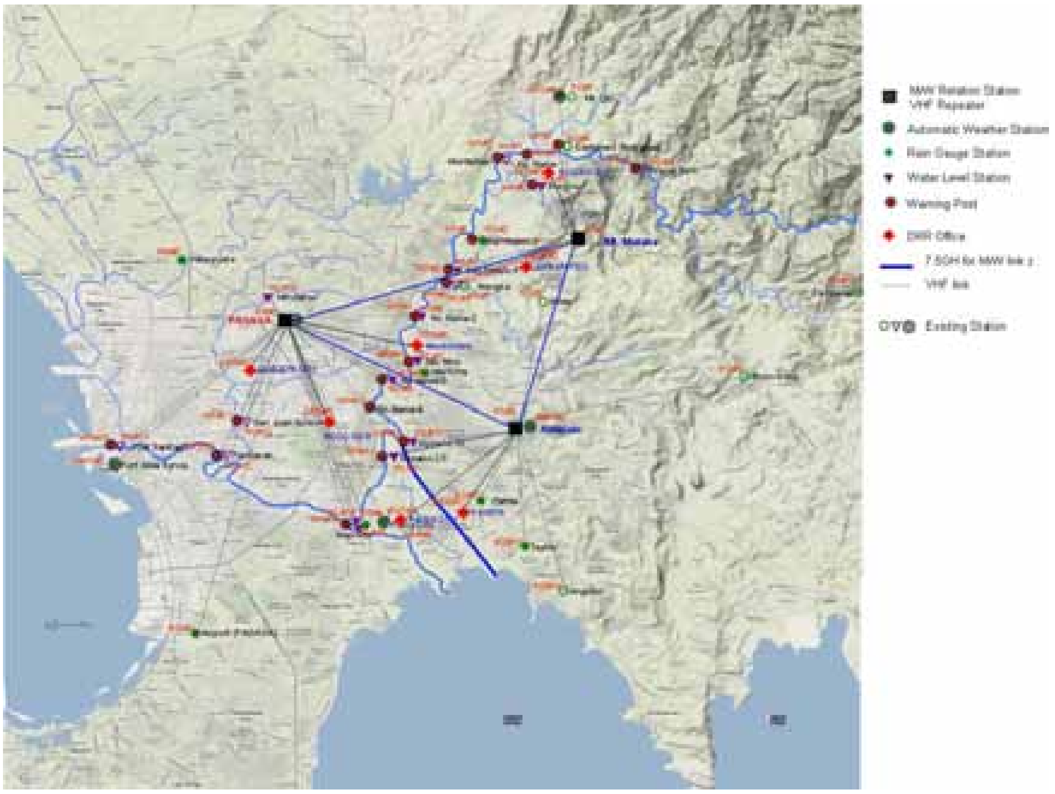


Fig. II-6-8. Network of the Early Warning and Monitoring System for Disaster Mitigation in Metro Manila

b. Hydrological achievement/result

- Construction of a Quality Control System for National Hydrological Data

This study aims at developing standards on quality control for hydrological data, constructing a national quality control system for hydrological data for the Han River water system from 2007, and expanding it to the Nakdong River, the Geum River and the Yeongsan River in 2011. This year, standards on quality control for hydrological data for the Yeongsan River water system were developed, and the national quality control system for hydrological data for the Yeongsan River water system was constructed and reinforced.

This year's project consisted of the following components:

: Planning of quality control system for the Yeongsan river control center;

: Field application and management of quality control system;

: Construction and improvement of quality control computer system;

: System connection of standard hydrological database

Quality control methods according to hydrological data and observation methods of rainfall and water levels, which are continuous time series hydrological data, can be largely classified into three the following three categories:

- Inspection of hydrological observatories and management of checked results (Field quality control);
- Automatic review and handling of hydrological data (Automatic quality control);
- Manual review and handling of hydrological data (Manual quality control)

Regarding quality control of hydrological data, a computer-based full automation system is difficult to realize and may have undesirable consequences. Therefore, the process of manual review and handling is necessary for all data, and outlier determination rule and treatment procedures and methods should be determined in advance. Fig. II-6-9 presents the quality control procedures, general data management method for time-series hydrological data; this procedure was applied to the Yeongsan River area.

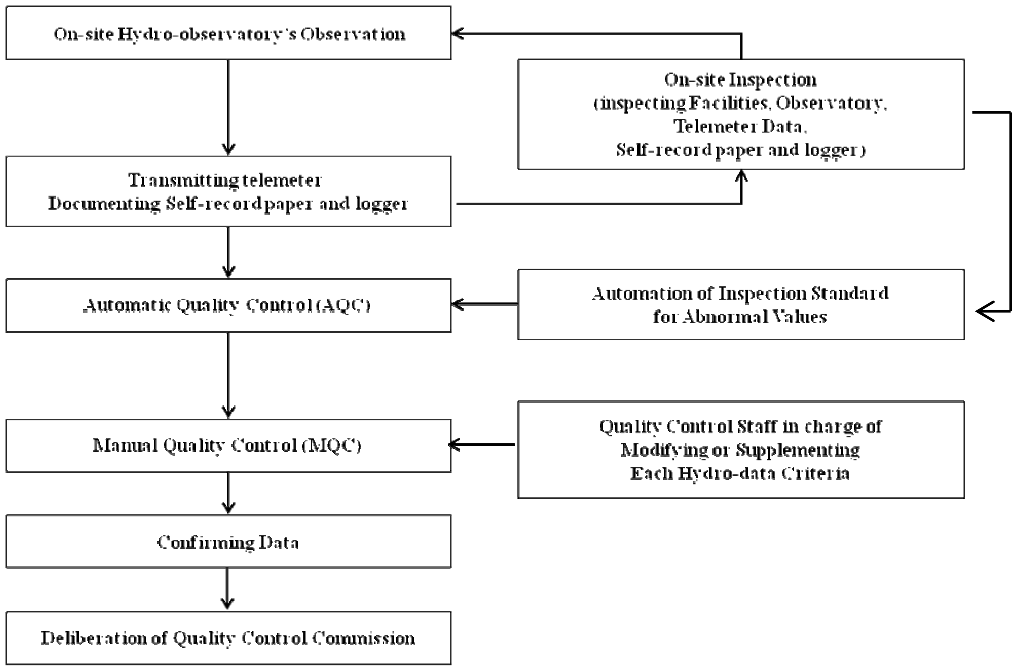


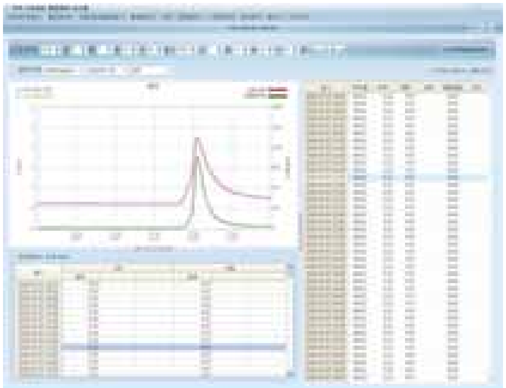
Fig. II-6-9. The Quality Control Procedure of Time-series Rainfall Volumes and Water Levels Data

To build the quality control system for the Yeongsan River area this year, the research committee assessed the status of quality control at the Yeongsan River Flood Control Center, and analyzed the function and status of the data management system in use. The committee prepared a quality control method for water flux volume data with rainfall volume and water level data, and adjusted the quality control system accordingly.

The research committee will forge a consensus among experts on the importance of hydrological observations, hydrological data management and quality control by continuously promoting projects to improve the quality of national hydrological data. The committee will also support various national activities for ensuring a minimal quality of life for the public by actively managing water resources and informing the public about the importance of national water resources, which are expected to contribute significantly to a positive change in public perception of water resources related activities.

(a) Status of basins

(b) Rain data inquiry



(c) Water-stage data inquiry

(d) Rain data revision using regression curve

Fig. II-6-10. Display of Quality Control System

c. Disaster risk reduction (DRR) achievements/results

- Nil.

d. Research, Training, and Other Achievements/Results

- Nil.

e. Regional Cooperation Achievements/Results

- Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

- Nil.

6. Progress on Key Result Area 7: **Enhanced Typhoon Committee's Effectiveness and International Collaboration.** (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)

a. Meteorological achievement/result

- <u>**TC-TRCG Typhoon Research Fellowship at KMA**</u>

KMA invited two typhoon experts from the Thai Meteorological Department (TMD), Thailand, and the National Hydro-Meteorological Service (NHMS) of Viet Nam from September to November in 2010. The invited experts participated in a training course on typhoon forecast and joint research. This activity was implemented as a part of the Typhoon Committee Research Fellowship and aims to provide training opportunities in typhoon forecasting for Typhoon Committee members and to contribute to the development of typhoon forecast. Mr. Kamol Promasakha na Sakolnakhon, modeling expert from the Numerical Weather Prediction Subdivision, Weather Prediction Bureau, TMD, and Mr. Tran Quang Nang, forecaster from the Short-range Meteorological Forecasting Division, National Center for Hydro-meteorological Forecasting of NHMS, performed their missions well at NTC/KMA. They raised understanding for typhoon forecast through the experience such as user-practice and operational work from learning about Typhoon Analysis and Prediction System-2 (TAPS-2) in September. After completing the one-month forecasting training, the fellowship recipients also conducted joint research for the development of a statistical model for the seasonal prediction of typhoon genesis frequency and the function improvement of TAPS-2 from October to November with NTC forecasters. The research findings are to be submitted to local journals or to be published as research papers.

Fig. II-7-1. Presentation by research fellowship recipient (left); the fellowhip recipients with NTC staff at the NTC front entrance on 19 Nov. 2010 (right)

- Joint Research Program with the NHMS of Viet Nam

The objective of this project is to directly establish KMA's typhoon analysis and prediction system at the NHMS of Viet Nam, in light of the numerous differences between Korean and Vietnamese meteorological forecast in general and tropical cyclone forecast in particular, which will inevitably pose a challenge in installing and applying TAPS-2 in Viet Nam in the absence of a concrete plan. KMA invited two NHMS forecasters to NTC, Jeju, to help NHMS develop a plan for the future integration of TAPS-2 into the NHMS system. The invited forecasters were seconded to NTC of KMA for 3 months, during which time they acquainted themselves with the TAPS-2 system and learned practical forecasting skills with guidance from NTC forecasters through OJT (on-the-job training).

- The 3rd Korea-China Joint Workshop on Tropical Cyclones

KMA and China Meteorological Administration (CMA) co-hosted the third joint workshop on tropical cyclones, which was held on 20-23 December 2010, at Hyatt Hotel in Jeju, Korea. Almost 50 experts in typhoons and related fields participated from KMA's National Typhoon Center, Korea Meteorological Satellite Center, Weather Radar Center, National Center for Meteorological Supercomputing, and Numerical Weather Prediction Division, KORDI, the Korea Water Resources Corporation, the Air Force of the Republic of Korea, three Korean universities, and CMA's Shanghai Typhoon Institute, Shanghai Weather Center, and Shanghai Centre for Satellite Remote-Sensing and Application. 18 papers were presented at the workshop on a wide range of topics such as typhoon-related forecasting technology, prediction in the upcoming year, modeling, and analysis of observations. The workshop reached a consensus on supporting the mission of each organization involved in the areas of numerical modeling, automatic weather station data, radar, satellite data, and typhoon best track data.

b. Hydrological achievement/result

- <u>Participation in the TC Integrated Workshop in Macao (2010)</u>

On 4-10 September 2010, the ‘2010 UNESCAP/WMO Typhoon Committee Integrated Workshop’ was held in Macao. Many experts and researchers from 14 member countries in the regions participated in the workshop to share advanced science and to discuss typhoon-related issues in the region.

Experts from many Korean organizations took part in this workshop to share developed techniques and strategies relevant to water-related disasters caused by typhoons with their counterparts from other member countries, especially developing countries.

The content of the activities is as follows:

: Participation in the typhoon hydrological component meeting;

Preparation of hydrological component action plans for 2010 and participation in meeting;

: Presentation of research findings

Sharing research findings of flood damage reducing plan

: Proposal to host workshop

Proposal to host workshop on ‘Assessment system for flood control measures on socio-economic impacts’ during the 43rd TC Session

Expected effects are as follows:

: International status and influence reinforcement through research result promotions performed by MLTM

: Used to reflect future policy through understanding of activities and technical trends of member countries and relevant organization

Fig. II-7-2. TC Integrated Workshop in Macao, September 2010

c. Disaster risk reduction (DRR) achievements/results

- 4th Asian Ministerial Conference on Disaster Risk Reduction (AMCDRR)

The 4th Asian Ministerial Conference on Disaster Risk Reduction (AMCDRR; Fig. II-7-3) was held in Songdo, Incheon on 25-27 October, under the main theme of “Disaster Risk Reduction through Climate Change Adaptation.” Along with disaster management ministers from 62 nations, more than 800 participants attended the international conference to discuss mutual cooperation and common resolution in the Asian region for disasters induced by climate change, such as typhoons and heavy rains. The event participants included three heads of state (the Prime Ministers of Nepal, Bhutan, and Viet Nam), representatives from UN agencies, the Vice President of the Asian Development Bank (ADB), the Commissioner of the European Commission (EU), and representatives of different NGOs.

Fig. II-7-3. AMCDRR conference

AMCDRR is the only official international ministerial conference for disaster management in the Asian region. It has been sponsored by the United Nations International Strategy for Disaster Reduction (UNISDR) secretariat since 2005 for DRR in the Asian region in the wake of the tsunami that hit South Asia in December 2004. As mentioned earlier, the overarching theme of the conference was “Disaster Risk Reduction for Climate Change Adaptation,” with particular focus on (1) the convergence of DRR and climate change adaptation (CCA); and (2) the available information and green technologies. The objectives of the 4th AMCDRR were:

- to review the action taken by the national governments and other stakeholders for the implementation of HFA as a follow-up to the Beijing Action for Disaster Risk Reduction in Asia, the Delhi Declaration, and the Kuala Lumpur Declaration;

- to establish a practical and problem-solving cooperation system against extreme disasters due to climate change;
- to execute technical and tangible solutions using available cutting-edge technologies and policies for DRR in the Asian region; and to identify various ways of sharing climate information and technical developments in the field of disaster management.

Data show that although only 38% of the global disasters happen in Asia, 90% of the global-disaster victims are found therein. Therefore, Asia is the most disaster-vulnerable area in the world, and because of the difference in the disaster management systems and technical levels of the Asian countries, it is difficult to elicit practical cooperation within the region. The meeting participants agreed on the adoption of Incheon REMAP and Action Plan, an action plan composed of five-year projects to be implemented to equip each nation's disaster management system with CCA. The action plan also reorganized disaster prevention standard and vulnerability analysis through a systematic study of the disaster status and climate ideas in the Asia-Pacific region, so as to strengthen the Asian countries' disaster management capacities. The action plan was also designed to introduce a global website and technology related to climate change and disaster prevention by building a CCA technology-information platform, and to improve Asian countries' response capabilities by sharing good and bad large-disaster cases.

South Korea demonstrated leadership in the disaster prevention area in relation to climate change by hosting the Asian ministerial conference and encouraging Asian countries to support the declaration on DRR through CCA. Especially, at this conference, South Korea suggested that Incheon REMAP and Action Plan be adopted in the Asian region, and an agreement was reached regarding the enhancement of national prestige by building a platform for sharing climate change information and technologies among the Asian countries. To contribute to DRR in the Asia-Pacific region, NEMA will provide South Korea's excellent up-to-date disaster prevention systems, such as WGTCDIS and the Earthquake Disaster Response System, to each country in the region free of charge.

During the aforementioned conference, Climate Change Adaptation and Disaster Risk Reduction Exhibition (2010 CADRE) was held, providing an opportunity for international marketing and export by introducing disaster prevention and CCA technologies using South Korea's developed IT. 2010 CADRE consisted of four pavilions with specific themes: Four-River Special Hall, Climate Change Adaptation Hall, Storm and Flood Damage Prevention Hall, and Earthquake Disaster Prevention Hall. Through this exhibition, South Korea's excellent technologies related to climate change countermeasures and Green Growth were introduced to the other Asian countries. A number of side events were held on 25 October and while the conference was in session, where various disaster-related issues other than those caused by climate change were discussed. In particular, South Korea prepared some side events for the discussion of automatic response methods for disasters like typhoons and earthquakes, which are global issues, such as an event where WGTCDIS and the Earthquake Disaster Prevention System were introduced. This conference departs from the previous ideal and declaratory international conference and instead offers practical solutions to climate-change-related problems that every country faces.

- <u>Working Group on Disaster Risk Reduction (WGDRR) meeting</u>

In its 39 years of existence, TC has been repeatedly recognized as an outstanding regional body that has integrated meteorological, hydrological, and DRR contents into an action plan to produce meaningful results. The purpose of this WGDRR meeting (Fig. II-7-4) is for TC to identify the regional areas, goals, and activities where WGDRR wants to continue to produce meaningful results so as to save lives, mitigate the damage wrought by typhoons, and decrease the socioeconomic impact of typhoon-related events. Due to the TC member countries' highest typhoon-related disaster risk, it was agreed that the DRR activities be specifically focused on such countries, particularly in the areas of urban flashfloods, landslides, and marine accidents. While supporting the upgrade of WGTCDIS activities, the TC member countries also considered activities to strengthen the management strategies for typhoon and tropical-cyclone disasters in Asia and the Pacific as additional WGDRR activities.

Fig. II-7-4. Commemorative photograph of the WGDRR meeting.

This year, the WGDRR meeting was opened as a side event of the AMCDRR conference. The theme of the WGDRR meeting was "Strengthening the Management Strategies for Typhoon and Tropical-Cyclone Disasters in Asia and the Pacific." The WGDRR session's aims were to:

- identify possible areas of cooperation between the DRR and CCA agencies as well as opportunities for promoting their active participation in the common and relevant regional and national activities and initiatives;

- discuss ways and means of improving cooperation and coordination in the planning and implementation of DRR and CCA programs on the regional, national, and subnational levels;
- discuss ways and means of developing, establishing, and promoting a database on various sectors for a region-wide disaster information system that will be accessible to all the TC member countries' decision makers, disaster services, communities, and others designated by the TC member countries; and
- establish and distribute an inventory of the TC member countries' existing disaster reduction techniques and management strategies.

To contribute to DRR in the Asia-Pacific region, WGDRR suggested the TC member countries' adoption of South Korea's excellent, up-to-date disaster prevention systems, such as WGTCDIS, for the action plan of AMCDRR.

d. Research, Training, and Other Achievements/Results

- Nil.

e. Regional Cooperation Achievements/Results

- Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

- Nil.

III. Resource Mobilization Activities

-Nil

IV. Update of Member's Working Groups representatives

1. **Working Group on Meteorology**

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4. **Training and Research Coordinating Group**

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5. **Resource Mobilization Group**

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   Fax : +82-2-2181-0689
   E-mail: hyoo@kma.go.kr

II. **Summary of progress in Key Result Areas** (For achievements/results which apply to more than one Key Result Area, please describe them under the most applicable Key Result Area. Then, at the end of the description, place in parentheses ( ) the other applicable Key Result Areas)

1. Progress on Key Result Area 1: Reduced Loss of Life from Typhoon-related Disasters. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

   a. Meteorological Achievements/Results

      (i) To help alleviate the impact of storms such as squalls, or tropical cyclones, the Meteorological Services Division (MSD) of the National Environment Agency (NEA) provides heavy rain and strong winds advisory and warning to various government agencies for enhancing preparedness for expected heavy rain and strong winds. The warnings are also issued to the public via the media. In view of several heavy rain incidents which have led to flooding in 2010, NEA together with the Public Utilities Board is in the process of implementing an alert system (via SMS) to warn the public of heavy rain and rising water levels in canals. In the first phase of the project which was implemented in October 2010, SMS alerts will be sent to representatives from each town centre in Singapore in the event heavy rain is forecast and/or whenever water levels in canals rise above 70% and 90% of threshold levels and recede below 50%. The system will be extended to the general public in the second quarter of 2011.

   b. Hydrological Achievements/Results

      Over the past decades, Singapore has been improving the drainage infrastructure. The flood-prone areas have been reduced from 3200 ha in the 1970s to about 79ha in 2009. Singapore continuously reviews and upgrades her drainage infrastructure to ensure an effective drainage network for flood alleviation and prevention.

   c. Disaster Prevention and Preparedness Achievements/Results

      -

   d. Regional Cooperation Achievements/Results

      -

   e. Identified Opportunities/Challenges for Future Achievements/Results

      -

2. Progress on Key Result Area 2: Minimized Typhoon-related Social and Economic Impacts. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

   a. Meteorological Achievements/Results

      As in KRA 1(a) and KRA 6 (a)

   b. Hydrological Achievements/Results

      -

   c. Disaster Prevention and Preparedness Achievements/Results

      -

   d. Research, Training, and Other Achievements/Results

      Singapore's Civil Defense Academy provides disaster rescue and mitigation courses to the international community.

   e. Regional Cooperation Achievements/Results

      Under the ambit of the United Nations Environment Programme/Office for the Coordination of Humanitarian Affairs (UNEP/OCHA) Joint Environment Unit (JEU)), Singapore provides international assistance for Hazardous Materials emergencies (HazMat) that may arise from typhoon-related incidents.

   f. Identified Opportunities/Challenges for Future Achievements/Results

      -

3. Progress on Key Result Area 3: Enhanced Beneficial Typhoon-related Effects for the Betterment of Quality of life. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

-

b. Hydrological Achievements/Results

-

c. Disaster Prevention and Preparedness Achievements/Results

-

d. Research, Training, and Other Achievements/Results

(i) Besides hosting the 42nd TC session on 21-25 Jan 2010, Singapore participated in training workshops/conferences/meetings during the year. Some were sponsored/organized by the Typhoon Committee. Singapore would like to express her thanks and appreciation to the Typhoon Committee for giving us the opportunity to participate in the workshops which our officers have found very useful and beneficial in their course of work. The list of relevant workshops/conferences attended in 2010 are as follows:

– Training Course on “Tsunami Early Warning in the Indian Ocean, 25 Jan–13 Feb 2010, Jakarta, Indonesia.
– 14th session of the Commission of Aeronautical Meteorology, 3-10 Feb 2010, Hong Kong, China
– WMO Regional Association V working group meeting on climate-related matters, 8-11 Feb 2010, Fiji
– 4th Regional OPMET Data Banks Coordination Meeting, 11-12 Feb 2010, Chiang Mai, Thailand
– United Nations Framework Convention on Climate Changes Technical Workshop, 2-5 Mar 2010, Samoa
– 8th Meeting of the Asia-Pacific Operational Meteorology Management Task Force, 23-25 Mar 2010, Bangkok, Thailand
– 7th Session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System, 14-16 Apr 2010, Banda Aceh, Indonesia
– WMO RA V 15th session, 30 Apr-6 May 2010, Bali, Indonesia
– 32nd Meeting of the ASEAN Sub-Committee on Meteorology and Geophysics, 9-13 May 2010, Da Nang, Vietnam
– Technical Meeting for the Development of the ASEAN Peatland Fire Prediction and warning system, 10 Jun 2010, Kuala Lumpur, Malaysia
– APEC Climate Symposium 2010, 20-24 Jun 2010, Busan South Korea
– WMO International Training Course on Satellite Meteorology, 22-Jun-2 Jul 2010, Beijing, China
– Technical Workshop on the Development of the ASEAN Peatland Fire Prediction and Warning System, 13-14 Jul 2010, Kuala Lumpur, Malaysia
– 14th Meeting of the Communications/Navigation/surveillance and Meteorology Sub-gorup, 19-22 Jul 2010, Jakarta, Indonesia
– Japan Meteorological Agency Attachment Training Programme for Operational Forecasters, 20-31 Jul 2010, Tokyo, Japan
– ESCAP/WMO Typhoon Committee Integrated Workshop “Urban Flood Risk Management in Changing Climate” 6-8 Sep 2010, Macau
– Atlantic Conference on Eyjafjallajokull and Aviation, 15-16 Sep 2010, Reykjavik Kef, Iceland
– 6th Meeting of the Technical Working Group on Transboundary Haze Pollution in the Mekong Sub-region, 20-21 Sep 2010, Nay Pyi Taw, Myanmar

- UNESCO Intergovernmental Oceanographic Commission (IOC) Sub-Regional Workshop on "South China Sea Standard Operating Procedures for Tsunami Warning Centres", 4- 8 Oct 2010, Petaling Jaya, Malaysia
- Training Workshop on Mesoscale Numerical Weather Prediction, 27 Sep-8 Oct 2010, Seoul, South Korea
- 11th World Meteorological Organisation Symposium on Education and Training, 25-29 Oct 2010, Citeko, Indonesia
- Typhoon Committee Roving Seminar 2010, 30 Nov-03 Dec 2010, Ubon Ratchathani, Thailand
- Asia-Pacific Wind Shear Systems Acquisition Workshop, 1-3 Dec 2010, Bangkok, Thailand
- 6th Session of the Technical Task Force Meeting on the Establishment of Monitoring Network of TEWS in Southeast Asia, 20-21 Dec 2010, Jakarta, Indonesia

(ii) There are on-going efforts to improve the short to medium-range forecasts through the use of NWP models i.e. the Weather and Research Forecasting (WRF) model. A 2-way nested regional run is currently being used to produce high resolution forecasts over Singapore. Some of the development work in WRF is done jointly with the local universities mainly to improve the forecasts through the use of model output statistics. Going forward, the effort will focus on incorporating satellite/radar data into the WRF model to refine the predictions.

(iii) There is a growing demand from government agencies and industries for seasonal forecasts to help in resource planning. Seasonal forecasts are produced using the IRI Climate Prediction Toolkit (CPT) and the BOM SCOPIC software. The CPT uses Global Climate Model output updated monthly at the IRI website while the SCOPIC relies on historical SST data. Both software use statistical techniques to downscale the global data using the local station rainfall data to produce probabilistic climate forecasts for the next few months. A trial ASEAN-wide seasonal forecast has been developed using the CPT software and is available on the ASEAN Specialised Meteorological Centre's website.

e. Regional Cooperation Achievements/Results
-

f. Identified Opportunities/Challenges for Future Achievements/Results
-

4. Progress on Key Result Area 4: Improved Typhoon-related Disaster Risk Management in Various Sectors. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results
As in KRA 1(a) and KRA 6(a)

b. Hydrological Achievements/Results
-

c. Disaster Prevention and Preparedness Achievements/Results
-

d. Research, Training, and Other Achievements/Results
-

e. Regional Cooperation Achievements/Results
-

f. Identified Opportunities/Challenges for Future Achievements/Results
As in KRA 2(e).

5. Progress on Key Result Area 5: Strengthened Resilience of Communities to Typhoon-related Disasters. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

   a. Meteorological Achievements/Results
      -

   b. Hydrological Achievements/Results
      -

   c. Disaster Prevention and Preparedness Achievements/Results
      -

   d. Research, Training and Other Achievements/Results
      -

   e. Regional Cooperation Achievements/Results

   f. Identified Opportunities/Challenges for Future Achievements/Results
      -

6. Progress on Key Result Area 6: Improved Capacity to Generate and Provide Accurate, Timely, and understandable Information on Typhoon-related Threats. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

   a. Meteorological Achievements/Results

(i) <u>Formation of Climate Science Department</u>

A new Climate Science Department in MSD was set up in July 2010 to address the growing concern of climate change and its impact on Singapore and the region. The focus areas of the department include climate modelling and prediction, climatology and climate studies, and weather and environmental prediction. Under the area of climate modelling and prediction, the ongoing activities include the production of monthly climate forecasts over Singapore and the region using US NOAA statistical Climate Prediction Toolkit (CPT) and developing long-term climate assessments using the UK Hadley Centre's PRECIS climate modelling system.

With the establishment of the Climate Science Department, MSD aims to strengthen its capabilities in climate modelling and research so as to produce climate predictions and assessments to assist government agencies and policymakers in the formulation of climate change mitigation and adaptation strategies. One of the areas of concern is the potential changes in Singapore's long term rainfall patterns which could have critical impacts on water resource and flood management.

(ii) <u>Replacement of Weather Radar</u>

The existing S-band Doppler Weather Radar at MSD is one of the main weather observation tools used for real-time surveillance of extreme weather conditions (such as thunderstorms and wind shear) which can adversely affect the safety of airline and shipping operations as well as activities of the general public. The replacement of the radar with a new S-band dual-polarization radar was completed in May 2010.

(iii) <u>Implementation of On-Line Weather Monitoring Network</u>

MSD is currently in the process of implementing a comprehensive On-Line Weather Monitoring Network for Singapore. The system, when completed, will consist of a total of 64 weather stations transmitting data in real-time back to a Central Processing System for processing and display. In addition to the rain gauges which will be installed at all the stations, some stations will also be equipped with wind, temperature, pressure and other weather sensors. 58 out of the 64 stations are in place and the remaining stations are expected to be installed by the first quarter of 2011. The data from the On-Line Weather Monitoring Network will be provided to government agencies and the public upon completion of the system, through a web-based interface. The data from the network is currently used to support operational forecasting, weather assessments (of heavy rain and strong wind events) as well as for the purpose of flood and other monitoring and research purposes.

(iv) Quantitative Precipitation Estimation

Although the network of rain gauges over Singapore is relatively comprehensive, there are still locations which are not covered by rain gauges. In order to capitalize on the advantages of the weather radar in terms of its spatial coverage, the rainfall data from the On-Line Weather Monitoring Network has been integrated into the weather radar system in order to generate products showing accumulated rainfall amounts. These products will be evaluated over a trial period to ensure that they provide representative indications of radar-derived rainfall estimations.

(v) Testing of Quantitative Precipitation Forecast Tools

The new Weather Radar system is installed with Nowcasting software applications to utilize radar data to perform tracking of thunderstorm cells and estimations of probabilities of rainfall exceeding pre-defined thresholds. Heavy rain events in Singapore are often associated with monsoon surges, squalls and localized convective thunderstorms. Given the short-lived nature and generally low predictability of such systems, especially the localized convective systems, further evaluations would be done to determine the effectiveness of these applications.

(vi) Message Switching System

The Message Switching System which handles the reception of information via GTS/AFTN (including TC advisories etc) has been replaced with a new system to enhance its reliability and capability. The international links to RTH-Melbourne, RTH-Bangkok, NMC-Kuala Lumpur, NMC-Jakarta and NMC-Manila (as part of the GTS) were also recently migrated from Frame Relay to MPLS. The new Message Switching System handles the switching, decoding and processing of BUFR coded messages.

(vii) Satellite Reception System

MSD will also be installing a new 2.4m X/L-band satellite reception system to receive data from the NOAA and EOS Terra and Aqua satellites as well as the new FY3 and NPP (NASA-NOAA). The new system is planned to be commissioned in mid 2011.

b. Hydrological Achievements/Results

-

c. Disaster Prevention and Preparedness Achievements/Results

As in KRA 1(c)

d. Research, Training, and Other Achievements/Results

-

e. Regional Cooperation Achievements/Results

-

f. Identified Opportunities/Challenges for Future Achievements/Results

-

7. Progress on Key Result Area 7: Enhanced Typhoon Committee's Effectiveness and International Collaboration. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

   a. Meteorological Achievements/Results

      -

   b. Hydrological Achievements/Results

      -

   c. Disaster Prevention and Preparedness Achievements/Results

      As in KRA 2(e).

   d. Research, Training, and Other Achievements/Results

      -

   e. Regional Cooperation Achievements/Results

      -

   f. Identified Opportunities/Challenges for Future Achievements/Results

      -

a. Resource Mobilization Activities

-

b. **Update of Members' Working Groups representatives**

1. Working Group on Meteorology

   Mr Lesley Choo
   Chief Meteorological Officer
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   Meteorological Services Division
   National Environment Agency
   Singapore

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2. Working Group on Hydrology

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3. Working Group on Disaster Prevention and Preparedness

   Ms Lim Lay Eng
   Head
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   Meteorological Services Division
   National Environment Agency
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4. Training and Research Coordinating Group

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5. Resource Mobilization Group
    -

II. Summary of progress in Key Result Areas (*For achievements/results which apply to more than one Key Result Area, please describe them under the most applicable Key Result Area. Then, at the end of the description, place in parentheses ( ) the other applicable Key Result Areas)*

1 Progress on Key Result Area 1: Reduced Loss of Life from Typhoon-related Disasters. (*List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)*

a Meteorological Achievements/ Results

1. Enhancement of Radar network:

To strengthen severe weather observations and monitoring networks, and nowcasting of the country, the following three C-band Doppler Radars which started the installations in the South of Thailand in 2010 have been completely implemented and are now in operations:
(1). C-band Doppler Radar in Songkhla province,
(2). C-band Doppler Radar in Samui. Surat Thani province,
(3). C-band Doppler Radar in Surin province.

Totally, there are 25 weather radars in the TMD's precipitation monitoring network.

2. Enhancement of the Meteorological Satellite Data Receiving Station

To enhance the capability in receiving meteorological information derived from the different platforms of meteorological satellites, such as MTSAT, FY-2, TIROS (NOAA-16, NOAA-18, NOAA-19), FY -1, FY-3, MODIS, METOP, the TMD's implementation of the satellite signal receiving station, which began its installation in 2009, is now being in the last phase of the installation process, and it is expected to be successfully completed and will be in the operation in the early 2011. TMD is strongly confident the improvement of the satellite data receiving station will have the great role in severe weather monitoring, including typhoon and typhoon-related disasters to reduce the loss of life and damage associated with typhoon and other severe weathers.

The enhanced capability of TMD in receiving the remotely-sensed data from the GEO-stationary and Polar orbits are as shown below:

Table 1.

Satellite Platforms	Current status	Remarks
GEO-stationary	MTSAT, FY2	All Implementations completed
Polar orbit	NOAA, TIROS, MODIS, METOP, FY3, METEOSAT	

3. Improvement of storm surge forecasting

To be the effective warning of storm surges that might be occur in the coastal areas in the Gulf of Thailand and the Andaman Sea during the typhoon season, the IIT Storm Surge Model was adopted and applied using the 1 km. resolution bathymetry data interpolated from the GTOPO1. The maximum storm surge height map along the coastal areas of the Gulf of Thailand for each tropical storm category/ strength has been produced. However, TMD will also be appreciated to accept and introduce the RSMC-Tokyo Storm Surge Model into the TMD storm surge forecasting of the country.

4. The Meteorological Telecommunication Data Storing and Recording Project

To improve the receiving-disseminating of meteorological data on the network of the Global Telecommunication System (GTS) in order to fully support the information exchange in the form of the Table Driven Code Form (TDCF) as specified by the WMO, the TMD's Meteorological Telecommunication Data Storing and Recording Project has been under implementation. Its installation was started in 2009, and is expected to complete by the end of 2011. The completion of this project will also lead to the increase in potential of TMD to be the RTH Bangkok WIS portal in the South East Asia region.

5. Enhancement of the Meteorological Telecommunication Network Control System

The purpose of the project is to develop and enhance the telecommunication network for severe weather and weather-related disaster warning of the country, and to develop the whole country observation data collecting system

6. The Aeronautical Data Dissemination Project

To improve the aviation meteorological data reporting system, the improvement will disseminate the present meteorological data, forecast data, and the warning of severe weather data to pilots by using Short Wave Radio System. The project will take one year to complete, thus it will be in the TMD's operation by the end of 2011.

7. Development of Weather Chart Display System

To produce and display weather map of the Table Driven Code Form (TDCF) data, the Weather Chart Display System (WDS) has been developed. The WDS runs on the Messir Vision system to facilitate and assist forecasters to be able to visualize and analyze weather patterns produced by the system on an hourly basis.

b. Hydrological Achievements/Results

Royal Irrigation Department (RID) and Water Resource Department (DWR) of Thailand are responsible for water management. DWR's main functions relates to water policy, planning and strategy. RID is responsible for water source development, water management, including flood and drought relief, especially in floodplains and downstream watershed, whereas DWR takes care of natural rivers and steep-slope upstream watershed.

The Royal Irrigation Department implements strategies for flood prevention and relief. Our aims are to decrease the loss of lives and property especially in urban and agricultural areas. The Water Watch and Monitoring System for Warning Centre (WMSC) was set up to monitor flood situations on a 24 hourly basis.

There is also collaboration with other related organizations to plan flood prevention. Local flood protection systems were set up in important economic areas where severe floods may occur.

In addition, early warning systems using various technologies were established. This includes a telemetry and flood forecasting system for water management.

The RID to date has installed and operated about 208 telemetric stations in 13 of 25 river basins in Thailand. In addition, 555 manual river gauges and 2,294 manual rain gages were installed and operated all over country. As part of the local flood warning system, DWR has developed and installed early warning systems in 458 villages of the total 2,370 villages in Thailand and included with automatic flood-warning sirens are being operated.

Flood Forecasting and Warning System for protecting in 25 basins are being developed. For this system, In this 2010 the new telemetric stations and infrastructure networks will be installed 7 telemetering and in 2011 the new telemetering will be installed 7 networks together with a flood modeling system that include both hydrometeorology and hydrodynamic such as MIKE11, MIKEGIS ,INFOWORK and AIT River network.

To mitigate and reduce the risk of floods, the flood warning system is carefully managed in the following process.

First, telemetry system is used as a method for flood forecasting in different river basins covering nearly the whole country. Only Royal Irrigation Department has already got the system for monitoring 12 river basins from 25 in the criteria of real-time hydrological data.

Second, the forecasting situation is then announced to public with different ways like website or radio broadcasting or networks. For network mentioned above it means regional offices which take part in communicating in the local areas with other methods or media.

Third, after flooding situation, pumping for water drainage has to be prepared in order to reduce the height of water level or inundated areas. The equipment in the Head and Regional offices are ready for flood recovery operations such as 1200 mobile pumps, 121 impeller pumps, 37 backhoes, 17 dredgers, 29 tractors 44 trucks, 295 water trucks and 6 boats.

c. Disaster Prevention and Preparedness Achievements/Results

SG 1: To enhance cooperation among TC Members to reduce the number of death by typhoon-related disasters by half (*using the decade 1990-99 as the base line compared to the decade 2006-2015).*

1) *Identify Members' key agencies and sectors working on disaster preparedness and protection of vulnerable communities against typhoon-related disasters and encourage establishment of linkages, networking, and exchange of information among them*

- **Disaster Prevention and Mitigation Committee**

The National Disaster Prevention and Mitigation Committee (NDPMC), under the Disaster Prevention and Mitigation Act B.E 2550(2007), will be appointed to be the disaster management policy mechanism of the country. The committee is comprise of Prime Minister or designated Deputy Prime Minister as chairperson, Ministry of Interior as first vice chairperson, Permanent Secretary to Ministry of Interior as second vice chairperson and the membership from the national government organizations concerned. Director – General of Department of Disaster Prevention and Mitigation is designed as member and secretariat of the committee.

The main functions of NDPMC are to determine the policy for formulating the national disaster prevention and mitigation plan, to integrate the development on disaster prevention and mitigation mechanism among government and local administration agencies including other relevant private sectors, and to issue the regulations on the payment of remuneration, compensation and other expenditures relevant to disaster prevention and mitigation activities under the regulation of Ministry of Finance.

- **Department of Disaster Prevention and Mitigation**

After the bureaucratic reform in 2002, the Department of Disaster Prevention and Mitigation (DDPM) has been set up under the Ministry of Interior to serve the national disaster management system so as to sustain Thailand's habitability and safety. When the current Disaster Prevention and Mitigation Act B.E.2550 was issued and forced in November 2007, the Department of Disaster Prevention and Mitigation (DDPM) has been designed as the national government organization and operating agency on national disaster prevention and mitigation activities. Moreover, DDPM can establish the Disaster Prevention and Mitigation Regional Centers and the Disaster Prevention and Mitigation Provincial Offices to carry out the efficient disaster management.

Nowadays, DDPM has set up 18 Disaster Prevention and Mitigation Regional Centers and 75 Disaster Prevention and Mitigation Provincial Offices over the country. DDPM Regional Centers and Provincial offices will be the front line unit to carry out the disaster prevention and mitigation. DDPM will cooperate with the relevant organizations both government and private sector and local agencies to perform the task. To mobilize the technology and know-how, exchange and share experience and information, DDPM has cooperated with various international organizations such as ADRC, ADPC, JICA, GTZ, UNDP UNISDR, UNOCHA, UNEP, etc.

2*) Assist as request Member's policy development and strategic planning on disaster risk management with special emphasis on densely populated areas and vulnerable communities*

- **Strategic Action Plan (SNAP) for Disaster Risk Reduction for Thailand**

Thailand recognized that the strategic plan on disaster risk reduction is essential to minimize the incidents, consequently, DDPM cooperated with United Nations International Strategy for Disaster Reduction (UNISDR) and Asian Disaster Preparedness Centre (ADPC) to formulate Strategic Action Plan (SNAP) for Disaster Risk Reduction for Thailand and set up a working group which is composed of the representatives of the government agencies concerned, private sector and experts to draft SNAP. The draft plan is on process to submit to Cabinet for approval.

3) Provide an effective framework for integrating early warning systems for vulnerable communities into development process.

The early warning system in Thailand could divide into 2 levels. In the national level, there are many organizations to take responsibility for the task relevant disaster warning. Thai Meteorological Department, Royal Irrigation Department, Department of Water Resources and Disaster Forecasting and Warning of Electricity Generating Authority of Thailand (EGAT) Public Co. Ltd are the main agencies to forecast the disaster warning on their own function. Therefore, Thailand's Early Warning Information from these agencies will be transferred to the people via mass media and agencies concerned and Department of

Disaster Prevention and Mitigation (DDPM) will transmit the information through mechanism of Ministry of Interior to provinces, districts and local organizations.

After Tsunami disaster triggered the 6 southern provinces of Thailand on 26 December 2004, the government reviewed disaster early warning system to develop the system more efficiency and to make more confidence in safety in the country. In 2005, the cabinet appointed the Committee on Early Warning System Development which comprise the representatives of the departments concerned, will be responsible for making the decision as to when a warning should be issued. The National Early Warning Center has been set up to carry out the early warning system.

In the local level, the rain gauge and manual disaster siren have been installed in the flood prone areas. This device is employed for observing and notifying of local flood conditions, forecasts and warnings. The rain gauge is extremely low cost and very simple to use. The villagers will be trained to measure, record and read the daily amount of rainfall. Whenever the amount of rainfall exceeds the predefined normal level, the villager in charge of surveillance signal the warning by using the manual siren device to notify the village headman to disseminate the warning through the village news broadcast center.

d. Research, Training, and Other Achievements/Results

Research :

In 2010, the tropical cyclones-related and flood research topics were carried out as follows:

- The IIT Storm Surge model development for Storm surge forecast in the Gulf of Thailand and the Andaman Sea
- The amount of rainfall criteria that cause flood in upper Thailand
- The Study on Drought Indices in Thailand

Training:

In 2009, TMD received WMO/ TCTF/ TCS support to attend the training courses in the TC as follows:

Overseas Training

During 1 January 2010-30 December 2010, the staff of TMD had participated in nine overseas trainings as shown in table:

No	Course	Duration	Country	Person
1	Tsunami Early warning in the Indian Ocean	22 Jan.10 - 13 Feb.10	Indonesia	1
2	Climate applications	7-11 Jan.10	Turkey	1
3	Satellite Meteorology	22 Jun.-2 July 10	China	3
4	Multi-Hazard Early Warning	10-28 May 10	China	1
5	Weather Radar	10-14 May 10	Turkey	1
6	Information management for Maritime Activity and Disaster Prevention	8 Jun-26 N0v.10	Japan	1
7	Numerical Weather Prediction	13-24 Sep.10	China	1
8	Mesoscale Numerical Weather Prediction Phase I	27 Sep.-8 Oct.10	Republic of Korea	2
9	Flood Mitigation and Stormwater Management 2010	4-22 Oct.10	Malaysia	1

Local Training

No	Course	Duration	Person
1	Basic of Weather Forecasting Technique	30 Aug.-3 Sep.10	40
2	Analyzing the Meteorological Satellite Data I	19-23 July 10	36
3	Analyzing the Meteorological Satellite Data II	2-6 Aug. 10	37
4	Meteorological Ozone and Radiation	23-27 Aug. 10	34
5	Numerical Weather Prediction Workshop on Data Assimilation	6-10 Sep. 10	30

e. Regional Cooperation Achievements/Results

Participation in the Regional Storm Surge Watch Scheme Suitable for the Typhoon Committee Region Project

TMD, with the kind cooperation of the Hydrographic Department Royal Thai Navy, has involved in the Regional Storm Surge Watch Scheme Suitable for the Typhoon Committee Region Project by providing the tidal data of sea level at the stations in the Gulf of Thailand expected to be in typhoon tracks. The Royal Thai Navy-created bathymetric data in the gulf of Thailand are also contributed to the RSMC -Tokyo for the storm surge watch to be modified suitably.

f. Identified Opportunities/Challenges for Future Achievements/

Results

- The KMA-supported Typhoon Committee TRCG Research fellowships on TIPs provided to TMD's staff will strengthen the potential of TMD on TIPs implementation and utilizing the ensemble typhoon forecast data of the country.
- Participating in the Pilot City Project will enhance the capability of the city regarding the flood risk management in the urban area.

2. **Progress on Key Result Area 2: Minimized Typhoon-related Social and Economic Impacts.** (*List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)*

a. Meteorological Achievements/Results

Please refer to KRA 1a

b. Hydrological Achievements/Results

Please refer to KRA 1b

c. Disaster Prevention and Preparedness Achievements/Results

Nil

d. Research, Training, and Other Achievements/Results

Please refer to KRA 1d

e. **Regional Cooperation Achievements/Results**

Please refer to Regional Cooperation Assessment

f. Identified Opportunities/Challenges for Future Achievements/ Results

Please refer to KRA 1f

3. **Progress on Key Result Area 3: Enhanced Beneficial Typhoon-related Effects for the Betterment of Quality of life.** (*List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)*

a. Meteorological Achievements/Results

Nil

b. Hydrological Achievements/Results

Nil

c. Disaster Prevention and Preparedness Achievements/Results

Nil

d. Research, Training, and Other Achievements/Results

Please refer to KRA 1d

e. Regional Cooperation Achievements/Results

Nil

f. Identified Opportunities/Challenges for Future Achievements/ Results

Nil

4. **Progress on Key Result Area 4: Improved Typhoon-related Disaster Risk Management in Various Sectors.** (*List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)*

a. Meteorological Achievements/Results

Please refer to KRA 1a

b. Hydrological Achievements/Results

Flood hazard mapping in Chiang Mai city, Nan city and Lampang city were completed. The hazard maps are provided to concerned local government unit.

c. Disaster Prevention and Preparedness Achievements/Results

SG4a: To provide reliable typhoon-related disaster information for effective policy making in risk management in various sectors

DPP related:

1) Survey and document Members' legal framework for disaster Prevention and Preparedness policy, plan, and governance structure for priority sectors for sharing among Members

- **Structure of Disaster Management System**

The structure of disaster prevention and mitigation system in Thailand was divided into 3 levels as follows

1. *Policy Level*: The National Disaster Prevention and Mitigation Committee is the policy maker body. The national disaster prevention and mitigation plan will be the tool to drive the disaster management.

2. *Command Level*: Minister of Interior as Commander in Chief has authority to control and supervise the situation throughout the country, however, in the catastrophe event, Prime Minister or Designate Prime Minister will be Chief of Commander. The Department of Disaster Prevention and Mitigation is the national government organization to operate the disaster prevention and mitigation all over the country

3. *Operation Level*:

DDPM Director General as Central Director has the duties to prevent and mitigate disaster throughout the country and supervise the Provincial and Local Director, staffs and civil defence volunteers.

Provincial Governor as Provincial Director has the duties to copes with the disaster prevention and mitigation in the province.

Chief of District as District Director has the duties to carry out the disaster prevention and mitigation in the district.

Head of Local Administration Agencies as the Local Director have the duties to carry out the disaster prevention and mitigation in their local areas.

Bangkok Metropolitan Administration (BMA) Governor as BMA Director has the duties to carry out the disaster prevention and mitigation in Bangkok.

National Prevention and Mitigation Plan

In 2007, Thailand repealed the Civil Defence Act 1979 that was issued since 1979 and enacted the Disaster Prevention and Mitigation Act 2007 to increase capacity of the disaster management. This act has significantly changed the Thailand's disaster management system particularly on the structure of the national disaster management. As mentioned in SG1, under the present Act, the Disaster Prevention and Mitigation Committee is responsible for formulating the national disaster prevention and mitigation plan. The substantial of the national plan shall comprise as fellows:

1) Guideline, measures and adequate budget to contribute systemically and continuously the disaster prevention and mitigation

2) Guideline and method to assist the victims in short and long term, evacuate the effected people, provide the public health and solve the communication and public utility problems

3) Relevant government and local agencies have the duty to operate all tasks under 1) and 2)

4) Guideline on the resources and asset preparedness and operation system including to building capacity of staffs and people.

5) Guideline on reconstruction, recovery and rehabilitation to the effected people.

Nevertheless, DDPM has cooperated with the organizations concerned to formulate the master plan of the various disaster types such as Master Plan on Flood, Windstorm and Landslide Disaster Prevention and Mitigation, Master Plan on Tsunami Disaster Prevention and Mitigation, Master Plan on Earthquake and Building Collapse Disaster Prevention and Mitigation.

SG4b: To strengthen capacity of the Members in typhoon-related disaster risk management in various sectors

DPP related:

Focus on disaster preparedness and prevention: Thai disaster management has been shifted its focus from “assistance” or “relief” to “preparedness and prevention”. This approach was accepted to reduce the damage and impact substantially. Several projects, both the construction and non construction measures, have launched for disaster risk reduction for example Community Base Risk Reduction Project, Mr. Warning Project, Early Warning System Installation in the risk areas.

Develop database: Thailand develops the disaster database by using the high technology, GIS will be applied in the disaster risk assessment.

Enhance public awareness: The training course, training material are organized to educate and increase knowledge in the disaster field meanwhile the disaster prevention and mitigation manual on specific disaster type are produced and disseminate to the public

Exercise or evacuation drill: Due to the Disaster Prevention and Mitigation Act 2007, BMA, Provinces, Districts have to organize the exercise or evacuation drill at least 2 time per year. DDPM will contribute the budget to operate it. The exercise aim at testing the efficiency of the plan and well prepare to people in confront with disaster occurrence.

SG4c: To enhance international and regional cooperation and assistance in the field of disaster risk reduction

Thailand has adopted Hyogo Framework for Action (HFA) since 2005 and has initiated various projects to minimize disaster risk. The technical, experts, know-how and information sharing from the international organizations and developed countries have been transferred to the related organizations for increasing disaster management capacity. Moreover, in the disaster regional committees meeting, Thai representatives from department concerned are the national focal point in regional committee such as TMD Director–General as the national focal point of Typhoon Committee, DDPM Director–General as the national focal point of ASEAN Committee on Disaster Management**.**

d. Research, Training, and Other Achievements/Results

e. Regional Cooperation Achievements/Results

f. Identified Opportunities/Challenges for Future Achievements/ Results

Nil

5. **Progress on Key Result Area 5: Strengthened Resilience of Communities to Typhoon-related Disasters.** (*List progress on the*

Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

Public Awareness:

To give the public awareness on the nature and impacts of typhoon and disaster associated with typhoon, the Typhoon-related Disaster Awareness from Department to Community Program was introduced. This program is to educate people in the flood prone and in the most likely typhoon-affected area of the country. In 2010 the following activities were successfully carried out ;

1. Awareness program for school children in the northern region (13,980 persons)
2. Awareness program for school teacher in the northern region (400 persons)
3. Awareness program for the Disaster Mitigation and Rescue Volunteer for the Community in the northern region (2,457 persons)

TMD Website Improvement:

With the TMD important roles and responsibilities on forecasting and early warning for natural disasters such as tropical cyclone, storm surge, severe weather, flash flood, and river flow, TMD's website (www.tmd.go.th) has been consistently developed to serve the people of the country and a variety of organizations by which meteorological information and warning can be accessed in more friendly oriented website. Many forms and types of information, including tropical cyclone warning and tracking, earthquake-related information and warning are offered to the public

b. Hydrological Achievements/Results

Staff of RID attended various training classes, workshops and conference both local and overseas to acquire the latest knowledge on advanced technology relating to flood forecasting and water resource management.

c. Disaster Prevention and Preparedness Achievements/Results

SG 5a: To promote **and enhance culture of community-based disaster risk management among the Member**

- **Community Based Disaster Risk Management (CBDRM) Approach**

Thailand has realized that it is essential to improve public safety for every sector of the people, particularly those who are in the risk areas. "Community Based Disaster Risk Management (CBDRM)" approach is to reduce vulnerabilities and to strengthen people capacity to cope with the disaster risk. Therefore, CBDRM has been applied to generate the awareness and to implant the culture of safety for the people in disaster prone areas.

Thailand by DDPM has cooperated with the local agencies such as Thai Red Cross, Local Authority Department and International Agencies; Asian Disaster Preparedness Centre (ADPC), GTZ, Asian Disaster Reduction Center(ADRC), Japanese International Cooperation Agencies(JICA) to generate the awareness of the general public CBDRM approach. It has attracted the intervention of the people in every community to participate in holistic disaster management. Since 2003-2008, DDPM has continuously launched CBDRM training, at present, more than 30,000 persons in 3,354 villages 75 provinces which are the risk communities have been trained on CBDRM approach.

In this year, DDPM has initiated the new project to strengthen the community which has been trained on CBDRM. The 18 communities which were selected from all over the country will be retrained to be sustainable community on disaster prevention.

- **Mr. Warning Project**

Thailand is the flood prone areas. Therefore, DDPM initiated the Flashflood and Mudslide Warning Program to enhance capacity of the local in risk assessment and early warning. Under this program, DDPM has collaborated with Department of Provincial Administration, Department of Local Administration, The Meteorological Department, National Park Wildlife and Plant Conservation Department, and National Disaster Warning Centre to design "Mr. Disaster Warning" training course. This course aims at creating disaster warning network particularly in flashflood and mudslide prone village. "Mr. Disaster Warning" is the village volunteer who has been selected and trained to function as a vigilant, a forewarner and a coordinator. Nowadays, the 7,817 people in the flood prone areas to be trained in this programme.

SG 5b: To promote education, training and public awareness of typhoon-related disasters among the Members

DPP relate: Provide training and outreach activities to and face – to-face meetings with the people at the last kilometer/ mile and the local first responders.

- **Disaster Prevention and Mitigation Academy**

Department of Disaster Prevention and Mitigation has set up Disaster Prevention and Mitigation Academy (DPMA) in October 2004 to be the national training center in the field of disaster management. DPMA has coordinated with the agencies and developed countries including international organizations to develop curricula and mobilize the technology and know-how for standardize training. The courses will be organized to serve the capacity of the government officers, local administration officers and private sector who are in charge of the disaster management including civil defence volunteers. Nowadays, DPMA has extended to 6 campuses in upcountry. The standard curricula have consisted of the Fire Fighting, Building Collapse (Search and Rescue), Hazmat Emergency Management, Civil Defense Volunteer and Disaster Management.

- **One Tambon One Search and Rescue Team Project (OTOS)**

Thailand has recognized the immediate need to establish a range of search and rescue capacities at national, provincial and particularly in local levels. In 2004, Thailand by DDPM has launched the "One Tambon(sub-district) One Search and Rescue Team (OTOS) Programme" which will resulted in the establishment, training and long- term maintenance of specially trained search and rescue team in every tambon community. DDPM, has incorporated various government agencies and NGO such as Department of Local Administration, Health Insurance Office, Office of Health Promotion and Support Fund, and Thai Red Cross, to achieve the OTOS objectives which the OTOS objectives are (i) to ensure the safety of life, and the rapid and efficient search and rescue operation; (ii) to establish efficient search and rescue team at every provinces, district and tambon in the country; (iii) to enhance capacity and efficient search and rescue team through technical training and drilling; and (iv) to provide first aid treatment and rapid transfer to the appropriate medical establishment. As of November 2009, OTOS program is 85% completed with 6,615 SAR teams (10 members) based in each tambon or local administration offices throughout the country and more than 68,000 volunteers trained.

- **Building Capacity of Civil Defense Volunteer Program**

The disaster management role in Thailand, apart from the government organizations and private sector, the other important resource in the operation level is Civil Defense Volunteer. Pursuant to the Disaster Prevention and Mitigation Act 2007 and Ministry of Interior's Civil Defense Regulations 2005; civil defence volunteers will be recruited from local residents with age over 18 years and will be trained on Civil Defense Volunteer course for 5-days. Their function is to holistically assist the government official's operation of all type of disaster. Currently, there are approximately 1 million Civil Defense Volunteers (As of 31 October 2009, there are around 1,146,140 Civil Defense Volunteers in the country)

DDPM provides the training courses for Civil Defense Volunteers to increase their capacity on disaster prevention and support their various activities. The training courses for Civil Defense Volunteer will be more intensive so as to equip them with know-how on various disaster management activities including search and rescue. After their training, these volunteers will be officially organized and based at their local communities and can be summoned to assist the officials in managing the emergencies anytime.

d. Research, Training, and Other Achievements/Results

Please refer to KRA 5c/SG4b

e. Regional Cooperation Achievements/Results

Nil

f. Identified Opportunities/Challenges for Future Achievements/Results

Nil

6. **Progress on Key Result Area 6: Improved Capacity to Generate and Provide Accurate, Timely, and understandable Information on Typhoon-related Threats.** *(List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)*

a. Meteorological Achievements/Results

1. Improvement of tools for weather analyzing and forecasting

Weather forecast Bureau of TMD has prepared the standard operating procedure (SOP) for weather forecast and early warning system, including

(1). The knowledge management of weather forecasting technique

(2). The forecasting handbook for forecaster

(3). The manual of Tropical cyclone Analyzing and warning

2. Improvement the accuracy of tropical cyclone track forecasting for Thailand

To improve the accuracy of tropical cyclone track forecasting for Thailand, the typhoon data from the WMO assigned typhoon forecasting centers, such as JMA, CMA, HKO, ECMWF are used together with the Thailand Model to forecast tropical cyclone affecting the country. The TC warning will be issued via the GTS circuit and disseminating to public every 6 hours, however the TC warning will be issued more frequently on every 3-hour or 1-hour time basis in the typhoon season of the country.

3. Preparation for the Pilot City Project

For Hat Yai to be the Pilot City for the Urban Flood Risk Management (UFRM) project, the site and feasibility survey/ studied had been conducted by the Taskforce Team of the Typhoon Committee URFM project during 12-13 December 2010 at the URFM's Pilot City, the U-tapao Basin, Hat Yai, Songkhla province where the big flood with 2-4 m. depth of flooding occurred by the intense tropical depression during 31st October - 2nd November 2010. The implementation plan is expected to be finalized in conjunction with the TMD, RID and DDPM after Thailand receives the UFRM Guidance for the Pilot City from the Typhoon Committee's Taskforce Team.

b. Hydrological Achievements/Results

Please refer to KRA 1b,

c. Disaster Prevention and Preparedness Achievements/Results

Nil

d. Research, Training, and Other Achievements/Results

Please refer to KRA 1,5c

e. **Regional Cooperation Achievements/Results**

Nil

f. **Identified Opportunities/Challenges for Future Achievements/ Results**

Nil

7. **Progress on Key Result Area 7: Enhanced Typhoon Committee's Effectiveness and International Collaboration.** (*List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2010 Typhoon Committee Annual Operating Plan goals)*

a. **Meteorological Achievements/Results**

Publicizing the WMO activities on the occasion of the WMO Day and TMD Day by organizing seminars to educate public better understanding and appreciating the roles of WMO, Typhoon Committee, TMD, RID and DDPM on weather monitoring, typhoon and flood forecasting and disaster risk management.

b. **Hydrological Achievements/Results**

Nil

c. **Disaster Prevention and Preparedness Achievements/Results**

Nil

d. **Research, Training, and Other Achievements/Results**

Nil

e. **Regional Cooperation Achievements/Results**

Nil

f. **Identified Opportunities/Challenges for Future Achievements/ Results**

Nil

III. Resource Mobilization Activities

Nil

IV. Update of Members' Working Groups representatives

1. Working Group on Hydrology

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Thailand

monsoonal activity across the region. Developing tropical cyclone and the monsoon are beneficial in that they bring needed rainfall to the Micronesia islands.

In the Federated States of Micronesia, trade-wind showers did produce rainfall across Yap State, but at a lower level than usual. This lower rainfall resulted in damaged food crops across some of the low islands of Yap. Reduced rainfall over Pohnpei caused stream flow in the rivers to slacken. People using the river water were advised to boil the water before using it. The drought on Pohnpei did damage to the taro, breadfruit, banana, tapioca and coconut crops.

Across the Republic of the Marshall Islands aquifers of several of the northeastern island experienced salt intrusion. Some residents migrated to islands with better water resources because of the drought. The National Weather Service Office in Guam issued drought statements for these conditions until 24 June.

Central North Pacific (140W to 180, North of the Equator) Overview

A comprehensive tropical cyclone outreach program for the 2010 Central Pacific Hurricane Season generated a heightened awareness of emergency preparedness in the State of Hawaii. The theme of the 2010 campaign, *Prepare! Watch! Act!* focused on preparations needed before a hurricane threatens an area, maintaining an awareness of possible tropical cyclone development near Hawaii, and then acting on plans and preparedness when a hurricane hits. RSMC Honolulu emphasized that even though there was a likelihood of developing La Niña conditions and a resulting decrease in tropical cyclone activity expected, it only takes one hurricane hitting Hawaii to produce major damage and impacts.

4. Regional Cooperation Assessment (highlighting regional cooperation successes and challenges)

Western North Pacific (130E to 180, north of the equator) Overview

To provide some critical hydrological information for the smaller, less developed countries of Nauru and Kiribati, WFO Guam discussed them in the drought statements that were issued for Kapingamaringi. These bulletins were passed to the US and Australian Embassies to pass to the affected nations.

II. Summary of Progress in Key Result Areas

1. Progress on Key Result Area 1: Reduced Loss of Life from Typhoon-related Disasters
   a. Meteorological - Achievements/Results. N/A
   b. Hydrological – Achievements/Results. N/A
   c. Disaster Risk Reduction - Achievements/Results. N/A
   d. Training, Research, and Other – Achievement/Results
      - RSMC Honolulu hosted a three-day class for 18 Emergency Managers and First Responders on February 23-25, 2010. The three-day course was a specialized training opportunity to build the capacity of the civil defense/emergency manager to understand hurricanes and make effective protective action decisions during a hurricane threat. Through hands-on and interactive instruction with specialists at RSMC Honolulu, the course provided participants with an intensive instruction on all aspects of tropical cyclone forecasts and products, along with local National Weather Service forecast office products. This was the second year that RSMC Honolulu presented this training.
   e. Regional Cooperation – Achievement/Results. N/A
   f. Identified Opportunities/Challenges for Future - Achievements/Results. N/A

2. Progress on Key Result Area 2: Minimized Typhoon-related Social and Economic Impacts
   a. Meteorological - Achievements/Results. N/A
   b. Hydrological – Achievements/Results. N/A
   c. Disaster Risk Reduction - Achievements/Results. N/A
   d. Training, Research, and Other – Achievement/Results. N/A
   e. Regional Cooperation – Achievement/Results. N/A
   f. Identified Opportunities/Challenges for Future - Achievements/Results. N/A

3. Progress on Key Result Area 3: Enhanced Beneficial Typhoon-related Effects for the Betterment of Quality of life.
   a. Meteorological - Achievements/Results. N/A
   b. Hydrological – Achievements/Results. N/A
   c. Disaster Risk Reduction - Achievements/Results. N/A
   d. Training, Research, and Other – Achievement/Results. N/A
   e. Regional Cooperation – Achievement/Results. N/A
   f. Identified Opportunities/Challenges for Future - Achievements/Results. N/A

4. Progress on Key Result Area 4: Improved Typhoon-related Disaster Risk Management in Various Sectors.
   a. Meteorological - Achievements/Results
      - American Meteorological Society (AMS) Conference on Hurricanes/Tropical Meteorology. WFO Guam Science and Operations Officer (SOO) attended the AMS Tropical conference in May in the state of Arizona and provided two presentations on the "Analysis of typical tropical cyclone genesis during TCS-08" and "Signs of rapid intensification as depicted in microwave imagery". He also participated in a coordination meeting for this summer's TCS-10 Field experiment to be held between 20 August and 20 October. Guam will be one of the coordinating centers where two weather reconnaissance aircraft will be stationed.
      - During tropical cyclone season, RSMC Honolulu prepares and transmits a text and graphical Tropical Weather Outlook. This text product and graphical representation describes the probability of tropical cyclone development in the next 48 hours. Starting in 2010, RSMC Honolulu began providing specific probabilities of development (10%, 20%, 30%, etc.) rather than a three categorical outlook.
   b. Hydrological – Achievements/Results. N/A
   c. Disaster Risk Reduction - Achievements/Results
      - Hawaii State Hazard Mitigation Forum. The Hawaii State Hazard Mitigation Forum, of which RSMC Honolulu is a member, is tasked with maintaining and updating the Hawaii State Hazard Mitigation Plan. Forum members met regularly and to discuss hazard threat, risk assessment, and actions which can be taken to mitigate the hazard risk to protect lives and property from loss and destruction during a natural hazard.
      - Hawaii Emergency Preparedness Executive Consortium (HEPEC). RSMC Honolulu is a member of the HEPEC. HEPEC is comprised of emergency managers and disaster mitigation personnel from local, state, and federal agencies. HEPEC meets quarterly to provide updates on current and outstanding threats, both natural and manmade, to the State of Hawaii. The RSMC Honolulu Director provided a hurricane presentation to the

group during the June 2010 meeting.

- FEMA Catastrophic Plan unveiled. WFO Guam participated in several meetings with the Federal Emergency Management Agency (FEMA) and the US Agency for International Development/Office of Foreign Disaster Assistance (USAID/OFDA) to ensure that the transition from a FEMA disaster assistance mode to a USAID/OFDA disaster assistance mode went off smoothly and without significant degradation to islanders. This transition affected the FSM and the Republic of the Marshall Islands.
- The US operates under an "all hazards" disaster preparedness and response methodology. This means that most communications, infrastructure, evacuation shelters and the like are designed to support responses to multiple hazards. During December 2009, WFO Guam participated in the implementation of a newly developed tsunami inundation model for Guam and preliminary model development for Saipan. In July, the WFO Guam Warning and Coordination Meteorologist (WCM) participated in 2-day Tsunami Awareness Workshops in Guam and in Saipan. This work resulted in updates to the local All Hazards Response Plans. The Meteorologist-in-Charge also attended a tsunami training course, allowing her to better integrate the all hazards concepts into operational plans.
- The Guam WCM also participated as an instructor at a week-long Climate Services Workshop that included attendees from Palau, Yap, Chuuk, Guam, Pohnpei, Majuro, Kwajalein, and the Islands of Hawaii. This Workshop presented climatological techniques that will improve all aspects of both climate assessment and prediction throughout the region. The relevance of climate patterns to tropical cyclone activity was covered in detail.

d. Training, Research, and Other – Achievement/Results

- Exercise Pakyo. A 3-day exercise sponsored by the Department of Homeland Security/FEMA was held on Guam on 7 to 9 June. WFO Guam participated in this exercise and was responsible for devising the scenario of the exercise. The scenario consisted of an intensifying Category 5 typhoon (super typhoon) moving directly over Guam. Local and Federal government agencies and several representatives of the private sector plus observers from the FSM and from the CNMI participated in the exercise. The objective was to evaluate a recently updated All-Hazards Response Plan. It also validated the Guam Typhoon Operations Plan and synchronized the Department of Defense (DoD) and the Government of Guam Conditions of Readiness. Participants/players responded to three distinct phases: Elevated threat, Credible threat, and Response.
- Makani Pahili Hurricane Exercise. The annual Makani Pahili Hurricane Exercise, coordinated by Hawaii State Civil Defense in partnership with the National Weather Service (NWS) Forecast Office in Honolulu was held May 28 - 31. RSMC Honolulu created over 175 text and graphical products for the exercise, featuring a fictitious, category 4 hurricane making landfall on Oahu. RSMC Honolulu also provided four separate VTC briefings and experimented with *GoToMeeting* to provide a visual component to participants who only participate via phone previously. The *GoToMeeting* format was a huge success in decision support for over 60 Federal, state, and county agencies.

e. Regional Cooperation – Achievement/Results. N/A

f. Identified Opportunities/Challenges for Future - Achievements/Results. N/A

5. Progress on Key Result Area 5: Strengthened Resilience of Communities to Typhoon-related Disasters.

a. Meteorological - Achievements/Results
  - RSMC Honolulu Pacific El Niño -Southern Oscillation (ENSO) Applications Climate (PEAC) Center sponsored a Pacific Region Climate Operations Course for 22 people, mostly from NWS offices but also NOAA Corps officers from National Environmental Satellite, Data, and Information Service, and National Ocean Service. The course presented basic climate aspects, impacts, and outreach/education activities.
  - US National Weather Service Pacific Region and Pacific ENSO Applications Climate (PEAC) Center are foundation members of the Pacific Climate Information System (PaCIS) which is the pilot regional climate program under the new NOAA Climate Service.
  - Monthly Pacific ENSO Discussion. Each month, WFO Guam WCM provides a written discussion on the status of the ENSO and its effects on Micronesia. This discussion is relayed to weather officials, emergency managers, US ambassadors and other agencies in Micronesia. These discussions not only entail the trend of the ENSO but provide information on tropical cyclone, hydrological and sea level conditions associated with it. These Monthly Discussions are not usually issued if Drought Statements are in effect. The Weather Forecast Office also helps write the quarterly Pacific ENSO Update newsletter produced by the Pacific ENSO Applications Center.

b. Hydrological – Achievements/Results
  - Hazard Mapping on Guam. Hazard mapping for sediment-related disasters on Guam was completed on 15 January. This report looked into mapping areas on Guam that might be susceptible to sediment-related disasters and the use of these to set warning areas for landslides. Two major criteria for this are having the slope of valley at least 10 degrees and finding a valley where people reside on the alluvial fan. Of the areas on Guam that may be steep enough to be a concern, none are in populated areas.

c. Disaster Risk Reduction - Achievements/Results
  - RSMC Honolulu Press Conference for the 2010 Central Pacific Hurricane Season. RSMC Honolulu hosted a press conference to announce the 2010 Central Pacific Hurricane Season Outlook on May 19. Following opening remarks from the RSMC Honolulu Director, guest speaker Barry Stieglitz, Hawaii and Pacific Islands National Wildlife Refuge Complex, U.S. Fish and Wildlife Service, spoke on the timely and accurate watches and warnings and provided critical decision support briefings provided to his agency which permitted the successful evacuation effort of 7 people on Laysan Island by NOAA ship Oscar Sette and 10 people from Tern Island and French Frigate Shoals by US Coast Guard C-130 aircraft. RSMC personnel members were awarded a Department of Commerce silver medal for these actions and the US Fish and Wildlife Service presented the office with an award for service. The keynote speaker was the Honorable Linda Lingle, governor of the State of Hawaii who spoke on the need for family preparedness in the event of a hurricane. All four local television stations and the state-wide newspaper attended the press conference and featured stories that evening and/or the next day on hurricane preparedness and the forecast for an 70 percent chance of a below normal season, a 25 percent chance of a normal season, and a 5 percent chance of an above average season based upon the development of La Niña conditions.

- RSMC Honolulu continued to conduct extensive outreach and education. They held two news conferences, one on tropical cyclone preparedness and the other in preparation of the wet season; participated in the University of Hawaii, School of Ocean and Earth Science and Technology, Open House with over 1000 children attending; staff a booth at the Hawaii Fishing and Seafood festival for over 20,000 participants; judged at the state science fair; made a presentation to the Hawaii Emergency Preparedness Executive Consortium and to the Hotel Security Association; a radio and two television hurricane preparedness seminars; a statewide hurricane exercise; and over a 100 other presentations and events.
- Saipan StormReady/TsunamiReady Recognition Extended. The island of Saipan, CNMI, was recognized as StormReady/TsunamiReady for an additional three years through 2013. StormReady and TsunamiReady are two prestigious NOAA programs that recognize locations as being highly prepared to respond to and recover from severe storms and tsunamis.
- Annual Tropical Cyclone and Disaster Preparedness Workshop. These two-day, 15-module workshops are designed for decision makers in the local, state, and national governments and agencies. They cover various topics such as: tropical cyclone behavior, structure and hazards; the WFO Guam tropical cyclone program, products and timing of products; tsunamis and volcanoes; rip currents, currents, and tides; tropical cyclone plotting and speed-distance-time computations; climate variability and climate change; typhoon risk and vulnerability; a scale that relates tropical cyclone wind speed to damage and storm surge; El Niño /La Niña and their effects, impacts and status; and tropical cyclone decision making for individual islands/states. WFO Guam conducted workshops at Pohnpei, Yap, Kosrae and Chuuk in the FSM, at Saipan and Rota in the CNMI, on Guam, and at Majuro and Kwajalein/Ebeye in the Republic of the Marshall Islands. *(also in KRA 4)*
- National Disaster Preparedness Month. September was declared National Disaster Preparedness Month for 2010. The Emergency Management Offices on Guam and in the CNMI took the leads and arranged the events. On Guam, several events and numerous activities such as school presentations and a Grand Finale event at a major shopping center showcased the Preparedness Month. WFO Guam participated in the proclamation signing by the Governor of Guam, several awareness activities with over 250 contacts, the Grand Finale Display at the local Shopping Center with more than 300 contacts.

d. Training, Research, and Other – Achievement/Results

- Aviation Training. Seven Aviation Training sessions were held on Guam throughout the year to familiarize new pilots with tropical weather. The presentations included basic weather and its causes in the west Pacific, typhoons and outlook for 2010, thunderstorms, wind shear, ENSO update for aviators, and local aviation issues.
- University of Guam lectures. Environmental Biology classes at the University of Guam participated in a lecture series at the WFO Guam during the spring and fall semesters. The Guam WCM gave the 2-hour presentations, which covered basic weather concepts and weather and ocean hazards, such as tropical cyclones, volcanic eruptions, and tsunamis. There were a total of six of the presentations, with about 175 total students. Similarly, the Guam SOO hosted a class from the University of Guam Marine Lab and presented topics on basic meteorology, marine forecasting and tsunamis**.**
- About 13 tours were given to Guam public school children at the weather forecast office.

These tours included watching a weather balloon launch, a weather-related seminar with typhoon and tsunami video footage, and a tour of the operations area. Participants included 315 students from kindergarten to 12th grade and teachers. Similar tours were given to local agencies, such as the police, civil defense, and the military.

- Summer Science Programs. RSMC Honolulu participated in three summer science programs for elementary and high school students. One was for students from the "How to be a Weather Wiz Kid" class at Kamehameha Schools to learn about tropical cyclones and severe weather and the second were students from the "Discovering Science through Aerospace" class at Mid Pacific Institute to learn about tropical cyclones and climate in Hawaii. The third was the Sky and Space Class taught at the University of Hawaii Lab School.

e. Regional Cooperation – Achievement/Results. N/A

f. Identified Opportunities/Challenges for Future - Achievements/Results. N/A

6. Progress on Key Result Area 6: Improved Capacity to Generate and Provide Accurate, Timely and understandable Information on Typhoon-related Threats.

a. Meteorological - Achievements/Results

- Coastal Data Information Program (CDIP). A new CDIP buoy was placed recently east of Majuro in the Republic of the Marshall Islands. The buoy is monitored by Scripps Institute of Oceanography and the University of Hawaii and funded by a grant from the National Science Foundation. This buoy, the second active one in the western North Pacific within WFO Guam's Area of Responsibility (AOR), will address inundation and sea level rise in the Marshalls while providing invaluable ground truth to the WFO Guam and the Wave Watch 3 (WW3) developers at National Centers for Environmental Predication (NCEP) on sea conditions in this part of the AOR.
- WMO THORPEX Pacific Asian Regional Campaign (T-PARC). The T-PARC program continued again this past year with the TCS10/ITOP (Impact of Typhoons on the Ocean in the Pacific Ocean) field experiment that was held in the western North Pacific between 20 August and 20 October 2010. The scientific goals for THORPEX include examining the interaction of various scales of motion in order to improve the description and prediction of medium range weather phenomena. This summer, the TCS10/ITOP experiment focused on the impact and response of the ocean to the passing of typhoons. These impacts included the examination and measurements of cold wakes from strong typhoons, air/sea interactions; and the study of ocean eddies. A continuation of some of the TCS08 objectives included determining how the environment affected tropical cyclone genesis as well as intensification and movement. Mission centers were on Guam, as well as in Taiwan and Monterey, California. Multiple international agency cooperation was again required to coordinate the complex mix of aircraft, research vessels, satellite and land-based observations. The WFO Guam SOO provided critical analysis and interpretation support to the ITOP.
- The US is participating in the WMO RA-V Severe Weather Forecasting Demonstration and Disaster risk reduction Project (SWFDDP) for the South Pacific Islands. The goals of the SWFDDP are to: 1) further explore and enhance the application of outputs of existing NWP systems available through WFO's Global Data-Processing and Forecasting System (GDPFS) for the improvement of severe weather forecasting in South Pacific Islands where currently sophisticated NWP outputs are underutilized; 2) Provide training

for the National Meteorological Services (NMH) of South Pacific Islands; and 3) Through the WMO Public Weather Services Programme, improve the warning services in four main areas: Strong Winds (≥ 25 knots), Large Waves (≥2.5 meters), Heavy Rain (≥ 50 mm in 24 hours), and Tropical Cyclones (impacts). The SWFDDP pilot phase was carried out from 1 November 2009 to 31 October 2010 and involved the NMH's of Fiji, Samoa, Solomon Islands, and Vanuatu.

b. Hydrological – Achievements/Results. N/A

c. Disaster Risk Reduction - Achievements/Results

- On two occasions, RSMC Honolulu hosted Forecasters and Typhoon Duty Officers from the Naval Maritime Forecast Center (NMFC) and Joint Typhoon Warning Center (JTWC). The visits were to familiarize NMFC and JTWC staff with RSMC Honolulu operations and forecast software packages and to increase collaboration amongst the two agencies.
- RANET Chatty Beetle. The Radio and Internet (RANET) Chatty Beetle (see Figure 2) is a messaging device designed for remote alert and warning applications. Prototyping and pilot deployment is funded by the USAID/OFDA. The current terminal design is hardened to operate in remote and environmentally harsh locations where communications are limited. It can operate in stand-by for 36- 48 hours, and, based upon Iridium Short Burst Data (SBD) service, the terminal supports two-way communication. Twenty units have been distributed to Guam and the five Micronesia Weather Service Offices.

Figure 2: Chatty Beetle

- WFO Guam WCM provided surf observation training at locations throughout Micronesia. This included 1 hour of classroom (theory) training and 1-2 hours of field training.

d. Training, Research, and Other – Achievement/Results

- From January 1 to December 17, the Pacific International Desk Training Programme, RSMC Honolulu, Hawaii Islands, USA trained 11 forecasters from 6 different members of WMO RA V regions, including Cook Islands, Kiribati, Solomon Islands, Papua New Guinea, Vanuatu, and Tonga. Since its inception in 2001, 61 people from 15 Members of WMO RA V (Philippines and Malaysia are also Members of the Typhoon Committee) and Viet Nam and Cambodia from the Typhoon Committee have attended this programme. The USA government, through NOAA NWS funded the training programme.
- Hurricane Specialists and Hurricane Forecasters at RSMC Honolulu completed their annual hurricane and Dvorak technique training.

e. Regional Cooperation – Achievement/Results

- RSMC Honolulu participated in an international test of Tropical Cyclone SIGMET dissemination which was coordinated by the WMO. RSMC Honolulu issued a test Tropical Cyclone Advisory followed by a test Tropical Cyclone SIGMET.
- The WFO Guam WCM was part of a State Department Team that represented the US at the WMO Regional Association V (RA-V) Tropical Cyclone Conference and at the RA-V Annual Meetings in Bali, Indonesia from 30 April to 6 May. The WCM provided a progress report on the WMO's *Global Guide to Tropical Cyclone Forecasting*. In

addition to several reviews, Guam WCM wrote two Position Papers on "Enhanced Capabilities of Members in Multi Hazard, Early Warning and Disaster Prevention and Preparedness" and on "Enhanced Capabilities of Members to Provide and Use Weather and Climate, Water, and Environmental Applications and Services." Numerous recommendation and action items came out of both conferences that will strengthen Pacific typhoon/cyclone support.

- Interagency Climate Change Meeting. WFO Guam WCM attended the Interagency Climate Change Adaptation Task Force Meeting held on Friday, 9 July. In addition to comprehensive input from the Governor of Guam representative, the WCM encouraged the Task Force to more actively engage the education community so that local climate and hazard information could be better incorporated into school curricula and could more easily become a part of the culture.
- Video-teleconferencing equipment at WFO Guam. The FEMA provided video-teleconferencing equipment to the WFO Guam to assist with briefings to the FEMA headquarters in preparation for tropical cyclones threatening Micronesia. The equipment provides a valuable communication tool to effectively provide coordination during severe weather event.

f. Identified Opportunities/Challenges for Future - Achievements/Results

7. Progress on Key Result Area 7: Enhanced Typhoon Committee's Effectiveness and International Collaboration.
   a. Meteorological - Achievements/Results. N/A
   b. Hydrological – Achievements/Results
      - USA participated in the Typhoon Committee Integrated Workshop on "Urban Flood Risk Management in a Changing Climate: Sustainable and Adaptation Challenges" in Macau, China from September 25 – 29, 2010. The main focus was on urban flood risk management and possible pilot projects.
   c. Disaster Risk Reduction - Achievements/Results. N/A
   d. Training, Research, and Other – Achievement/Results. N/A
   e. Regional Cooperation – Achievement/Results. N/A
   f. Identified Opportunities/Challenges for Future - Achievements/Results. N/A

III. Resource Mobilization Activities

None.

IV. Update of Members' Working Groups representatives

1. Working Group on Meteorology
   - Mr. Bill Ward
     Pacific Guardian Center
     737 Bishop Street, Suite 2200
     Honolulu, HI 96813-3213
     Phone: 808-532-6415
     Facsimile: 808-532-5569
     bill.ward@noaa.gov

2. Working Group on Hydrology
    - Mr. Michael Ziobro
      3232 Hueneme Road
      Barrigada, GU 96913
      Phone: 671-472-0950
      Facsimile: 671-472-7405
      michael.ziobro@noaa.gov

3. Working Group on Disaster Risk Reduction
    - Ms. Genevieve Miller
      3232 Hueneme Road
      Barrigada, GU 96913
      Phone: 671-472-0944
      Facsimile: 671-472-0980
      genevieve.miller@noaa.gov

4. Training and Research Coordinating Group
    - Mr. Roger Edson
      3232 Hueneme Road
      Barrigada, GU 96913
      Phone: 671-472-0950
      Facsimile: 671-472-7405
      roger.edson@noaa.gov

5. Resource Mobilization Group
    - Mr. James Weyman
      2525 Correa Road, Suite 250
      Honolulu, HI 96822-2219
      Phone: 808-973-5272
      Facsimile: 808-973-5271
      james.weyman@noaa.gov

II. Summary of progress in Key Result Areas

(For achievements/results which apply to more than one Key Result Area, please describe them under the most applicable Key Result Area. Then, at the end of the description, place in parentheses ( ) the other applicable Key Result Areas)

1. Progress on Key Result Area 1:

Reduced Loss of Life from Typhoon-related Disasters. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2009 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

Nil.

b. Hydrological Achievements/Results

Nil.

c. Disaster Prevention and Preparedness Achievements/Results

Nil.

d. Regional Cooperation Achievements/Results

Nil.

e. Identified Opportunities/Challenges for Future Achievements/Results

Nil.

2. Progress on Key Result Area 2:

Minimized Typhoon-related Social and Economic Impacts. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2009 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

Nil.

b. Hydrological Achievements/Results

Nil.

c. Disaster Prevention and Preparedness Achievements/Results

Nil.

d. Research, Training, and Other Achievements/Results

Nil.

e. Regional Cooperation Achievements/Results

Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

Nil.

3. Progress on Key Result Area 3:

Enhanced Beneficial Typhoon-related Effects for the Betterment of Quality of life. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2009 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

Nil.

b. Hydrological Achievements/Results

Nil.

c. Disaster Prevention and Preparedness Achievements/Results

Nil.

d. Research, Training, and Other Achievements/Results

Nil.

e. Regional Cooperation Achievements/Results

Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

Nil.

4. Progress on Key Result Area 4:

Improved Typhoon-related Disaster Risk Management in Various Sectors. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2009 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

b. Hydrological Achievements/Results

c. Disaster Prevention and Preparedness Achievements/Results

d. Research, Training, and Other Achievements/Results

e. Regional Cooperation Achievements/Results

f. Identified Opportunities/Challenges for Future Achievements/Results

5. Progress on Key Result Area 5:

Strengthened Resilience of Communities to Typhoon-related Disasters. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

b. Hydrological Achievements/Results

c. Disaster Prevention and Preparedness Achievements/Results

d. Research, Training, and Other Achievements/Results

e. Regional Cooperation Achievements/Results

f. Identified Opportunities/Challenges for Future Achievements/Results

6. Progress on Key Result Area 6:

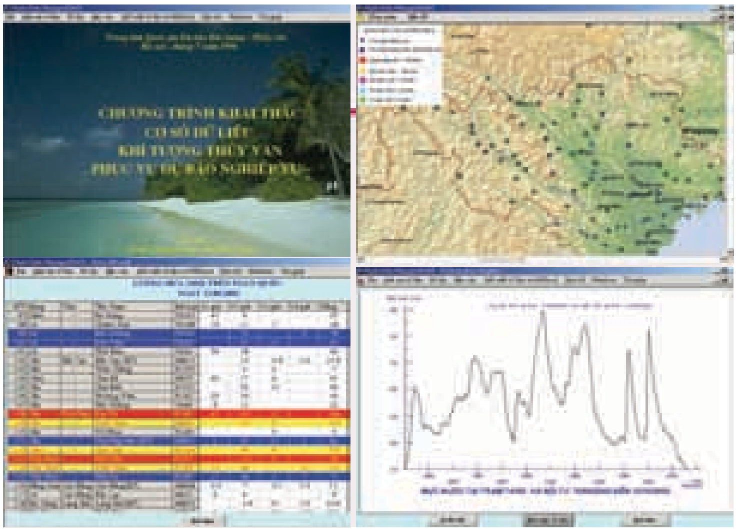
Improved Capacity to Generate and Provide Accurate, Timely, and understandable Information on Typhoon-related Threats. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

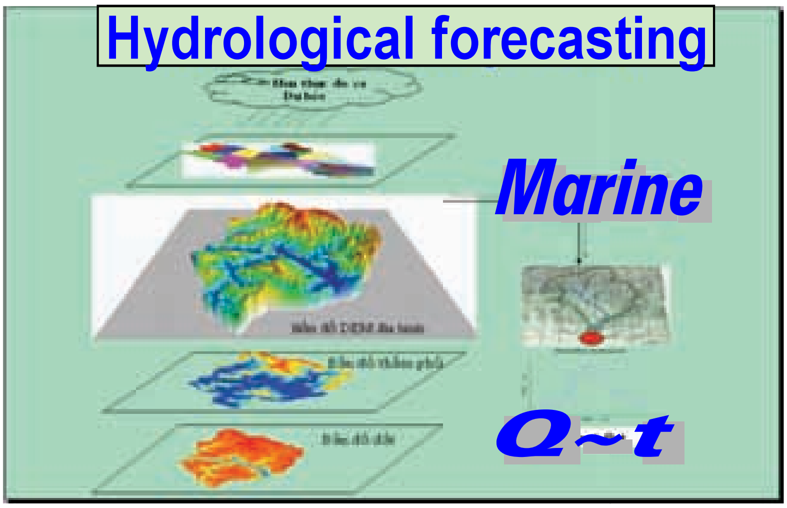
- 15 automatic rainfall station in Ha Noi city was set up and operated from October 2010.

b. Hydrological Achievements/Results

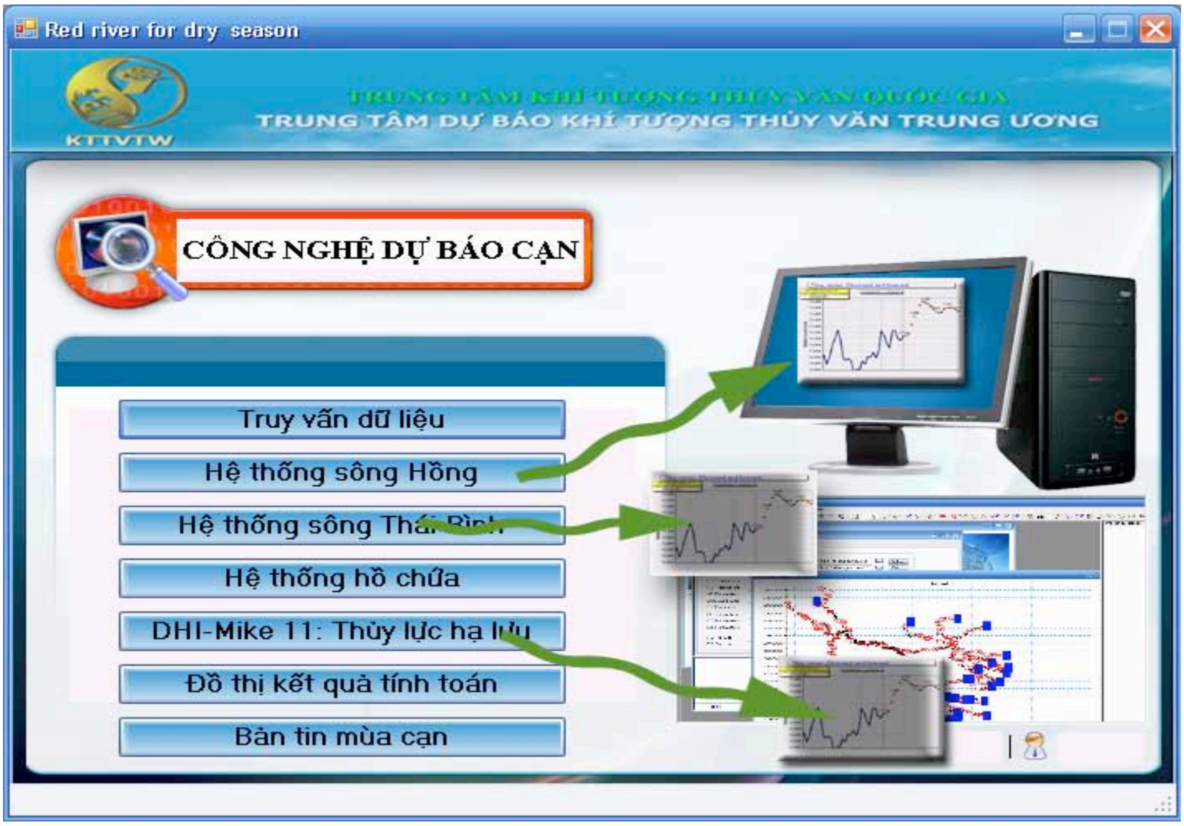
- *Improvements of software in data processing and analysis:* Continued to develop the software for the preservation of hydro-meteorological database, for hydrological data collection, processing and timely transmitting hydrological information and forecasts to end-users.



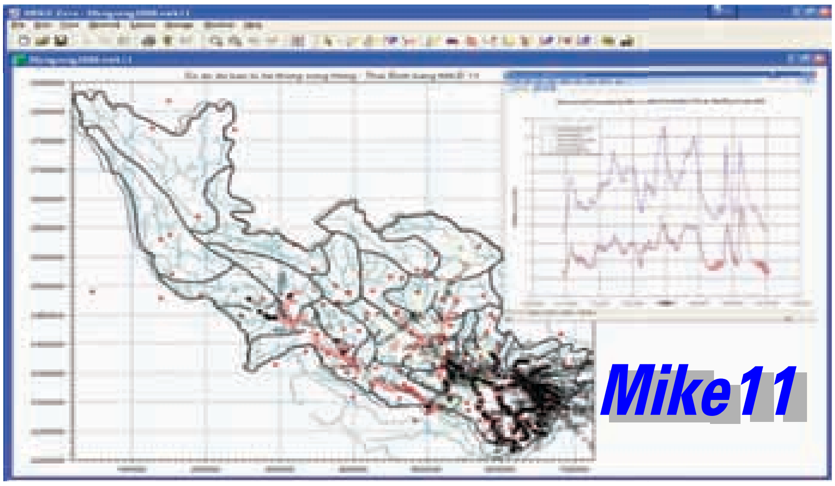
- Employ the MARINE and FIRR models to forecast flow in upstream area of Da, Thao, Lo rivers, *Reservoir Flood Routing* model for reservoir's regulation in Da river and create the input for the Hydraulic model TL2 in lower stream of Red river.



- Developing the TANK Model for flood forecasting with lead time 120h and time step of 6h since flood season of 2005 for flood forecasting with lead time 120h



- Developing MIKE-11 Model for flow forecasting with lead time 48h in the lower Red river.



c. Disaster Prevention and Preparedness Achievements/Results

d. Research, Training, and Other Achievements/Results

- Flash flood mapping Project with purposes: drawing up of flash flood map and establishing flash flood warning system in the North Viet Nam.
- Research applying satellite data, numerical rainfall forecast, combining with ground data in flood forecasting on the Hong-Thai Binh River system.
- Sub-project "Building up real time inundation forecasting technology for Hanoi downtown" in-line with technical assistance from the Typhoon Committee "Urban Flood Risk Management Project".

Proposal project: **BUILDING THE RAINFAL AND FLOOD EARLY WARINNING SYSTEMS, FORECASTING AND WARNING DETAIL HANOI INUNDATION from 2011-2013.**

- The Integrated Workshop on "Urban Flood Risk Management in a Changing Climate: Sustainable and Adaptation Challenges" in Macao, China from 6 to 10 September 2010.
- 1-month TANK model Training by EXCEL sheets in Malaysia "Configuring operation flood forecasting system based on the Tank model"
- 2-week training on small hydropower in China
- IFAS training in the Space Application Workshop to Reduce Water-related Disaster Risk in Asia, in Bangkok on 7-9 December 2010
- International Workshop on Hue Water Research, January 11-12, 2010, University of Tokyo, Japan
- The 6th International Coordination Group (ICG) Meeting, GEOSS Asian Water Cycle Initiative (AWCI), Bali, Indonesia, 10-13 March 2010
- The 7th meeting of the GEOSS Asian Water Cycle Initiative (AWCI), International Coordination Group (ICG) in Tokyo, Japan on 5 – 6th October 2010
- The meeting of the RA II (Asia) Working Group on Hydrology, 23-26 November 2010 in Seoul, Republic of Korea
- The Training Workshop on Mesoscale Numerical Weather Prediction - Phase I for all ASEAN member States in Seoul, Korea, from 27 September to 08 October 2010.
- The Research with topic TIPS Development in National Meteorological Center, China from October to December.
- The Study on Improvement of Typhoon analysis and forecast system with KMA's typhoon analysis and prediction system (TAPS) in Korea Meteorological Administration from September to November.
- The Seventh WMO International Workshop on Tropical Cyclones (IWTC-VII) will be held in St. Denis, La Reunion, France from 15 to 20 November 2010.
- The Roving Seminar in Ubon Ratchathani, Thailand, from 30 November to 03 December 2010.

e. Regional Cooperation Achievements/Results

- Participate actively the Project on Urban Flood Risk Management.(UFRM). With the strong support and kind arrangement of the National Hydro-Meteorological Service of Viet Nam, from 18 to 19 December 2010, the UFRM Task Force Mission implemented the survey successfully in Ha Noi, Viet Nam

- Participate actively the Severe Weather Forecasting Demonstration Project (SWFDP) Development for Southeast Asia (Viet Nam. Lao PDR, Cambodia and Thailand): In cooperation with the World Meteorological Organization, the NHMS of Viet Nam organized successfully the Workshop on Severe Weather Forecasting Demonstration Project (SWFDP) Development for Southeast Asia from 02 to 05 January 2010 in Ha Noi, Viet Nam; Attending the meeting to develop a strategy for preparing an Implementation Plan for a SWFDP in Southeast Asia, Tokyo, Japan, 17-18 September 2010.

(Nill)

f. Identified Opportunities/Challenges for Future Achievements/Results

(Nill)

7. Progress on Key Result Area 7:

Enhanced Typhoon Committee's Effectiveness and International Collaboration. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2009 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

(Nill)

b. Hydrological Achievements/Results

(Nill)

c. Disaster Prevention and Preparedness Achievements/Results

(Nill)

d. Research, Training, and Other Achievements/Results

(Nill)

e. Regional Cooperation Achievements/Results

(Nill)

f. Identified Opportunities/Challenges for Future Achievements/Results

(Nill)

III. Resource Mobilization Activities

(Nill)

IV. Update of Members' Working Groups representatives

(Nill)

1. Working Group on Meteorology

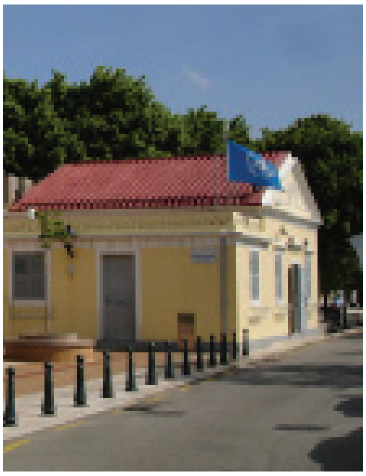
2. Working Group on Hydrology

3. Working Group on Disaster Prevention and Preparedness

4. Training and Research Coordinating Group

5. Resource Mobilization Group

1.2 TYPHOON COMMITTEE SECRETARIAT (TCS)



MAIN ACTIVITIES OF TCS IN 2010

The Typhoon Committee Secretariat (TCS) is the executive arm of the TC. It was established in 1968 as the ECAFE/WMO Joint Unit on Typhoons, initially located in Bangkok, Thailand. In response to an invitation from the Philippines, the Joint Unit was transferred to Manila in 1971 and was renamed Typhoon Committee Secretariat. Following a preliminary proposal of the Interim Working Group (IWG) on the Regional Cooperative Programme Implementation Plan (RCPIP) to the 36th Session of the Typhoon Committee, the Working Group on the Review of Operations and Structure of the TC (ROSTY) recommended the rotational hosting of the Secretariat. This recommendation was adopted at the 37th Session of the TC, held in Shanghai in November 2004, and was followed by decision of the 38th Session, held in Hanoi in November 2005. Based upon this decision the TCS was transferred in 2007 to Macao, China for a minimum of 4 years with possibility of extension of another four years. The Committee, at its 42nd Session, held in Singapore on 25-29 January 2010, decided to accept the generous offer the Government of Macao, China to host the TCS for a second four-year period from 2011 to 2014.

PARTICIPATION OF TCS IN INTERNATIONAL ACTIVITIES

Since the 42nd Session of TC, the Typhoon Committee Secretariat was represented at the in the following events:

- **66th Session of ESCAP - Senior Officials segment - Incheon, Republic of Korea, 13-19 May 2010**

The Secretary of TC, Mr. Olavo Rasquinho, attended the Senior Officials segment, from 13 up to 15 May, of the 66th Session of ESCAP which was held in Incheon, Republic of Korea.

- **Meeting on Urban Flood Risk Management (UFRM) Project, in Bangkok, 19-20 July 2010**

The Secretary, the Hydrologist (Mr. Jinping Liu) and the Meteorologist (Mr. Leong Kai Hong – Derek) of TCS participated in this meeting. The main topics of the project were established, including the project overview and information exchange, mechanism of implementing the project, terms of reference of the task force and pilot cities. More than 30 participants took part in the meeting, including representatives from TC Members, ICHARM, JAXA, UNDP, UN/ISDR, UNOCHA), ADPC, ESCAP, WMO and TCS.

- **Asia-Pacific Water Minister's Forum (APWMF) and Singapore International Water Week (SIWW) – Singapore, 28 June to 1 July 1, 2010**

Mr. Liu Jinping was appointed by WGH Chairperson Mr. Okazumi to be representative of WGH to participate in the Asia-Pacific Water Minister's Forum (APWMF) held in Singapore on June 28, as decided by TC at its 42nd Session. He also has taken the opportunity to participate in the Singapore International Water Week (SIWW) from June 29 to July 1.

- **Expert Group Meeting and Stakeholder Meeting on Mechanism on Drought Monitoring and Early Warning - Nanjing, China, 14-16 September 2010**

Following invitation from ESCAP, the Secretary of TC participated in these two meetings. The Executive Secretary of ESCAP, Dr. Noeleen Heyzer, officially launched the "Regional Cooperative Mechanism on Disaster Monitoring and Early Warning, Particularly Drought" (the Mechanism) at the meeting, with the statement read by Mr. Xuan Zengpei, Chief of the Information and Communications Technology and Disaster Risk Reduction Division of ESCAP.

- **Regional Workshop on ICT Applications for Disaster Risk Reduction and Sustainable Economic Development – Astana, Kazakhstan, 28-30 September 2010**

Mr. Jinping LIU was invited by UN ESCAP to participate in this Regional Workshop. Mr. Liu introduced the TC Strategy on Flood Disaster Risk Reduction. The workshop expressed appreciation to Typhoon Committee for offering their support to this initiative on sub-regional network for flood risk reduction in Central Asia and neighboring countries.

- **First Anniversary and Workshop of AHMRI of NUIST - Nanjing, China, 15-16 October 2010**

Mr. Jinping LIU participated at the celebration of the first anniversary and attended a workshop of the Applied Hydro-meteorological Research Institute (AHMRI) of the Nanjing University of Information Science & Technology (NUIST). He introduced the Activities on Sediment-related Disaster Reduction in TC Region at the workshop on Extreme Hydro-meteorological Events and Flood-Protection & Disaster Reduction and had the opportunity to exchange information on Typhoon Committee activities with academicians, professors and high level persons from China and other countries/ regions.

- **3rd WMO International Conference on QPE/ PQF and Hydrology, Nanjing, China, 18-22 October 2010**

The Meteorologist and Hydrologist of TCS participated at this conference, in which Mr. Jinping Liu was appointed to be a member of International Organizing Committee (IOC) of the conference and invited to give a presentation on "Hydrological Perspective on QPE/ QPF".

- **5th WGDRR Working Group Meeting, Incheon, Republic of Korea, 24-25 October 2010**

Mr. Olavo Rasquinho, Mr. Leong Kai Hong (Derek), Mr. Jinping Liu and Ms. Denise Lau (Senior Administrative Secretary of TCS) participated at the meeting, under invitation and support of NIDP-NEMA. The Secretary, on behalf of TC, gave a speech at the Opening Ceremony and chaired the session on "How to Cope with Strengthening Typhoons and Cyclones" and Mr. Liu gave a presentation on TC Urban Flood Risk Management project. The representatives of TCS also attended the opening ceremony of 4th Asian Ministerial Conference on Disaster Risk Reduction (AMCDRR).

- **Regional High-Level Expert Group Meeting to Reduce Flood Disaster Risks in Pakistan - Islamabad, Pakistan, 9 -10 November 2010**

The Secretary was invited by ESCAP to participate in the meeting, which was jointly organized by ESCAP, United Nations Country Team (UNCT) and the Government of Pakistan, on 9 to 10 November 2010, in Islamabad, Pakistan. The Secretary and the representative of UNICEF, Mr. Gary Ovington, were presenters at Session 5 - Education and Public Awareness.

- **Seventh WMO International Workshop On Tropical Cyclones-IWTC-VII, La Réunion, France, 15-20 November 2010**

Mr. Jinping Liu, invited by WMO, participated in this meeting in which, as one of the rapporteur of keynote 3 – TC precipitation (QPE/QPF) and related inland flood modeling, he contributed to the part of the report related to hydrological modeling and presented the progress and challenges on QPE/QPF utilization in hydrology.

- **Meeting of WMO RA-II (Asia) Working Group on Hydrology (WGH), Seoul, Republic of Korea, 23-26 November 2010**

Mr. Jinping LIU participated in the meeting of WMO RA-II (Asia), in which he presented the activities that are being undertaken by TC WGH. Reviewing the work areas of both working groups, and based on his presentation on the activities of the WGH of TC, the RA II WGH agreed to cooperate in joint activities to the benefit of the Members of RA II and Typhoon Committee.

- **Workshop on Space Application to Reduce Water-related Disaster Risk in Asia Bangkok, Thailand, 7-9 December 2010**

The Secretary, the Meteorologist and the Hydrologist of TCS participated in the Workshop on Space Application to Reduce Water-related Disaster Risk in Asia to be held in Bangkok, Thailand, 7-9 December 2010, which was co-organized by ESCAP, ICHARM and JAXA. The workshop was attended by experts from the TC Members, ICHARM, JAXA and Pakistan.

- **Expert group meeting on Regional Cooperation Mechanisms on Space Applications for Disaster Management and Sustainable Development - Manila, Philippines, 15-16 December 2010.**

The Secretary of TC has taken part of this meeting by invitation of ESCAP. The main objectives consisted of reviewing and developing strategies for building regional cooperative mechanisms on effective access to and applications of space-based products and services for disaster management and sustainable development in the region and reviewing the terms of reference of the Mechanism (TOR). The TOR were discussed in detail so that they could be submitted to the Intergovernmental Consultative Committee (ICC) on the Regional Space Applications Programme for Sustainable Development.

- **14th Session of the Intergovernmental Consultative Committee (ICC) on the Regional Space Applications Programme for Sustainable Development (RESAP), Manila, Philippines, 16-17 December**

The Intergovernmental Consultative Committee (ICC) approved the Terms of Reference of the "Regional Cooperative Mechanism on Disaster Monitoring and Early Warning, Particularly Drought" ("the Mechanism") and discussed the hosting of the Secretariat of the Mechanism. There were the following offers from the participants for hosting the Secretariat: Asia Pacific Space Cooperation Organization (APSCO); Bangladesh; Philippines; Macao, China; Space & Upper Atmosphere Research Organization (SUPARCO) and PITA (Pacific Islands Telecommunications Association). APSCO was selected for hosing the Secretariat of the Mechanism.

- **Meeting on Best Track Consolidation, Hong Kong, China, 13-14 December 2010**

The Meteorologist of TCS, Mr. Leong Kai Hong (Derek), participated at this meeting, which was also attended by representatives from HKO, RSMC Tokyo, JTWC, Shanghai Typhoon Institute and WMO. The methodology and procedures of the determination of best track were presented by the representatives of the attending organizations. The Typhoon Megi was used as a case study to investigate the possible reason behind the discrepancy of the determination of the location and intensity of Typhoon Megi. Among other recommendations it was advised that communications amongst tropical cyclone centers should be enhanced and that all centers should make their best endeavor to exchange relevant information and data to facilitate the determination of operational and post analysis best tracks.

- **Visit to Pilot Cities of the UFRM Project (Hat Yai, Manila, Hanoi), 12-19 December 2010**

Mr. Jinping LIU, participated in the Task Force (TF) Mission from 12 to 19 December, 2010 with the project consultant Prof. Xiaotao CHENG contracted by UN ESCAP. The TF Mission had discussions with representatives from departments of meteorology, hydrology and disaster risk reduction (DRR) at various levels and conducted field surveys in 3 pilot cities: Hat Yai, Thailand; Manila, Philippines and Hanoi, Vietnam. The Mission has had very strong support and cooperation from the 3 TC Members of Pilot cities.

COORDINATION OF INTERNATIONAL ON-THE-JOB TRAINING COURSES AND WORKSHOPS

TCS, together with the Working Groups, ESCAP and WMO, under supervision of the Advisory Working Group, coordinated the preparation of the following events:

- **ESCAP/WMO Typhoon Committee Integrated Workshop on "Urban Flood Risk Management in a Changing Climate: Sustainable and Adaptation Challenges" - Macao, China, 06-10 September 2010**

The workshop was held in Macao, China, in cooperation with ESCAP, WMO, Macao Meteorological and Geophysical Bureau (SMG), KICT and IDI, and was attended by 78 participants: 67 from Typhoon Committee Members, 2 representatives from ESCAP, 1 from WMO, 1 from JAXA, 1 from Kyoto University, 1 from University of Philippines and 5 from TCS. All the TC Members were represented.

- **Forth On-the-job Training of Flood Forecasting - Kuala Lumpur, Malaysia, 12 July- 6 August 2010**

The 4th On-the-Job training on Flood Forecasting with the title "Configuring an Operational Flood Forecasting System based on the Tank Model" was held in Kuala Lumpur, Malaysia from 12 July to 6 August 2010.

- **Field Training on Hazard mapping of Sediment-Related Disasters - Zhuhai, China - 5 September 2010**

The TCS has coordinated, together with SMG, the realization of the field training in Zhuhai, Chinese neighbor city of Macao, under the project "Hazard Mapping of Sediment-Related Disasters. The Hydrologist of TCS participated in this field training.

- **TRCG Roving Seminar 2010 - Ubon Ratchathani, Thailand, 30 November to 3 December 2010**

The Roving Seminar 2010 was held in Ubon Ratchathani, Thailand, with the support of the Thai Meteorological Department and the Typhoon Committee Trust Fund, and was attended, besides 15 local participants from Thailand, by 10 participants from TC Members. The general theme was on tropical cyclone genesis and large scale interaction. Mr. Derek Leong, Meteorologist of the Typhoon Committee, represented the TC at the opening ceremony. The

Seminar Programme focused mainly three topics: Mr. S.M. LEE (Hong Kong Observatory) presented Topic A on "Tropical cyclone genesis and seasonal prediction of cyclone activities"; Professor ZHANG Qinghong (Peking University) presented Topic B on "Effects of tropical cyclone interaction with monsoon, with emphasis on enhanced rainfall" and Dr. Mark LANDER (University of Guam) presented Topic C on "Tropical cyclone satellite analysis, including microwave images" and tutorial sessions.

COORDINATION OF THE TYPHOON COMMITTEE FELLOWSHIP SCHEME

The Training and Research Coordinating Group together with TCS coordinated the fellowship scheme in 2010. Three research fellowships were offered by China Meteorological Administration, Hong Kong Observatory and Korea Meteorological Administration with the duration of the research activities ranged from 2 months to 3 months in the second half of the year. One meteorologist from Viet Nam and one from Thailand were accepted by CMA with the research topic on "TIPS Development"; one meteorologist from CMA attended the fellowship offered by HKO with the research topic on "Can the extreme rainfall associated with Typhoon Morakot (0908) happen in Hong Kong?" and one meteorologist from Viet Nam and another from Thailand were accepted by KMA with the research topic on "Improvement of typhoon analysis and forecast system with KMA's typhoon analysis and prediction system (TAPS)".

TYPHOON COMMITTEE AND THE MEDIA OF MACAO

Interview of the Secretary to the Portuguese Channel of the Television of Macao (TDM)

On May 23, the Secretary was interviewed for half an hour by the Portuguese Channel of the Television of Macao (TDM) on the Sunday's program "TDM Interview". The talk focused the main aspects related to the projects and activities of TC, on the importance to Macao by being the host of the Secretariat of Typhoon Committee.

VISITS TO TCS HEADQUARTERS

- **Representatives of the Office of the Commissioner of the Minister of Foreign Affairs in Macao SAR – Macao, 21 January 2010**

Two representatives of the Office of the Commissioner of the Minister of Foreign Affairs in the Macao Special Administrative Region of China, Ms. Zhang Yunfei, Deputy Director-General, Department of International Organization & Legal Affairs Office, and Ms Shen Yuan, also from the Department of International Organization & Legal Affairs, visited the TCS headquarters.

- **Regional Director of ITU Regional Office for Asia and the Pacific - Telecommunication Development Bureau – 29 July 2010**

Ms. Eun-Ju Kim, Regional Director of International Telecommunication Union – Telecommunication Development Bureau, visited TCS headquarters on July, 29. A brief explanation of the activities of TC was given by the Secretary and TCS staff.

- **Researcher of NILIM and the Chief of International Affairs Division of SABO Technical Center – 5 September 2010**

Mr. Shinichiro Hayashi (Researcher, Research Center for Disaster Risk Management – National Institute for Land and Infrastructure Management - NILIM) and Mr. Hiruma Masaki (Chief of International Affairs Division, Planning Department – SABO Technical Center) visited the TCS headquarters, following a preliminary survey of the field in which the Field Training on Hazard mapping of Sediment-Related Disasters, in order to prepare a training event in Zhuhai (China) on September 5, one day before the 5th Integrated Workshop.

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- **Visit of the participants at IWS – 8 September 2010**

The participants of the TC Integrated Workshop on "Urban Flood Risk Management in a Changing Climate: Sustainable and Adaptation Challenges" visited the Secretariat on September 8. This visit was integrated at the tour offered by SMG to the participants.

OTHER ACTIVITIES

Visit to the commissioner's Office of PRC - 10 March 2010

On March 10 a delegation of the Typhoon Committee Secretariat composed of the Secretary, the Meteorologist and the Hydrologist visited the Commissioner's Office of RPC in Macao SAR, following an invitation of the RPC Commissioner, Mr Lu Shumin. The Secretary presented the compliments to Mr Lu Shumin and summarized the resolutions of the 42nd TC Session, related to the continued support to the Committee given by Government of Macao Special Administrative Region of China, namely in what refers to hosting of TCS and to the secondement of the Meteorologist. He also referred the resolution thanking China for the secondment of a hydrologist to work at, encouraging also the continuation of those services for the second four-year period of the Secretariat in Macao.

Panel on Risks and Protection against Natural Catastrophes-Macao, China, 8 June 2010

The Secretariat was invited to participate at the Panel on Risks and Protection against Natural Catastrophes, which was held at the C&C Lawyers, in Macao, China, on 8 June 2010. This panel was organized by Dr. Jorge Morbey, professor at the Macao University of Science and Technology. An interesting recreation made by the Macao Meteorological and Geophysical Bureau of the most devastating typhoon ever recorded in Macao was presented by the meteorologist Ms. Crystal Chang. An interesting discussion was held about the possible consequences of a similar typhoon in Macao today, and what adaptation measures should be implemented. The Secretary of Typhoon Committee had the opportunity to introduce the main activities of the Committee, stressing the importance of efficient early warning systems and the harmonization of the meteorological, hydrological and disaster risk reduction Services for a more efficient struggle against the consequences of the typhoon-related disasters.

TROPICAL CYCLONES IN 2010

2.1 Overview

This is a summary of the tropical cyclones that developed over the western North Pacific and the South China Sea bounded by the Equator, 60oN, 100oE and 180oE. In 2010, a total number of 14 tropical cyclones (TCs) with tropical storm (TS) intensity or higher formed in the western North Pacific and the South China Sea, of which 7 reached typhoon (TY) intensity, 4 at severe tropical storm (STS) intensity and 3 at tropical storm (TS) intensity. The total number of tropical cyclones with tropical storm intensity or higher is less than the 30 year average (1981 – 2010) of 25.6. This is the lowest in record and broke the record low of 16 in 1998.

Due to the strong subtropical ridge of high pressure over the western North Pacific which suppressed the convection activities over the region and partly due to the persistent easterly winds in tropical region from 15oN to the south as well as the weak summer monsoon over the South China Sea, as a result there were fewer than normal the formation of tropical cyclones in 2010.

There were no tropical cyclones developed over the western North Pacific and South China Sea from January to February. The first tropical cyclone for the year 2010 occurred in March with the formation of Omais. The most intense cyclone was Megi (1013) which had an maximum sustained wind of 231 km/h with the minimum sea level pressure of 885 hPa, lowest record since Venessa in 1984 (880 hPa) when it was located over the western North Pacific about 600 km northeast of Manila.

During the year of 2010, 7 tropical cyclones made landfall over China, 1 crossed Taiwan, 3 affected the Peninsula of Korea, 2 made landfall over Japan, 2 traversed the Philippines and 2 directly affected Viet Nam.

There were no tropical cyclones occurred over the western North Pacific and South China Sea during January and February. Being the first tropical cyclone occurred in 2010; Omais (1001) formed as a tropical depression over the Caroline Islands on 22 March and moved west-northwestwards. It intensified into a tropical storm at 12 UTC on 24 March. It gradually turned to move north-northwestwards the next day. Omais weakened into a tropical depression at 00 UTC on 26 March, then dissipated over the western North-Pacific to the east of Luzon Island 18 hours later.

After the quite months of the convection activities over the western North Pacific in the month of April, May and June whereas no tropical cyclones have occurred, Conson (1002) formed as a tropical depression over the sea east of the Philippines on 11 July. Moving westwards with rapid development, it intensified into a tropical storm at 00 UTC and typhoon at 18 UTC on 12 July. Conson crossed the southern part of Luzon and moved to the South China Sea during the night of 13 July, which was then downgraded to tropical storm on 14 July. Keeping its westward track, Conson re-intensified again into a typhoon on 15 July and skirted the coast of southwestern Hainan at night on 16 July. It crossed the Beibu Wan on 17 July and made landfall over the coast of Viet Nam that evening and gradually weakened into a tropical storm. Conson weakened into a tropical depression on 18 July and dissipated inland later. It was reported that Conson caused the economic damages amount to 8.8 million US dollars in the Philippines and 46 million US dollars in China. More than 70 people were killed in Viet Nam and 2 in China.

Chanthu (1003) formed as a tropical depression off the eastern coast of Luzon Island on 17 July. After crossing the Luzon Island, it intensified into a tropical storm in South China Sea on 19 July. Moving north-westwards, Chanthu intensified into a typhoon to the east of Hainan Island on 21 July. It made landfall over the southern coast of China on 22 July and then weakened into tropical storm the next day and eventually dissipated over the southern China. It was reported 5 people were killed and the economic damages was estimated to 988 million US dollars in China.

Five tropical cyclones occurred over the western North Pacific and South China Sea in August but only one reached typhoon intensity. Dianmu (1004) formed as a tropical depression over the western North Pacific about 530 km to the southeast of Taiwan on 7 August. Moving northwards and gradually intensified into a severe tropical storm on 9 August over the East China Sea. Turning to move northwestwards across Jeju which was then downgraded to tropical storm. Keeping its east-northeast track, Dianmu made landfall in the northern part of Honshu on 12 August. It became an extra-tropical cyclone over the sea east of Japan that evening. It was reported 4 people were killed and hundreds of homes were flooded in the Republic of Korea.

Mindulle (1005) formed as a tropical depression over the northern part of South China Sea on 22 August and moved westwards. Turning to move west-northwest and gradually intensified into a tropical storm the next day which later attained its maximum intensity at 00 UTC on 24 August. It made landfall over northern Viet Nam in the evening and dissipated over Laos on 25 August. It was reported that 10 people were killed and 64 were injured in Viet Nam.

Lionrock (1006) formed as a tropical depression to the west of Luzon in the South China Sea on 27 August moving northwestwards. It intensified into tropical storm the next day. Lionrock tuned gradually to the east and was upgraded to severe tropical storm on 30 August and attained its maximum intensity. It turned gradually northwestwards across the northern part of South China Sea and made landfall over the coast of southern Fujian on 2 September, then weakened into a tropical storm and subsequently into a tropical depression while moving inland westwards. It dissipated over Guangdong on 4 September. It was reported that 1 people was killed and the economic loss was 117 million US dollars in China.

Kompasu (1007) formed as a tropical depression over the western Pacific to the southeast of Okinawa on 28 August. Moving northwestwards, it gradually intensified into a typhoon on 30 August. It then turned to move northeastwards and crossed the Korean Peninsula into Sea of Japan on 2 September. It became an extra-tropical cyclone on 3 September. It was reported that 5 people missing, 112 people injured and the economic loss of 148 million US dollars in Republic of Korea. Power outages and cancellations of flights were reported in Okinawa.

Namtheum (1008) formed as a tropical depression over the East China Sea on 29 August and moved generally westwards. It intensified into a tropical storm on 30 August. Namtheun moved across the Taiwan Strait on 31 August and weakened into a tropical depression and dissipated later on the same day. No damages were reported.

There were four tropical cyclones formed over this region in September. Malou (1009) formed as a tropical depression over the western North Pacific on 1 September and moved northwestwards. Malou intensified into a tropical storm on 4 September. It turned to move northwards on 5 September and gradually turned to move northeastwards. Malou crossed the Sea of Japan on 7 September and made landfall over central Honshu the following day. It dissipated over the sea east of Japan on 10 September. No significant damages were reported.

Meranti (1010) formed as a tropical depression over the sea south of Taiwan on 7 September. Moving south-southwest, it intensified into a tropical storm on 8 September. Meranti tuned sharply to move northwards approaching the coast of southern China and further intensified into a severe tropical storm on 9 September. After landing on the coast of southern China, Meranti weakened into a tropical depression and turned to move north-northeastwards. After passing through the East China Sea and across the southern part of Korean Peninsula, Meranti became an extra-tropical cyclone on 12 September. It later dissipated over the Sea of Japan on 14 September. It was reported that 3 people were killed and the economic loss amounted to 102 million US dollars in China.

Fanapi (1011) formed as a tropical depression to the east of Luzon Island on 14 September and moved northwestwards. It turned to move northwards and attained the typhoon intensity over the same waters on 16 September. Gradually turning to move westwards, Fanapi weakened into severe tropical storm on 19 September just after crossing the Taiwan. Fanapi crossed the Taiwan Strait that night and made landfall over the coastal areas of southern Fujian on 20 September. Then it gradually weakened into a tropical depression and finally dissipated in southern China on 21 September. According to the reports, two people were reported missing and 75 injured in Taiwan. In China, 137 people were reported killed and the economic losses amounted to 1.09 billion US dollars.

Malakas (1012) formed as a tropical depression over the western North Pacific around the Mariana Islands on 20 September and moved slowly westwards. It intensified into a tropical storm on 22 September. It further intensified into a typhoon after turning to move northwestwards the following day. Turning gradually to move northeastwards, Malakas became an extra-tropical cyclone east of Japan on 25 September. No damages were reported.

There were two tropical cyclones occurred in the month of October. Being the strongest typhoon in the year of 2010, Megi (1013) formed as a tropical depression southwest of Guam on 13 October and moved generally westwards. Megi intensified into a typhoon on 15 October. It gradually turned to move west southwestwards and attained its peak intensity with maximum sustained winds of 231 km/h on 17 October over the sea east of the Philippines. Megi crossed Luzon on 18 October and then turned to move northwards over the South China Sea. Continuing its northward trajectory, Megi weakened into a tropical depression on 23 October after landing on the southern coast of Fujian Province of China, then dissipated over southern China on 24 October. It was reported that 37 were killed and caused the economic damages of 418 million US dollars in China. Estimated economic losses in the Philippines were around 257 million US dollars.

Chaba (1014) formed as a tropical depression east of the Philippines on 23 October and moved northwestwards. It intensified into a typhoon on 26 October and attained its maximum intensity at 06 UTC on 28 October after turning to move northeastwards. Continuing its tractor, Chaba became an extra-tropical cyclone over the western North Pacific to the east of Honshu on 31 October.

There were no tropical cyclones formed over the western North Pacific and the South China Sea in the month of November and December in 2011.

Detailed narrative reports of individual tropical cyclones of 2011, which are extracted from the Annual Report on the Activities of the RSMC Tokyo – Typhoon Center 2010, are presented in Section 2.2.

Of the 10 tropical cyclones affecting the Members of Typhoon Committee in 2010, disastrous events occurred in China, the Philippines and Viet Nam. In China, even though the economic losses were less in 2010, it was reported that more than 13 million people were affected and 185 people were killed. The total direct economic loss was about 2.7 billion US dollars whereas the total economic loss was about 265.8 million US dollars in the Philippines and 148 million US dollars in Republic of Korea, In Viet Nam, more than 36 people were killed or missing. There were no disastrous events due to the tropical cyclones were reported in the remaining Members in 2010, the economic damages mainly caused by flooding, landslides and power outages. List of tropical cyclones affecting the Members is shown on table 2.1.2, and list of casualties and damages sustained by Members is shown on table 2.1.3.

Table 2.1.1 *List of tropical cyclones in 2010*

Name of Tropical Cyclones			Beginning of Composite Track				End of Composite Track				Maximum Intensity	
			Date	Time	Position		Date	Time	Position		Maximum sustained surface wind (km/h)	Minimum central pressure (hPa)
				UTC	°N	°E		UTC	°N	°E		
TS	OMAIS	(1001)	22 Mar	12	8.4	141.7	26 Mar	12	17.7	132.1	65	998
T	CONSON	(1002)	11 Jul	12	13.9	132.6	18 Jul	00	21.0	105.0	129	970
T	CHANTHU	(1003)	17 Jul	06	15.8	123.1	23 Jul	12	23.5	106.5	129	970
STS	DIANMU	(1004)	7 Aug	00	20.7	124.2	13 Aug	00	43.4	151.2	93	985
TS	MINDULLE	(1005)	22 Aug	00	16.4	115.1	25 Aug	00	19.4	104.1	83	985
STS	LIONROCK	(1006)	27 Aug	18	16.5	118.0	4 Sept	06	22.5	111.2	93	985
T	KOMPASU	(1007)	28 Aug	12	18.4	139.0	2 Sept	18	40.7	134.8	148	960
TS	NAMTHEUN	(1008)	29 Aug	06	25.1	124.3	31 Aug	12	25.2	119.8	65	996
STS	MALOU	(1009)	1 Sept	12	15.6	141.4	10 Sept	06	33.7	148.2	93	992
STS	MERANTI	(1010)	7 Sept	00	22.5	123.8	11 Sept	18	34.7	125.5	102	985
T	FANAPI	(1011)	14 Sept	18	19.6	129.1	21 Sept	12	24.3	110.1	176	930
T	MALAKAS	(1012)	20 Sept	06	19.0	146.5	25 Sept	06	36.9	145.9	157	945
T	MEJI	(1013)	13 Oct	00	11.9	141.4	24 Oct	06	26.1	118.3	231	885
T	CHABA	(1014)	23 Oct	18	15.0	133.6	30 Oct	15	35.3	142.7	176	930

· Maximum peak intensity from available post analyses

() The 4-digit codes for tropical cyclones are assigned by RSMC Tokyo-Typhoon Center

Table 2.1.2 *List of tropical cyclones in 2010 affecting Members of Typhoon Committee*

Name of Tropical Cyclones			Beginning of Composite Track				End of Composite Track				Maximum Intensity	
			Date	Time UTC	Position °N	Position °E	Date	Time UTC	Position °N	Position °E	Maximum sustained surface wind (km/h)	Minimum central pressure (hPa)
T	CONSON	(1002)	11 Jul	12	13.9	132.6	18 Jul	00	21.0	105.0	129	970
T	CHANTHU	(1003)	17 Jul	06	15.8	123.1	23 Jul	12	23.5	106.5	129	970
STS	DIANMU	(1004)	7 Aug	00	20.7	124.2	13 Aug	00	43.4	151.2	93	985
TS	MINDULLE	(1005)	22 Aug	00	16.4	115.1	25 Aug	00	19.4	104.1	83	985
STS	LIONROCK	(1006)	27 Aug	18	16.5	118.0	4 Sept	06	22.5	111.2	93	985
T	KOMPASU	(1007)	28 Aug	12	18.4	139.0	2 Sept	18	40.7	134.8	148	960
STS	MALOU	(1009)	1 Sept	12	15.6	141.4	10 Sept	06	33.7	148.2	93	992
STS	MERANTI	(1010)	7 Sept	00	22.5	123.8	11 Sept	18	34.7	125.5	102	985
T	FANAPI	(1011)	14 Sept	18	19.6	129.1	21 Sept	12	24.3	110.1	176	930
T	MEJI	(1013)	13 Oct	00	11.9	141.4	24 Oct	06	26.1	118.3	231	885

imum peak intensity from available post analyses
4-digit codes for tropical cyclones are assigned by RSMC Tokyo-Typhoon Center

Table 2.1.3 Causalities and damage sustained by Members of the Typhoon Committee due to the tropical cyclones in 2010

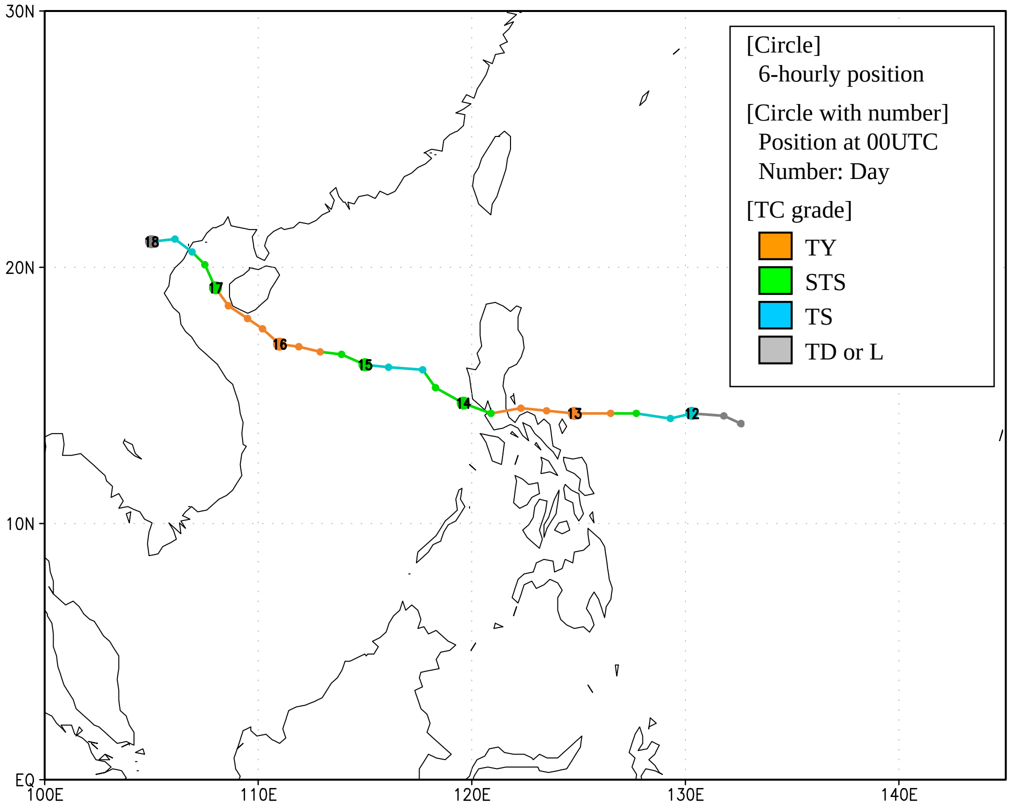
Name of Tropical Cyclones	Date	Member of Typhoon Committee Substained Damage	Causalities			Damage							Damage in monetary terms (in million USD)		
			Persons			Houses			Homeless		Affected		Infrastructure	Agriculture Production	Total Damage
			Dead	Missing	Injured	Destroyed	Damaged	Affected	Persons	Families	Persons	Families			
T CONSON	22-26 Mar	Philippines													8.8
		China	2								916000				46
		Viet Nam	70												
T CHANTHU	17-23 Jul	China	5								6425000				988
STS DIANMU	7-13	Republic of Korea	4												
TS MINDULE	22 -25 Aug	Viet Nam	10		64										
STS LIONROCK	27 Aug – 4 Sept	China	1								935000				117
T KOMPASU	28 Aug – 2 Sept	Republic of Korea		5	112										148
STS MERANTI	7-11 Sept	China	3								344000				102
T FANAPI	14-21 Sept	China and Taiwan	137	2	75						4025000				1090
T MEJI	13-24	China	37								647000				418
		Philippines													257
TOTAL	Year 2010	China	185	2	75						13292000				2766
TOTAL	Year 2010	Vietnam	21	15	107	636	48								
TOTAL	Year 2010	Philippines													265.8

Note: Causalities and damage figures were complied from Member's country report.

2.2. NARRATIVE REPORTS OF INDIVIDUAL TROPICAL CYCLONES

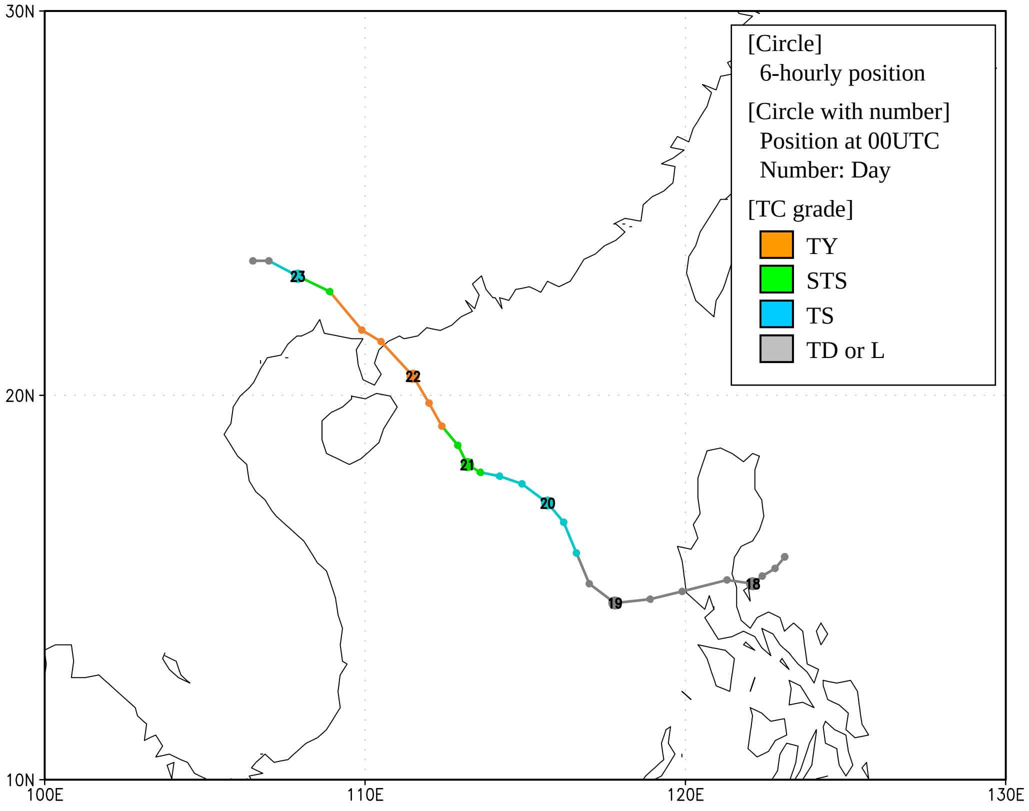
CONSON (1002)

Conson formed as a tropical depression (TD) over the sea east of the Philippines at 12 UTC on 11 July 2010. Moving westward with rapid development, it was upgraded to tropical storm (TS) intensity at 00 UTC and typhoon (TY) intensity at 18 UTC the next day. After it crossed Luzon Island, Conson was downgraded to TS intensity at 12 UTC on 14 July. Keeping its westward track in the South China Sea, it was again upgraded to TY intensity at 12 UTC on 15 July and reached its peak intensity with maximum sustained winds of 70 kt and a central pressure of 970 hPa south of Hainan Island 18 hours later. After it moved northwestward over the Gulf of Tonkin and reached the coast of Viet Nam, Conson weakened to TD intensity at 00 UTC on 18 July before dissipating 6 hours later.



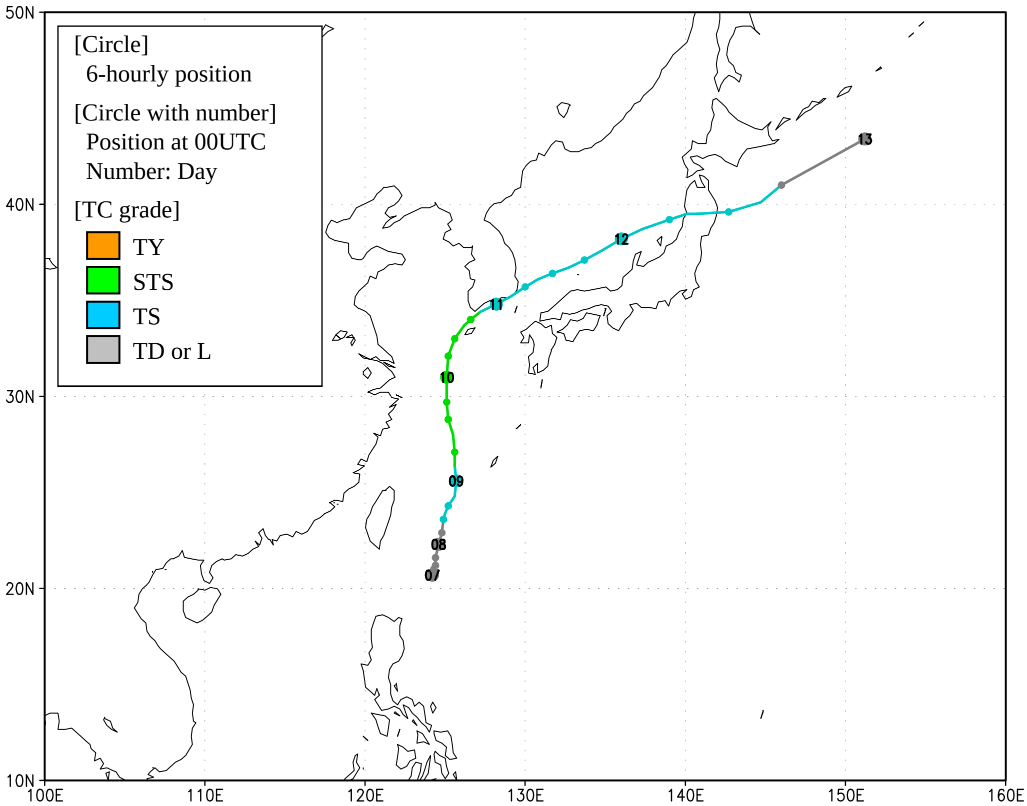
CHANTHU (1003)

Chanthu formed as a tropical depression (TD) off the eastern coast of Luzon Island at 06 UTC on 17 July 2010. It moved westward crossing the island and it was upgraded to tropical storm (TS) intensity in the South China Sea at 12 UTC on 19 July. Moving northwestward, Chanthu was upgraded to typhoon (TY) intensity east of Hainan Island at 12 UTC on 21 July and reached its peak intensity with maximum sustained winds of 70 kt and a central pressure of 970 hPa 12 hours later. Keeping its northwestward track, it was downgraded to severe tropical storm (STS) intensity at 18 UTC on 22 July after it reached the southern coast of China. Chanthu weakened to TD intensity at 06 UTC on 23 July and dissipated 12 hours later over the southern China.



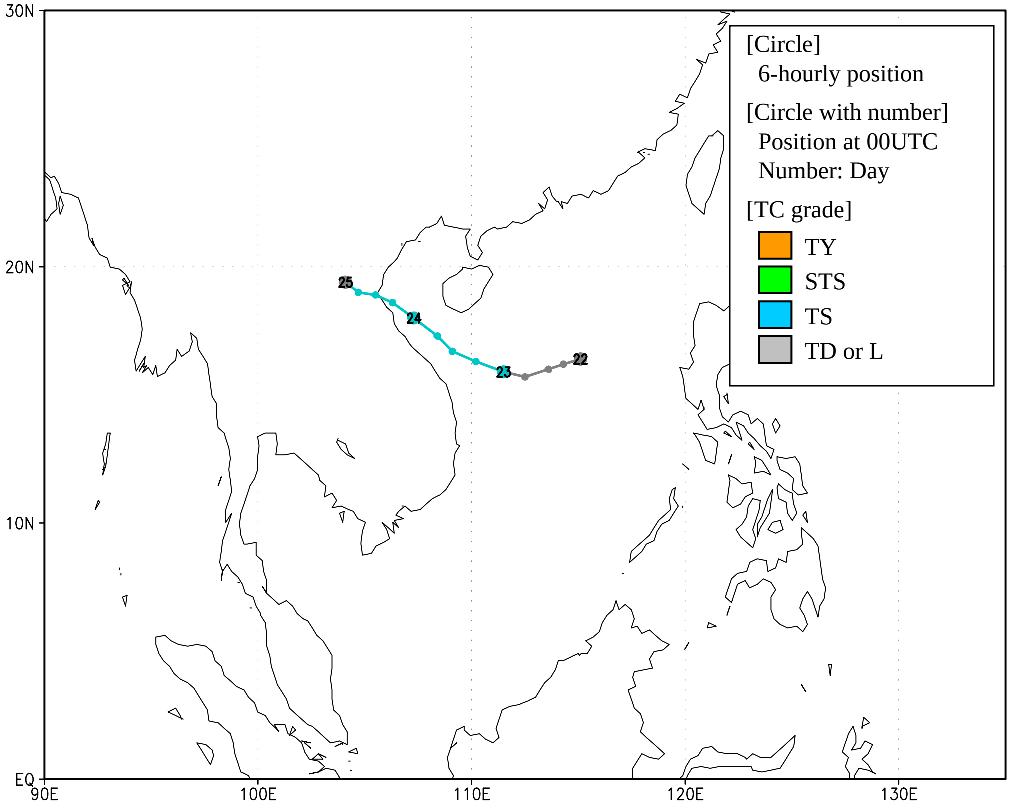
DIANMU (1004)

Dianmu formed as a tropical depression (TD) south of the Okinawa Islands at 00 UTC on 7 August 2010. Moving northward, it was upgraded to tropical storm (TS) intensity south of Miyakojima Island at 12 UTC the next day. After approaching the island around 6 hours later, it reached its peak intensity with maximum sustained winds of 50 kt and a central pressure of 985 hPa in the East China Sea at 03 UTC on 9 August. After turning to the east-northeast, it moved along the southern coast of the Korean Peninsula and was downgraded to TS intensity at 21 UTC the next day. Keeping its east-northeastward track, Dianmu made landfall in the northern part of Honshu around 08 UTC on 12 August with TS intensity. It transformed into an extratropical cyclone south of Hokkaido at 18 UTC that day and dissipated south of the Aleutian Islands 12 hours later.



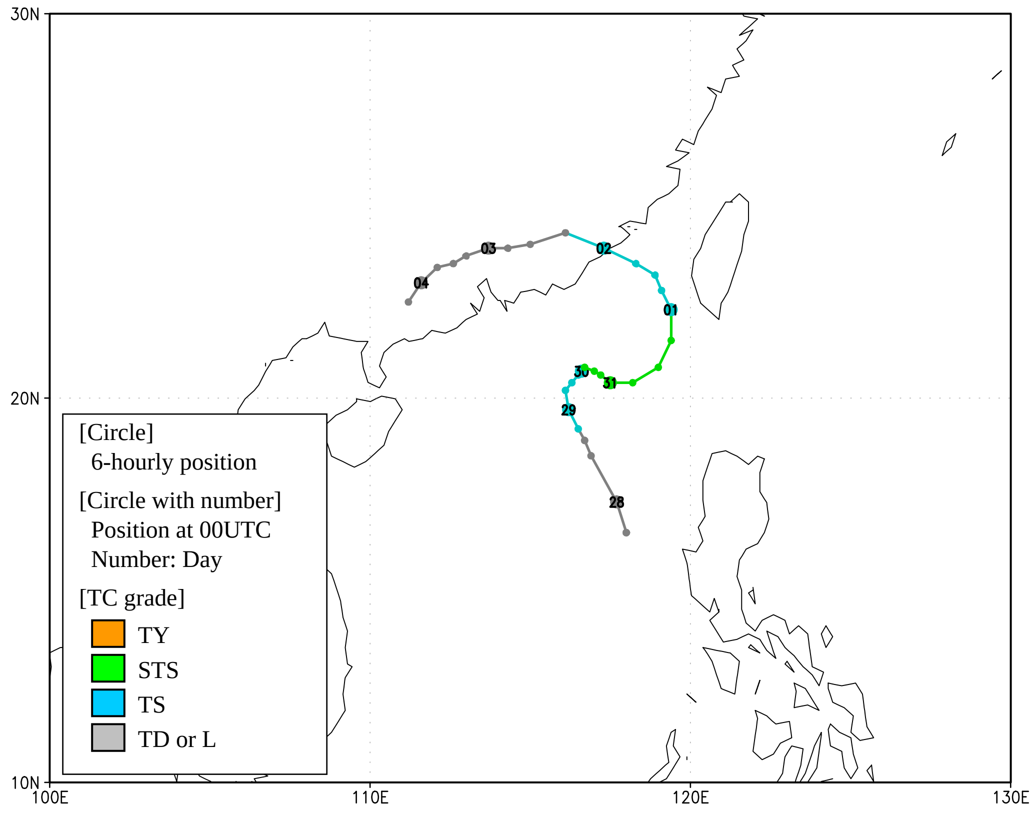
MINDULLE (1005)

Mindulle formed as a tropical depression (TD) in the South China Sea at 00 UTC on 22 August 2010. Moving west-southwestward, it was upgraded to tropical storm (TS) intensity 24 hours later. Turning gradually west-northwestward and moving into the Gulf of Tonkin, Mindulle reached its peak intensity with maximum sustained winds of 45 kt and a central pressure of 985 hPa at 00 UTC on 24 August. Soon after it hit Viet Nam, Mindulle was downgraded to TD intensity at 00 UTC on 25 August and dissipated around Laos 6 hours later.



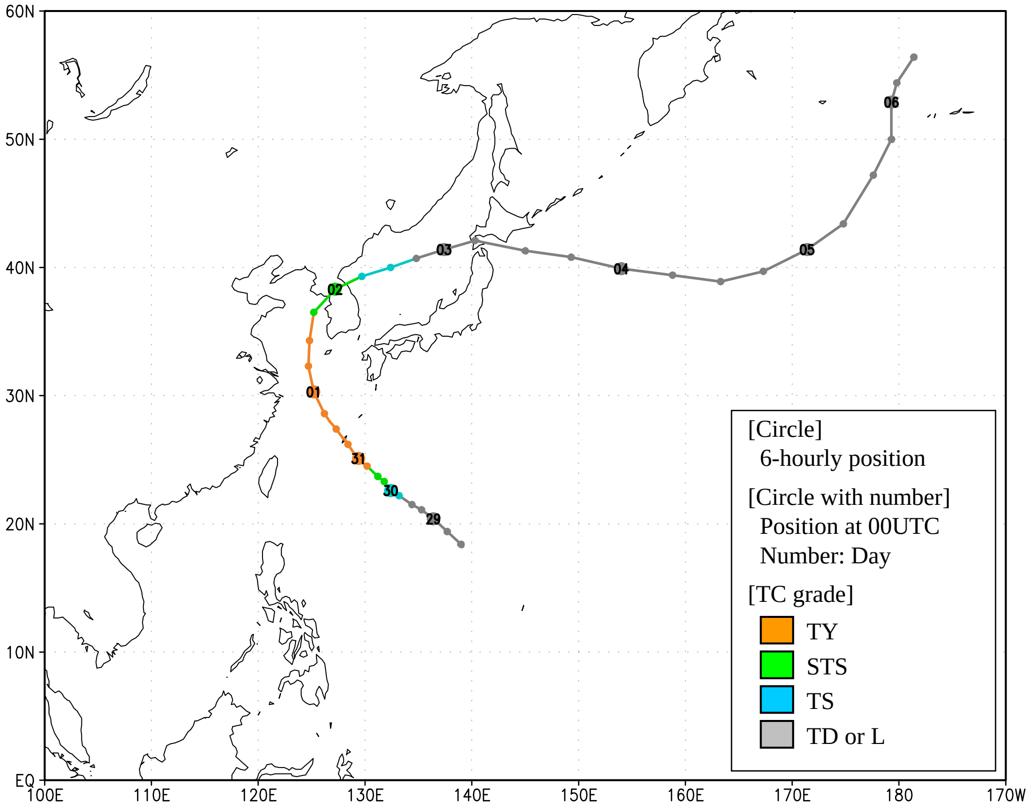
LIONROCK (1006)

Lionrock formed as a tropical depression (TD) west of Luzon Island in the South China Sea at 18 UTC on 27 August 2010. Moving northwestward it was upgraded to tropical storm (TS) intensity 24 hours later. After it turned gradually to the east, Lionrock passed around the Pratas Island and it was upgraded to severe tropical storm intensity (STS) at 06 UTC on 30 August. It turned gradually northwestward in the South China Sea, reached the coast of China, and then weakened to TD intensity at 06 UTC on 2 September. It dissipated in the China at 12 UTC on 4 September.



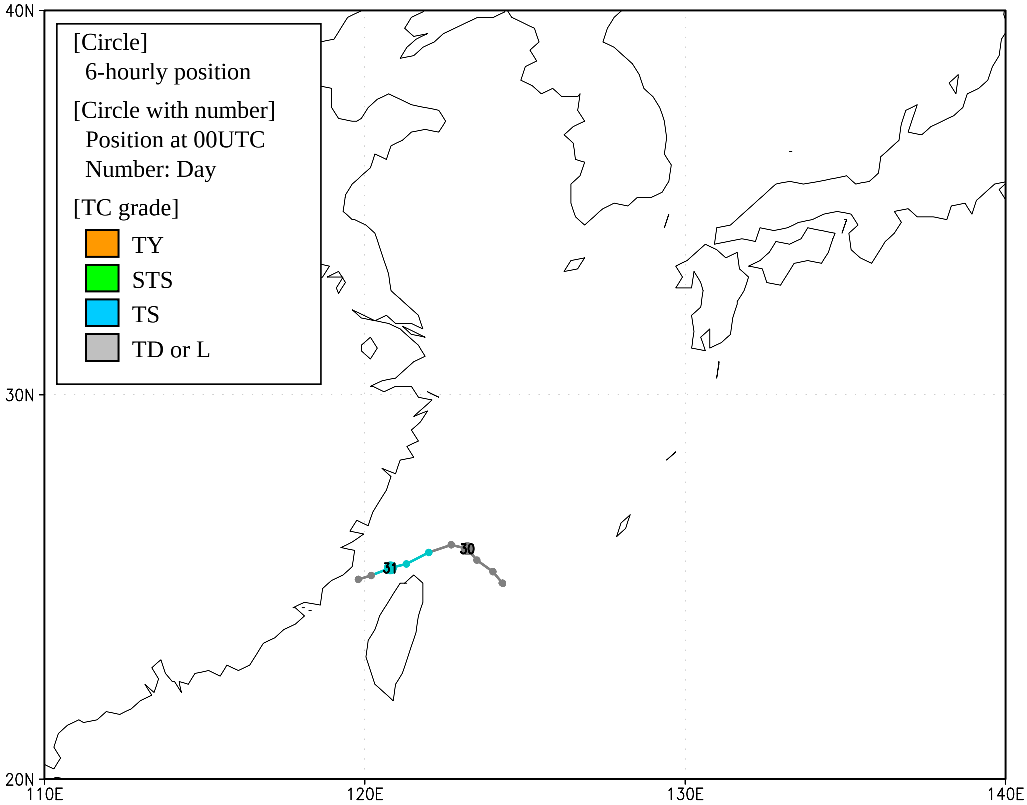
KOMPASU (1007)

Kompasu formed as a tropical depression (TD) southeast of Okinotorishima Island at 12 UTC on 28 August 2010. Moving northwestward, it was upgraded to tropical storm (TS) intensity northwest of the Island at 18 UTC on 29 August. Keeping its northwestward track, Kompasu was upgraded to typhoon (TY) intensity south of Minamidaitojima Island at 18 UTC on 30 August and reached its peak intensity with maximum sustained winds of 80 kt and a central pressure of 960 hPa 6 hours later. Holding its intensity, it crossed the northern part of Okinawa Island after 08 UTC on 31 August and entered the East China Sea. After turning eastward in the Yellow Sea and crossing the Korean Peninsula, Kompasu weakened to TD intensity in the Sea of Japan at 18 UTC on 2 September. It transformed into an extratropical cyclone southeast of Hokkaido at 12 UTC on 3 September after crossing Oshima Peninsula. Turning north-northeastward over the sea far east of Japan, it crossed longitude 180 degrees east in the Bering Sea before 12 UTC on 6 September.



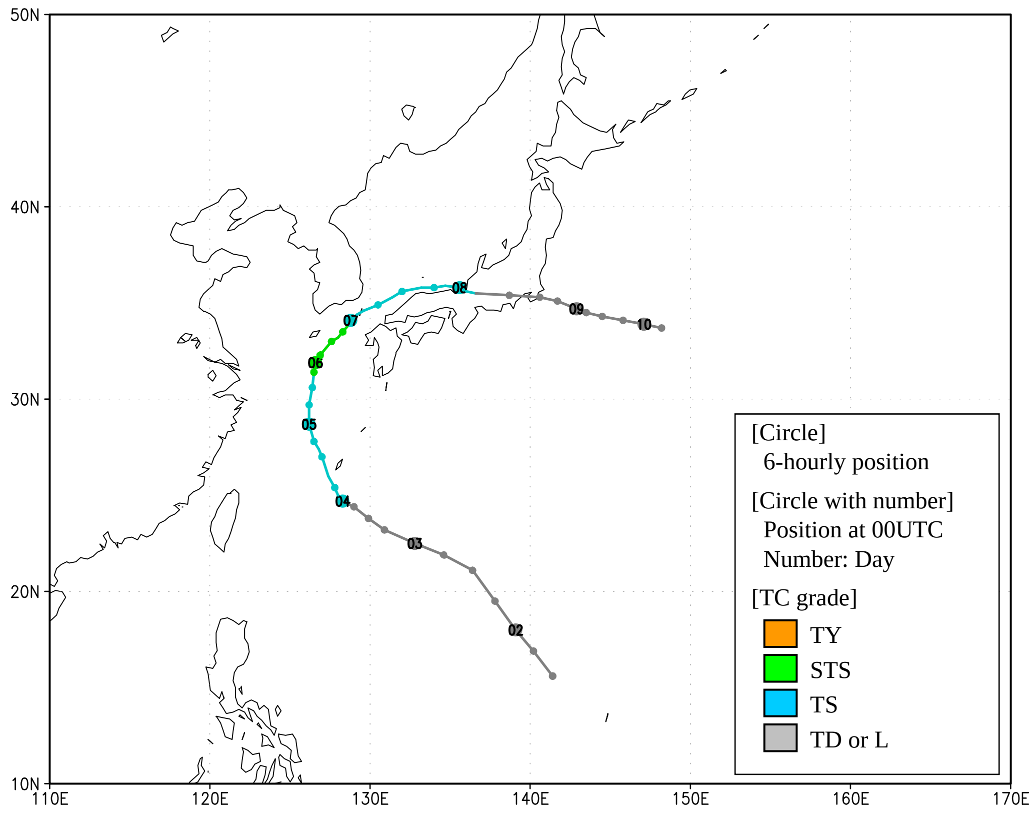
NAMTHEUN (1008)

Namtheun formed as a tropical depression (TD) north of Ishigakijima Island at 06 UTC on 29 August 2010. Moving northwestward then west-southwestward, it was upgraded to tropical storm (TS) intensity, reaching its peak with maximum sustained winds of 35 kt and a central pressure of 996 hPa north of Taiwan at 12 UTC the next day. Keeping its west-southwestward track, it weakened to TD intensity in the Taiwan Strait at 06 UTC on 31 August and dissipated 12 hours later.



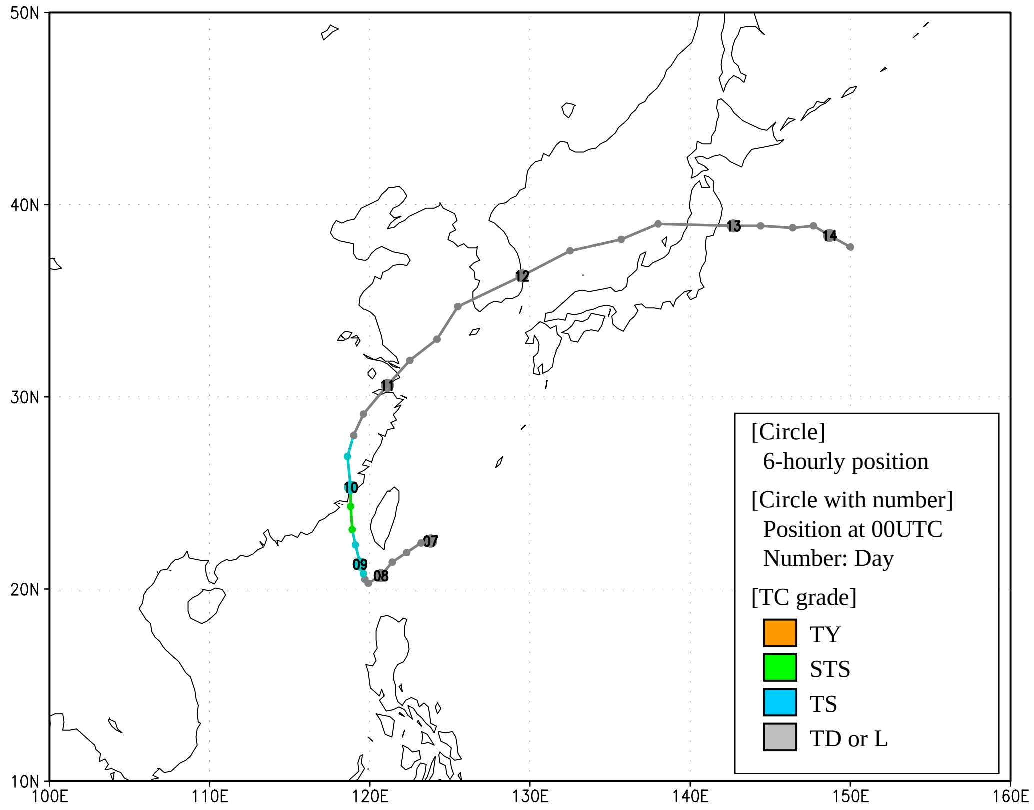
MALOU (1009)

Malou formed as a tropical depression (TD) west of Saipan Island at 12 UTC on 1 September. Moving northwestward, it was upgraded to tropical storm (TS) intensity south of Okinawa Island on 00 UTC on 4 September. During its recurvature, it reached its peak intensity with maximum sustained winds of 50 kt and a central pressure of 992 hPa in the East China Sea at 18 UTC on 5 September. Turning to the east, it crossed Tsushima Island early on 7 September and then made landfall in Japan just before weakening to tropical depression (TD) intensity at 03 UTC the next day. Malou moved east-southeastward in the eastern part of Japan early that day and then dissipated east of Japan at 12 UTC on 10 September.



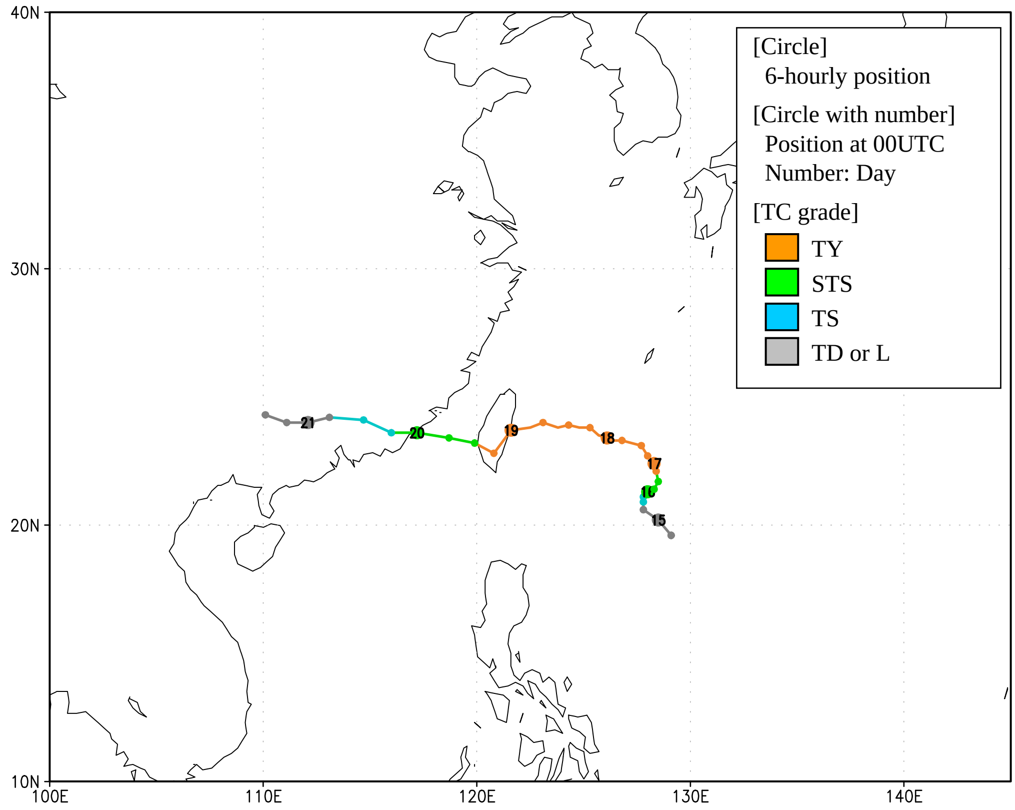
MERANTI (1010)

Meranti formed as a tropical depression (TD) south of Iriomotejima Island at 00 UTC on 7 September 2010. Moving southwestward and entering into the South China Sea, it was upgraded to tropical storm (TS) intensity at 18 UTC on 8 September. After turning sharply northward, it reached its peak intensity with maximum sustained winds of 55 kt and a central pressure of 985 hPa 24 hours later. It hit southern China and weakened to TD intensity at 12 UTC on 10 September. Accelerating northeastward, it passed the East China Sea on 11 September. Soon after crossing the Korean Peninsula, Meranti transformed into an extratropical cyclone at 00 UTC on 12 September. After moving eastward over the Sea of Japan and crossing Tohoku region of Japan, it dissipated east of Japan at 12 UTC on 14 September.



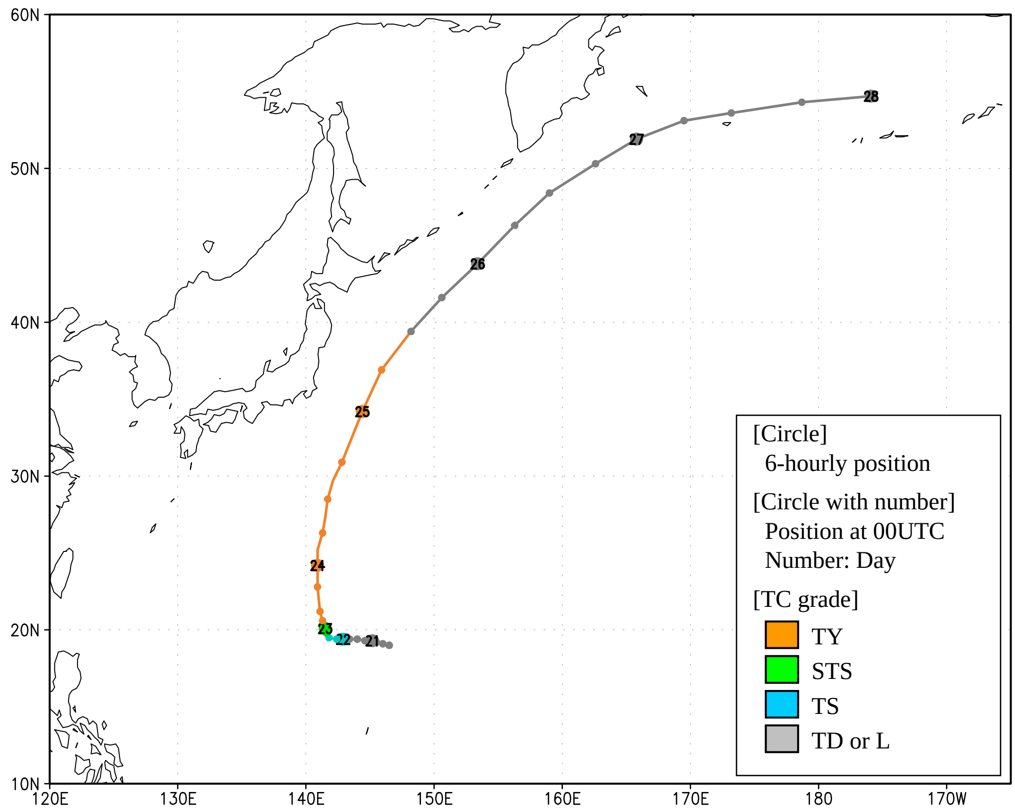
FANAPI (1011)

Fanapi formed as a tropical depression (TD) east of Luzon Island at 18 UTC on 14 September 2010. Moving northwestward, it was upgraded to tropical storm (TS) intensity south of Okinawa Island at 12 UTC the next day. Turning northward, it was upgraded to typhoon (TY) intensity over the same waters at 18 UTC on 16 September. Turning gradually westward, it reached its peak intensity with maximum sustained winds of 95 kt and a central pressure of 930 hPa south of Iriomotejima Island at 15 UTC on 18 September. Keeping its westward track, Fanapi was downgraded to severe tropical storm (STS) intensity at 12 UTC on 19 September just after crossing Taiwan Island. After crossing the Taiwan Strait and hitting southern China, it weakened to TD intensity north of Hong Kong at 18 UTC on 20 September and dissipated 24 hours later.



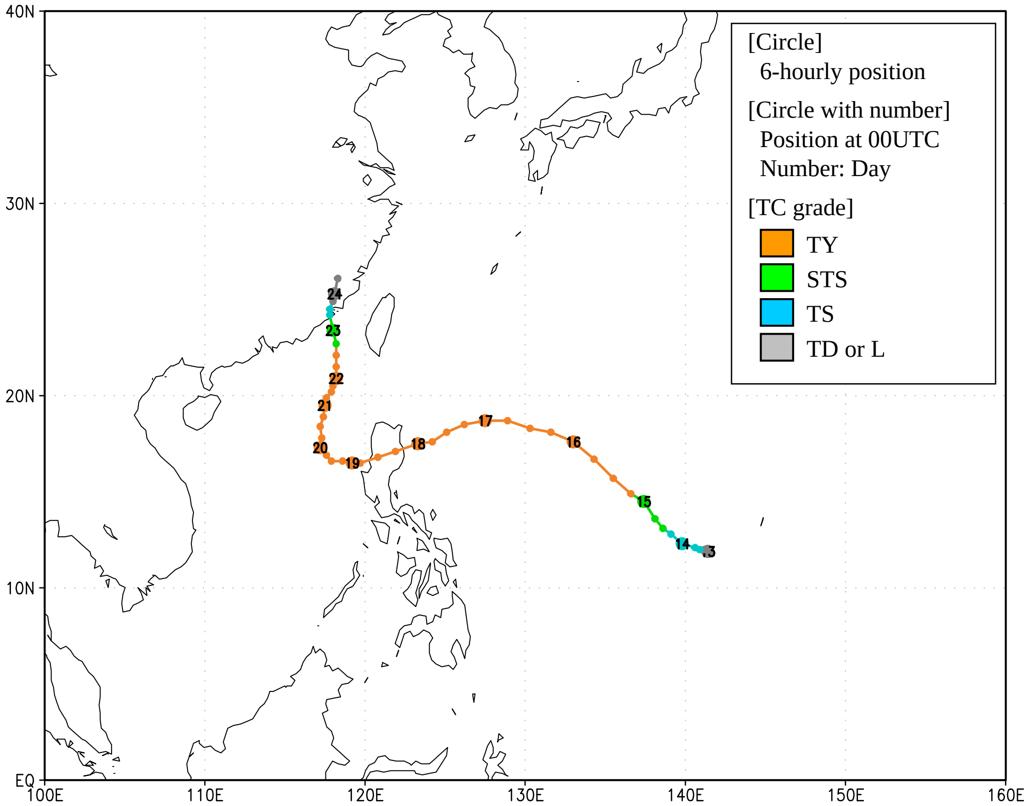
MALAKAS (1012)

Malakas formed as a tropical depression (TD) around the Mariana Islands at 06 UTC on 20 September 2010. Moving slowly westward, it was upgraded to tropical storm (TS) intensity west of the Mariana Islands at 00 UTC on 22 September. After turning to the north, it was upgraded to typhoon (TY) intensity at 06 UTC the next day. Keeping its northward track, it reached its peak intensity with maximum sustained winds of 85 kt and a central pressure of 945 hPa southeast of Hachijojima Island at 18 UTC on 24 September. Turning gradually to the northeast, Malakas transformed into an extratropical cyclone east of Japan at 12 UTC the next day. Turning to the east, it crossed longitude 180 degrees east over the Bering Sea before 00 UTC on 28 September.



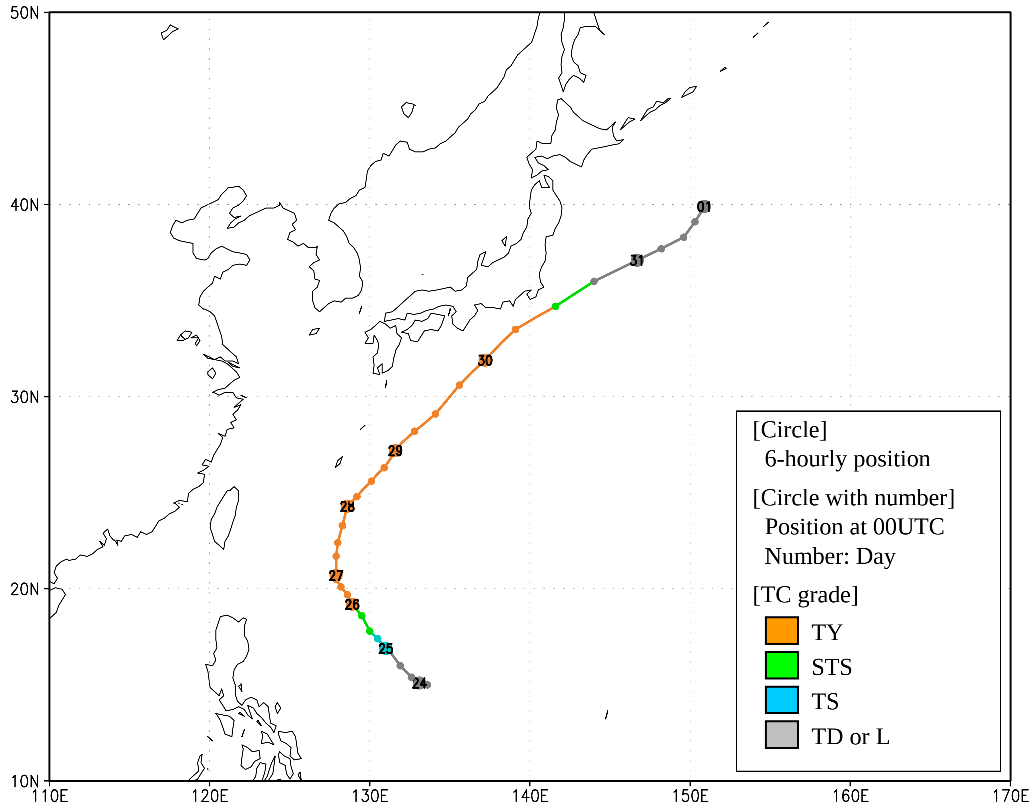
MEGI (1013)

Megi, the strongest typhoon in recent years, formed as a tropical depression (TD) southwest of Guam at 00 UTC on 13 October 2010. Moving northwestward, it was upgraded to tropical storm (TS) intensity 12 hours later and to typhoon (TY) intensity at 06 UTC on 15 October. Megi turned gradually west-southwestward and developed rapidly reaching its peak intensity with maximum sustained winds of 125 kt and a central pressure of 885 hPa east of the Philippines at 18 UTC on 17 October. It weakened rapidly, although holding TY intensity, when it crossed Luzon Island on 18 October. Megi turned sharply northward over the South China Sea and moved slowly northward with slow development. It weakened to TD intensity at 18 UTC on 23 October soon after it reached the southern coast of Fujian Province of China. Megi dissipated over southern China at 12 UTC on 24 October.

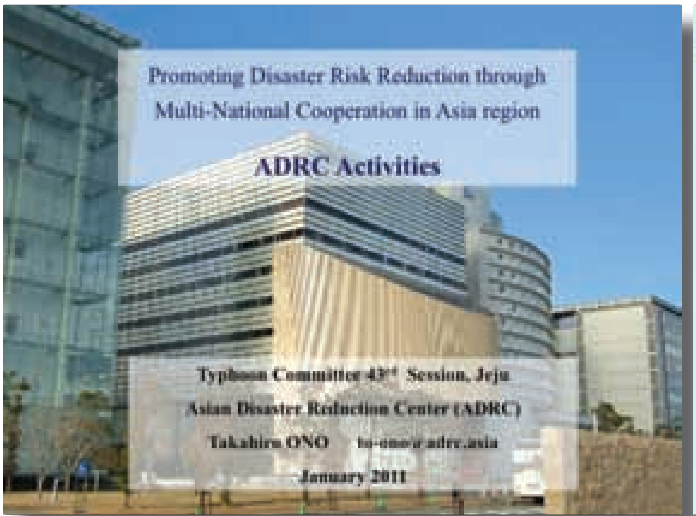


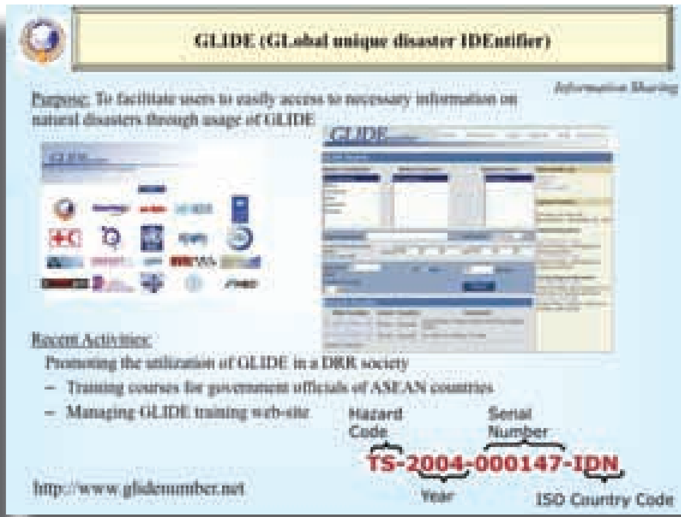
CHABA (1014)

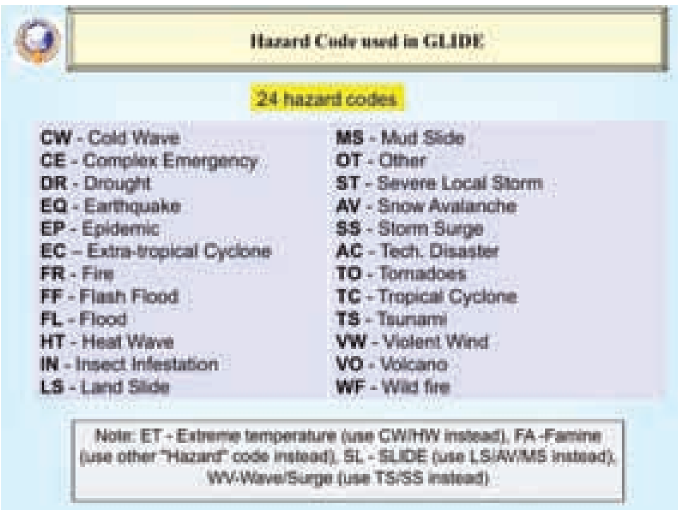
Chaba formed as a tropical depression (TD) east of the Philippines at 18 UTC on 23 October 2010. Moving northwestward, it was upgraded to tropical storm (TS) intensity 24 hours later. After it gradually turned to the northeast, Chaba reached its peak intensity with maximum sustained winds of 95 kt and a central pressure of 930 hPa south east of Okinawa Island at 06 UTC on 28 October. Accelerating and keeping its northeastward track over the sea south of the Japanese Islands, it transformed into an extratropical cyclone at 18 UTC on 30 October east of Kanto region and dissipated far east of Japan at 06 UTC on 1 November.

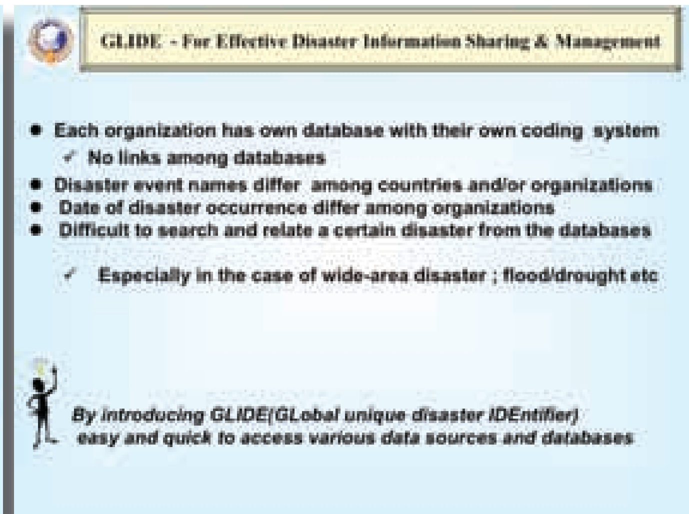


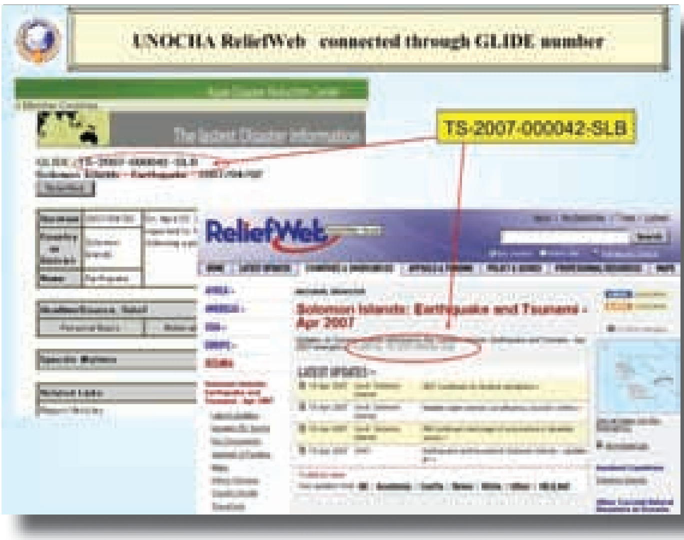
CONTRIBUTED PAPERS



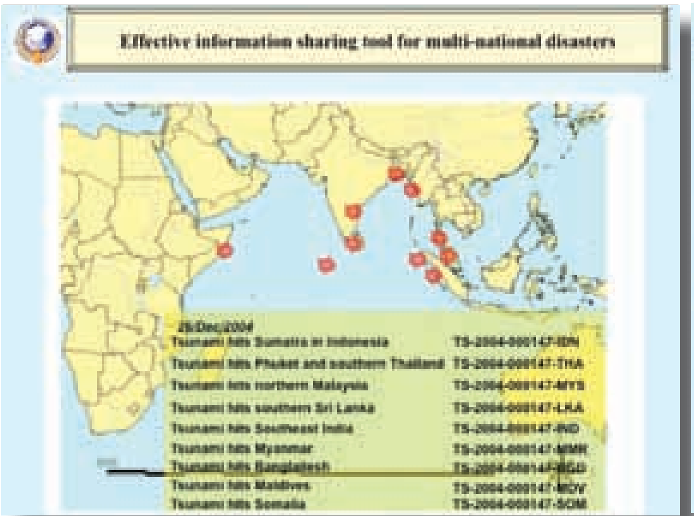


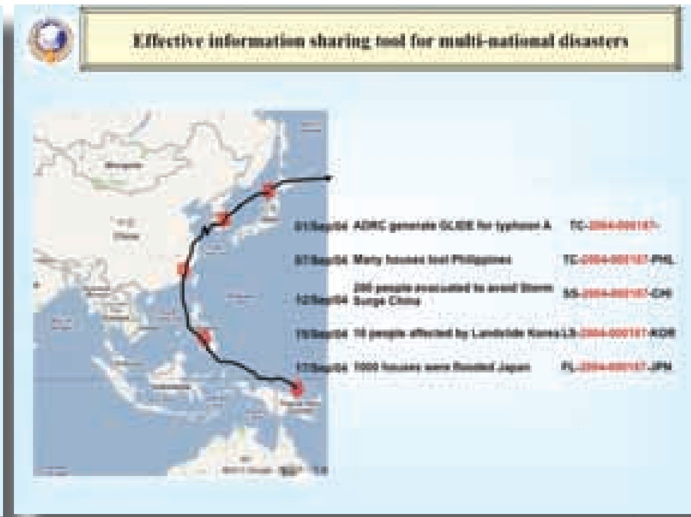


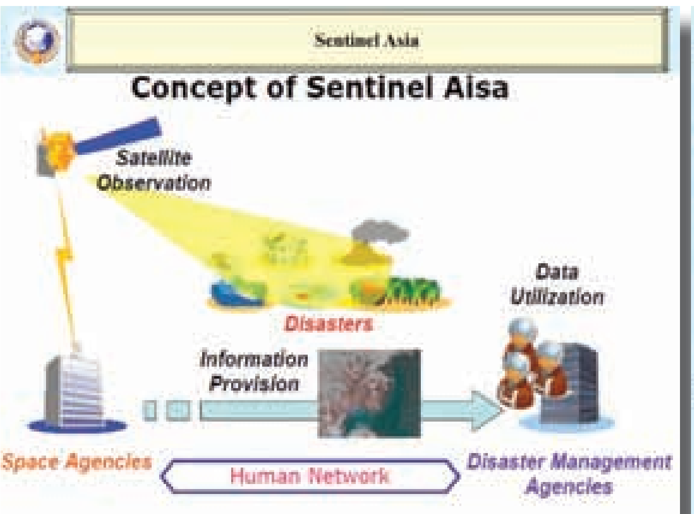


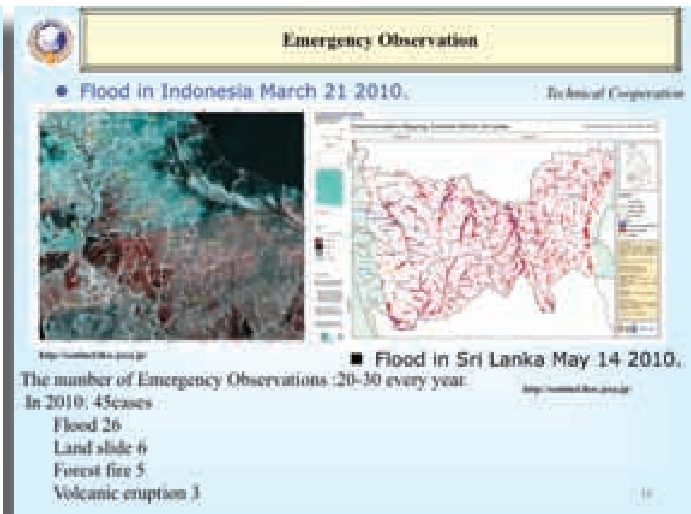

UNOCHA ReliefWeb connected through GLIDE number
TS-2007-000042-SLB
ReliefWeb
Solomon Islands: Earthquake and Tsunami - Apr 2007


Calamidat.ph
calamidat.ph
CALAMIDAT.PH is an internet-based GLIDE associated national disaster event database system that serves as a tool to support evidence-based preparedness and mitigation initiatives for disaster risk management. This system was developed by the Office of Civil Defense in cooperation with the Asian Disaster Reduction Center (ADRC).
View Event
TC-2006-000175-PHL


Effective information sharing tool for multi-national disasters
26/Dec/2004
Tsunami hits Sumatra in Indonesia TS-2004-000147-IDN
Tsunami hits Phuket and southern Thailand TS-2004-000147-THA
Tsunami hits northern Malaysia TS-2004-000147-MYS
Tsunami hits southern Sri Lanka TS-2004-000147-LKA
Tsunami hits Southeast India TS-2004-000147-IND
Tsunami hits Myanmar TS-2004-000147-MMR
Tsunami hits Bangladesh TS-2004-000147-BGD
Tsunami hits Maldives TS-2004-000147-MDV
Tsunami hits Somalia TS-2004-000147-SOM


Effective information sharing tool for multi-national disasters
01/Sep/04 ADRC generate GLIDE for typhoon A TC-2004-000187-
07/Sep/04 Many houses lost Philippines TC-2004-000187-PHL
12/Sep/04 200 people evacuated to avoid Storm Surge China SS-2004-000187-CHN
15/Sep/04 10 people affected by Landslide Korea LS-2004-000187-KOR
17/Sep/04 1000 houses were flooded Japan FL-2004-000187-JPN


Sentinel Asia
Concept of Sentinel Aisa
Satellite Observation
Disasters
Data Utilization
Information Provision
Space Agencies
Human Network
Disaster Management Agencies


Emergency Observation
Flood in Indonesia March 21 2010.
Technical Cooperation
Flood in Sri Lanka May 14 2010.
The number of Emergency Observations :20-30 every year.
In 2010: 45cases
Flood 26
Land slide 6
Forest fire 5
Volcanic eruption 3


Disaster Information with Satellite Images
ADRC


Thank You For Your Attention
http://www.adrc.asia

ESCAP/WMO Typhoon Committee 43rd Session
17-22 January 2011, Jeju Island, Republic of Korea

Brief Introduction of Storm Surge Model in NMC of CMA

Xu Yinglong

National Meteorological Center of CMA

Background of Strom Surge Model

- Established by National Meteorological Centre of CMA in collaboration with East China Normal University in 2009
- Based on FVCOM (Finite-Volume Coastal Ocean Model) developed by Marine Ecosystem Dynamics Modeling Laboratory led by Dr. C. Chen at University of Massachusetts – Dartmouth (UMASS-D) in collaboration with Dr. R. Beardsley at the Woods Hole Oceanographic Institution.

Model Description

Two storm surge models covering different regions are established:

- North and East China Sea storm surge model
- South China Sea storm surge model

Model Description

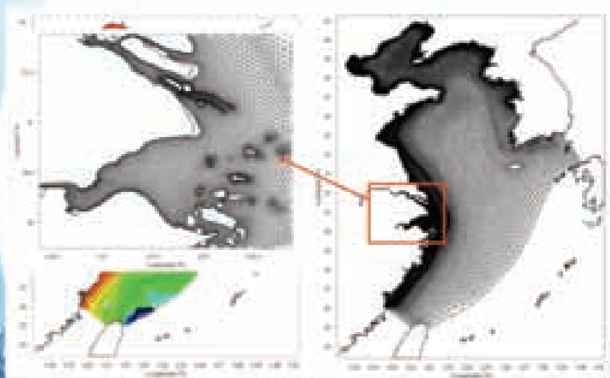
- unstructured grid
- free surface
- primitive equation
- finite-volume discrete method

combines the best attributes of finite-difference methods for simple discrete coding and computational efficiency and finite-element methods for geometric flexibility.

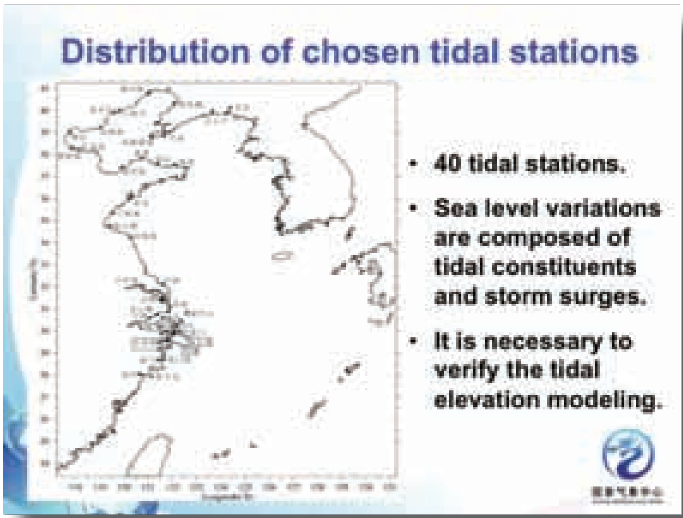
North and East China Sea Storm Surge Model

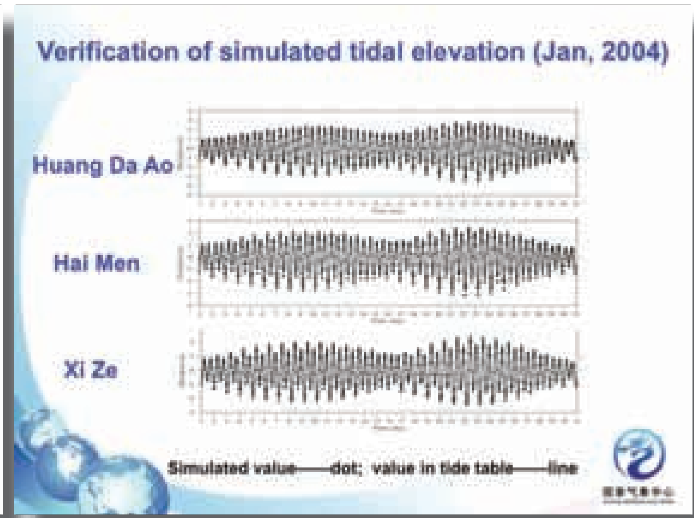
- Operational running from August, 2009
- Twice one day, 00:00UTC and 12:00UTC
- Forecasting validity: 72 hours
- Output storm surge values with 1-hour interval
- Driving forces: extra-tropical weather systems and tropical cyclone

Model region and unstructured grid



highest spatial resolution:200m





Errors of simulated tidal elevation

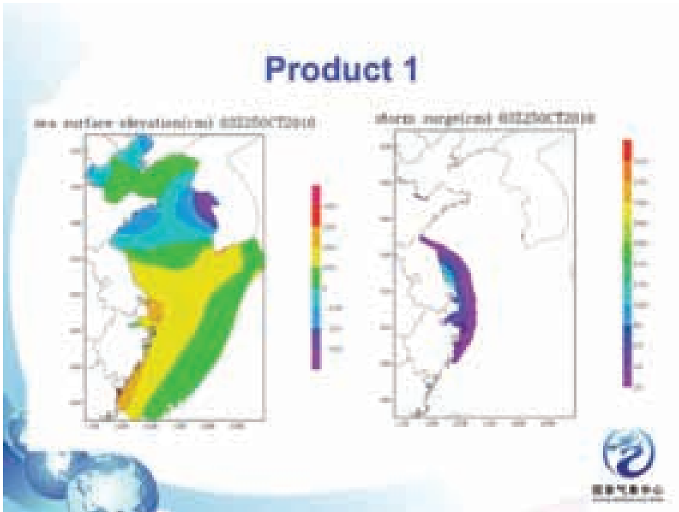
tide station	黄大岙	海门港	西泽	崎头角	北仑港	沈家门	镇海	定海
relative error (%)	2.89	4.73	4.51	2.55	12.12	5.13	11.42	6.75
tide station	岱山	乍浦	滩浒	金山嘴	绿华山	芦潮港	中浚	高桥
relative error (%)	9.3	7.16	6.6	7.89	5.28	0.5	0.02	9.7
Tide station	吕四	洋口	连云港	日照港	青岛	莱州港	威海	烟台
relative error (%)	12.31	0.8	2.12	2.21	0.92	13.43	1.53	9.26
Tide station	[illegible]	黄骅港	塘沽	京唐港	秦皇岛	山海关	鲅鱼圈	锦州港
Relative error (%)	17.4	4.85	3.25	0.95	5.3	2.44	1.97	5.96
Mean error (%)	5.66							

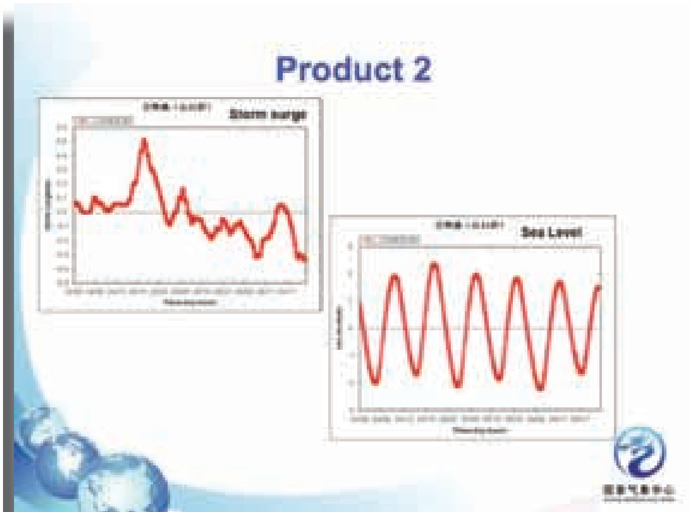
Mean errors of simulated sea level (typhoon storm surge + tidal elevations)

TC Number (Name)	大戢山	芦潮港	镇海	佘山	岱山	滩浒	石浦	mean error (%)
0509(Matsa)	0.92	21.80	14.51	15.34	1.58	9.38	5.33	9.84
0515 (Khanun)	15.82	2.53	7.21	1.16	24.41	23.37	11.65	12.31
0608(Saomai)	3.35	16.16	2.58	12.48	4.75	5.94	2.71	6.85

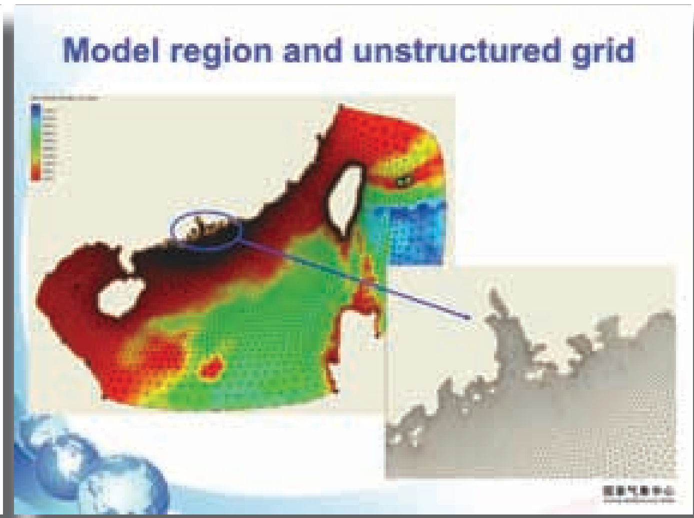
Mean errors of simulated sea level (extratropical storm surge + tidal elevations)

Time	大陈	洞头	坎门	三沙	石浦	镇海	mean error (%)
March 2006	12.24	13.85	4.23	11.19	29.54	18.66	14.95
April 2006	1.55	16.32	6.55	15.29	7.53	0.07	7.89
March 2007	5.96	17.68	1.80	15.04	16.74	19.59	12.80

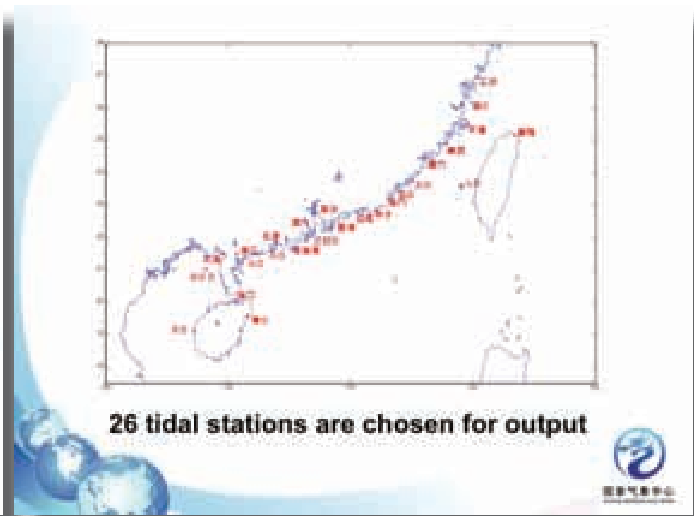


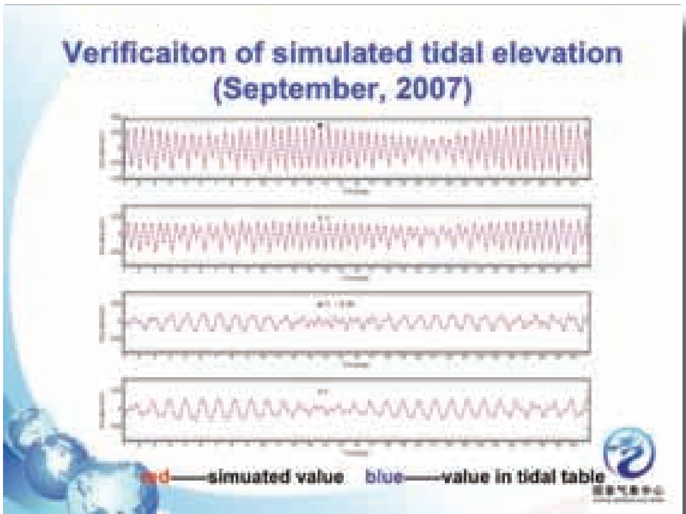


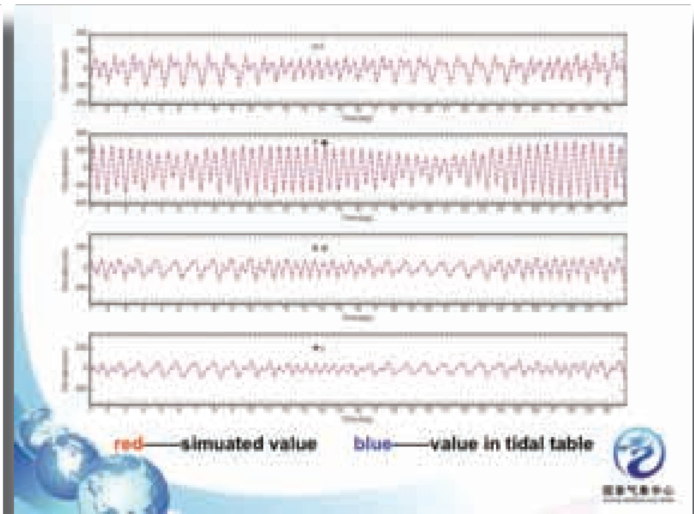

South China Sea Storm Surge Model
• Operational running from August, 2010
• Four times one day, 00:00UTC、06:00UTC、12:00UTC、18:00UTC
• Forecasting validity: 72 hours
• Output storm surge values with 1-hour interval
• Driving force: tropical cyclone


Model region and unstructured grid


Model Description
• Grid：unstructured triangular grid
• Region：13.6°N－28.2°N, 105.6°E －126.7°E
• Resolution：2km-80km
• Discrete method：finite volume method
• Initial condition：u = v = ω = 0
• Lateral boundary：tidal constituents （M2, S2, N2, K2, K1, O1, P1, Q1）；fresh water transport from the coastal solid boundary
• Surface forcing：wind stress、air pressure
• Bottom Friction Coefficient：Manning Formula


26 tidal stations are chosen for output


Verificaiton of simulated tidal elevation (September, 2007)
red——simuated value blue——value in tidal table


red——simuated value blue——value in tidal table

Errors of simulated tidal elevation

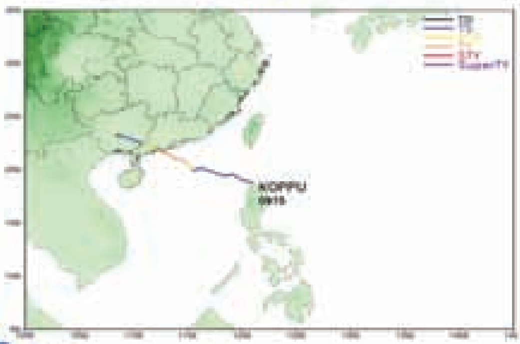
	厦门	东山	海口	东方	汕头	平潭	香港	[illegible]
absolute error(cm)	33.99	20.39	17.81	18.17	12.04	18.97	18.48	11.85
relative error(%)	14.51	13.37	12.85	21.54	9.57	5.86	16.09	15.45
mean absolute error (cm)	18.96							
Mean relative error(%)	13.65							

Hindcasting Cases

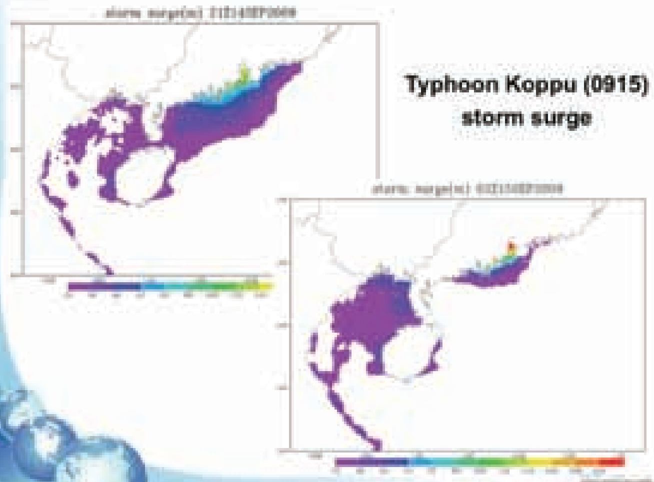
（1）Typhoon Koppu (0915) storm surge

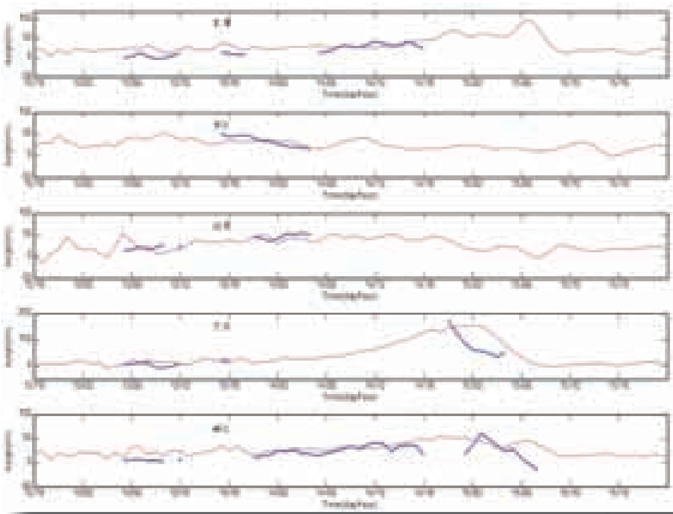
（2）Typhoon Ketsana (0916) storm surge

（1） Typhoon Koppu (0915) storm surge

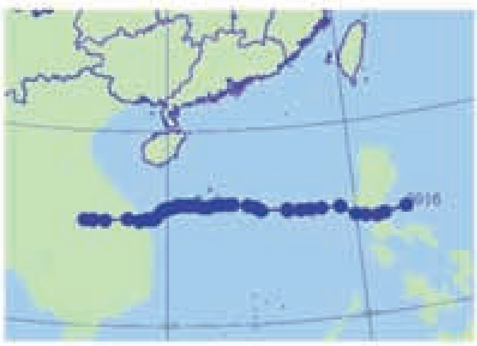


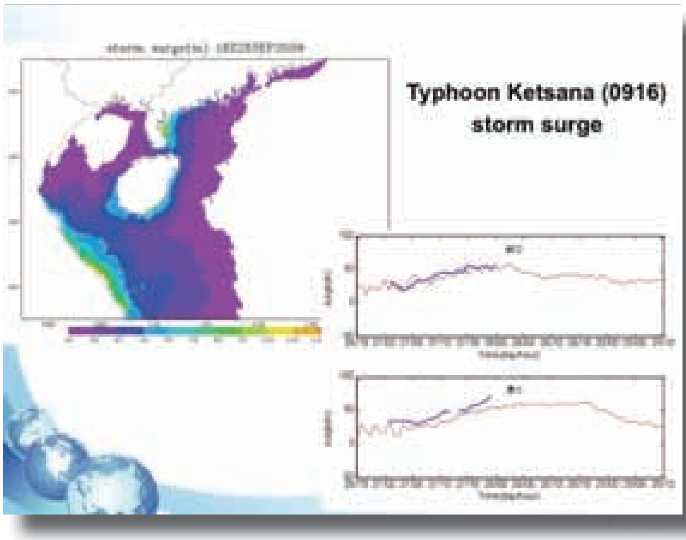
Typhoon Koppu (0915) storm surge

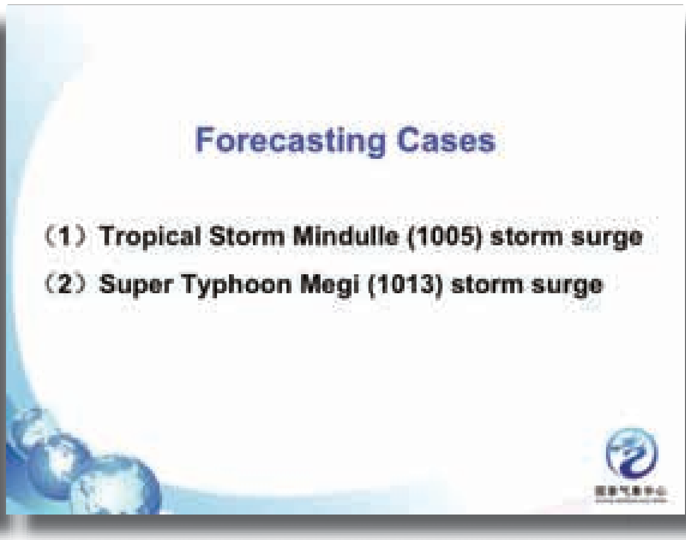




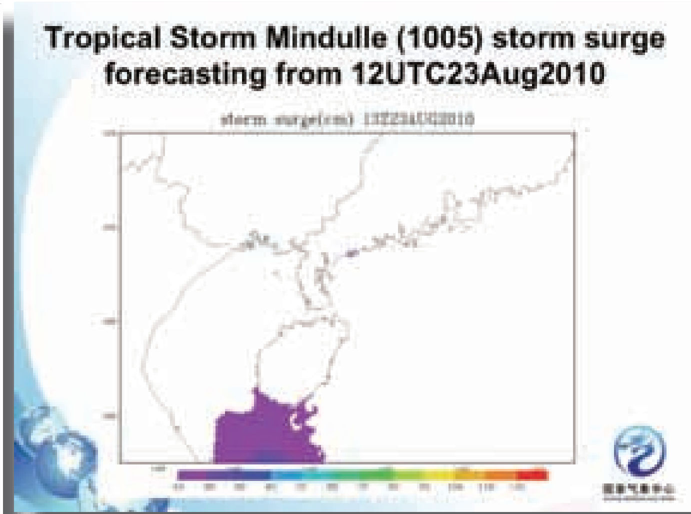
（2）Typhoon Ketsana (0916) storm surge

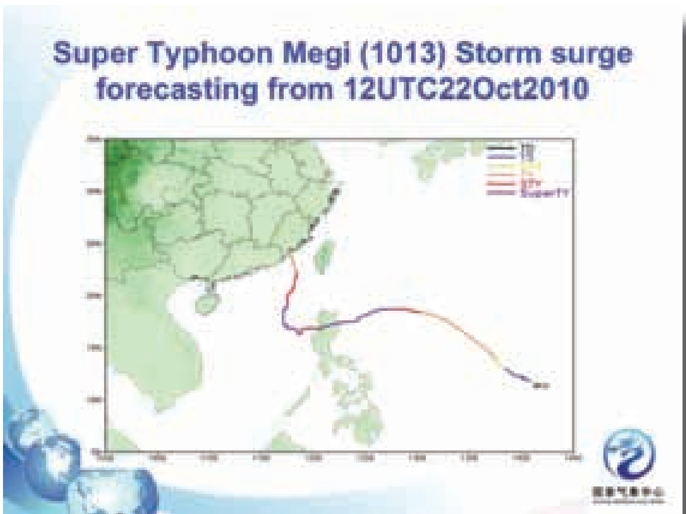


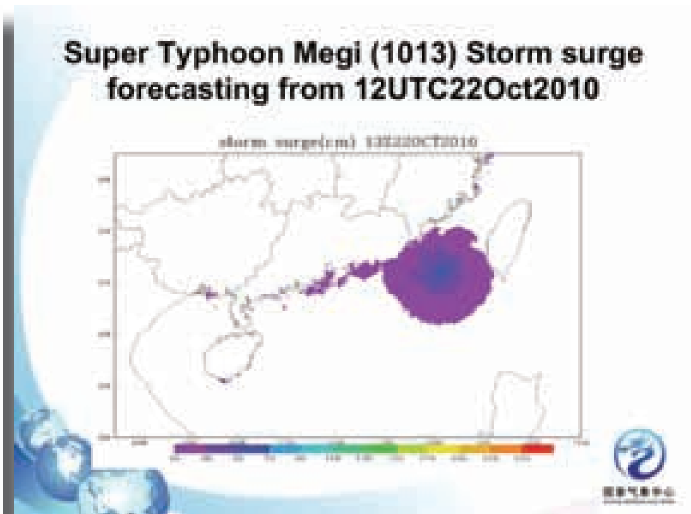

Typhoon Ketsana (0916)
storm surge


Forecasting Cases
(1) Tropical Storm Mindulle (1005) storm surge
(2) Super Typhoon Megi (1013) storm surge


Tropical Storm Mindulle (1005) storm surge
forecasting from 12UTC23Aug2010


Tropical Storm Mindulle (1005) storm surge
forecasting from 12UTC23Aug2010


Super Typhoon Megi (1013) Storm surge
forecasting from 12UTC22Oct2010

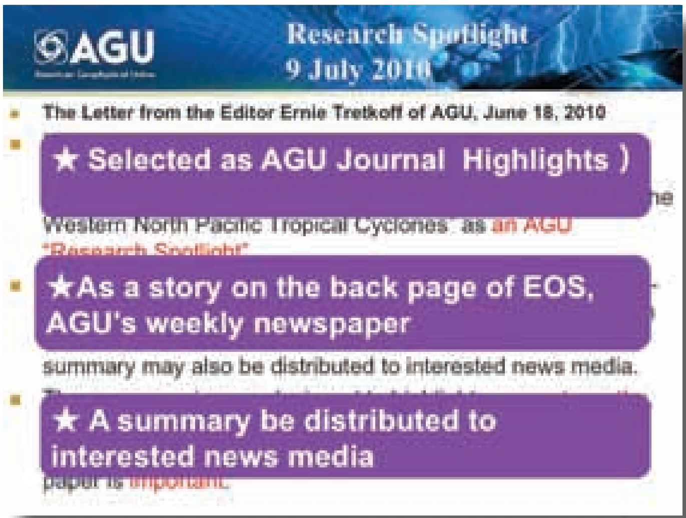

Super Typhoon Megi (1013) Storm surge
forecasting from 12UTC22Oct2010

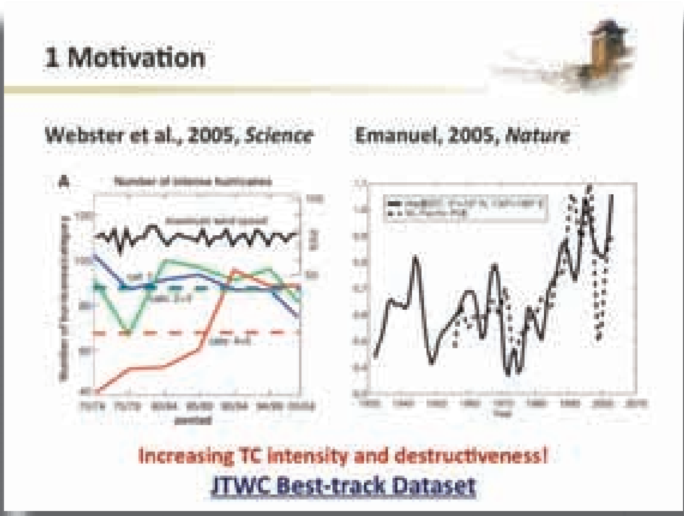

In Future
• High resolution, especially along the coastal areas (estuary and delta).
• Different weather forcing field from different numeraicl weather models.


Thank You for Your Attention!

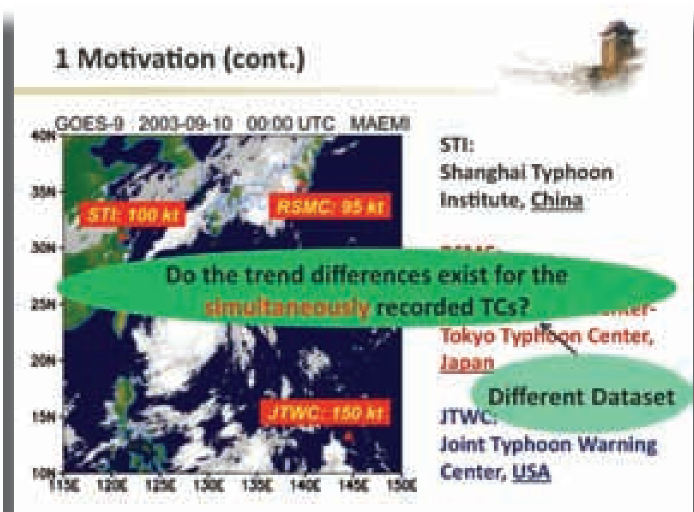

南京大学
NANJING UNIVERSITY
The Forty-third session of the Typhoon Committee/ESCAP/WMO
Trend Discrepancies among Three Best-track Datasets of Western North Pacific Tropical Cyclones
Prof. Yuan Wang(Corresponding Author)
Collaborators: Dr. Jin-Jie Song(First Author), Prof. Liguang Wu
Jeju island, Korea, Jan. 21, 2011

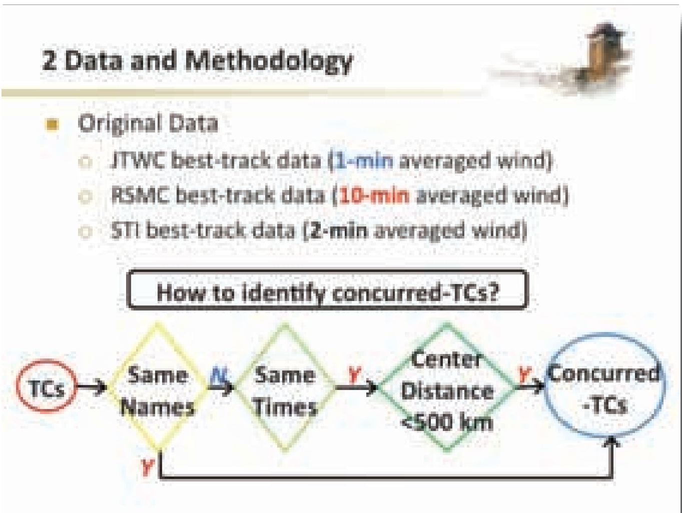

Outline
I. Motivation
II. Data and Methodology
III. Differences in TC Center Position and Intensity
IV. Trend Discrepancies in TC Activities
V. Conclusions and Discussions
More details can be found :
2010: J. Geophys. Res., 115, D12128, doi:10.1029/2009JD013058

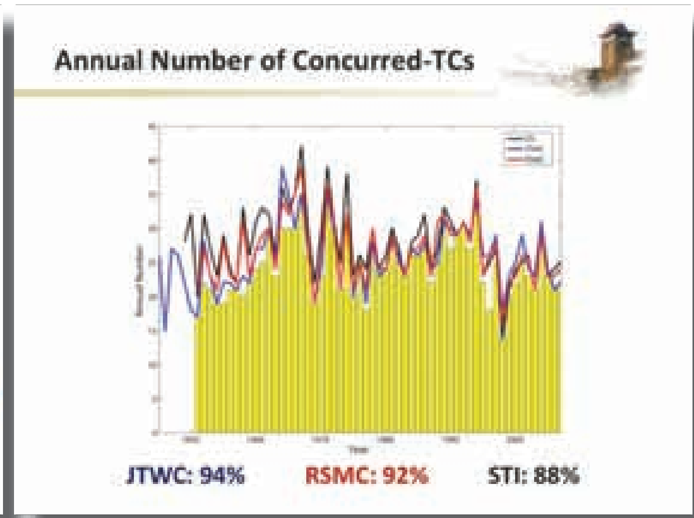

AGU
Research Spotlight
9 July 2010
The Letter from the Editor Ernie Tretkoff of AGU, June 18, 2010
★ Selected as AGU Journal Highlights)
★As a story on the back page of EOS, AGU's weekly newspaper
summary may also be distributed to interested news media.
★ A summary be distributed to interested news media


1 Motivation
Webster et al., 2005, Science
Emanuel, 2005, Nature
Increasing TC intensity and destructiveness!
JTWC Best-track Dataset


1 Motivation (cont.)
FIG. TC warning centers on the western North Pacific, including WMO Regional Specialized Meteorological Center (RSMC) and National Meteorological and Hydrological Service (NMHS)

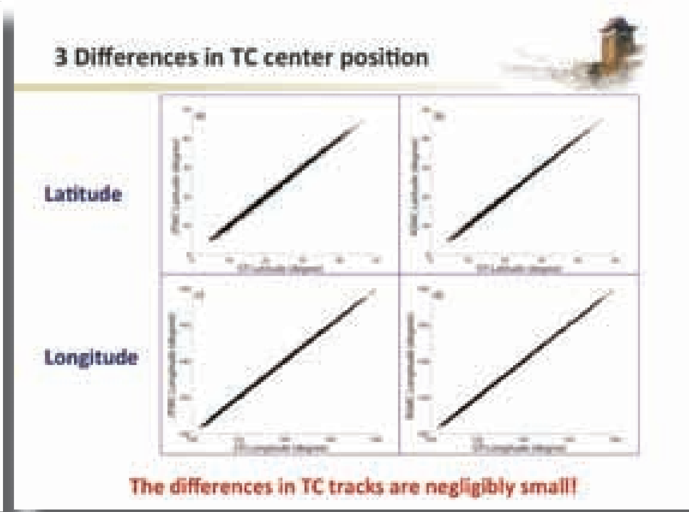

1 Motivation (cont.)
GOES-9 2003-09-10 00:00 UTC MAEMI
STI: 100 kt
RSMC: 95 kt
JTWC: 150 kt
STI:
Shanghai Typhoon Institute, China
Do the trend differences exist for the simultaneously recorded TCs?
Tokyo Typhoon Center, Japan
Different Dataset
JTWC:
Joint Typhoon Warning Center, USA

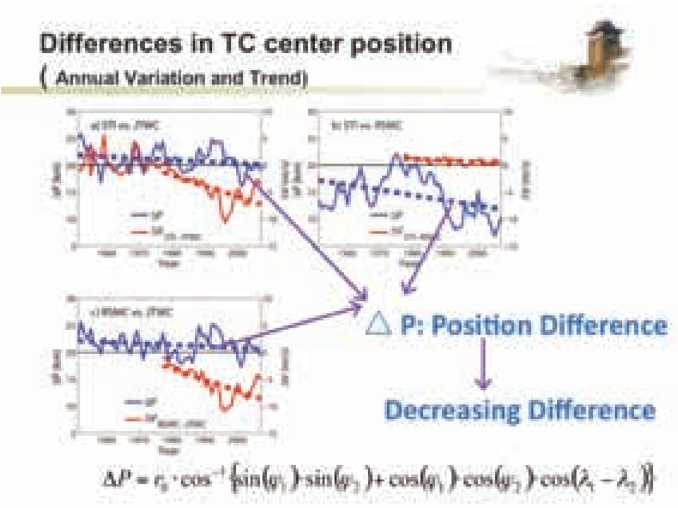


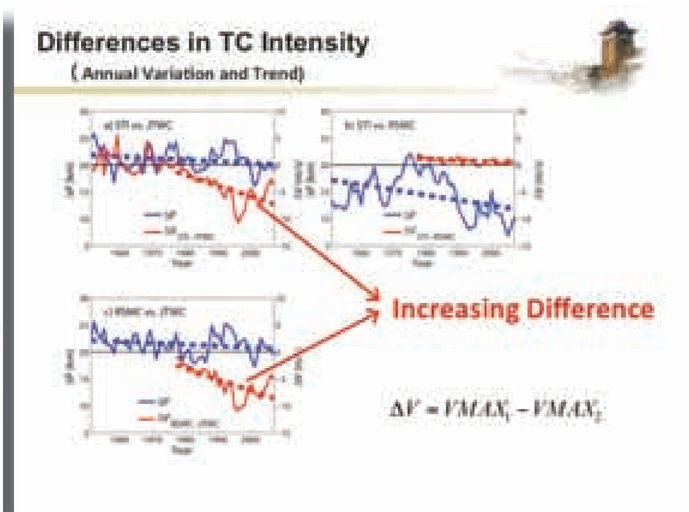


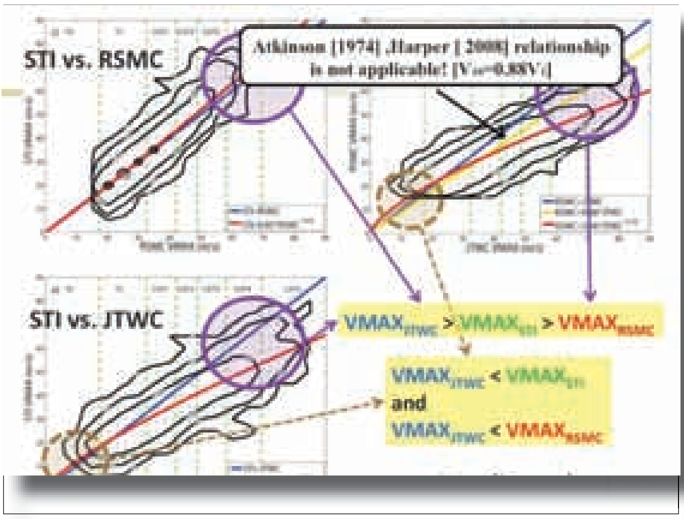
TC Intensity Scales

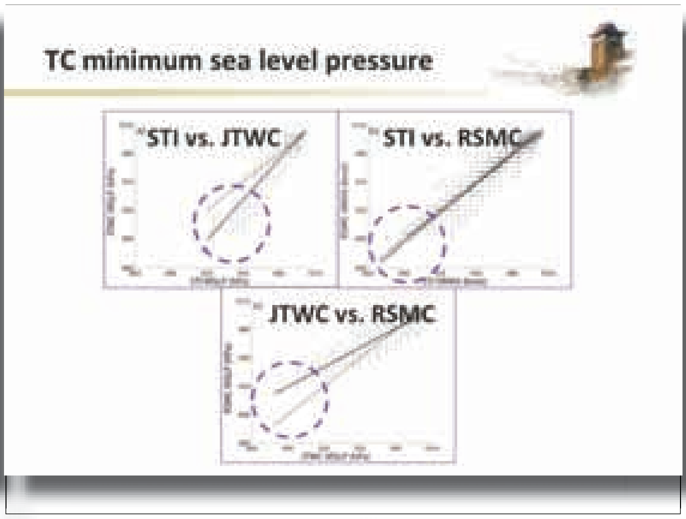
STI Scale 1949-1988	STI Scale 1989-2005	STI Scale 2006-2007	Saffir-Simpson Scale	VMAX (m s⁻¹)	MSLP (hPa)
Tropical Depression	Tropical Depression	Tropical Depression	Tropical Depression	<17.2	—
Typhoon	Tropical Storm	Tropical Storm	Tropical Storm	17.2-24.2	—
Typhoon	Severe Tropical Storm	Severe Tropical Storm	Tropical Storm	24.3-32.5	—
Severe Typhoon	Typhoon	Typhoon	Category 1 Typhoon	32.6-42.1	>980
Severe Typhoon	Typhoon	Severe Typhoon	Category 2 Typhoon	42.2-48.8	965-980
Severe Typhoon	Typhoon	Super Typhoon	Category 3 Typhoon	48.9-58.1	945-965
Severe Typhoon	Typhoon	Super Typhoon	Category 4 Typhoon	58.2-69.4	920-945
Severe Typhoon	Typhoon	Super Typhoon	Category 5 Typhoon	>69.4	<920

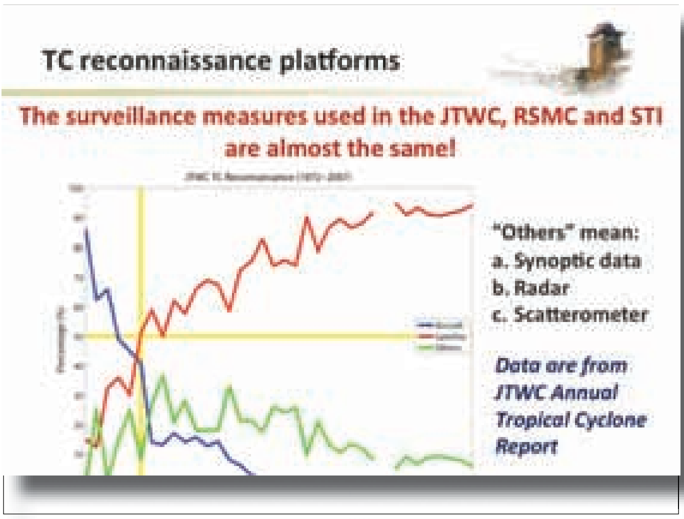


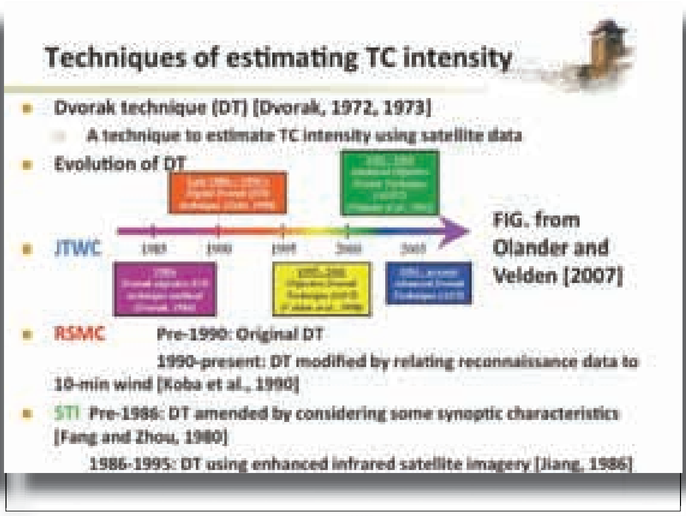


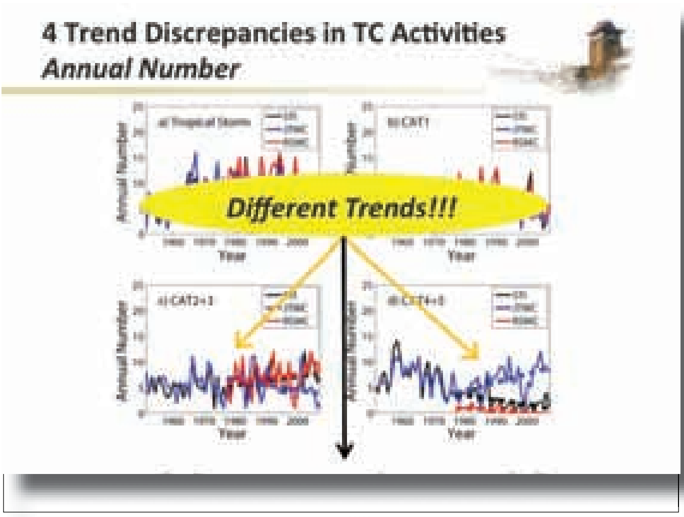


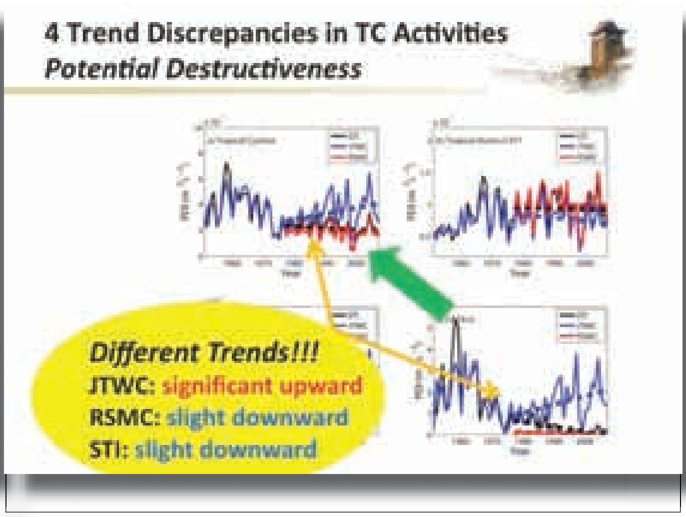

STI vs. RSMC
Atkinson [1974] ,Harper [2008] relationship is not applicable!
STI vs. JTWC
VMAX JTWC > VMAX STI > VMAX RSMC
VMAX JTWC < VMAX STI
and
VMAX JTWC < VMAX RSMC

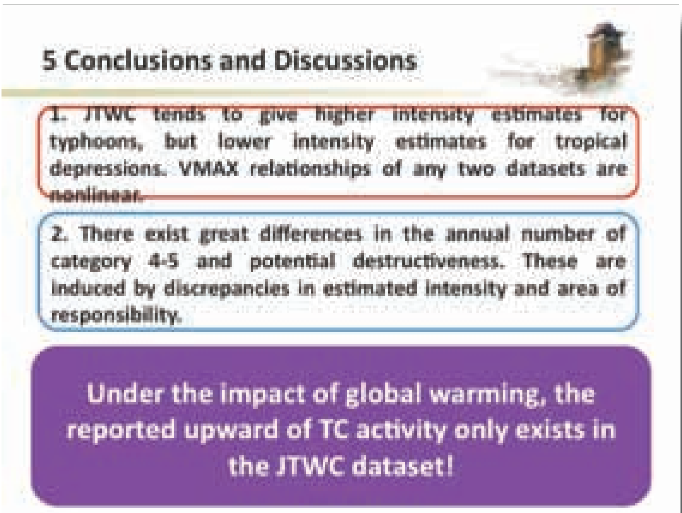

TC minimum sea level pressure
STI vs. JTWC
STI vs. RSMC
JTWC vs. RSMC


TC reconnaissance platforms
The surveillance measures used in the JTWC, RSMC and STI are almost the same!
"Others" mean:
a. Synoptic data
b. Radar
c. Scatterometer
Data are from JTWC Annual Tropical Cyclone Report


Techniques of estimating TC intensity
Dvorak technique (DT) [Dvorak, 1972, 1973]
A technique to estimate TC intensity using satellite data
Evolution of DT
JTWC
FIG. from Olander and Velden [2007]
RSMC Pre-1990: Original DT
1990-present: DT modified by relating reconnaissance data to 10-min wind [Koba et al., 1990]
STI Pre-1986: DT amended by considering some synoptic characteristics [Fang and Zhou, 1980]
1986-1995: DT using enhanced infrared satellite imagery [Jiang, 1986]

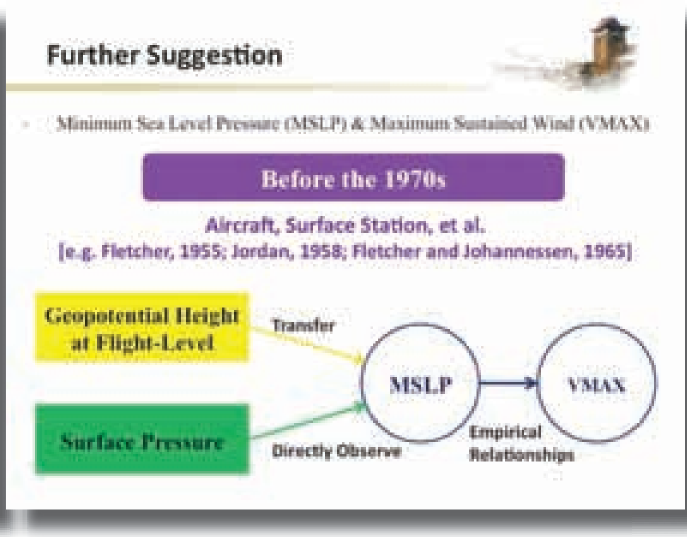

4 Trend Discrepancies in TC Activities
Annual Number
Different Trends!!!
Annual Number
Year

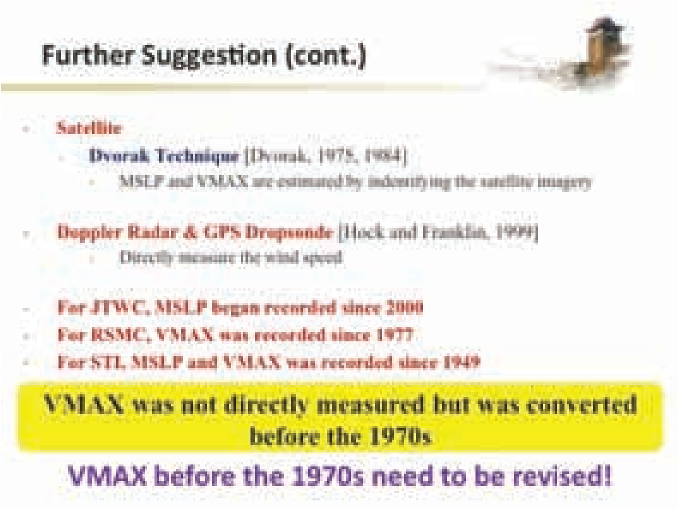

4 Trend Discrepancies in TC Activities
Potential Destructiveness
Different Trends!!!
JTWC: significant upward
RSMC: slight downward
STI: slight downward

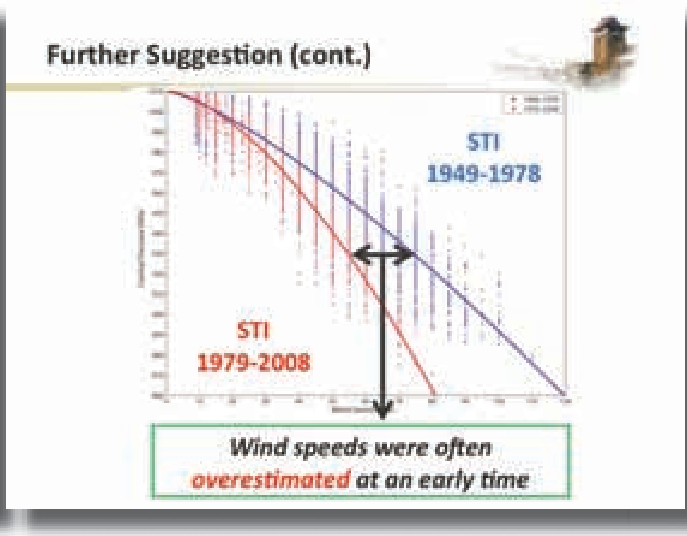

5 Conclusions and Discussions
1. JTWC tends to give higher intensity estimates for typhoons, but lower intensity estimates for tropical depressions. VMAX relationships of any two datasets are nonlinear.
2. There exist great differences in the annual number of category 4-5 and potential destructiveness. These are induced by discrepancies in estimated intensity and area of responsibility.
Under the impact of global warming, the reported upward of TC activity only exists in the JTWC dataset!

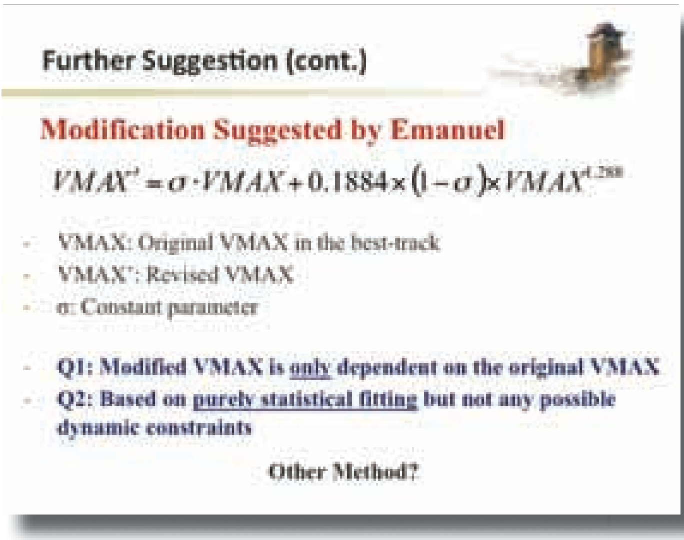

Further Application
Data Resources
IBTrACS
International
Best
Track
Archive
for
Climate
Stewardship
National Climatic Data Center
RSMC Miami,
RSMC Honolulu,
RSMC Tokyo,
RSMC New Delhi,
RSMC La Reunion,
RSMC Nadi,
TCWC Perth,
TCWC Darwin,
TCWC Brisbane,
TCWC Wellington,
CMA-Shanghai Typhoon Institute,
Joint Typhoon Warning Center,
Hong Kong Observatory,
NCDC DSI-9636
UCAR ds824.1

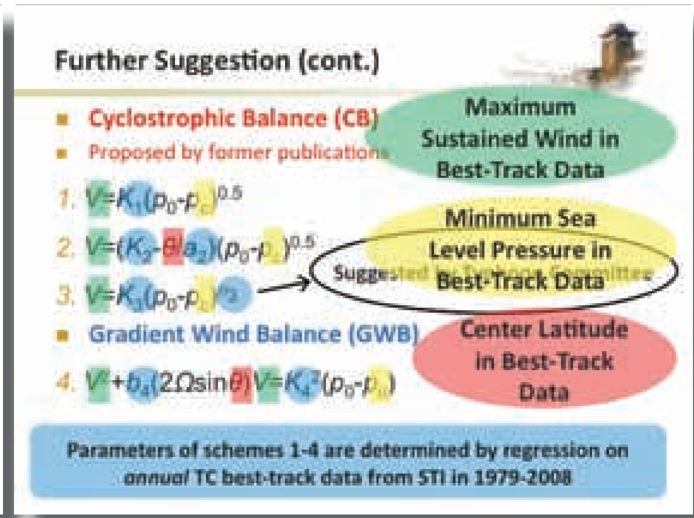

Further Application (cont.)
http://http://www.ncdc.noaa.gov/oa/ibtracs/index.php?name=faq
Why does IBTrACS differ from HURDAT (or data from other agencies)?
v02r01 and earlier
First, all winds are reported as 10-minute winds. Data from NOAA (HURDAT, CPHC), JTWC and the RSMC New Delhi (IMD) all provide data as 1-minute. Winds were converted to 10-min using:
Second, IBTrACS is a compilation of data from all available agencies. So the number storms in IBTrACS will likely be larger than the number of storms from an individual agency.
Third, since IBTrACS is a compilation of data from many agencies, the IBTrACS maximum sustained winds (MSW) is an average from all available agencies and will likely be different from the reports of each agency. Calculating statistics from IBTrACS (like ACE, number of super typhoons, etc.) will result in values which are more than likely different from those of any particular agency.
Needs to be improved!

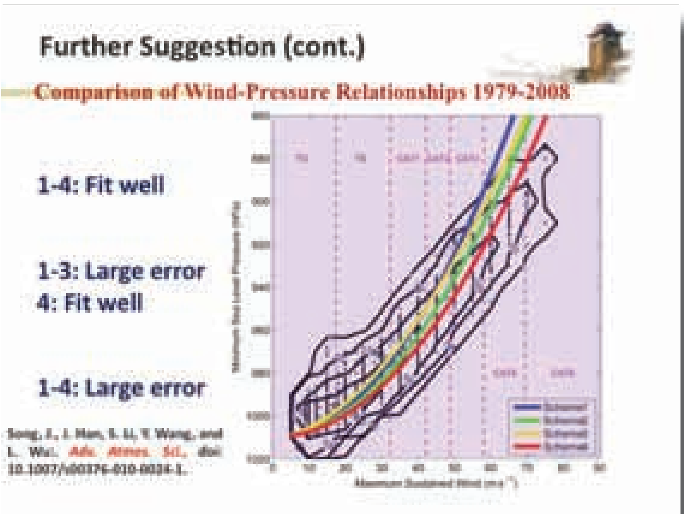

Further Suggestion
Minimum Sea Level Pressure (MSLP) & Maximum Sustained Wind (VMAX)
Before the 1970s
Aircraft, Surface Station, et al.
[e.g. Fletcher, 1955; Jordan, 1958; Fletcher and Johannessen, 1965]
Geopotential Height at Flight-Level
Transfer
Surface Pressure
Directly Observe
MSLP
VMAX
Empirical Relationships


Further Suggestion (cont.)
Satellite
Dvorak Technique [Dvorak, 1975, 1984]
MSLP and VMAX are estimated by indentifying the satellite imagery
Doppler Radar & GPS Dropsonde [Hock and Franklin, 1999]
Directly measure the wind speed
For JTWC, MSLP began recorded since 2000
For RSMC, VMAX was recorded since 1977
For STI, MSLP and VMAX was recorded since 1949
VMAX was not directly measured but was converted before the 1970s
VMAX before the 1970s need to be revised!


Further Suggestion (cont.)
STI
1949-1978
STI
1979-2008
Wind speeds were often overestimated at an early time


Further Suggestion (cont.)
Modification Suggested by Emanuel
VMAX' = σ·VMAX + 0.1884×(1−σ)×VMAX^1.288
VMAX: Original VMAX in the best-track
VMAX': Revised VMAX
σ: Constant parameter
Q1: Modified VMAX is only dependent on the original VMAX
Q2: Based on purely statistical fitting but not any possible dynamic constraints
Other Method?


Further Suggestion (cont.)
Cyclostrophic Balance (CB)
Proposed by former publications
Maximum Sustained Wind in Best-Track Data
Minimum Sea Level Pressure in Best-Track Data
Suggested by Typhoon Committee
Gradient Wind Balance (GWB)
Center Latitude in Best-Track Data
Parameters of schemes 1-4 are determined by regression on annual TC best-track data from STI in 1979-2008


Further Suggestion (cont.)
Comparison of Wind-Pressure Relationships 1979-2008
1-4: Fit well
1-3: Large error
4: Fit well
1-4: Large error
Song, J., J. Han, S. Li, Y. Wang, and L. Wu: Adv. Atmos. Sci., doi 10.1007/s00376-010-0024-1.


Thank You

INTRASEASONAL PREDICTION OF TROPICAL CYCLONE EVENTS: REAL-TIME USE OF THE ECMWF 32-DAY ENSEMBLE FORECASTS FOR ITOP/TCS-10 FIELD EXPERIMENT

Russell L. Elsberry & Mary Jordan
Department of Meteorology
Naval Postgraduate School

Frederic Vitart
European Center for Medium-range Weather Forecasts

OUTLINE

- Background on ECMWF ensemble storm generation
- Evaluation during 2009 season (manuscript in review)
- Case study of TY Megi during ITOP/*TCS-10**

*Impact of Typhoons on the Ocean in the Pacific (ITOP)
** Tropical Cyclone Structure 2010 (TCS-10)

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INTRASEASONAL PREDICTIONS DURING 2009 SEASON

Elsberry et al. (2010, *Asia-Pacific J. Atmos. Sci.*) examined the predictability of western North Pacific tropical cyclone events (formation and track) on intraseasonal timescales with the ECMWF monthly forecasts during June-December 2008 [TY Committee, January 2010]

Viable technique was developed to match ECMWF 32-day ensemble member tropical cyclone-like vortices to form storm tracks

Evidence was documented of some predictability of tropical cyclone formation and tracks on timescales of up to four weeks.

Objective is to evaluate ECMWF ensemble performance during the more typical 2009 typhoon season without the benefit of the special TCS-08/T-PARC field experiment observations

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DATA SOURCE

Experimental ECMWF 32-day ensemble forecasts made once a week on Thursdays

- Extension of operational ensemble integration from 10 days
- 50 members plus control
- Horizontal resolution ~ 60 km to Day 10 and then ~ 80 km (2009)
- ~ 30 km to Day 10 and then ~ 50 km (2010)
- 62 levels
- Stochastic physics in tropics
- Coupling with ocean begins at 10 days

Tropical cyclone-like vortex track positions each 12 h predicted by each of the members in the western North Pacific with same tracker as for seasonal forecasts

- Relative vorticity > 3.5 x 10^{-5} s^{-1}
- Warm temperature anomaly in upper troposphere
- Thickness maximum must exceed threshold
- Track must be longer than one day [only use if ≥ 3 days]

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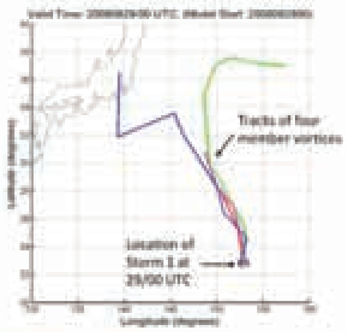
FORMING AN ENSEMBLE STORM

- Beginning at time t = 12 h, ensemble vortices within time-dependent separation distance ε(t) are grouped into an "Ensemble Storm" and a number is assigned.
- Once assigned to an ensemble storm, the vortex stays as a storm member for its entire lifetime.
- Example:
  - At 29/00 UTC, four vortices are within 180 n mi and form Storm 1.



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MATCHING ROUTINE FOR VALIDATING ECMWF STORMS

ECMWF storm tracks are matched with the JTWC storm tracks with same separation threshold ε (t) where t is forecast interval in each 32-day integration.

No time deviation is allowed, so the ECMWF position must be within ε (t) of the JTWC position at the corresponding time.

For each ECMWF storm in which at least one 12-h position matched a JTWC storm position, a quality indicator (excellent, above average, good below average, poor) is subjectively assigned based on similarity of paths and agreement in time over significant fractions of the tracks.

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GENERAL COMMENTS FROM 2009 EVALUATION

Even after having excluded ensemble storms that did not last at least 3 days, ECMWF ensemble model predicted many more ensemble storms than in the Joint Typhoon Warning Center best-track file

ECMWF ensemble storms begin 2-3 (and sometimes many more) days prior to first entry in the JTWC file

Late 2009 season ensemble storms continued to exist over tropical and subtropical ocean areas for extended periods after actual storm had dissipated

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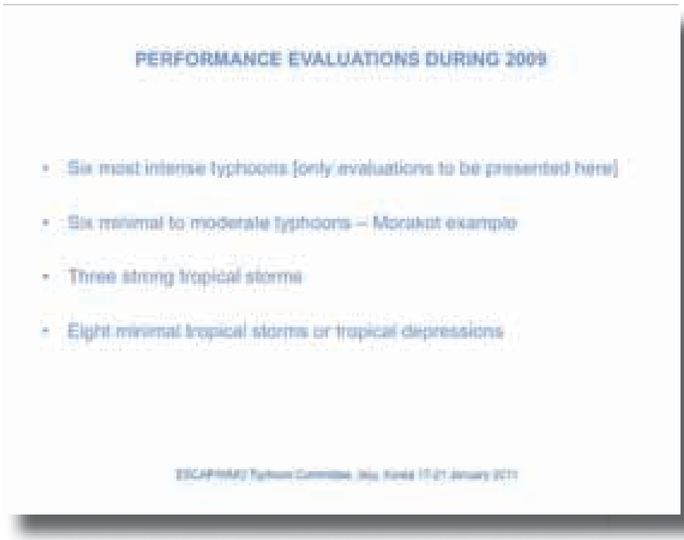
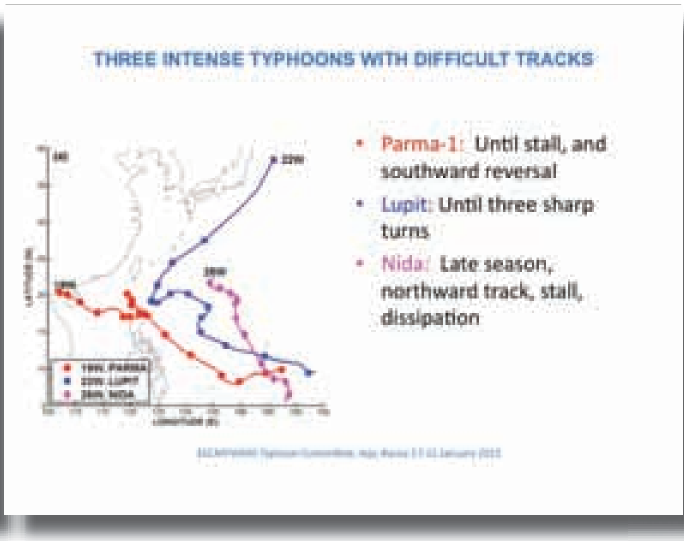
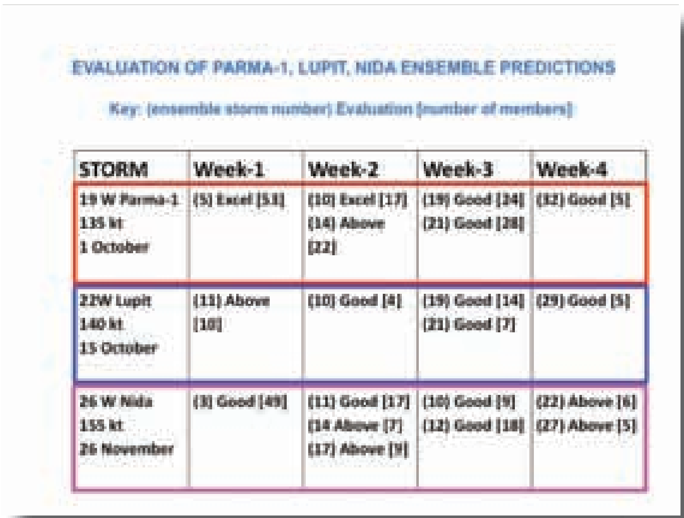
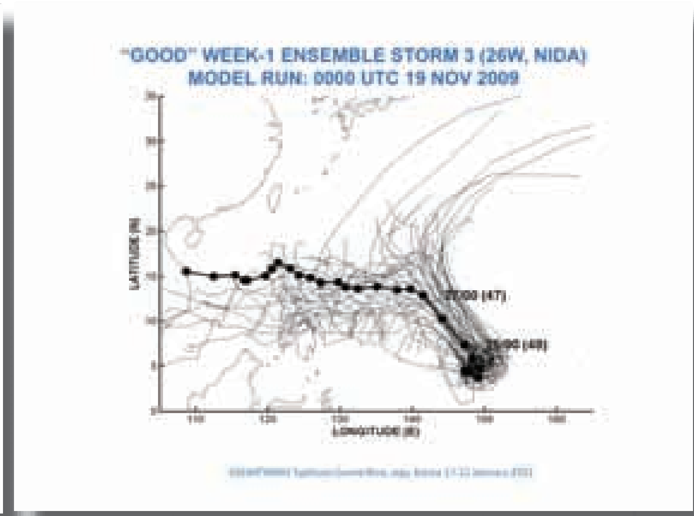
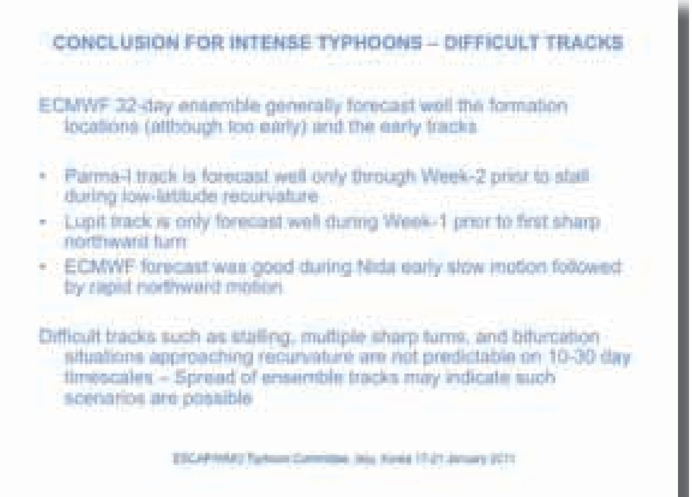


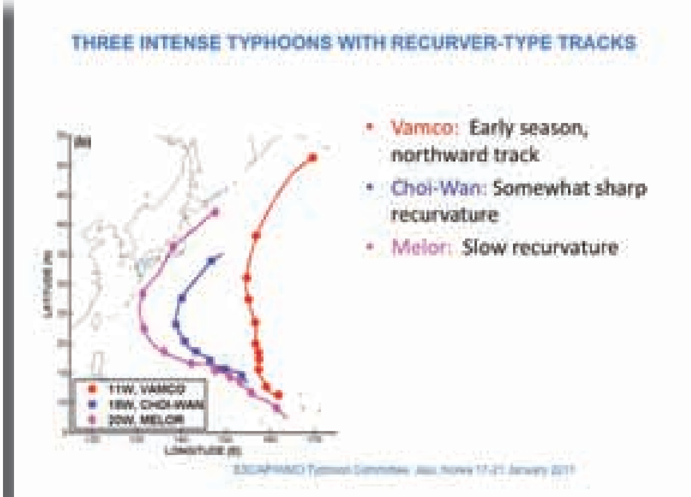




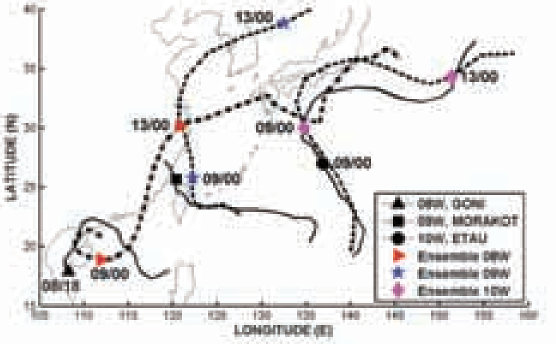
STORM	Week-1	Week-2	Week-3	Week-4
19 W Parma-1 135 kt 1 October	(5) Excel [53]	(10) Excel [17] (14) Above [22]	(19) Good [24] (21) Good [28]	(32) Good [5]
22W Lupit 140 kt 15 October	(11) Above [10]	(10) Good [4]	(19) Good [14] (21) Good [7]	(29) Good [5]
26 W Nida 155 kt 26 November	(3) Good [49]	(11) Good [17] (14 Above [7] (17) Above [9]	(10) Good [9] (12) Good [18]	(22) Above [6] (27) Above [5]







WHY WAS VAMCO (15W) FORECAST SO POORLY?



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CONCLUSIONS FOR OTHER INTENSE TYPHOONS

Melor classical slow recurvature track predominately determined by subtropical high may be forecast on 10-30 day timescales

Choi-Wan somewhat sharper recurvature that depends on midlatitude interaction may be indicated by spread of poleward and westward tracks, but which branch is not predictable on 10-30 day timescales

Although early season, northward track of Vamco (11 W) is somewhat difficult, the complete failure of the Week-1 – Week-3 ECMWF forecasts is attributed to poor initial conditions or poor forecasts of the preceding multiple TC scenario (08W, 09W, 10W)

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SUMMARY OF 2009 SEASON EVALUATION

2009 typhoon season had more typical tracks than during 2008 season. Multiple storm scenarios were common with 17 out of 23 tropical cyclones in the study

Multiple storm scenarios, and four early season typhoons with predominantly northward tracks, were found to be more difficult to forecast on intraseasonal time scales

Difficult tracks such as stalling, multiple sharp turns, and bifurcation situations approaching recurvature are not predictable on 10-30 day timescales – Spread of ensemble tracks may indicate such scenarios are possible

Focus of this study has been on typhoons – three strong tropical storms that involved difficult track scenarios were less successful (not presented here)

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OPERATIONS DURING ITOP/TCS-10 FIELD EXPERIMENT

Both the weekly 32-day and the daily (at 00 UTC) 15-day ECMWF ensemble forecasts were available during the Impact of Typhoons on the Ocean in the Pacific (ITOP) and Tropical Cyclone Structure (TCS-10) field experiment from 20 August – 20 October 2010

Both active and inactive periods of tropical cyclone activity in the field experiment domain were forecast by the weekly ECMWF 32-day ensemble

Ensemble tracks from the 00 UTC 15-day ECMWF forecasts using the weighted mean vector motion technique were nearly always quite competitive with the subjective consensus track forecasts prepared from the 12 UTC numerical model guidance

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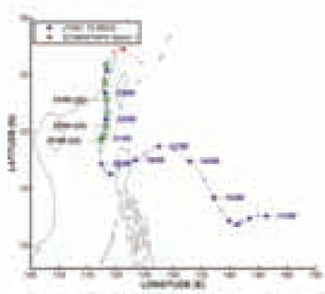
CASE STUDY OF TYPHOON MEGI DURING ITOP/TCS-10

- During second phase (1 – 20 October) of ITOP/TCS-10, oceanographic instrument deployment required one more typhoon of at least 100 kt and 100 flight hours of Air Force WC-130J ("Hurricane Hunters") were available.
- ECMWF ensemble predictions were indicating no typhoons within 1000 km of Guam during at least the first 10 days of October
- Key meteorological support question was: Will there be another typhoon between 10- 20 October?
- This case study examines weekly ECMWF predictions backward in time from when Megi struck the east coast of the Philippines on 18 October 2010.

Week 0* from 10/21 Model Run



- MEGI has existed for 10 days.
- Ensemble Storm 1 has only 32 of 51 members.
- Note early track with formation near 12.5°N 146°E
- Landfall:
  - Philippines on 10/18
  - Fujian on 10/23

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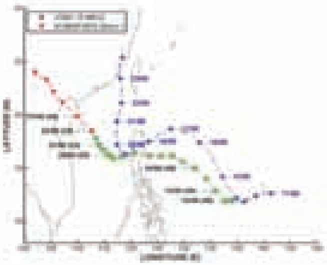
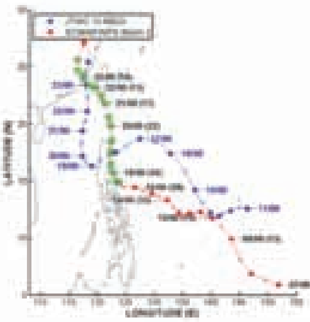
Week 0 from 10/14 Model Run



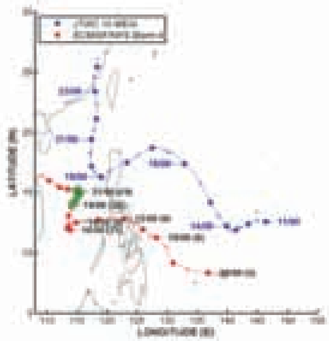
- Ensemble Storm 1 has 54 members because two members contributed multiple vortices.
- Excellent 4-day forecast of RP landfall timing, but ~100 km to the south.
- Did not forecast Day 6 sharp turn northward, so landfall on Hainan vice Fujian.

Week-1 from 10/07 Model Run



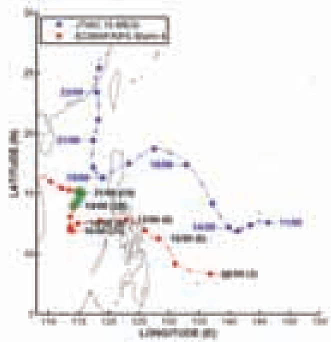
- Ensemble Storm 2 (33 members)
- Eastward formation location is early by 4 days, but slow motion on Days 3-4 in general region where Megi formed.
- Landfall on RP on correct day (Day 11)
- Forecast track to east of Luzon
- Nearly perfect timing and location of Fujian landfall (Day16)

Week-1 from 10/07 Model Run



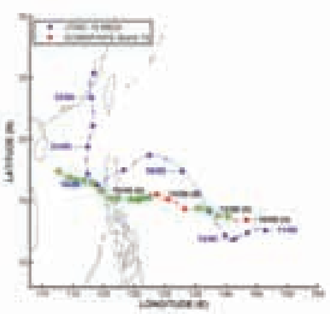
- Ensemble Storm 4 (23 members)
- Eastward formation location is early by 2 days and has fewer members east of RP.
- Landfall too early and too far south.
- Predicted sharp turn to north on correct dates, but then turned westward and persisted over land.

Week-2 from 9/30 Model Run



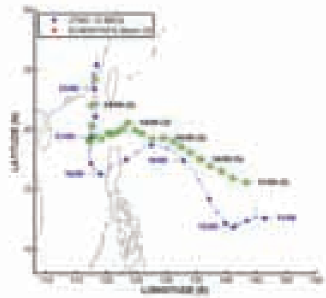
- Ensemble Storm 18 (24 members)
- Late (3 days) formation on Day 15 and 2° latitude to the south.
- Westward and the northwestward track to landfall (Day 24) on Luzon RP five days late.
- Westward, slow track after crossing RP and persists too long.

Week-3 from 9/23 Model Run

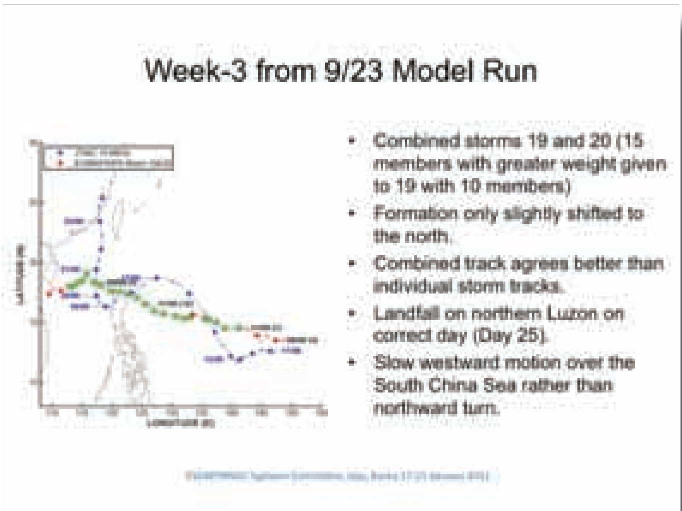


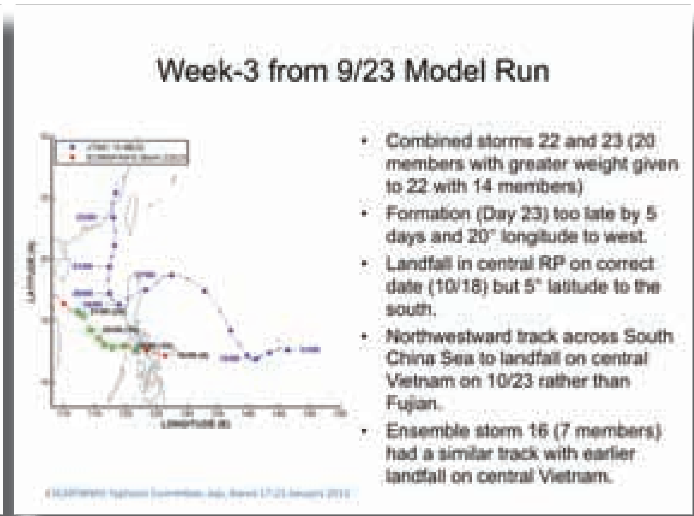
- Ensemble storm 19 (10 members)
- Formation timing (Day 18) is too early by one day.
- Formation location is to west by ~200 km.
- Landfall on Luzon on correct day (Day 25) but ~200 km to south.
- Slow westward to near end of 32-day forecast.

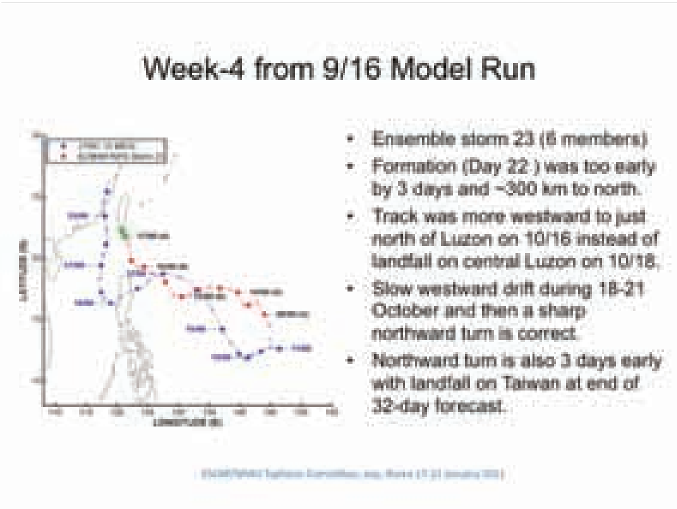
Week-3 from 9/23 Model Run

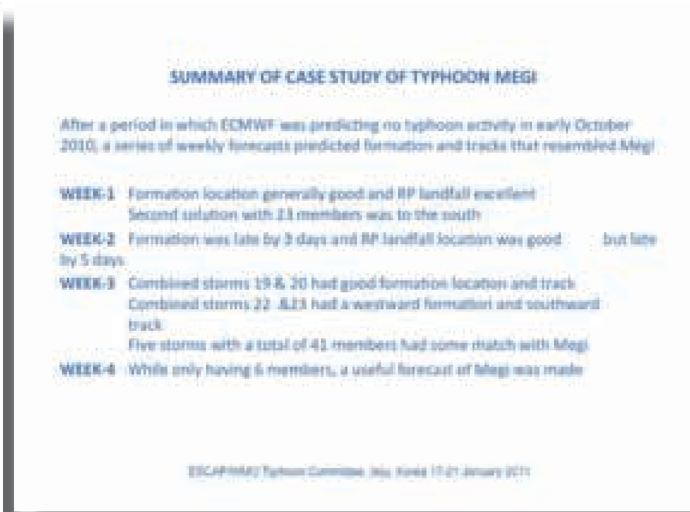


- Ensemble storm 20 (5 members)
- Formation timing (Day 19) is one day late and location is ~300 km to north.
- Track is too far north with no landfall on Luzon.
- Slow westward drift during 18-21 October and then a sharp northward turn is correct.
- Sharp northward turn to excellent landfall position on Fujian on correct day (Day 30).


Week-3 from 9/23 Model Run
Combined storms 19 and 20 (15 members with greater weight given to 19 with 10 members)
Formation only slightly shifted to the north.
Combined track agrees better than individual storm tracks.
Landfall on northern Luzon on correct day (Day 25).
Slow westward motion over the South China Sea rather than northward turn.
LONGITUDE (E)


Week-3 from 9/23 Model Run
Combined storms 22 and 23 (20 members with greater weight given to 22 with 14 members)
Formation (Day 23) too late by 5 days and 20° longitude to west.
Landfall in central RP on correct date (10/18) but 5° latitude to the south.
Northwestward track across South China Sea to landfall on central Vietnam on 10/23 rather than Fujian.
Ensemble storm 16 (7 members) had a similar track with earlier landfall on central Vietnam.
LONGITUDE (E)


Week-4 from 9/16 Model Run
Ensemble storm 23 (6 members)
Formation (Day 22) was too early by 3 days and ~300 km to north.
Track was more westward to just north of Luzon on 10/16 instead of landfall on central Luzon on 10/18.
Slow westward drift during 18-21 October and then a sharp northward turn is correct.
Northward turn is also 3 days early with landfall on Taiwan at end of 32-day forecast.
LONGITUDE (E)


SUMMARY OF CASE STUDY OF TYPHOON MEGI
After a period in which ECMWF was predicting no typhoon activity in early October 2010, a series of weekly forecasts predicted formation and tracks that resembled Megi
WEEK-1 Formation location generally good and RP landfall excellent
Second solution with 23 members was to the south
WEEK-2 Formation was late by 3 days and RP landfall location was good but late by 5 days
WEEK-3 Combined storms 19 & 20 had good formation location and track
Combined storms 22 &23 had a westward formation and southward track
Five storms with a total of 41 members had some match with Megi
WEEK-4 While only having 6 members, a useful forecast of Megi was made
ESCAP/WMO Typhoon Committee, Jeju, Korea 17-21 January 2011


43rd Session
ESCAP/WMO Typhoon Committee
ESCAP
WMO
Scientific Lecture:
Application of Mobile Platforms in Dissemination of Weather Warnings and Information
CM Shun
Hong Kong, China
香港天文台
Hong Kong Observatory

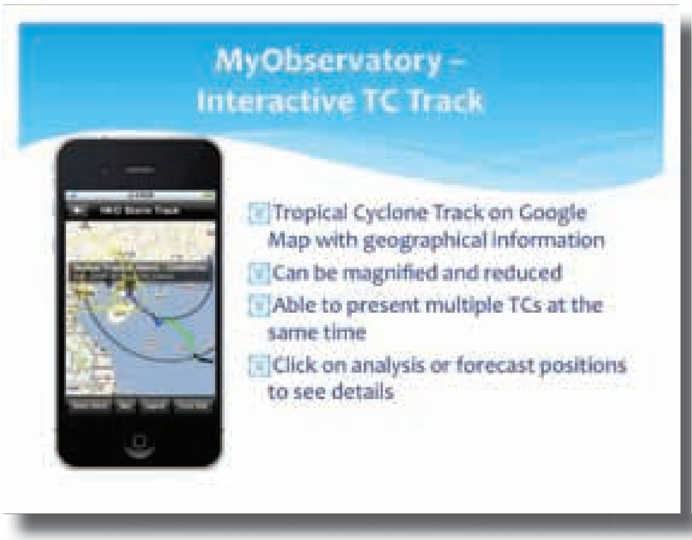

Mobile Devices Getting Popular
Q3 2010 vs Q3 2009
Worldwide mobile phone sales grew 35%
Smartphone sales increased 96%
Source: Gartner, Inc.


Example: Mobile Data Usage in Hong Kong, China
Oct 2010 1,657,557,216 +214% 274.6 +155%
Oct 2009 527,302,544 107.6
Source: Office of Telecom Authority, Hong Kong, China


Opportunities for Weather Service Enhancement
Smartphone can retrieve user's location
location-based weather service
Weather info can be pushed to users
timely warning delivery
Personalized weather service

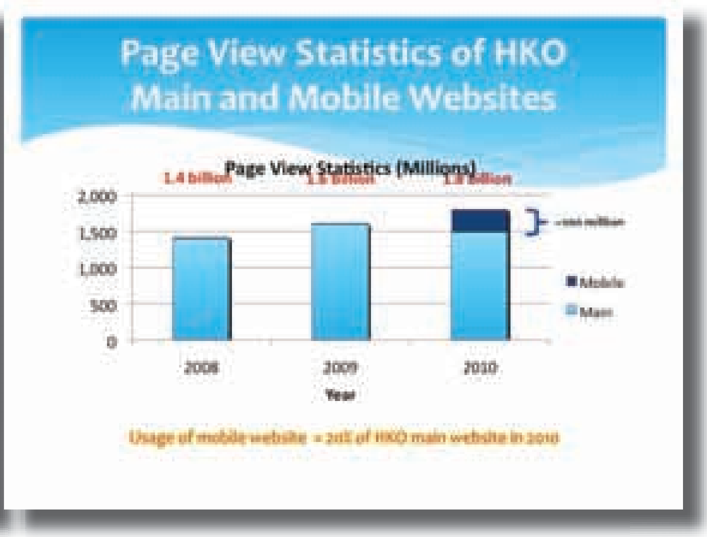

Example: MyObservatory – iPhone App (Launched in March 2010, Enhanced in July)
MyObservatory
14.8°C
Warning in force
Temperature, RH, wind, rainfall near user's location
7-day forecast
UV index
Youtube video
Weather photo

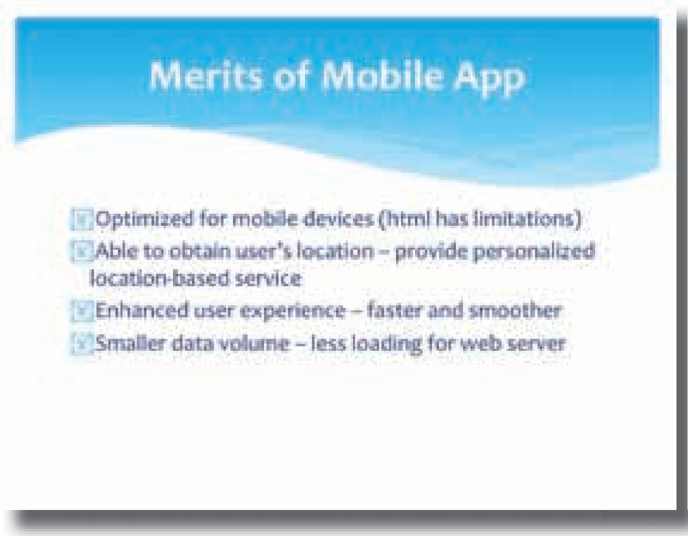

MyObservatory – Features Menu
Access to a suit of weather services
Radar / Satellite Imageries
Lightning Location
Regional Weather
Astronomical and Tidal Information
World Major Cities Forecast
Coastal Waters Forecast
Director's Blog (New Feature)
Rainfall Distribution (New Feature)
Push Notification (New Feature)

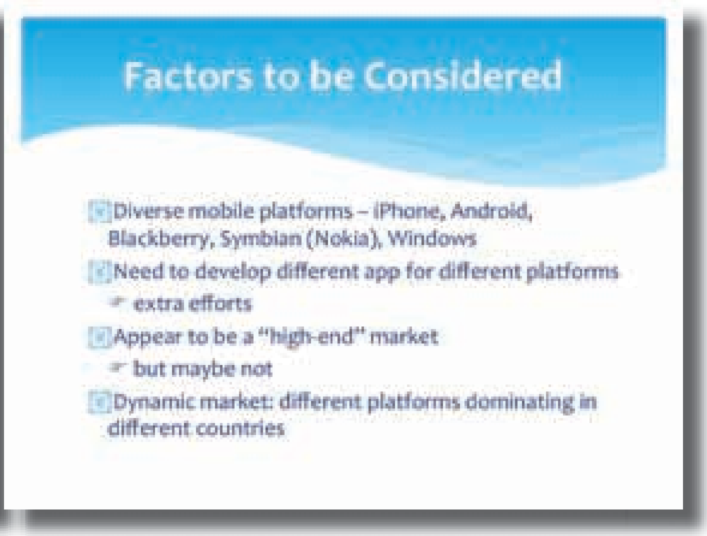

MyObservatory –
Interactive TC Track
Tropical Cyclone Track on Google Map with geographical information
Can be magnified and reduced
Able to present multiple TCs at the same time
Click on analysis or forecast positions to see details


MyObservatory on Android
(Launched in Nov 2010)
22.8°C
70%


Page View Statistics of HKO Mobile Website
Page Views Statistics (Millions)
350
300
250
200
150
100
50
0
299.9
2008
2009
2010
Year

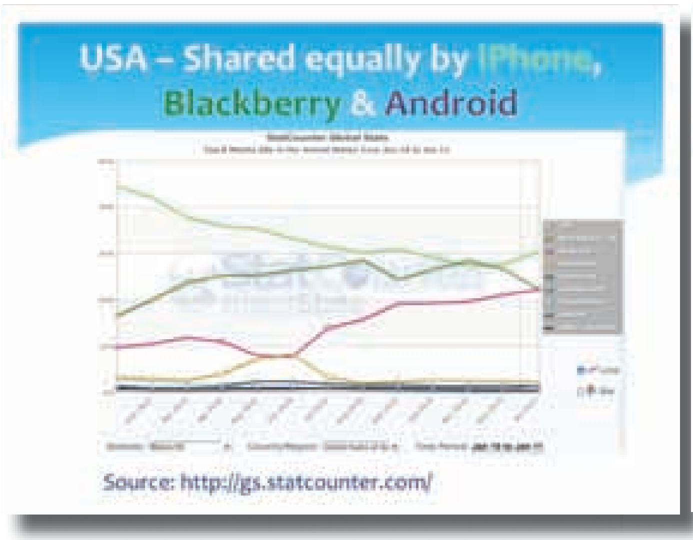

Page View Statistics of HKO Main and Mobile Websites
Page View Statistics (Millions)
1.4 billion
2,000
1,500
1,000
500
0
Mobile
Main
2008
2009
2010
Year


Merits of Mobile App
Optimized for mobile devices (html has limitations)
Able to obtain user's location – provide personalized location-based service
Enhanced user experience – faster and smoother
Smaller data volume – less loading for web server

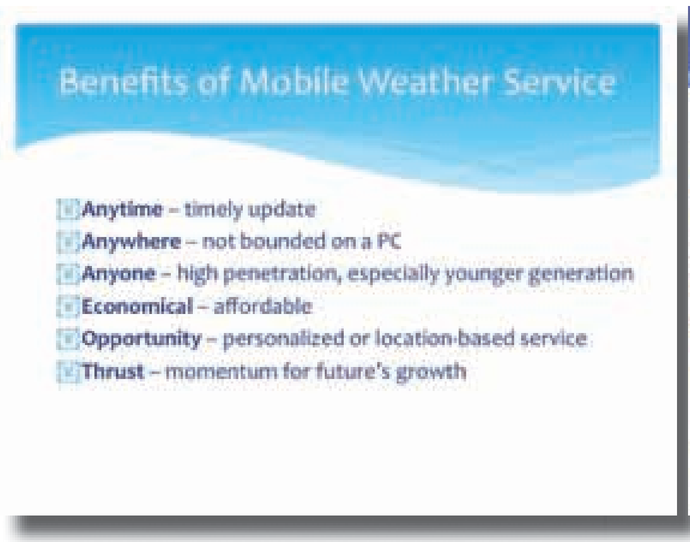

Factors to be Considered
Diverse mobile platforms – iPhone, Android, Blackberry, Symbian (Nokia), Windows
Need to develop different app for different platforms
extra efforts
Appear to be a "high-end" market
but maybe not
Dynamic market: different platforms dominating in different countries

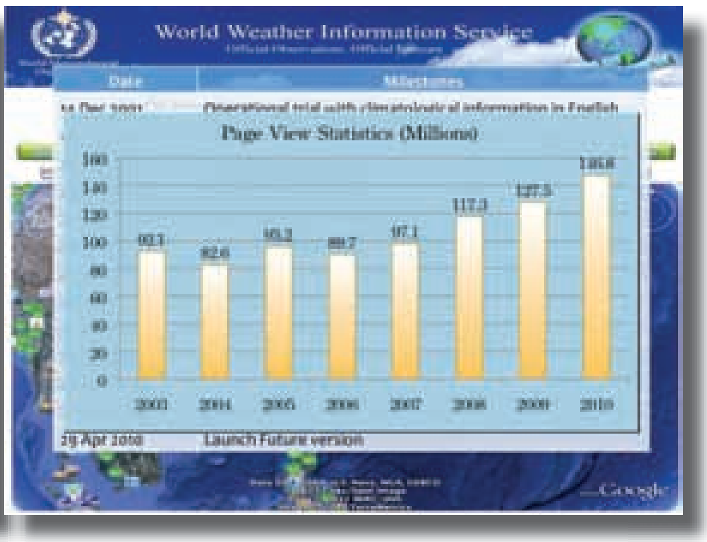

Republic of Korea –
Dominated by Android
Source: http://gs.statcounter.com/

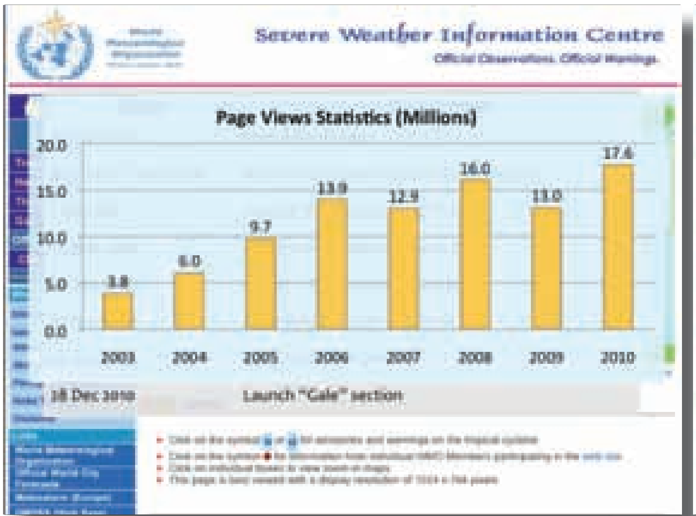

Hong Kong – Dominated by iPhone
Source: http://gs.statcounter.com/


USA – Shared equally by iPhone,
Blackberry & Android
Source: http://gs.statcounter.com/

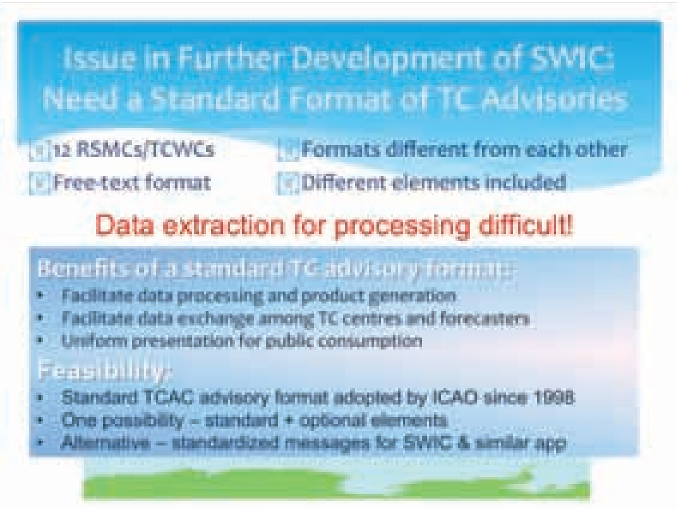

Website Customized for Mobile
Devices Could Serve the Majority
Revamped HKO mobile website will be launched in Q1 2011
Improved navigation
Automatically adapted to screen size of mobile devices
High res graphics possible as mobile data charges decrease
Personalized theme


Benefits of Mobile Weather Service
Anytime – timely update
Anywhere – not bounded on a PC
Anyone – high penetration, especially younger generation
Economical – affordable
Opportunity – personalized or location-based service
Thrust – momentum for future's growth

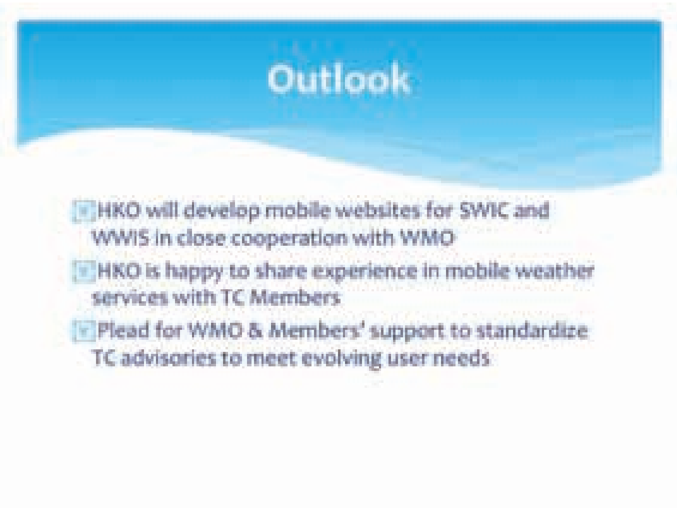

World Weather Information Service
Date
Milestones
Page View Statistics (Millions)
93.1
82.6
95.2
89.7
97.1
117.3
127.5
2003
2004
2005
2006
2007
2008
2009
2010
Launch Future version

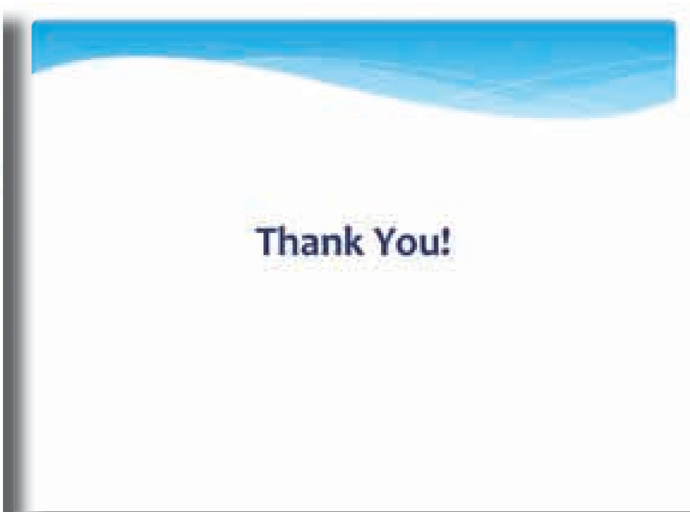

Severe Weather Information Centre
Official Observations. Official Warnings.
Page Views Statistics (Millions)
20.0
15.0
10.0
5.0
0.0
3.8
6.0
9.7
13.9
12.9
16.0
13.0
17.6
2003
2004
2005
2006
2007
2008
2009
2010
18 Dec 2010
Launch "Gale" section


SWidget
Briefed 43rd Session of TC in Jan 2010
Launched SWidget in June with three TC members providing warnings
5 million visits so far (30% of SWIC)
Republic of Korea and Singapore joined in December
Other TC members welcome to join


Issue in Further Development of SWIC: Need a Standard Format of TC Advisories
12 RSMCs/TCWCs
Formats different from each other
Free-text format
Different elements included
Data extraction for processing difficult!
Benefits of a standard TC advisory format:
• Facilitate data processing and product generation
• Facilitate data exchange among TC centres and forecasters
• Uniform presentation for public consumption
Feasibility:
• Standard TCAC advisory format adopted by ICAO since 1998
• One possibility – standard + optional elements
• Alternative – standardized messages for SWIC & similar app


Google

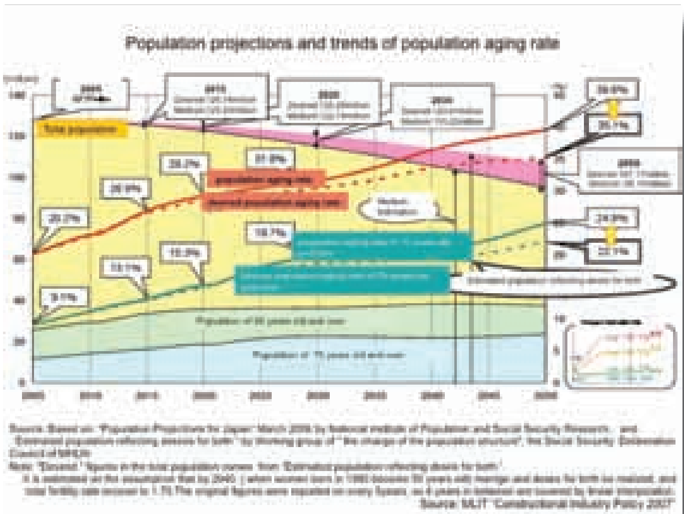

Outlook
HKO will develop mobile websites for SWIC and WWIS in close cooperation with WMO
HKO is happy to share experience in mobile weather services with TC Members
Plead for WMO & Members' support to standardize TC advisories to meet evolving user needs

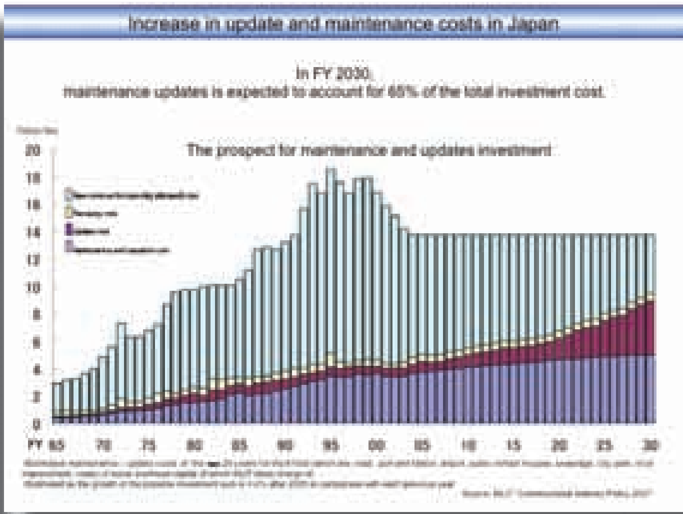

Thank You!

Adaptation for Climate Change, Flood Risk Management and other relevant concerns

Kamoto Minoru
Chief Researcher
International Centre for Water Hazard and Risk Management (ICHARM)

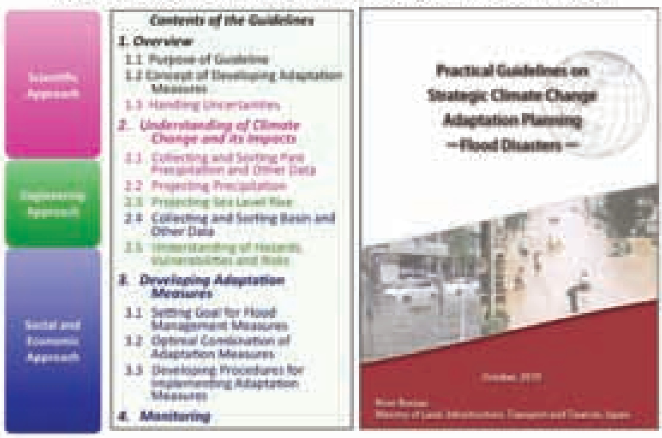
The Trend of Public Works in Japan





Practical Guidelines on Strategic Climate Change Adaptation Planning - Flood Disasters -

Approach on Climate Change Adaptation Procedure for Flood Risk Management based on the experiences in Japan



Background of the Guideline

- We have common issues, regarding flood management, to be solved in Asia-Pacific Region, such as
  - > rainfall intensity and seasonal mal-distribution
  - > high density land use in flood prone area
  - > frequent huge flood disasters
  - > current safety level
- It is necessary to overcome these severer conditions by selection and combination of measures based on accumulation of flood risk managements.

Purpose of the Guidelines

- To describe a framework for procedures to develop adaptation measures against the increases in the intensity and frequency of floods caused by climate change.

⇒ To support the decision making to secure the sustainable development in the Asia-Pacific Region (APR) in overcoming the flood risks.

Concept of Developing Adaptation Measures

- Setting "target years" considering future uncertainty.
- Flexible Approach through the PDCA Cycle like as "Climbing-up spiral" A. "End to End approach" B. Practical procedure for selection and combination of measures for flood management C. Common background of flood risk management experiences in APR

Setting "target years" (1)

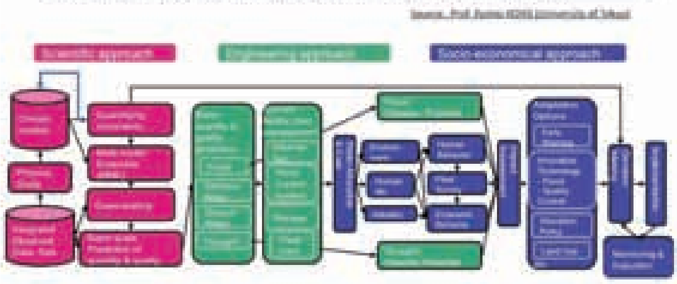
- Consideration future "uncertainty", such as changes of climate, economic, social and environmental conditions,
  ... It is necessary to use a feedback system composed of visible/definite target, and to take a flexible approach.
- Based on the viewpoint of science,
  "target years" for adaptation planning can be projected, such as certain magnitude of temperature rise in 20 ~ 30 years with some certainty without scenario.

Flexible Approach

- To optimize the combination of adaptation measures, considering the future climate change in 100 years, and setting the visible/definite target, a set / sets of the approaches every quarter century seem the climbing high mountain.
- It is necessary to use the feedback system to consider effects of future changes of climate / Economic / Social / Environmental conditions by utilizing the progress of science and technology.

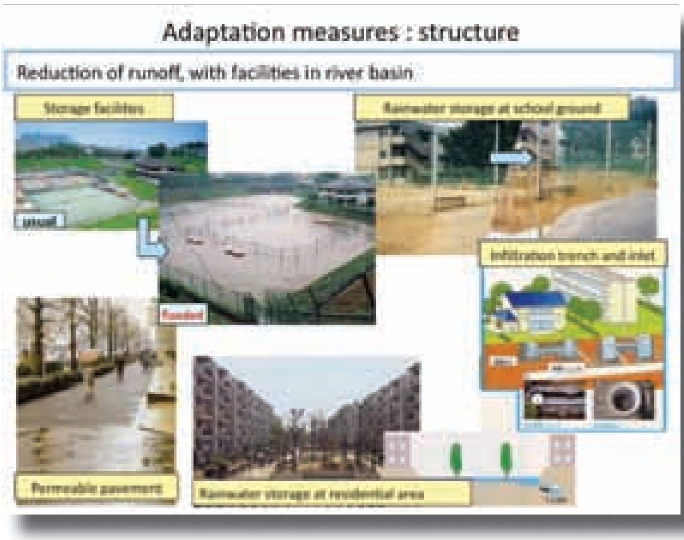
Structure of the Flexible Approach (2-1)

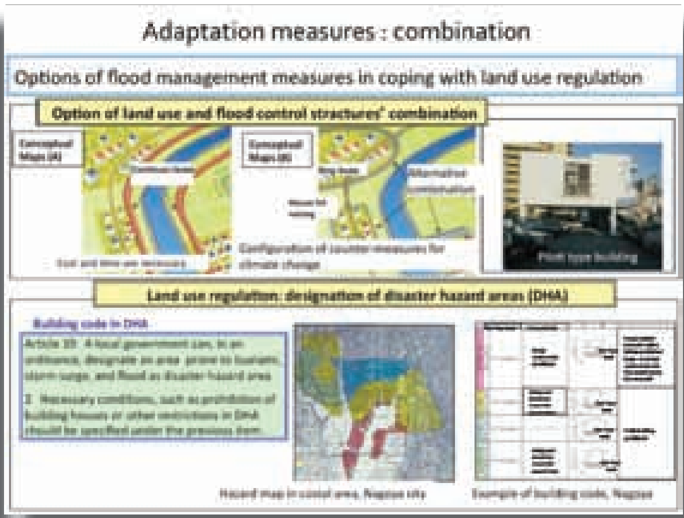
End to End Approach on Climate Change Adaptation

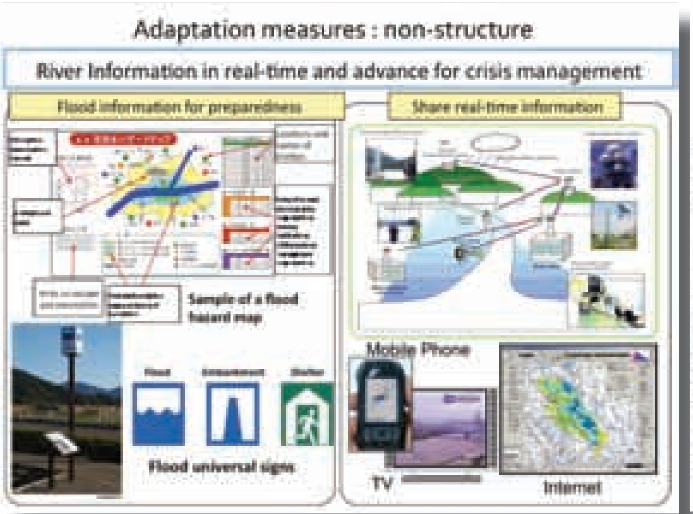


Adaptation measures : structure

Development of storage capacity and river discharge





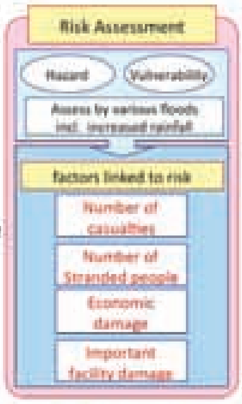


Evaluation of adaptation measures based on risk management

- Hazard; rainfall intensity, sea level raise and flood discharge and water level
- Vulnerability; current safety level, land use, population (elderly ratio) and important infrastructure in expected inundation area

Identification of flood risk based on damage factors considering flood damages by the hazards and with the vulnerabilities by various type & scale of floods

… for optimization selection and combination of adaptation measures



Visit our WEB site:

<Guideline :>

http://www.mlit.go.jp/river/basic_info/english/pdf/
Practical_Guideline_on_Strategic_Climate_Change_Adaptation_Planning_E.pdf
(to be updated soon)

<Policy Report for
Climate Change Adaptation Strategies to Cope with Water-related Disasters due to Global Warming>

[full report]
http://www.mlit.go.jp/river/basic_info/jigyo_keikaku/gaiyou/kikouhendou/pdf/
draftpolicyreport.pdf

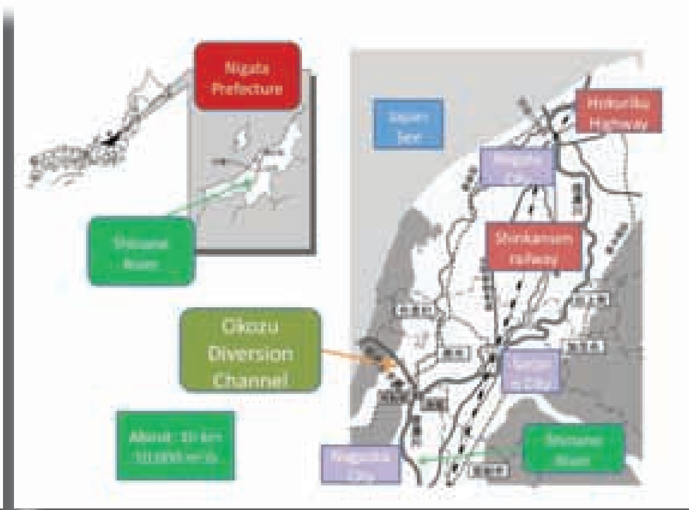
[text only]
http://www.mlit.go.jp/river/basic_info/english/pdf/policy_report.pdf

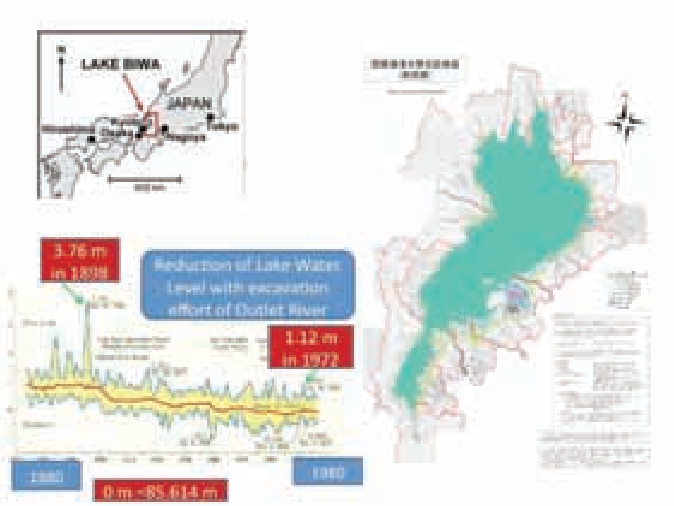
[reference]
http://www.mlit.go.jp/river/basic_info/jigyo_keikaku/gaiyou/kikouhendou/pdf/
draftpolicyreportref.pdf

Levee effect?

- The levee effect increases vulnerability to flooding in two different ways (Pielke 1999; State of California 2005).
- First, it creates a sense of complacency, which in turn, reduces flood preparedness and mitigation actions.
- Second, the levee effect provides incentives to continue to build structures in harm's way. The latter is significant in California's Central Valley, where tens of thousands of homes are in low lying basins surrounded by an aging, often insufficiently maintained, levee infrastructure (Independent Review Panel 2007; State of California 2005).

- Before Increasing Flood water level, Flood Risk management work was to reduce the flood water level
- Two Examples:
  1) Okozu Diversion Channel of Shinano River in Nigata Prefecture 90 years ago.
  2) Lake Biwa natural outlet excavation projects done in many decades



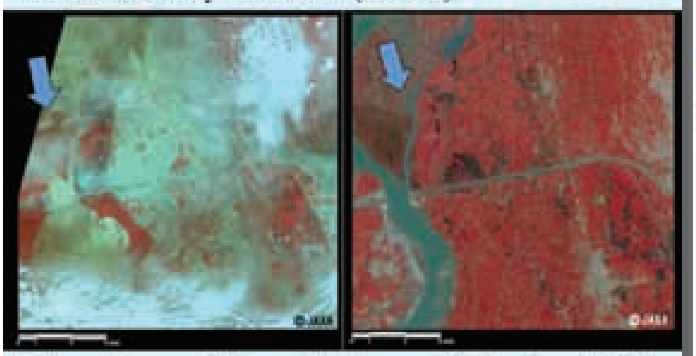


Infrastructures in the River

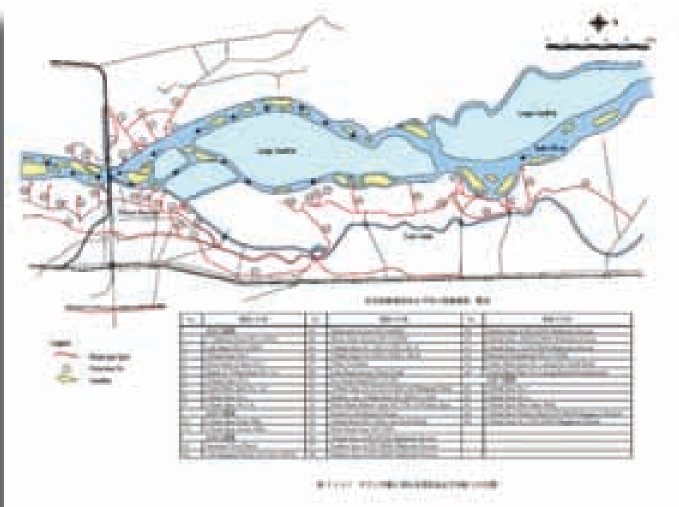
- The Barrages , Railway/Road Bridges, some times big obstacle against flood stream. Those have the conflict of interest. We need to have the careful concept and design.

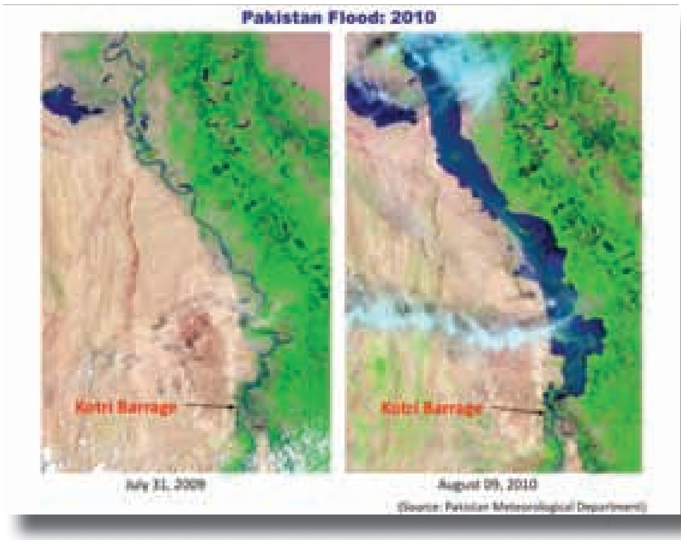
At the end of July, heavy rains triggered devastating floods in Pakistan. The floods in Pakistan have affected more than 20 million people. About one-fifth of Pakistan's total land area was underwater with a death toll of close to 2,000. The damage to the economic infrastructure and livelihoods is immense and Pakistan's development prospects may be disrupted for many years. As a result of enormous damages to irrigation networks many farmers who lost their crops and who are not able to plant their fields are likely to remain dependent on aid until well into 2012. (from OCHA)

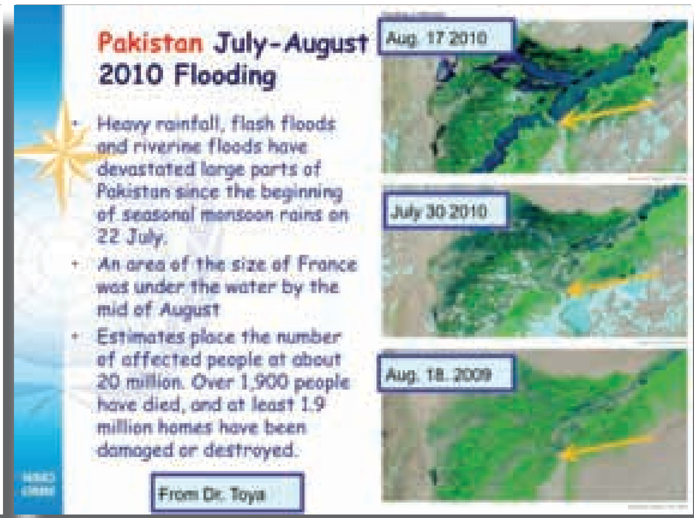
Emergency observation of concentrated heavy rain in Pakistan by "Daichi" (ALOS)



Enlarged images of the swollen rivers at Shadan Lund (324 square km, left: August 6, 2010; right: October 2, 2009) provided by JAXA







In light of the severity of the floods damage and losses, it is recommended that the Government reviews its current flood management strategy. The revised strategy should consider:

(i) enhancing the absorptive capacity of the catchments to reduce rainfall run-off,
(ii) building additional reservoirs to absorb flood peaks,
(iii) improving flood regulation through diversions,
(iv) enhancing the safe flood disposal capacities of the existing barrages and river training works,
(v) adopting a "living with the floods" approach for the riverine areas in Punjab and Sindh,
(vi) improving and expanding flood forecasting and early warning systems, and
(vii) enhancing evacuation and flood relief capacities.

(Preliminary Damage and Needs Assessment, Pakistan Gov. WB. ADB, Nov. 2010)

27-29 September 2011, Tsukuba-Japan

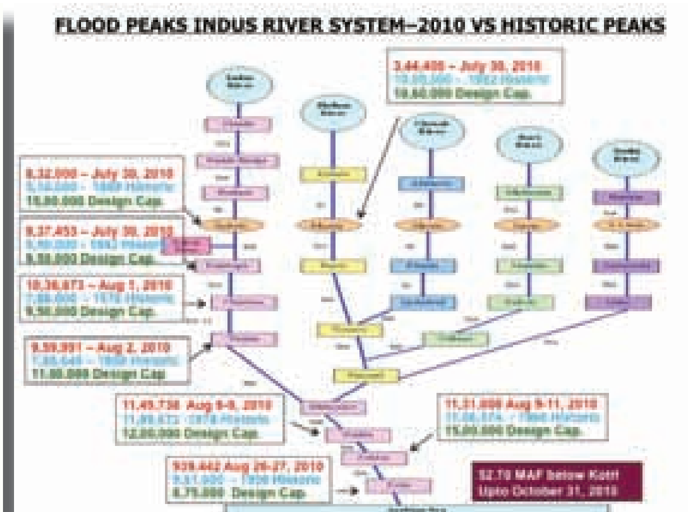
5th International Conference on Flood Management (ICFM5)

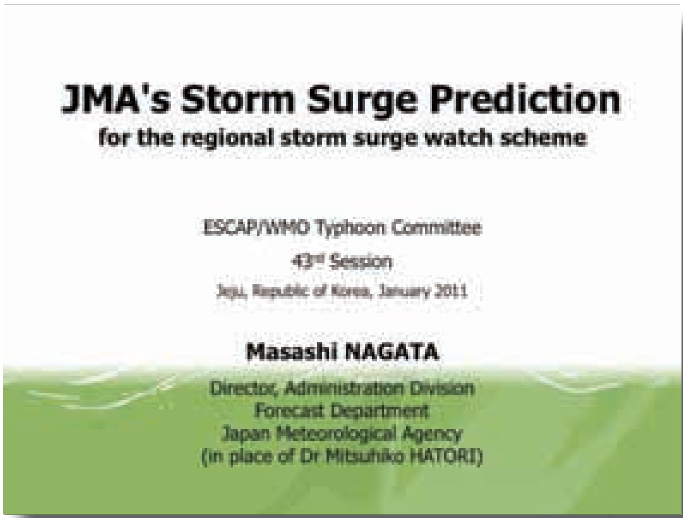
- The International Conference on Flood Management (ICFM) is the only recurring international conference wholly focused on flood related issues. ICFM5 theme is "Floods: From Risk to Opportunity", reflective of the continued trend towards a broader understanding of how we collectively make use of the opportunities provided by floods and flooding, cope with risks posed by them and plan to respond to flood events.
- ICFM5 will be held in Tsukuba, Japan, on 27-29 September 2011, and will be organized by the International Centre for Water Hazard and Risk Management (ICHARM) under the auspices of UNESCO and the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) of Japan.

info@ifi-home.info

Supporting Organizations

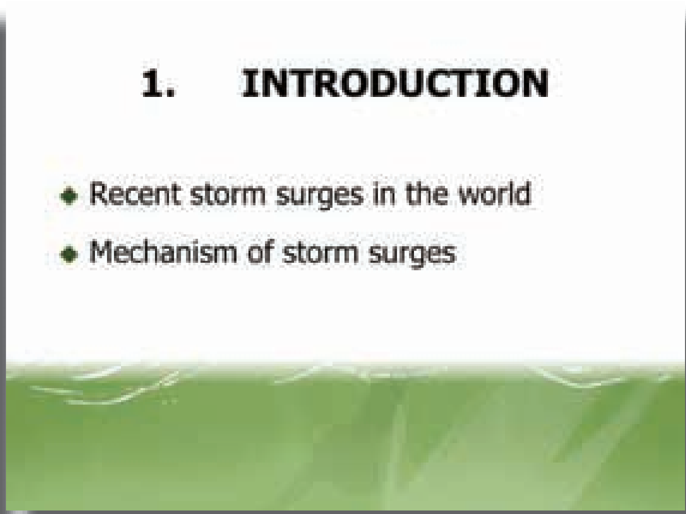
Thank you
For your
attention

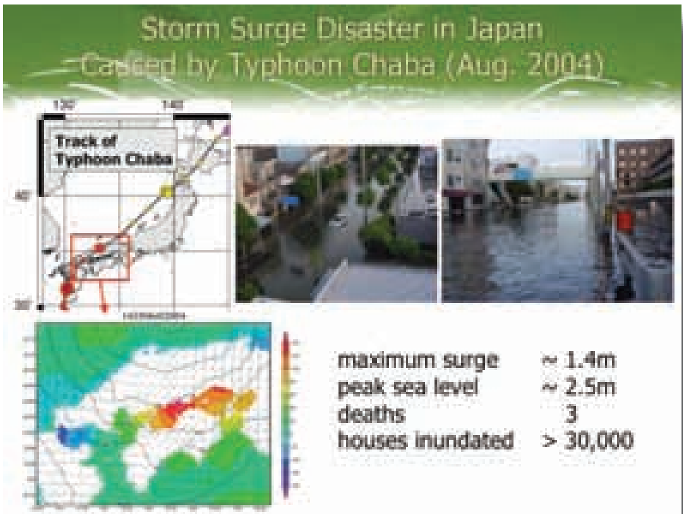


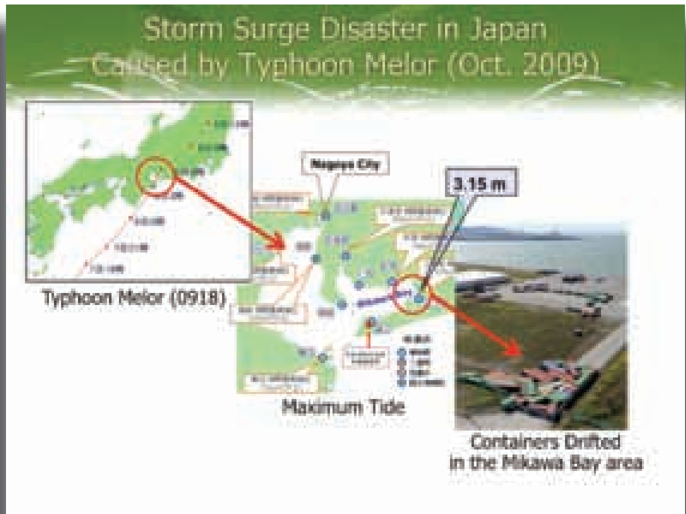

JMA's Storm Surge Prediction
for the regional storm surge watch scheme
ESCAP/WMO Typhoon Committee
43rd Session
Jeju, Republic of Korea, January 2011
Masashi NAGATA
Director, Administration Division
Forecast Department
Japan Meteorological Agency
(in place of Dr Mitsuhiko HATORI)


Change of Director General of JMA
Former DG
1/18/2011
Mr Kunio SAKURAI
4/1/2009 – 1/18/2011

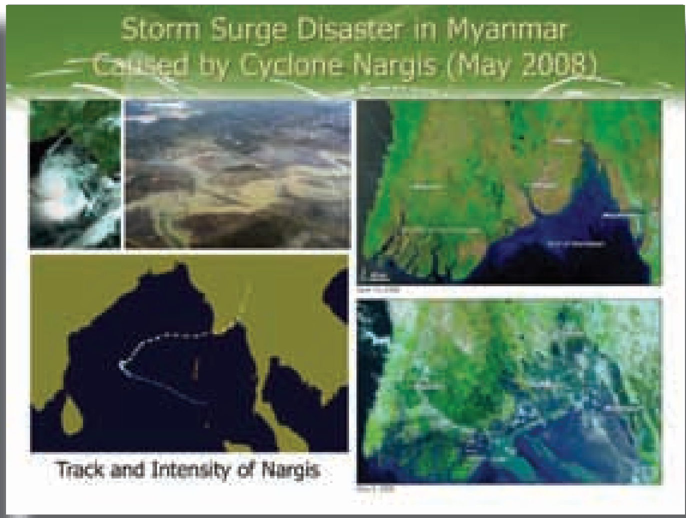

New DG
Dr Mitsuhiko HATORI
1/18/2011 ---
from
NHK Online

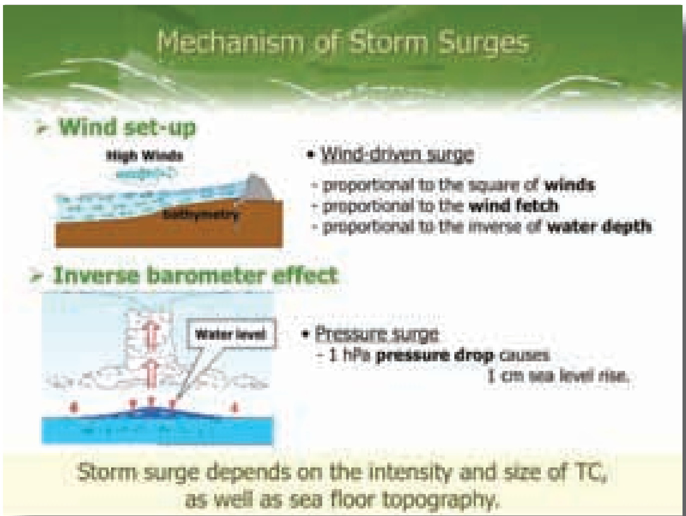

1. INTRODUCTION
Recent storm surges in the world
Mechanism of storm surges

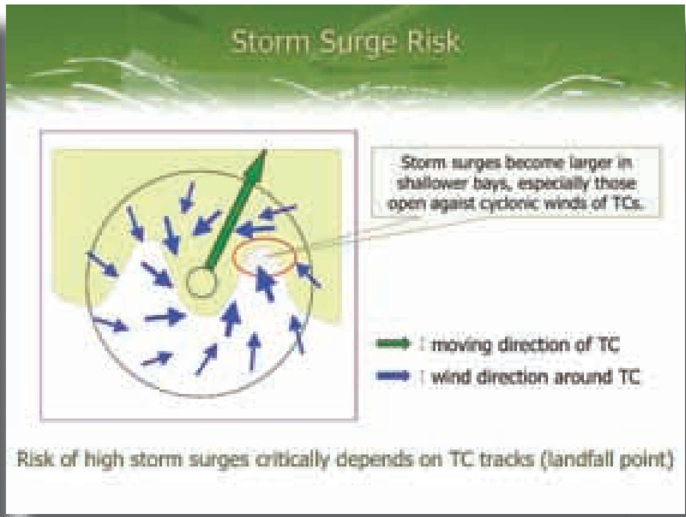

Storm Surge Disaster in Japan
Caused by Typhoon Chaba (Aug. 2004)
Track of
Typhoon Chaba
maximum surge ~ 1.4m
peak sea level ~ 2.5m
deaths 3
houses inundated > 30,000

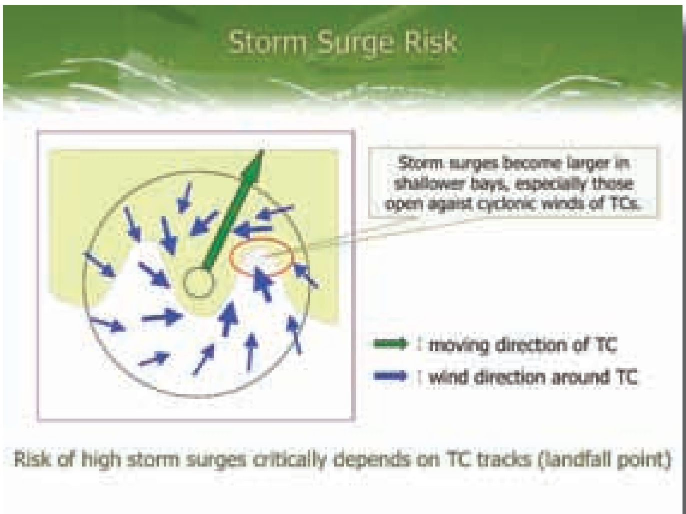

Storm Surge Disaster in Japan
Caused by Typhoon Melor (Oct. 2009)
Nagoya City
3.15 m
Typhoon Melor (0918)
Maximum Tide
Containers Drifted
in the Mikawa Bay area


Storm Surge Disaster in U.S.
Caused by Hurricane Katrina (Aug. 2005)
Track and Intensity of Katrina


Storm Surge Disaster in Myanmar
Caused by Cyclone Nargis (May 2008)
Track and Intensity of Nargis


Mechanism of Storm Surges
Wind set-up
High Winds
Bathymetry
• Wind-driven surge
- proportional to the square of winds
- proportional to the wind fetch
- proportional to the inverse of water depth
Inverse barometer effect
Water level
• Pressure surge
- 1 hPa pressure drop causes
1 cm sea level rise.
Storm surge depends on the intensity and size of TC,
as well as sea floor topography.


Storm Surge Risk
Storm surges become larger in
shallower bays, especially those
open agaist cyclonic winds of TCs.
: moving direction of TC
: wind direction around TC
Risk of high storm surges critically depends on TC tracks (landfall point)


Storm Surge Risk
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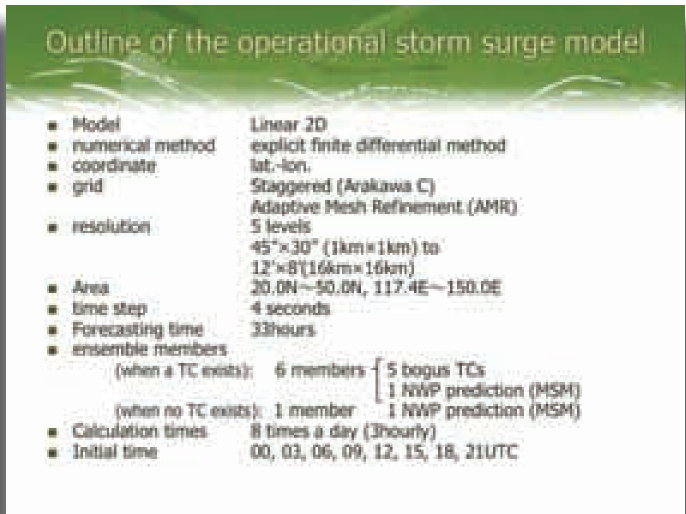
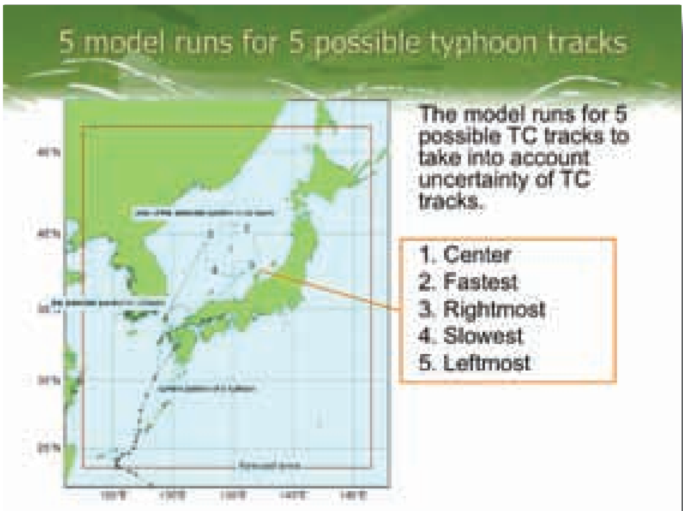
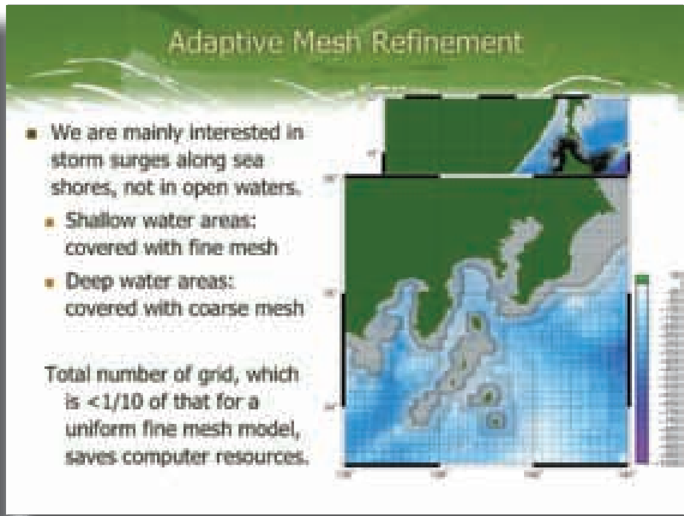
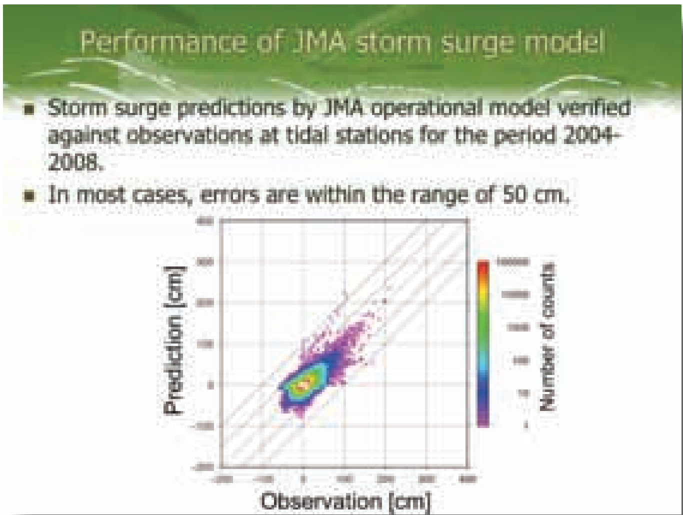
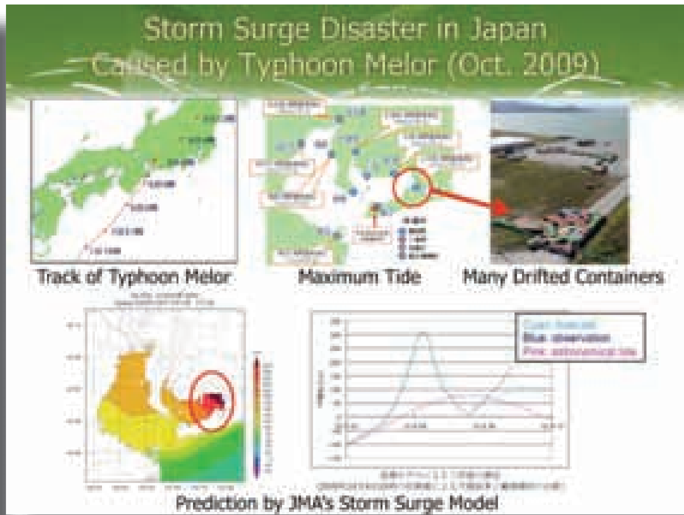
: wind direction around TC
Risk of high storm surges critically depends on TC tracks (landfall point)

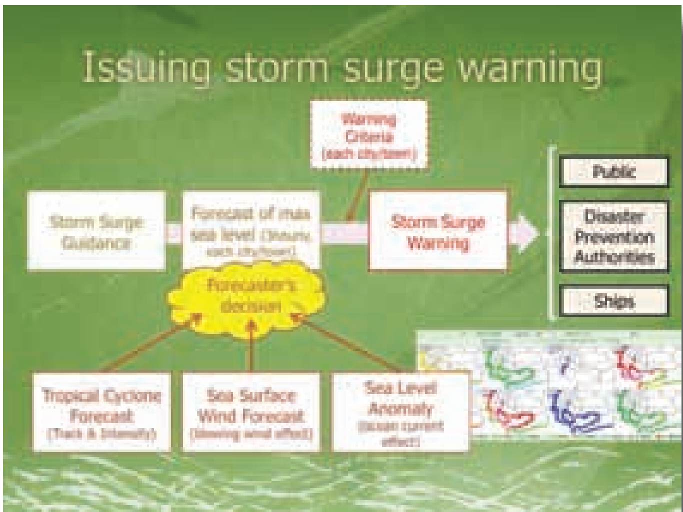

Outline of the operational storm surge model
Model Linear 2D
numerical method explicit finite differential method
coordinate lat.-lon.
grid Staggered (Arakawa C)
Adaptive Mesh Refinement (AMR)
resolution 5 levels
45"×30" (1km×1km) to
12'×8'(16km×16km)
Area 20.0N~50.0N, 117.4E~150.0E
time step 4 seconds
Forecasting time 33hours
ensemble members
(when a TC exists): 6 members 5 bogus TCs
1 NWP prediction (MSM)
(when no TC exists): 1 member 1 NWP prediction (MSM)
Calculation times 8 times a day (3hourly)
Initial time 00, 03, 06, 09, 12, 15, 18, 21UTC

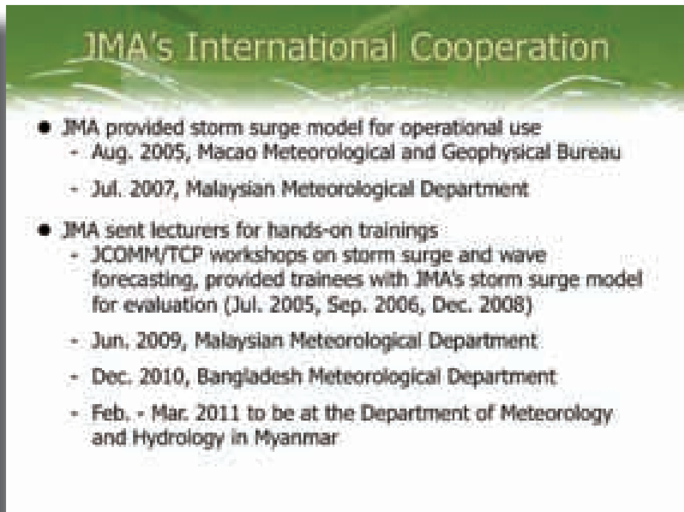

5 model runs for 5 possible typhoon tracks
The model runs for 5 possible TC tracks to take into account uncertainty of TC tracks.
1. Center
2. Fastest
3. Rightmost
4. Slowest
5. Leftmost


Adaptive Mesh Refinement
We are mainly interested in storm surges along sea shores, not in open waters.
Shallow water areas: covered with fine mesh
Deep water areas: covered with coarse mesh
Total number of grid, which is <1/10 of that for a uniform fine mesh model, saves computer resources.

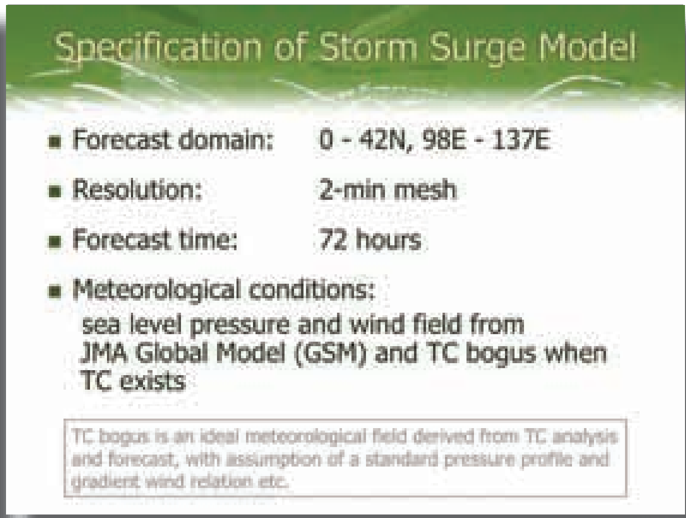

Performance of JMA storm surge model
Storm surge predictions by JMA operational model verified against observations at tidal stations for the period 2004-2008.
In most cases, errors are within the range of 50 cm.
Prediction [cm]
Observation [cm]
Number of counts

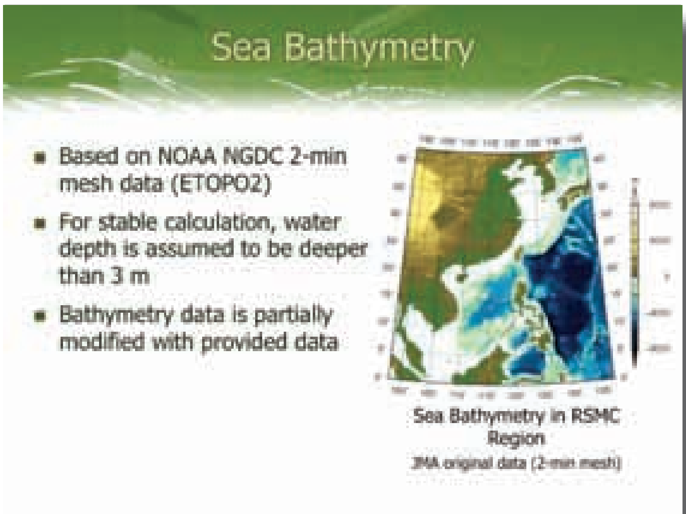

Storm Surge Disaster in Japan
Caused by Typhoon Melor (Oct. 2009)
Track of Typhoon Melor
Maximum Tide
Many Drifted Containers
Prediction by JMA's Storm Surge Model

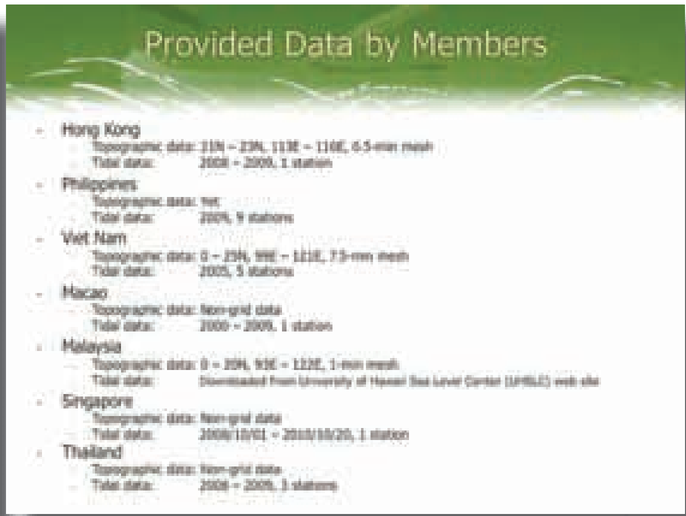

Issuing storm surge warning
Warning Criteria (each city/town)
Storm Surge Guidance
Forecast of max sea level (3hourly, each city/town)
Storm Surge Warning
Public
Disaster Prevention Authorities
Ships
Forecaster's decision
Tropical Cyclone Forecast (Track & Intensity)
Sea Surface Wind Forecast (blowing wind effect)
Sea Level Anomaly (ocean current effect)

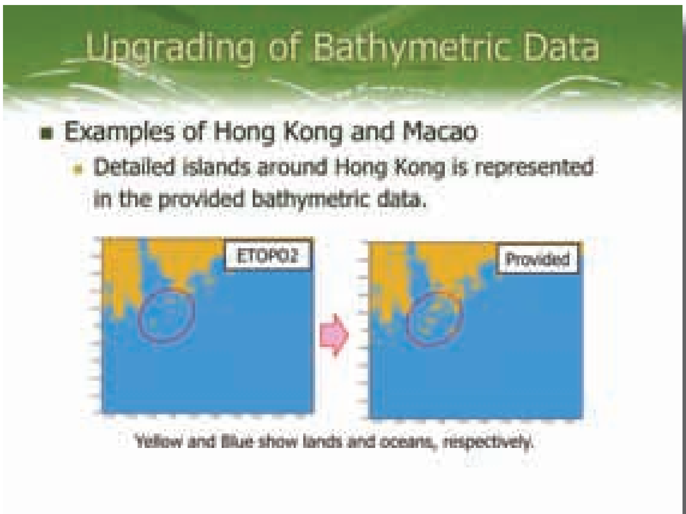

JMA's International Cooperation
JMA provided storm surge model for operational use
- Aug. 2005, Macao Meteorological and Geophysical Bureau
- Jul. 2007, Malaysian Meteorological Department
JMA sent lecturers for hands-on trainings
- JCOMM/TCP workshops on storm surge and wave forecasting, provided trainees with JMA's storm surge model for evaluation (Jul. 2005, Sep. 2006, Dec. 2008)
- Jun. 2009, Malaysian Meteorological Department
- Dec. 2010, Bangladesh Meteorological Department
- Feb. - Mar. 2011 to be at the Department of Meteorology and Hydrology in Myanmar

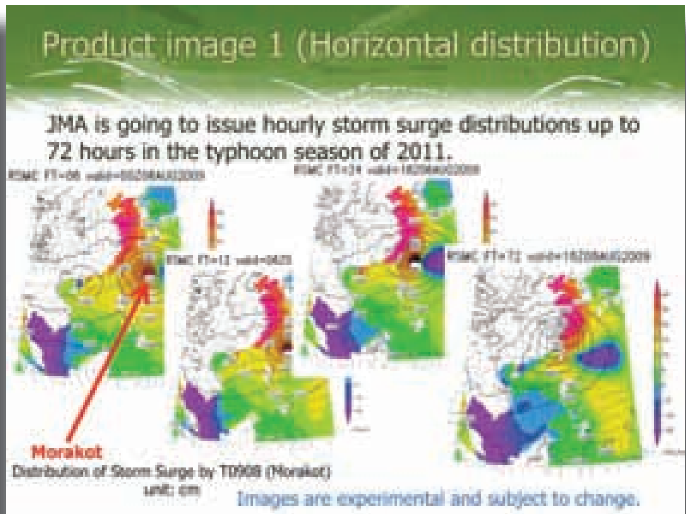

3. STORM SURGE WATCH SCHEME
Outline of storm surge model
Product images
An example of storm surge prediction
Schedule


Specification of Storm Surge Model
Forecast domain: 0 - 42N, 98E - 137E
Resolution: 2-min mesh
Forecast time: 72 hours
Meteorological conditions:
sea level pressure and wind field from JMA Global Model (GSM) and TC bogus when TC exists
TC bogus is an ideal meteorological field derived from TC analysis and forecast, with assumption of a standard pressure profile and gradient wind relation etc.


Sea Bathymetry
Based on NOAA NGDC 2-min mesh data (ETOPO2)
For stable calculation, water depth is assumed to be deeper than 3 m
Bathymetry data is partially modified with provided data
Sea Bathymetry in RSMC Region
JMA original data (2-min mesh)

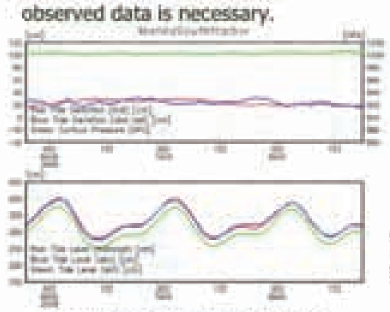

Provided Data by Members
Hong Kong
Topographic data: 21N – 23N, 113E – 116E, 0.5-min mesh
Tidal data: 2008 – 2009, 1 station
Philippines
Topographic data: Yet
Tidal data: 2009, 9 stations
Viet Nam
Topographic data: 0 – 25N, 99E – 121E, 7.5-min mesh
Tidal data: 2005, 5 stations
Macao
Topographic data: Non-grid data
Tidal data: 2000 – 2009, 1 station
Malaysia
Topographic data: 0 – 20N, 93E – 122E, 1-min mesh
Tidal data: Downloaded from University of Hawaii Sea Level Center (UHSLC) web site
Singapore
Topographic data: Non-grid data
Tidal data: 2008/10/01 – 2010/10/20, 1 station
Thailand
Topographic data: Non-grid data
Tidal data: 2008 – 2009, 3 stations


Upgrading of Bathymetric Data
Examples of Hong Kong and Macao
Detailed islands around Hong Kong is represented in the provided bathymetric data.
ETOPO2
Provided
Yellow and Blue show lands and oceans, respectively.


Product image 1 (Horizontal distribution)
JMA is going to issue hourly storm surge distributions up to 72 hours in the typhoon season of 2011.
Morakot
Distribution of Storm Surge by T0908 (Morakot)
unit: cm
Images are experimental and subject to change.

Product image 2 (time-series)

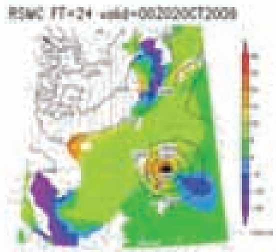
JMA is also planning to provide storm surge time series at selected points in 2012. For providing time series, further verification with observed data is necessary.



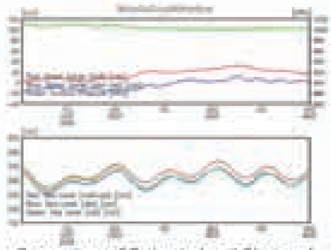
Upper: storm surges (cm) and surface pressures (hPa)
Lower: sea level (cm).

An image of storm surge time series (Station Manila)

Verification (Ongoing)



Distribution of Storm Surge for T0917 (Parma)
Using revised topography. Unit: cm



Comparison of Estimated and Observed Data at a Station in Manila
Upper: storm surge and surface pressure.
Bottom: sea level.

For better prediction

- Refinement of sea topography in the storm surge model with more precise sea bathymetry data
- Verification with observed data at tidal stations for longer periods including many storm surge cases.

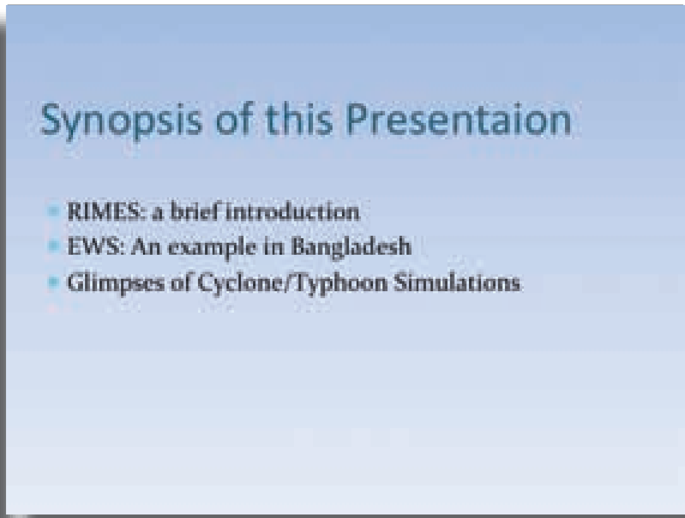
JMA expects the Typhoon Committee Members to provide available tidal data for further verification leading to better prediction, especially for local points...

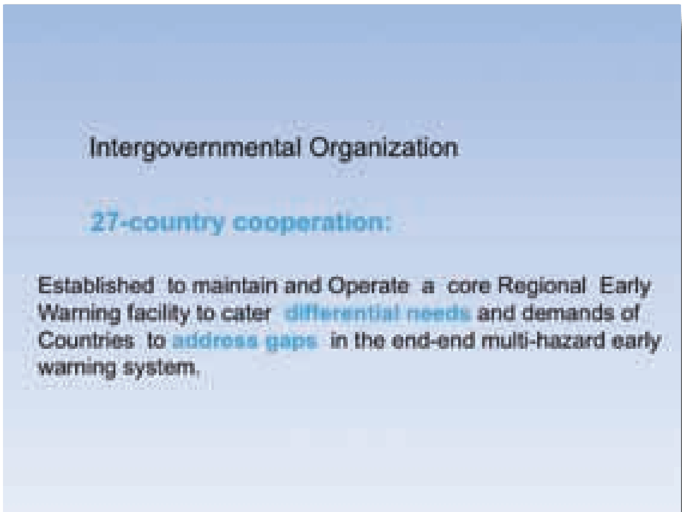
In the future

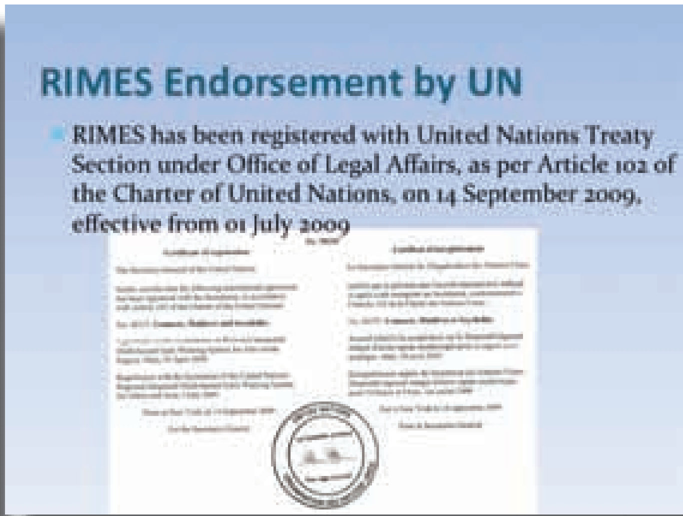
- Development of a prototype storm surge model using the provided bathymetric data (- Dec. 2010)
- Verification of the accuracy of the model with the provided tidal data (- Jan. 2011)
  - Further modification etc.
- System to be fixed and put into operation in the NWP system (- Feb. 2011)
- Start of providing products
  - horizontal surge distribution (2011 season-)
  - Point time series (2012 season-)

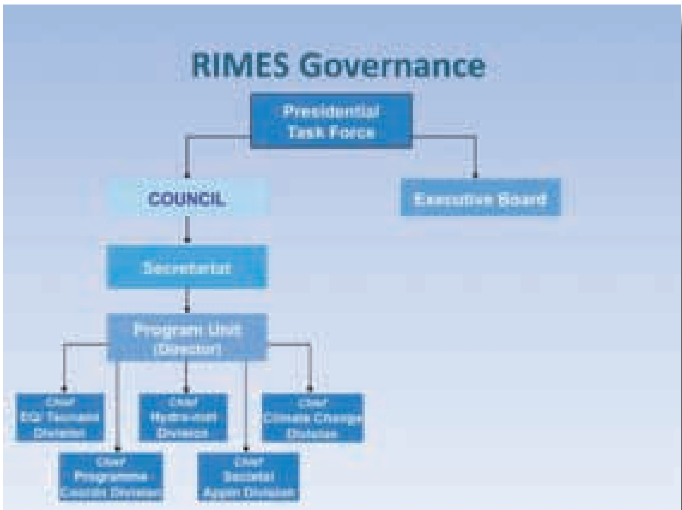
END


RIMES
Regional Integrated Multi-Hazard Early warning System (RIMES) for Africa and Asia: Activities
Jayaraman Potty
Jeju, 20 Jan 2011


Synopsis of this Presentaion
RIMES: a brief introduction
EWS: An example in Bangladesh
Glimpses of Cyclone/Typhoon Simulations


Intergovernmental Organization
27-country cooperation:
Established to maintain and Operate a core Regional Early Warning facility to cater differential needs and demands of Countries to address gaps in the end-end multi-hazard early warning system.


RIMES Endorsement by UN
RIMES has been registered with United Nations Treaty Section under Office of Legal Affairs, as per Article 102 of the Charter of United Nations, on 14 September 2009, effective from 01 July 2009


RIMES Governance
Presidential Task Force
COUNCIL
Executive Board
Secretariat
Program Unit (Director)


Services
Provision of regional tsunami watch
Capacity building and technology transfer to NMHSs for providing localized hydro-meteorological disaster risk information
Enhancing capacities to respond to early warning information at national and local levels for disaster preparedness and management
Acting as a test-bed to identify promising new, emerging technologies, and pilot test, and make it operational through demonstration of tangible benefits

Component 1

Regional Tsunami Watch Provision

UNESCAP-supported through the UN Tsunami Regional Trust Fund

RIMES Program Unit

- Housed in AIT Campus
- Provision of a research back-up support with AIT
- System operation is on a 24x7 scheme with 3 shifts (2 personnel per shift)

Component-II Hydro-Meteorology

- Providing localized severe weather information
- Short term customized weather information up to 3 days for member countries based on demand
- Seasonal climate outlook
- Capacity building for member countries
- In-house R&D activities
- Climate change impact analyses

Capacity building for member countries

Secondment Basis

- Myanmar (Nov. 2008- July 2010)
- Bangladesh (Feb-Jul. 2010)
- Maldives (Nov 2009-Jan 2010)
- Timor-Leste (July-Sep, 2009)
- Nepal (since Dec. 2010)

On-site Weather Forecast Training

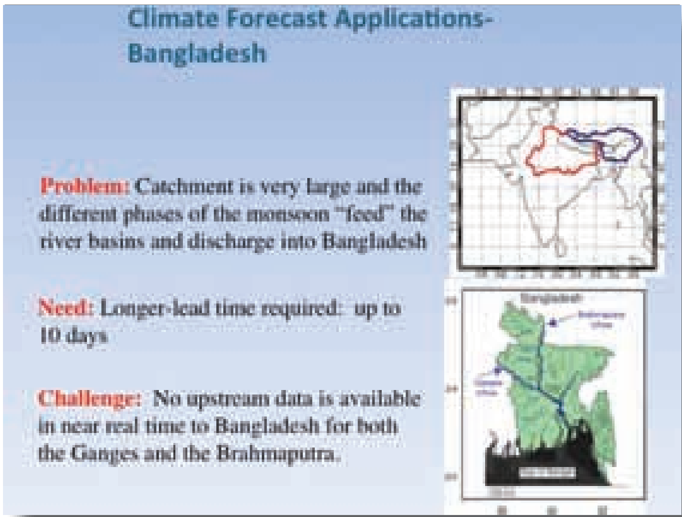
- Bhutan (July 2009)
- Cambodia (May 2008)
- Timor-Leste (July 2008)
- Maldives (July 2008)
- Nepal (Sept 2010)

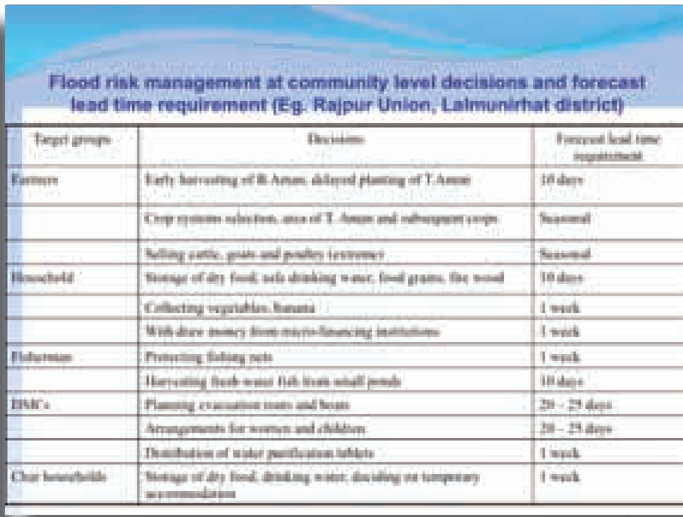
Available Manpower

- Director 1
- Chief Scientific Officers........................ 2
- Warning Coordination Scientist 1
- Oceanographer 1
- Seismologist 1
- Operation Watch standers (seconded from Member Countries) 7
- Climatologist 2
- Synoptician 1
- Communication Engineer 1
- ICT officer 1
- Admin Assistant 1

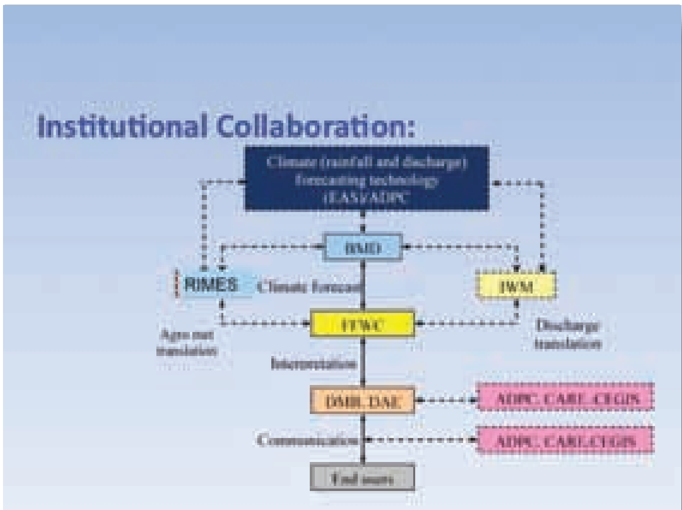
TOTAL 24

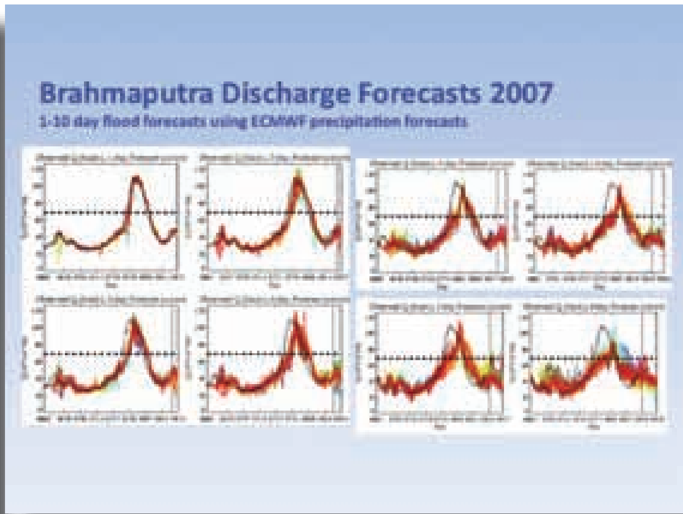
EWS: An example of Bangladesh



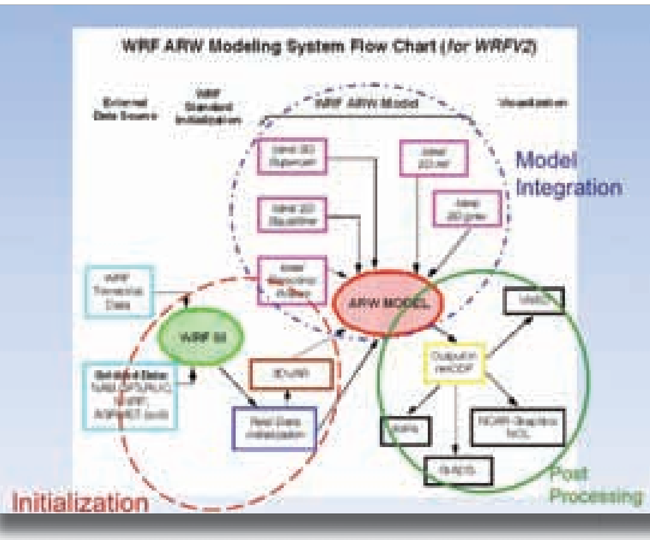


Target groups	Decisions	Forecast lead time requirement
Farmers	Early harvesting of B.Aman, delayed planting of T.Aman	10 days
	Crop systems selection, area of T. Aman and subsequent crops	Seasonal
	Selling cattle, goats and poultry (extreme)	Seasonal
Household	Storage of dry food, safe drinking water, food grains, fire wood	10 days
	Collecting vegetables, banana	1 week
	With draw money from micro-financing institutions	1 week
Fisherman	Protecting fishing nets	1 week
	Harvesting fresh water fish from small ponds	10 days
DMCs	Planning evacuation routes and boats	20 - 25 days
	Arrangements for women and children	20 - 25 days
	Distribution of water purification tablets	1 week
Char households	Storage of dry food, drinking water, deciding on temporary accommodation	1 week



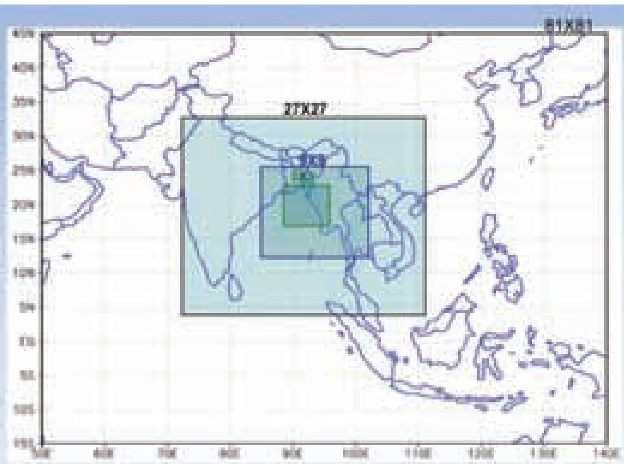


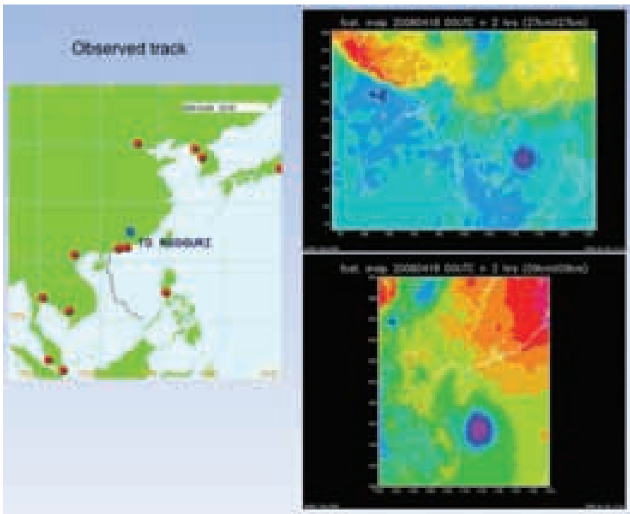
Severe Weather Simulations for Disaster Preparedness



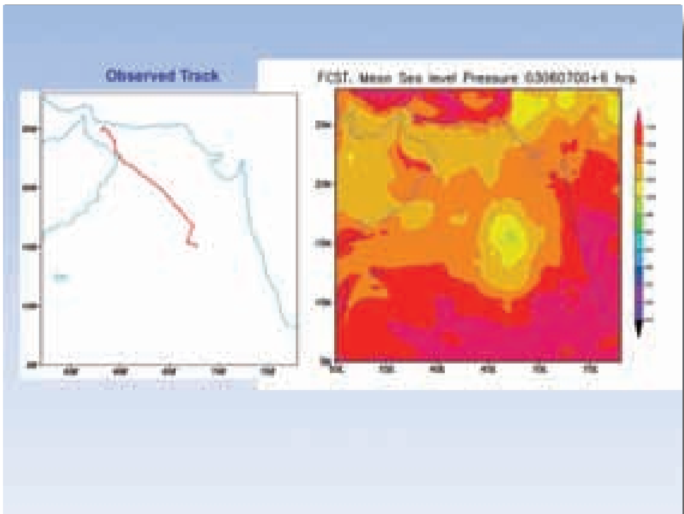
WRF Model Configuration

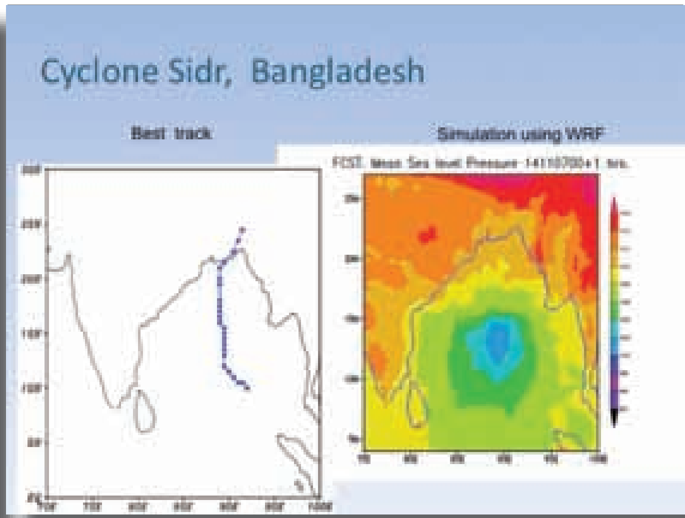
Dynamics	Non -hydrostatic
Main prognostic variables	u, v, w, T', P' and q
Number of domain	one
Horizontal grid distance	9 km
Number of grid points	X-direction 1365 : Y-direction 938
Map Projection	Mercator
Horizontal grid distribution	Arakawa C-grid
Vertical co-ordinate	Terrain-following hydrostatic-pressure co-ordinate
Time integration	3rd order Runge-Kutta
Spatial differencing scheme	6th order centered differencing
Initial conditions	NCEP analysis and forecast fields (GFS)
Lateral Boundary condition	Periodic, open,symmetric & specified options available
Top boundary condition	Gravity wave absorbing (diffusion or Rayleigh damping)
Bottom Boundary condition	Physical or free-slip
Microphysics	WSM-3 class simple ice scheme
Radiation Scheme	Dudhia's short wave radiation
Surface layer parameterization	Thermal diffusion scheme
Cumulus parameterization	Kain-Fritsch (new Eta) scheme
PBL parameterization	YSU scheme

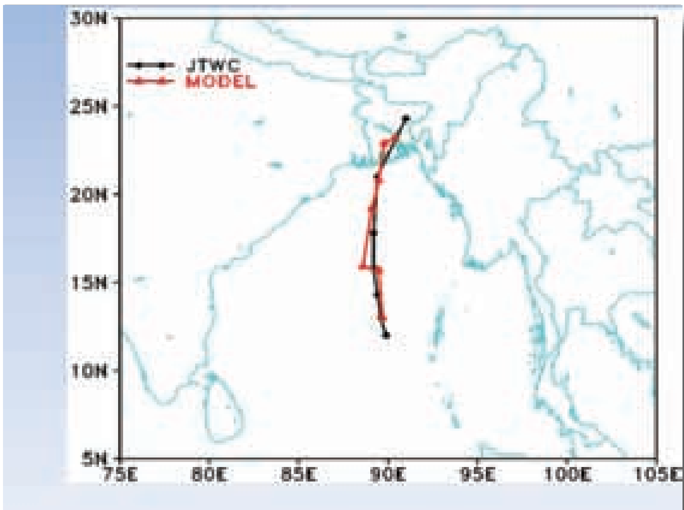


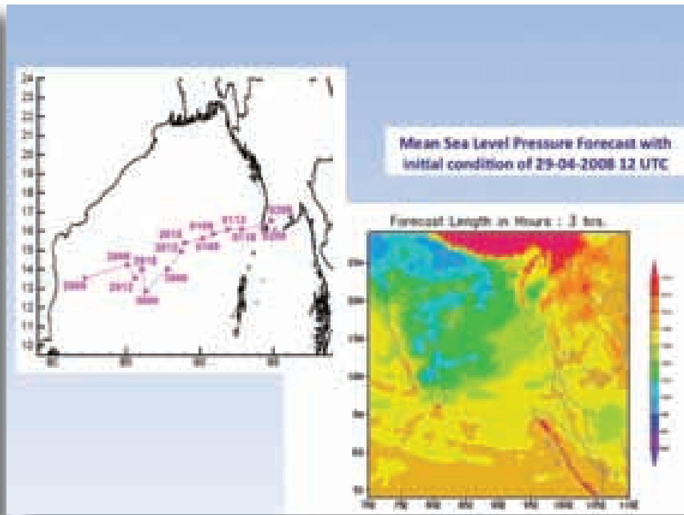


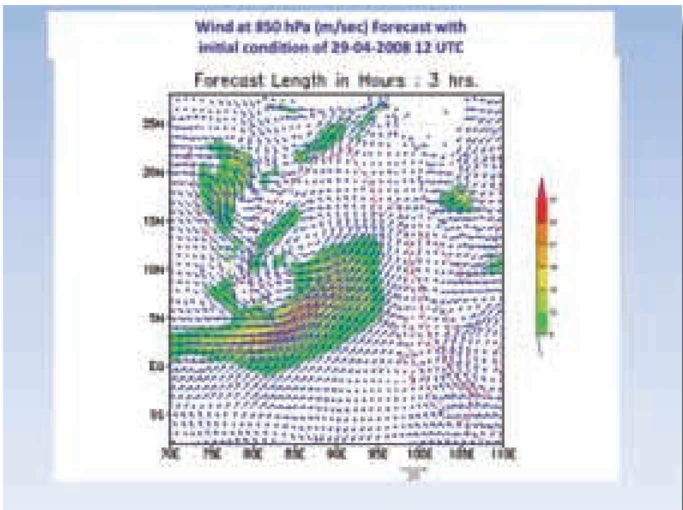
Glimpses of Cyclone/Typhoon Simulations

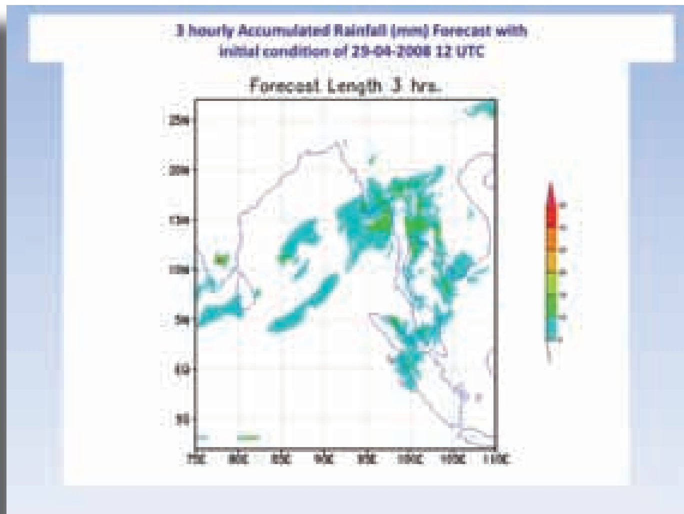

Observed Track

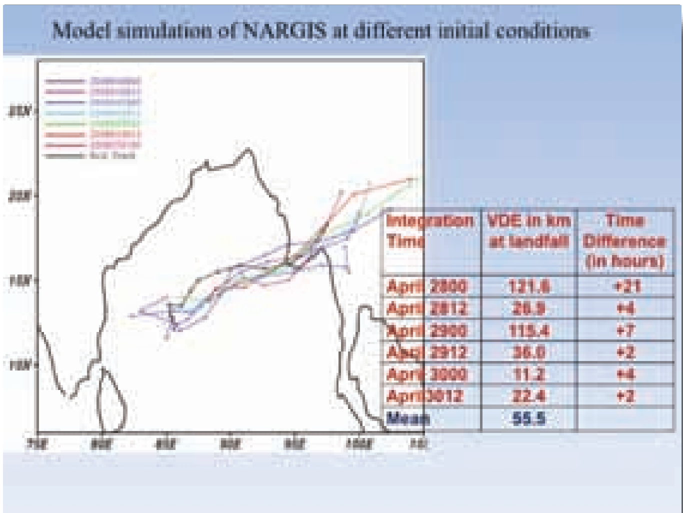

Cyclone Sidr, Bangladesh
Best track
Simulation using WRF

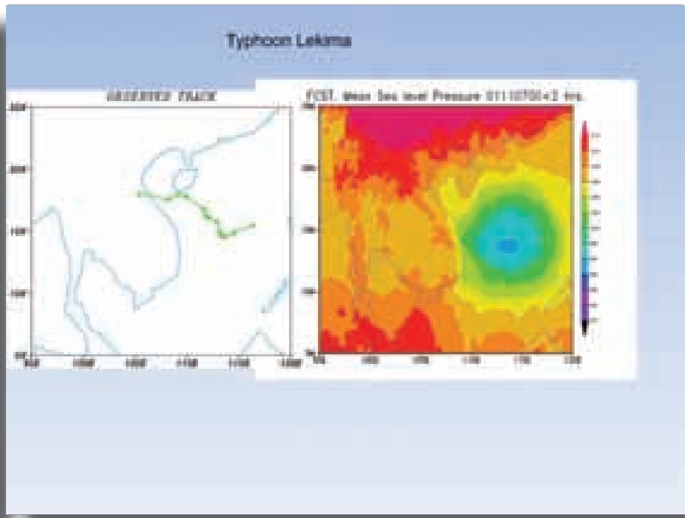

JTWC
MODEL
30N
25N
20N
15N
10N
5N
75E
80E
85E
90E
95E
100E
105E

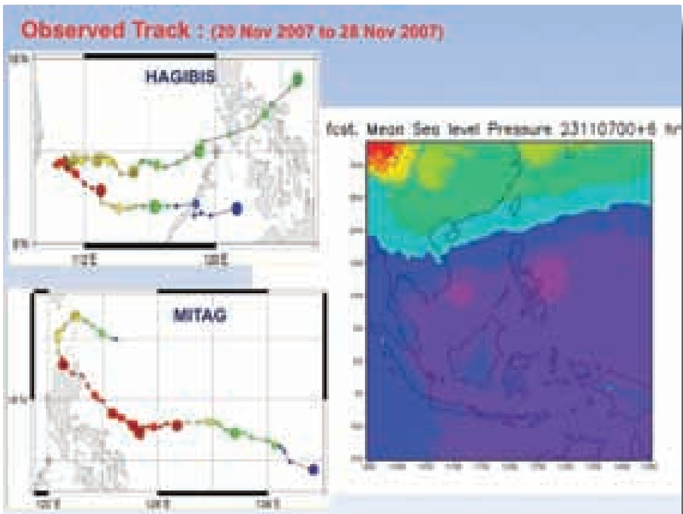

Mean Sea Level Pressure Forecast with
initial condition of 29-04-2008 12 UTC
Forecast Length in Hours : 3 hrs.

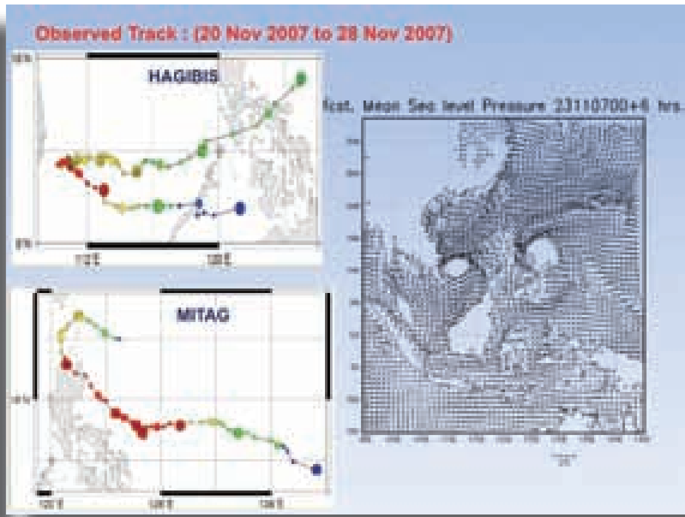

Wind at 850 hPa (m/sec) Forecast with
initial condition of 29-04-2008 12 UTC
Forecast Length in Hours : 3 hrs.

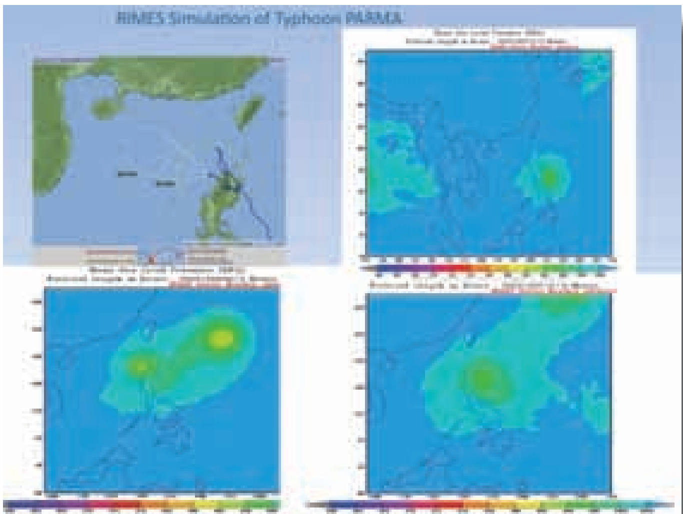

3 hourly Accumulated Rainfall (mm) Forecast with
initial condition of 29-04-2008 12 UTC
Forecast Length 3 hrs.

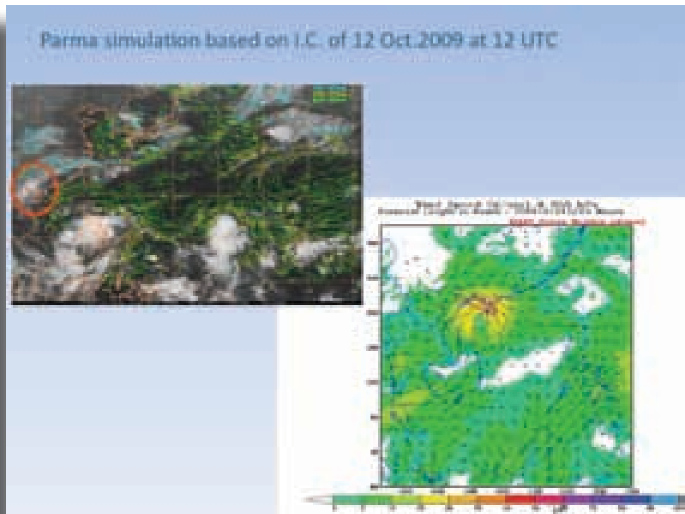

Model simulation of NARGIS at different initial conditions
Integration Time | VDE in km at landfall | Time Difference (in hours)
April 2800 | 121.6 | +21
April 2812 | 26.9 | +4
April 2900 | 115.4 | +7
April 2912 | 36.0 | +2
April 3000 | 11.2 | +4
April 3012 | 22.4 | +2
Mean | 55.5

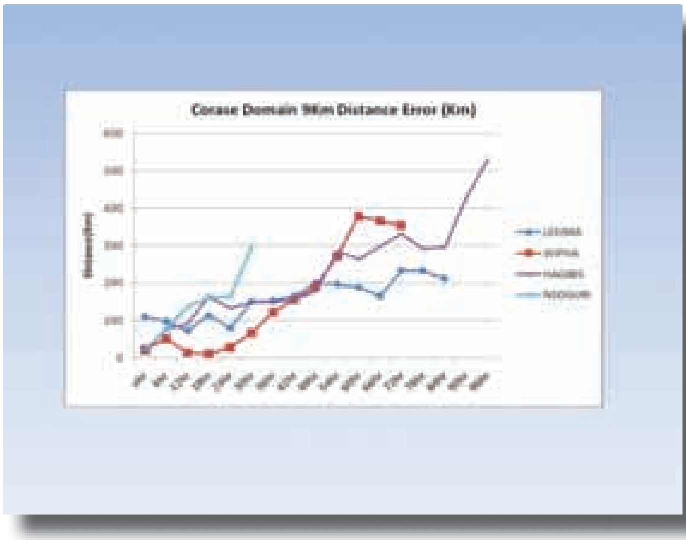

Typhoon Lekima
FCST. Mean Sea level Pressure 01110700+2 hrs.

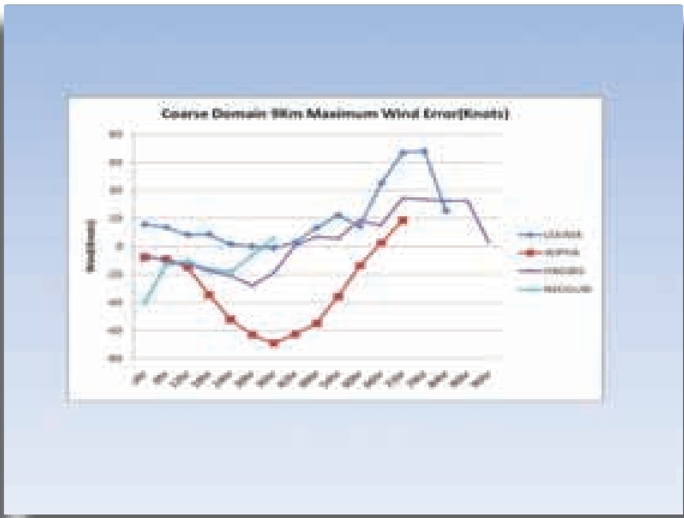

Observed Track : (20 Nov 2007 to 28 Nov 2007)
HAGIBIS
MITAG
fcst. Mean Sea level Pressure 23110700+6 hrs

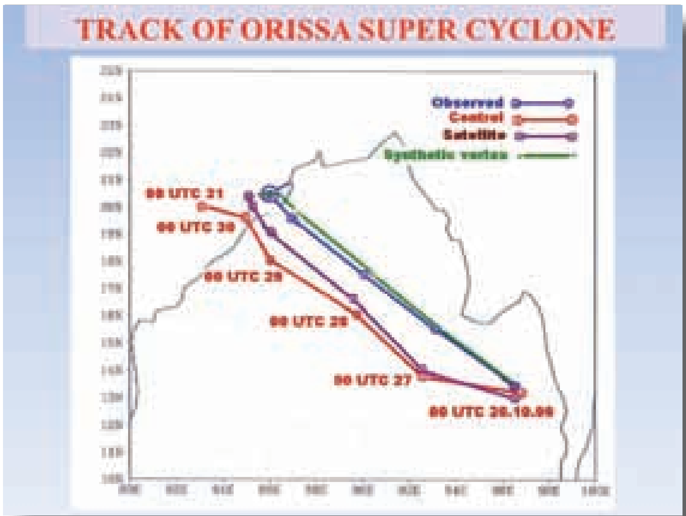

Observed Track : (20 Nov 2007 to 28 Nov 2007)
HAGIBIS
MITAG
fcst. Mean Sea level Pressure 23110700+6 hrs.

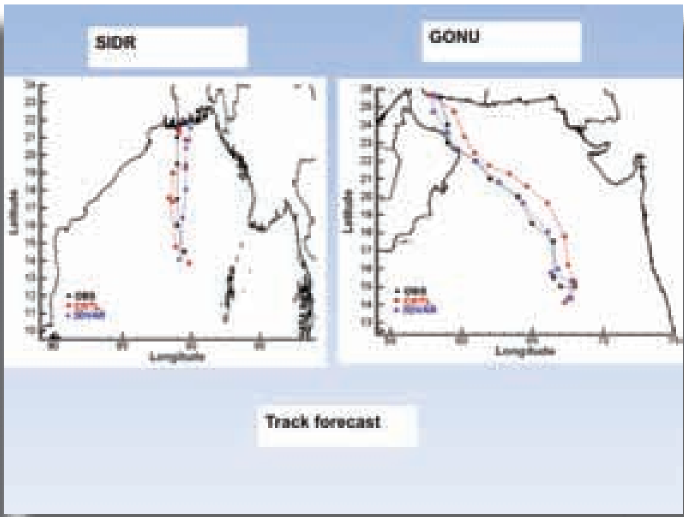

RIMES Simulation of Typhoon PARMA

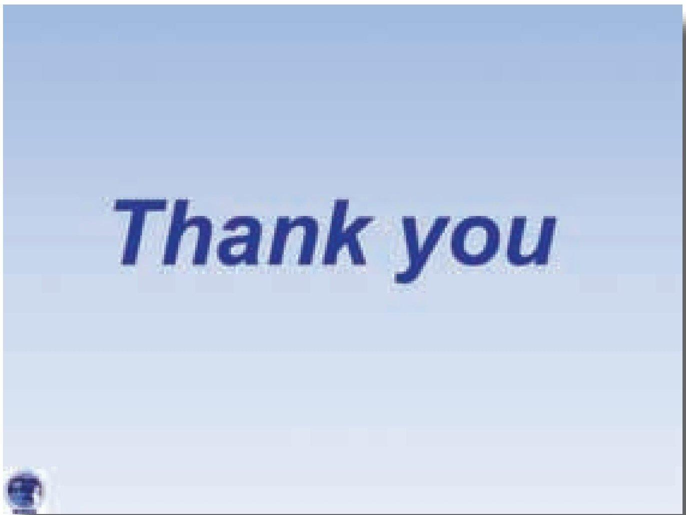

Parma simulation based on I.C. of 12 Oct.2009 at 12 UTC

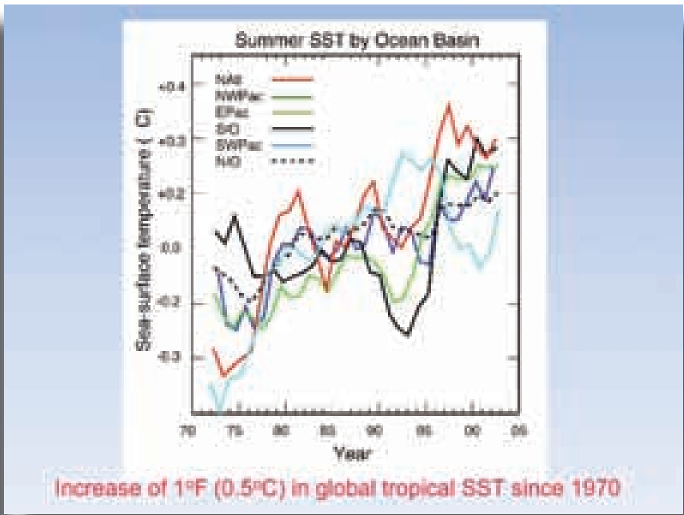

Corase Domain 9Km Distance Error (Km)

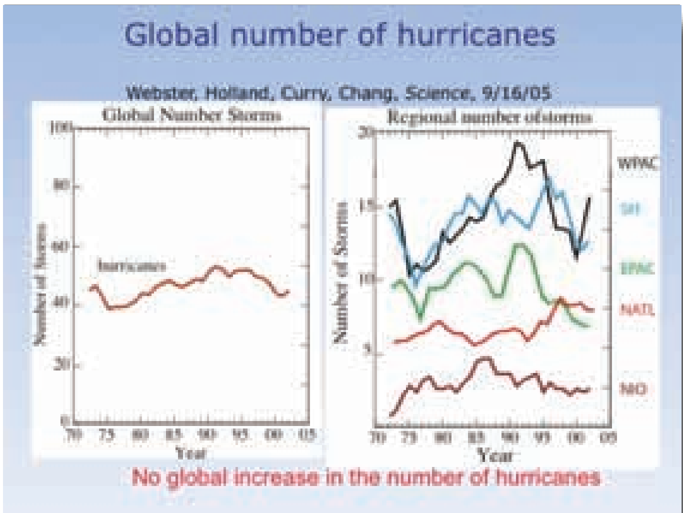

Coarse Domain 9Km Maximum Wind Error(Knots)

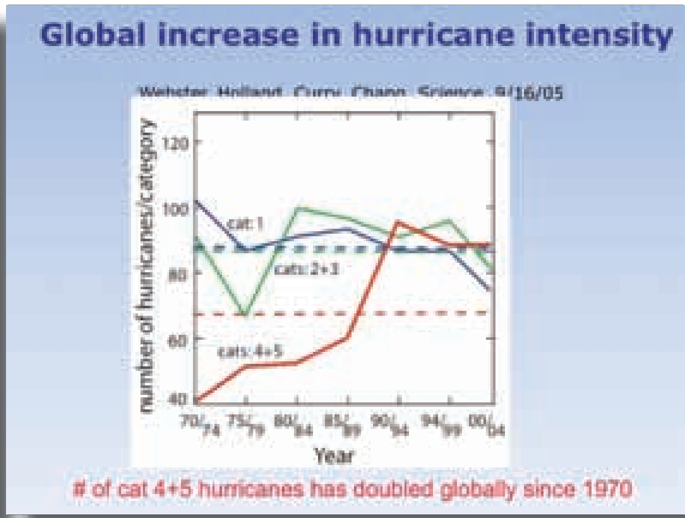

TRACK OF ORISSA SUPER CYCLONE
Observed
Control
Satellite
Synthetic vortex
00 UTC 31
00 UTC 30
00 UTC 29
00 UTC 28
00 UTC 27
00 UTC 26.10.99

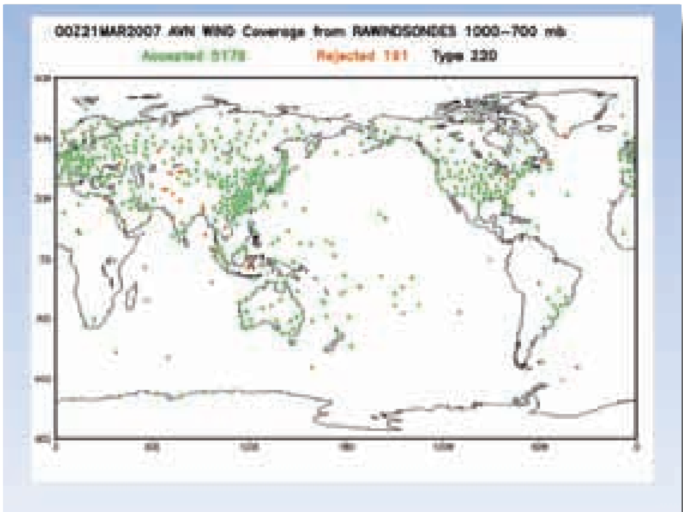

SIDR
GONU
Longitude
Latitude
Track forecast

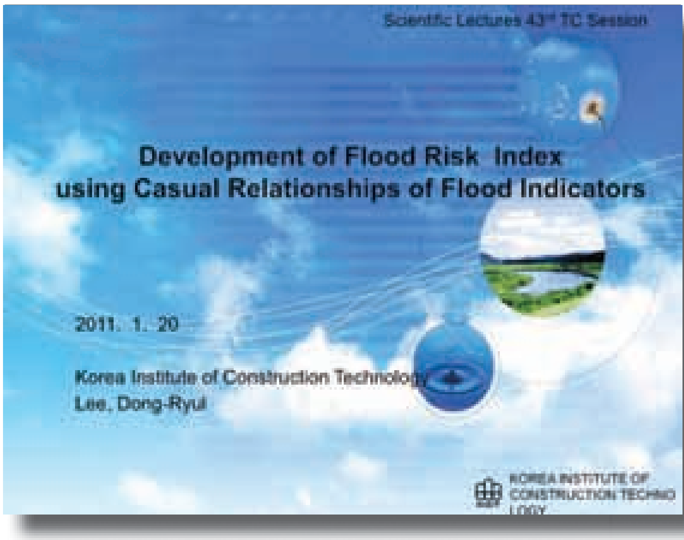

Thank you

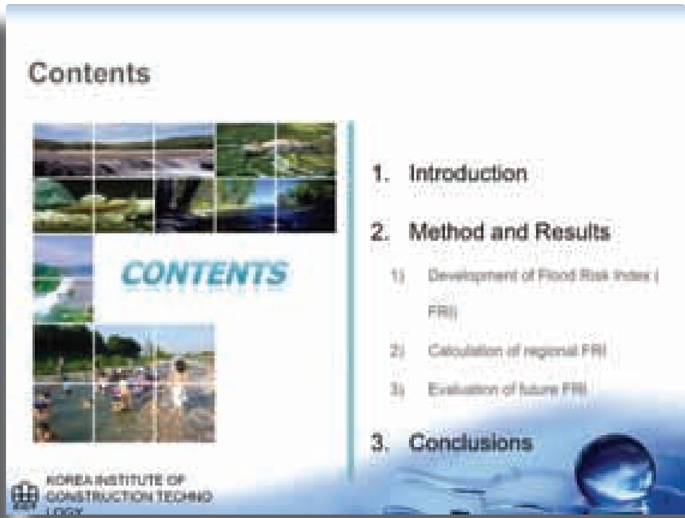

Summer SST by Ocean Basin
NAtl
NWPac
EPac
SIO
SWPac
NIO
Sea-surface temperature (C)
Year
Increase of 1ºF (0.5ºC) in global tropical SST since 1970

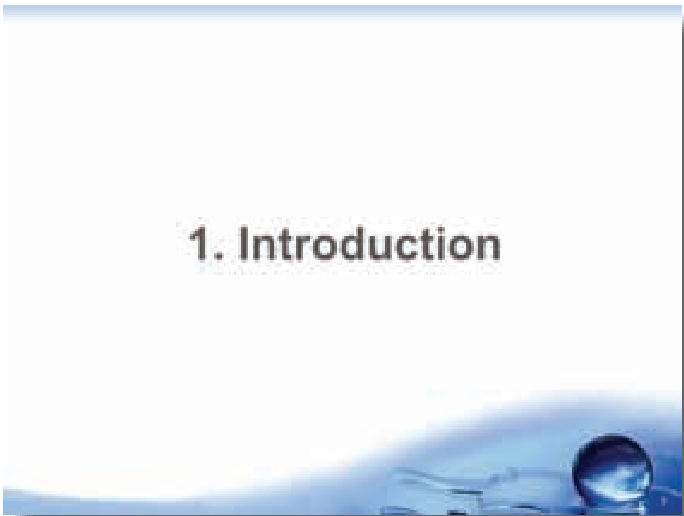

Global number of hurricanes
Webster, Holland, Curry, Chang, Science, 9/16/05
Global Number Storms
Number of Storms
hurricanes
Year
Regional number of storms
Number of Storms
WPAC
NATL
NIO
Year
No global increase in the number of hurricanes

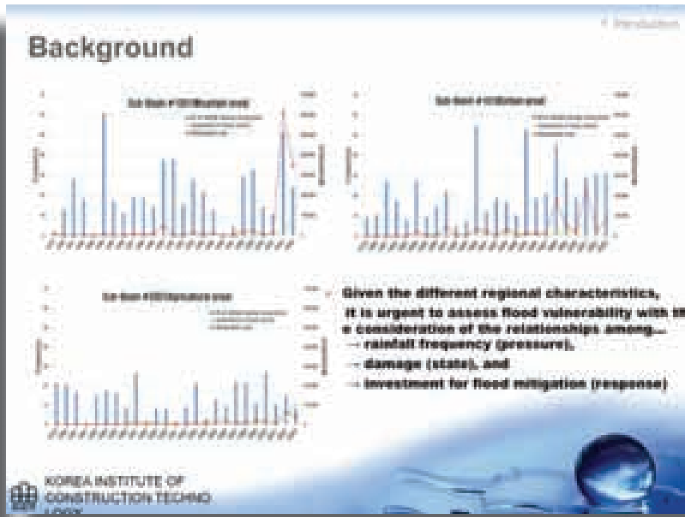

Global increase in hurricane intensity
Webster, Holland, Curry, Chang, Science, 9/16/05
number of hurricanes/category
cat: 1
cats: 2+3
cats: 4+5
Year
# of cat 4+5 hurricanes has doubled globally since 1970


00Z21MAR2007 AVN WIND Coverage from RAWINDSONDES 1000-700 mb


Scientific Lectures 43rd TC Session
Development of Flood Risk Index
using Casual Relationships of Flood Indicators
2011. 1. 20
Korea Institute of Construction Technology
Lee, Dong-Ryul
KOREA INSTITUTE OF CONSTRUCTION TECHNOLOGY


Contents
CONTENTS
1. Introduction
2. Method and Results
1) Development of Flood Risk Index (FRI)
2) Calculation of regional FRI
3) Evaluation of future FRI
3. Conclusions
KOREA INSTITUTE OF CONSTRUCTION TECHNOLOGY


1. Introduction


Background
Given the different regional characteristics,
it is urgent to assess flood vulnerability with the consideration of the relationships among...
→ rainfall frequency (pressure),
→ damage (state), and
→ investment for flood mitigation (response)
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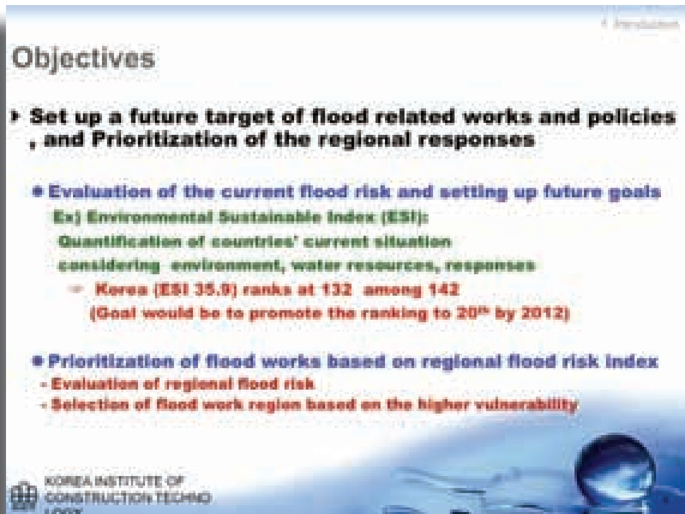
Objectives
Development of temporal and spatial quantified indices to assess performance and to give public service on effectiveness of flood countermeasures at the national and regional level
Limitation of expressing performance and effectiveness of flood countermeasures
- Existing performance index of flood works: response-oriented indicators
Ex.) river work rate, pumping facilities, etc
- Limitations:
1) Lack of understanding the causes and effects of the floods
Ex.) The damage could become severe,
even though adequate flood works with a design level,
if there are occurrences of rainfall over the level.
2) Difficulties in comparing performance over different times and regions
3) Provision of the information about flood countermeasures
to decision makers and the public
KOREA INSTITUTE OF CONSTRUCTION TECHNOLOGY


Objectives
Set up a future target of flood related works and policies
, and Prioritization of the regional responses
Evaluation of the current flood risk and setting up future goals
Ex) Environmental Sustainable Index (ESI):
Quantification of countries' current situation
considering environment, water resources, responses
Korea (ESI 35.9) ranks at 132 among 142
(Goal would be to promote the ranking to 20th by 2012)
Prioritization of flood works based on regional flood risk index
- Evaluation of regional flood risk
- Selection of flood work region based on the higher vulnerability
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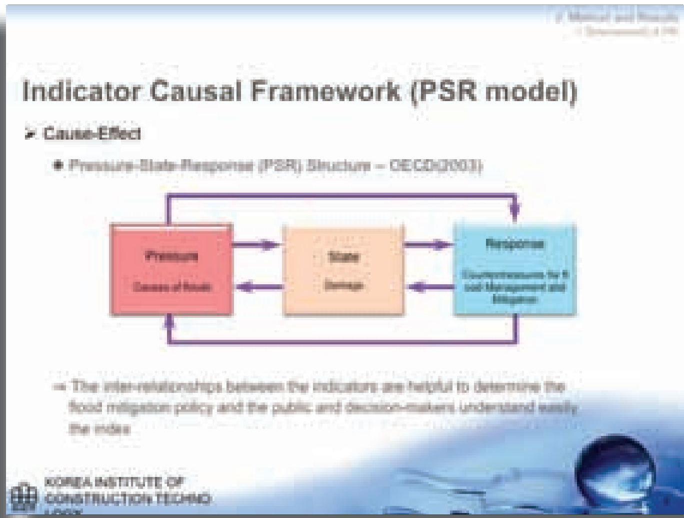
2. Method and Results
I. Development of Flood Risk Index (FRI)
II. Calculation of regional FRI
III. Evaluation of future FRI


Indicator Causal Framework (PSR model)
➢ Cause-Effect
● Pressure-State-Response (PSR) Structure – OECD(2003)
Pressure
State
Damage
Response
→ The inter-relationships between the indicators are helpful to determine the flood mitigation policy and the public and decision-makers understand easily the index
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Indices to measure flood risk
➢ Measuring thematic flood risk index based on PSR
● Pressure Index (PI) : composite index using cause indicators
● State Index (SI) : composite index using damage indicators
● Response Index (RI) : composite index using action indicators
➢ Measuring integrated Flood Risk index using thematic indies
● Flood Risk Index (FRI) : composite index using PI, SI, and RI to evaluate the comprehensive flood vulnerability in a region
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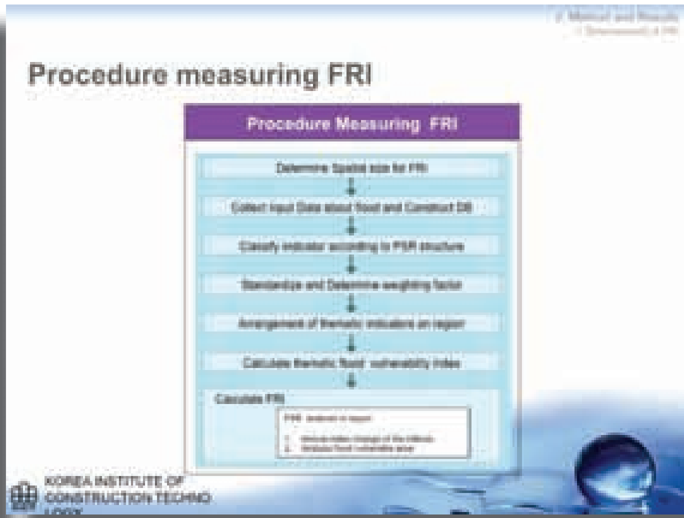
Procedure measuring FRI
Procedure Measuring FRI
Collect Input Data about flood and Construct DB
Classify indicator according to PSR structure
Standardize and Determine weighting factor
Arrangement of thematic indicators on region
Calculate thematic flood vulnerability index
Calculate FRI
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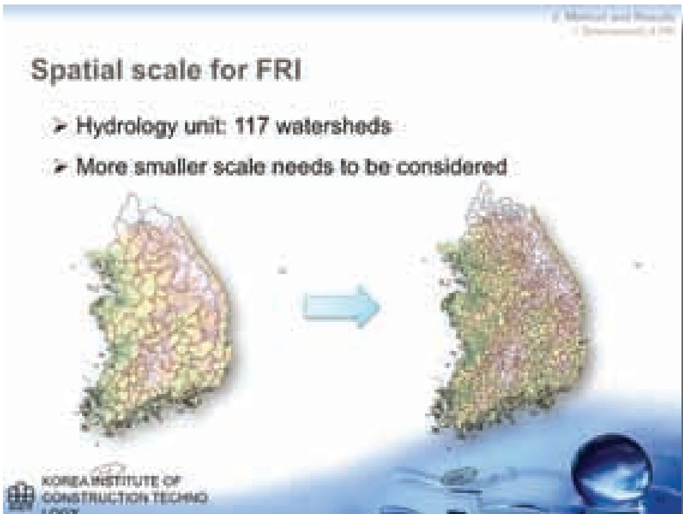
Spatial scale for FRI
➢ Hydrology unit: 117 watersheds
➢ More smaller scale needs to be considered
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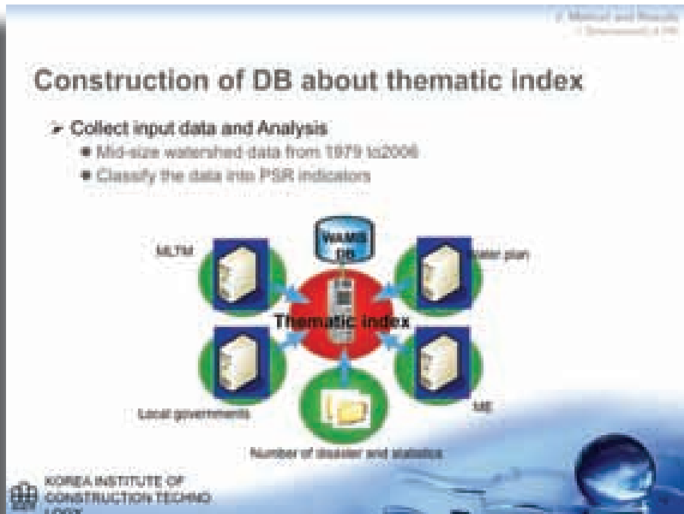
Construction of DB about thematic index
➢ Collect input data and Analysis
● Mid-size watershed data from 1979 to2006
● Classify the data into PSR indicators
MLTM
WAMIS DB
Thematic index
Local governments
ME
Number of disaster and statistics
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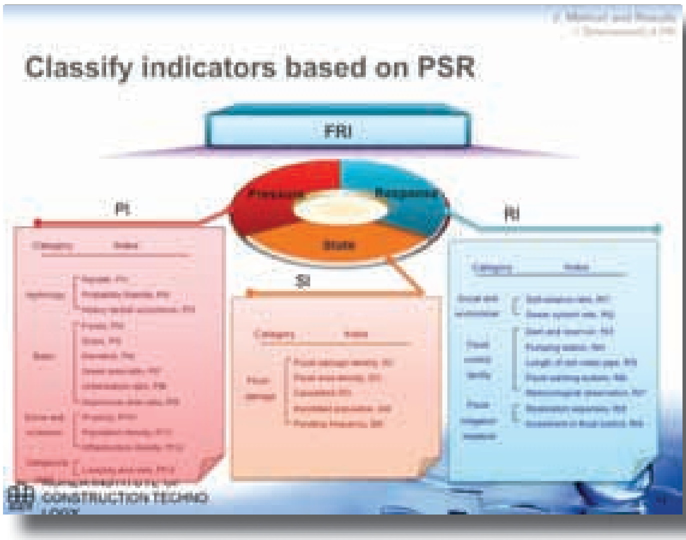
Classify indicators based on PSR
FRI
Pressure
Response
State
PI
SI
RI
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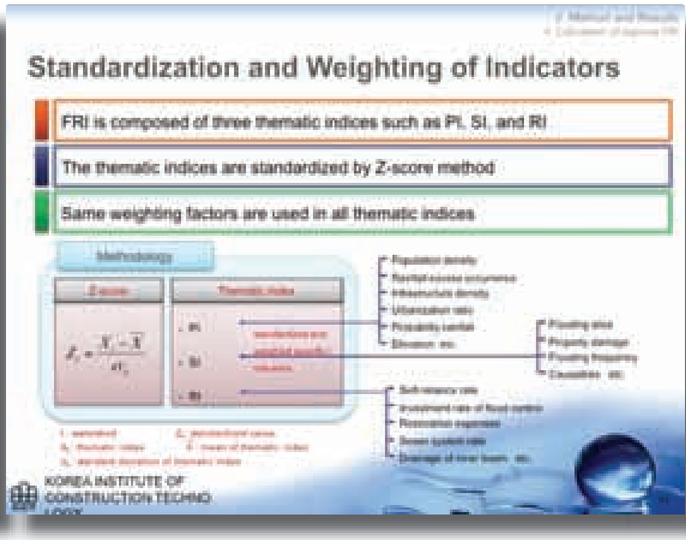
Standardization and Weighting of Indicators
FRI is composed of three thematic indices such as PI, SI, and RI
The thematic indices are standardized by Z-score method
Same weighting factors are used in all thematic indices
Methodology
Z-score
Thematic Index
Population density
Rainfall excess occurrence
Urbanization ratio
Elevation etc.
Flooding area
Property damage
Flooding frequency
Casualties etc.
Self-reliancy rate
Investment rate of flood control
Restoration expenses
Sewer system rate
Drainage of river basin etc.
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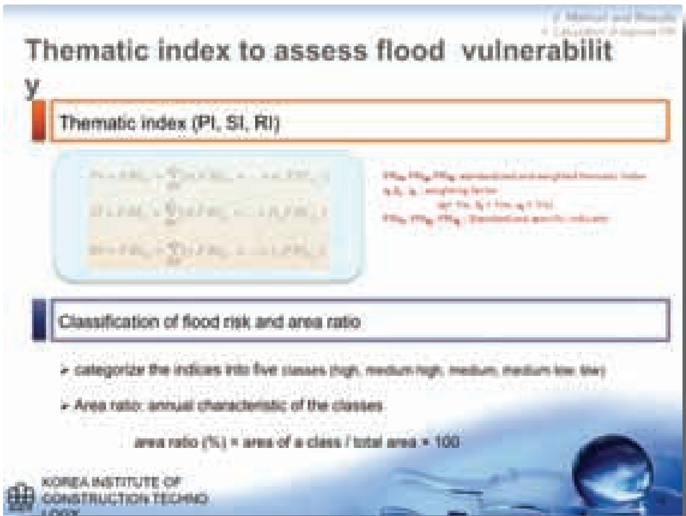
Thematic index to assess flood vulnerability
Thematic index (PI, SI, RI)
Classification of flood risk and area ratio
➢ categorize the indices into five classes (high, medium high, medium, medium low, low)
➢ Area ratio: annual characteristic of the classes
area ratio (%) = area of a class / total area × 100
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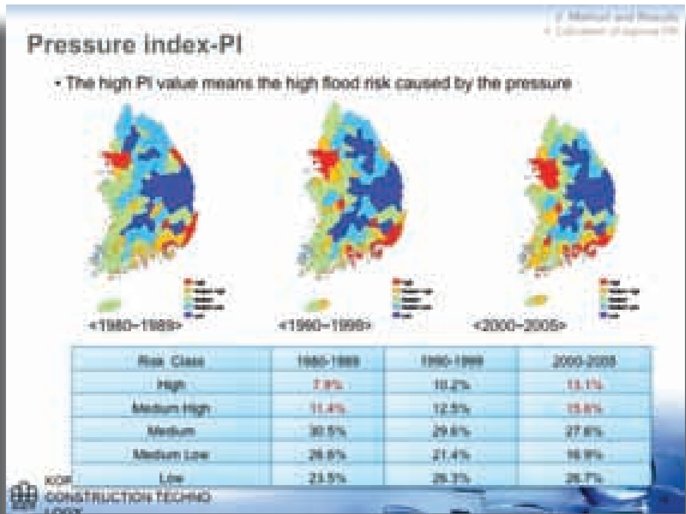
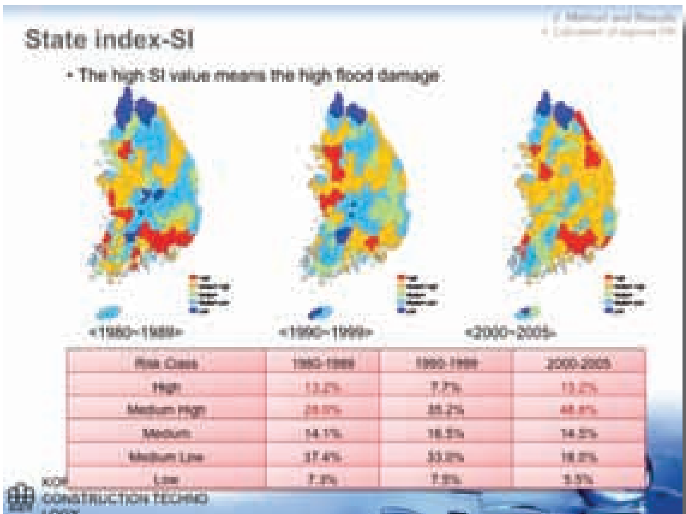
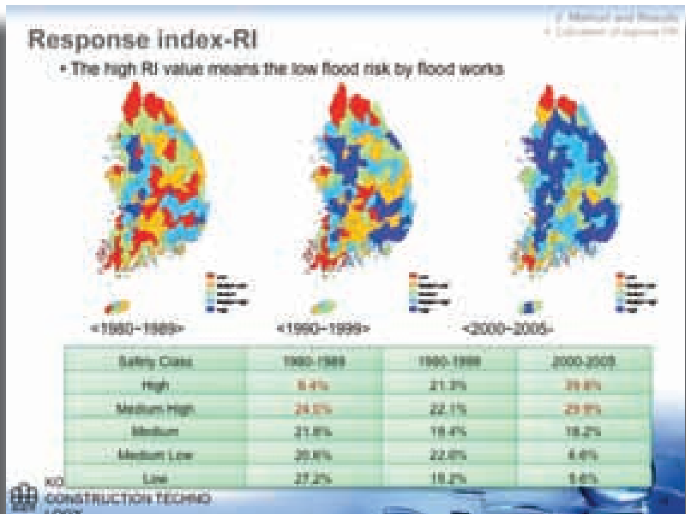
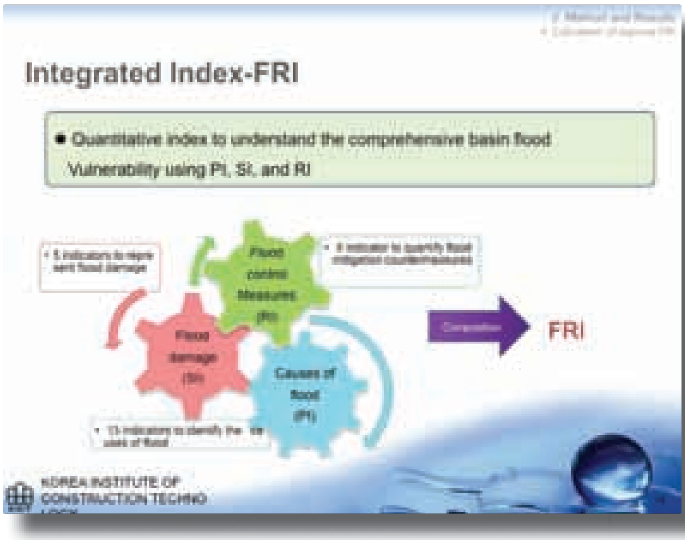

Pressure index-PI
• The high PI value means the high flood risk caused by the pressure
<1980~1989>
<1990~1999>
<2000~2005>
Risk Class | 1980-1989 | 1990-1999 | 2000-2005
High | 7.9% | 10.2% | 13.1%
Medium High | 11.4% | 12.5% | 15.6%
Medium | 30.5% | 29.6% | 27.6%
Medium Low | 26.6% | 21.4% | 16.9%
Low | 23.5% | 26.3% | 26.7%
CONSTRUCTION TECHNOLOGY


State index-SI
• The high SI value means the high flood damage
<1980~1989>
<1990~1999>
<2000~2005>
Risk Class | 1980-1989 | 1990-1999 | 2000-2005
High | 13.2% | 7.7% | 13.2%
Medium High | 28.0% | 35.2% | 48.4%
Medium | 14.1% | 16.5% | 14.5%
Medium Low | 37.4% | 33.0% | 18.0%
Low | 7.3% | 7.5% | 5.5%
CONSTRUCTION TECHNOLOGY


Response index-RI
• The high RI value means the low flood risk by flood works
<1980~1989>
<1990~1999>
<2000~2005>
Safety Class | 1980-1989 | 1990-1999 | 2000-2005
High | 8.4% | 21.3% | 39.6%
Medium High | 24.0% | 22.1% | 29.9%
Medium | 21.8% | 19.4% | 18.2%
Medium Low | 20.6% | 22.0% | 6.6%
Low | 27.2% | 15.2% | 5.6%
CONSTRUCTION TECHNOLOGY


Integrated Index-FRI
Quantitative index to understand the comprehensive basin flood Vulnerability using PI, SI, and RI
5 indicators to represent flood damage
Flood control Measures (RI)
Flood damage (SI)
Causes of flood (PI)
Composition
FRI
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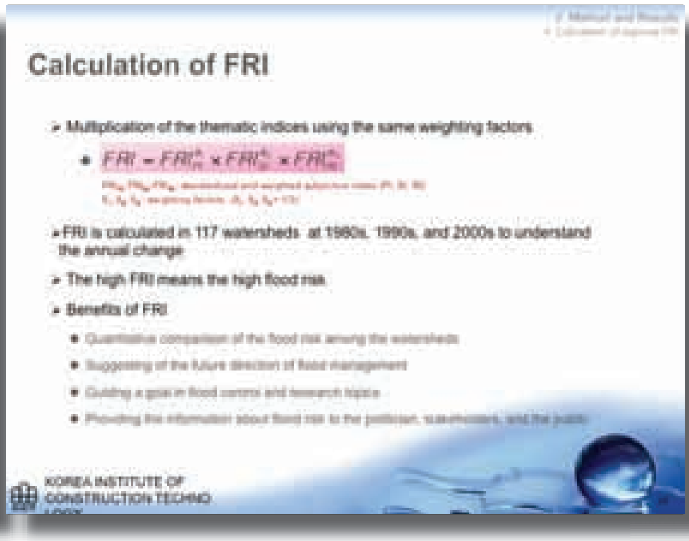
Calculation of FRI
Multiplication of the thematic indices using the same weighting factors
$FRI = FRI_{PI}^{\alpha} \times FRI_{SI}^{\beta} \times FRI_{RI}^{\gamma}$
FRI is calculated in 117 watersheds at 1980s, 1990s, and 2000s to understand the annual change
The high FRI means the high flood risk
Benefits of FRI
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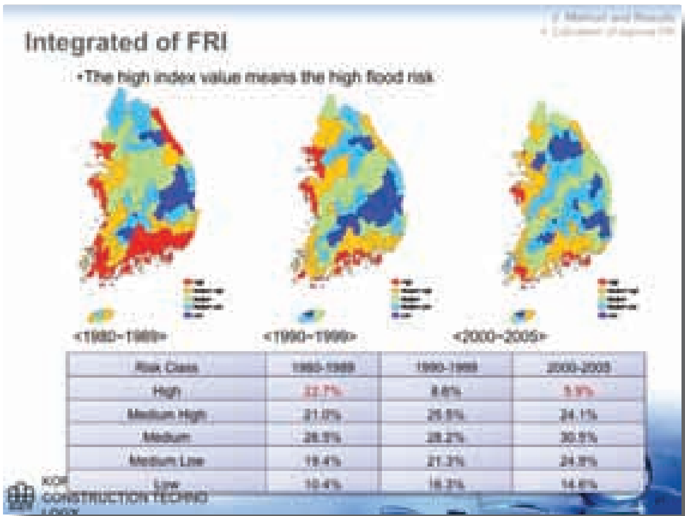
Integrated of FRI
The high index value means the high flood risk
<1980~1989>
<1990~1999>
<2000~2005>
Risk Class | 1980-1989 | 1990-1999 | 2000-2005
High | 22.7% | 8.8% | 5.9%
Medium High | 21.0% | 25.5% | 24.1%
Medium | 26.5% | 28.2% | 30.5%
Medium Low | 19.4% | 21.3% | 24.9%
Low | 10.4% | 16.3% | 14.6%
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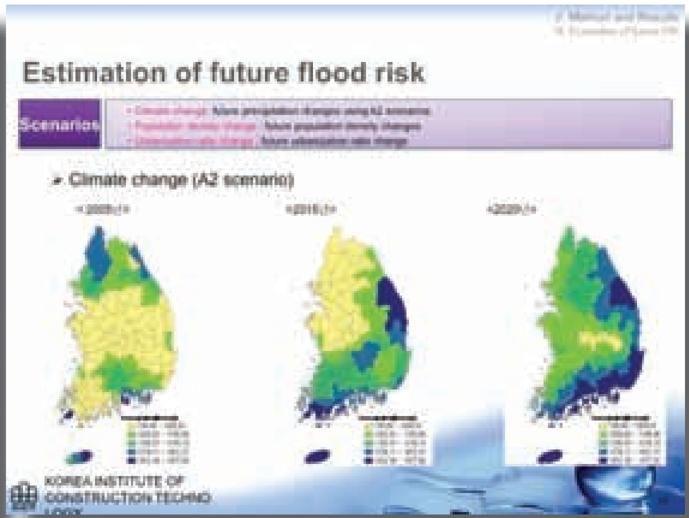
Estimation of future flood risk
Scenarios
Climate change (A2 scenario)
<2020s>
<2050s>
<2080s>
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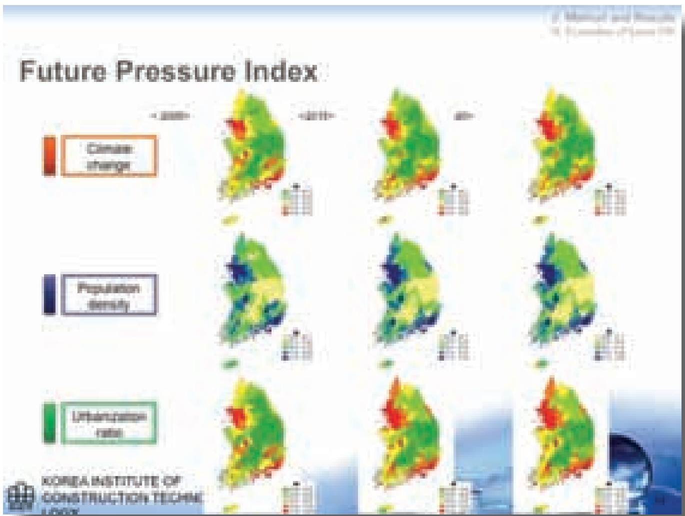
Future Pressure Index
Climate change
Population density
Urbanization ratio
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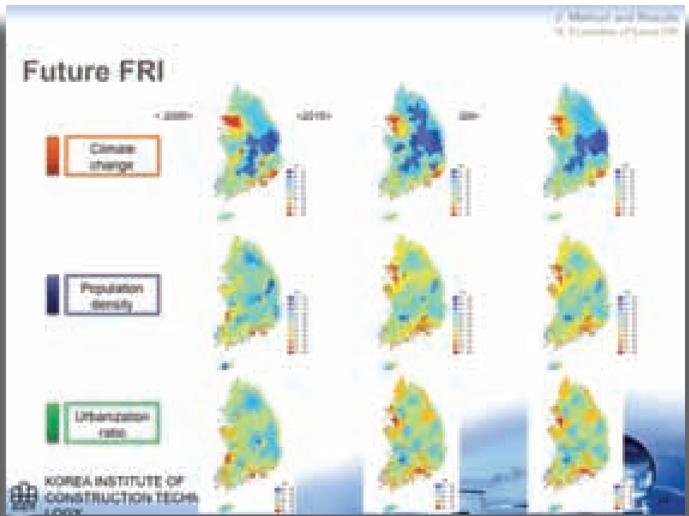
Future FRI
Climate change
Population density
Urbanization ratio
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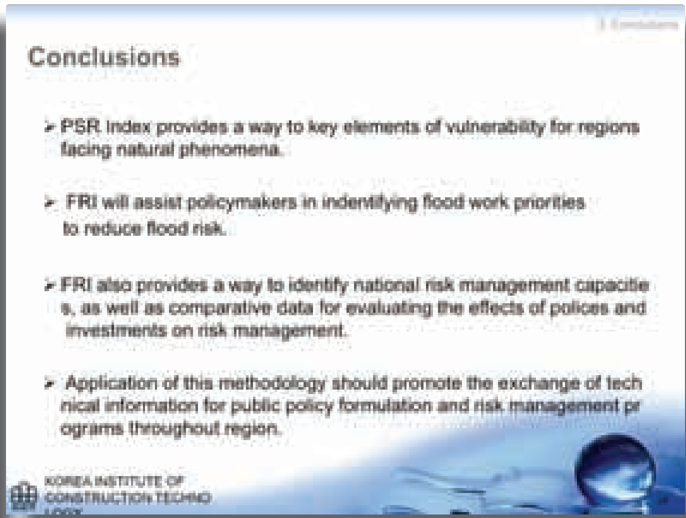
3. Conclusions


Conclusions
➢ PSR Index provides a way to key elements of vulnerability for regions facing natural phenomena.
➢ FRI will assist policymakers in indentifying flood work priorities to reduce flood risk.
➢ FRI also provides a way to identify national risk management capacities, as well as comparative data for evaluating the effects of polices and investments on risk management.
➢ Application of this methodology should promote the exchange of technical information for public policy formulation and risk management programs throughout region.
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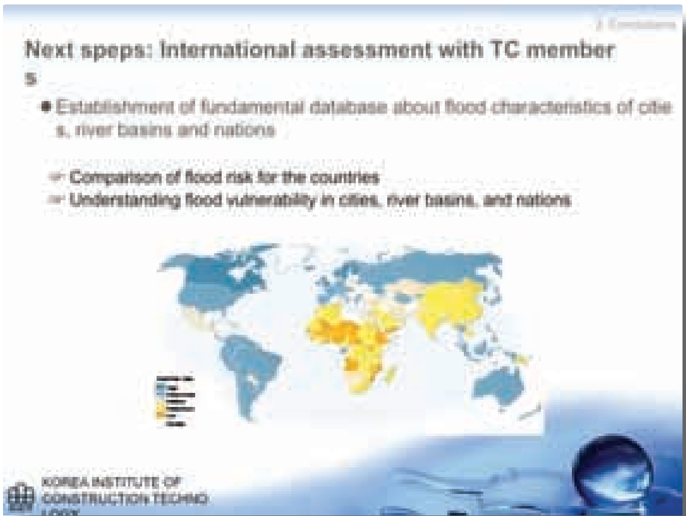
Next speps: International assessment with TC members
● Establishment of fundamental database about flood characteristics of cities, river basins and nations
☞ Comparison of flood risk for the countries
☞ Understanding flood vulnerability in cities, river basins, and nations
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Thank you for your attentions
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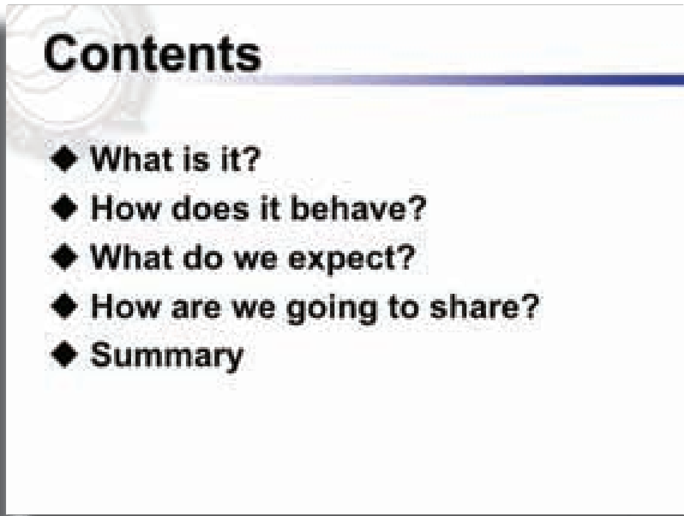
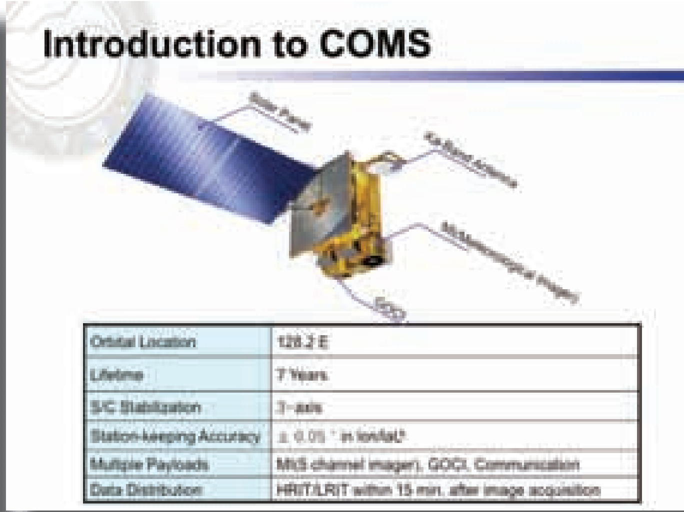
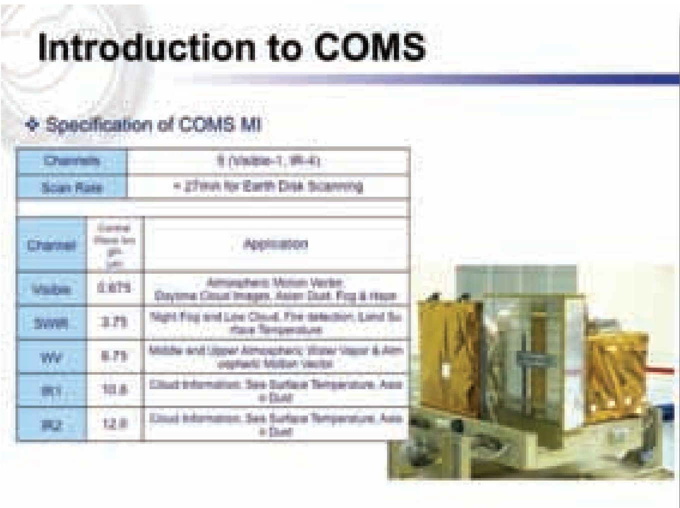




Orbital Location	128.2 E
Lifetime	7 Years
S/C Stabilization	3-axis
Station-keeping Accuracy	± 0.05 ° in lon/lat
Multiple Payloads	MI(5 channel imager), GOCI, Communication
Data Distribution	HRIT/LRIT within 15 min. after image acquisition

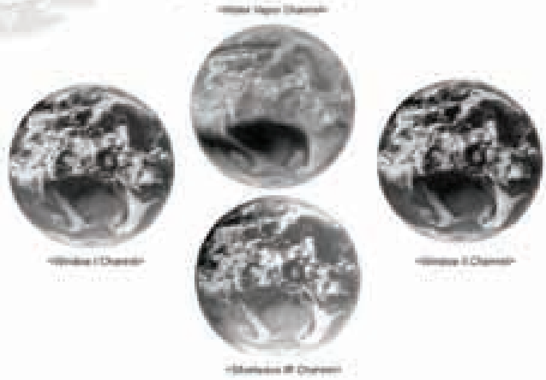


Channels	5 (Visible-1, IR-4)
Scan Rate	≈ 27min for Earth Disk Scanning

Channel	Central Wavelength (μm)	Application
Visible	0.675	Atmospheric Motion Vector, Daytime Cloud Images, Asian Dust, Fog & Haze
SWIR	3.75	Night Fog and Low Cloud, Fire detection, Land Surface Temperature
WV	6.75	Middle and Upper Atmospheric Water Vapor & Atmospheric Motion Vector
IR1	10.8	Cloud Information, Sea Surface Temperature, Asia Dust
IR2	12.0	Cloud Information, Sea Surface Temperature, Asia Dust

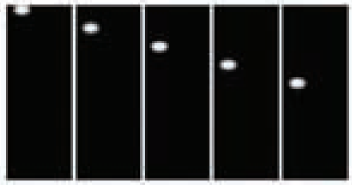
Something to celebrate

❖ and the first IR Images from COMS (August 11, 2010)



Something Interesting Images

❖ Solar intrusion effect



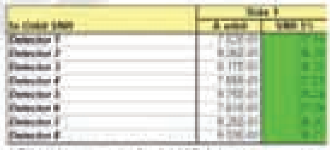
❖ Sun captured by Albedo Monitor

How does it behave?

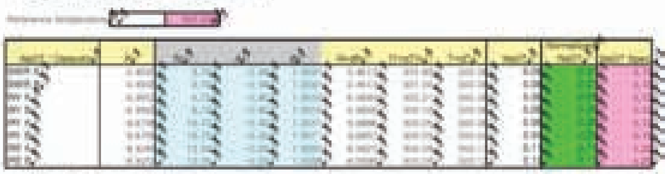
- The image quality is characterized by many parameters, including radiometric accuracy, INR(image navigation and registration) accuracy, MTF, etc.
- Currently, in orbit test (IOT) to test these characteristics is under going and is expected to be finished by end of January.
- The preliminary results from IOT are encouraging. The radiometric and INR performances are still under evaluation, although the preliminary results look satisfactory.

How does it behave?

❖ Test results for radiometric performance shows satisfactory results



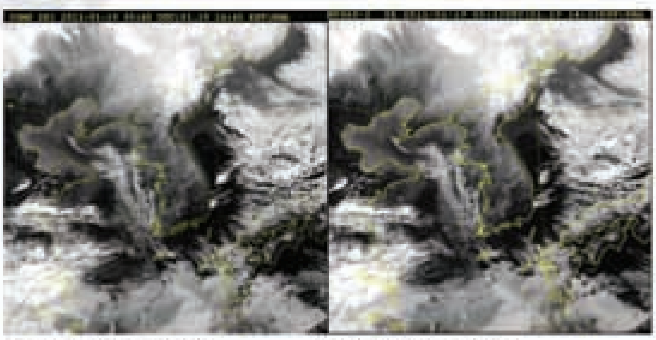
✓ Signal to noise ratio for the VIS detectors



✓ NeDT of the 8 IR detectors

How does it behave?

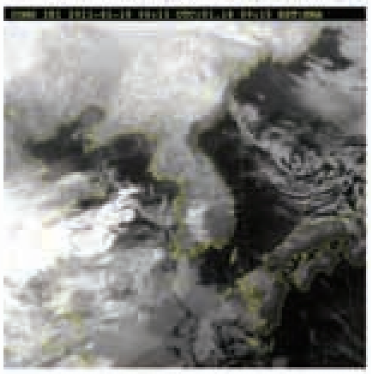
❖ Comparison with MTSAT looks satisfactory



✓ COMS IR1 2011.01.19 05:45 MTSAT2 IR1 2011.01.19 05:33

How does it behave?

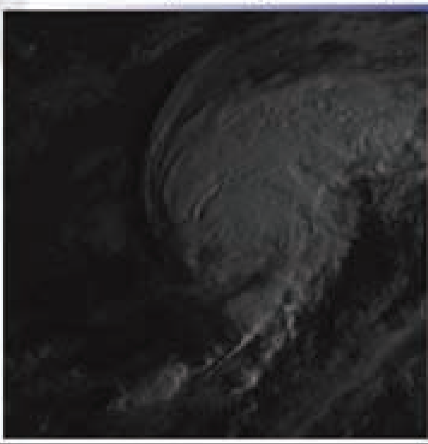
❖INR performance looks satisfactory, at least qualitatively



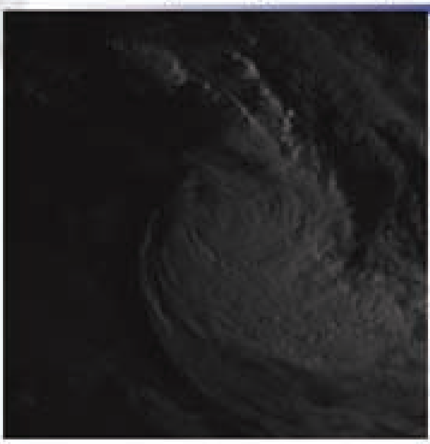
What do we expect

- We expect a high temporal satellite imagery data for the most of typhoon affected east Asia region (from 30 min to 15 min observation frequency)
- Some region will have a better spatial resolution data thanks to the longitudinal location of COMS

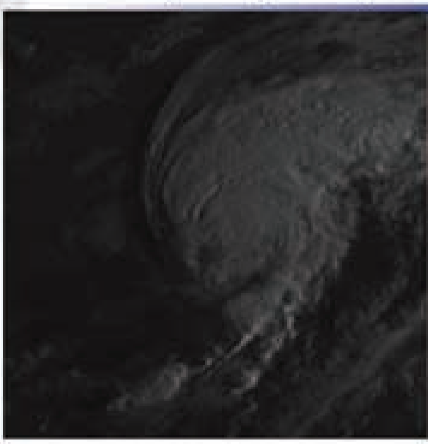
Typhoon Compasu(30 min)



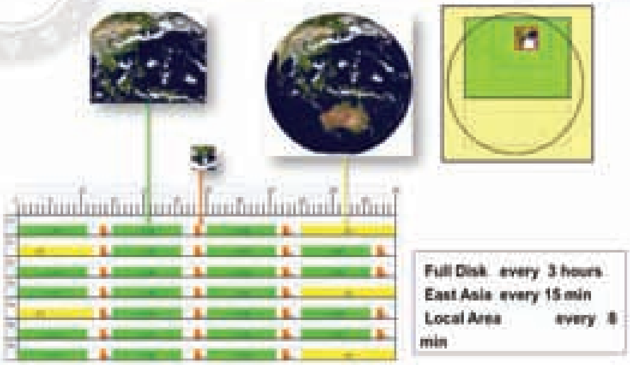
Typhoon Compasu(15 min)



Typhoon Compasu(8 min)

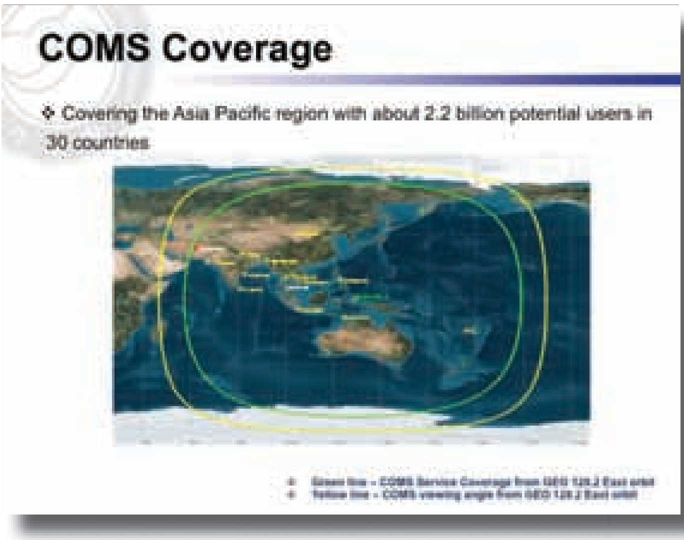


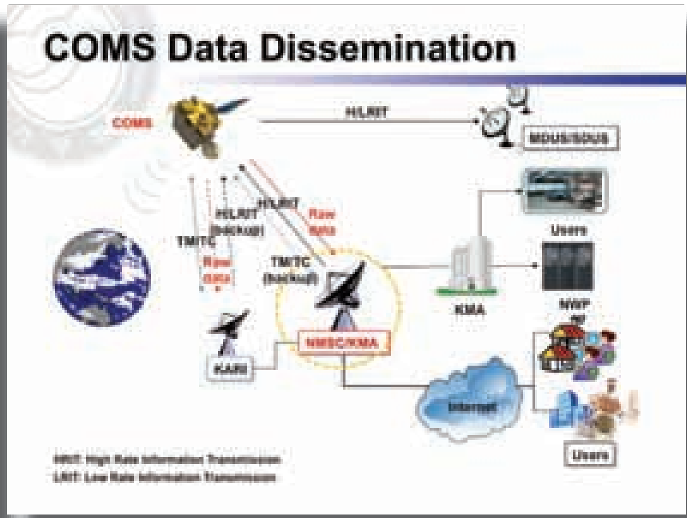
Observation Schedule(TBC)

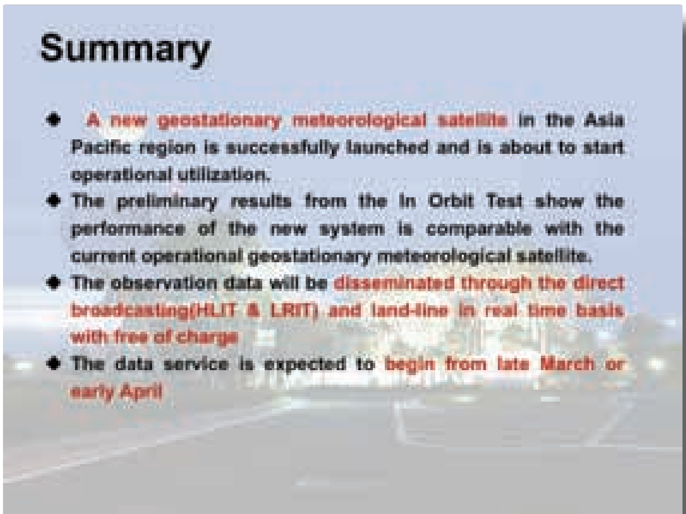


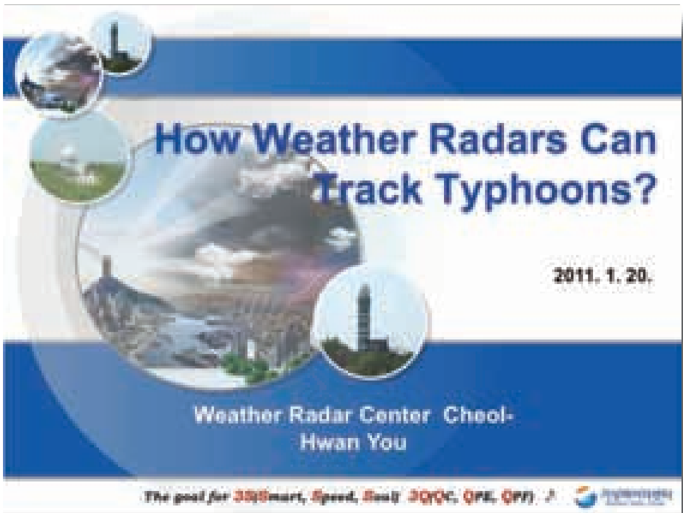
How are we going to serve?

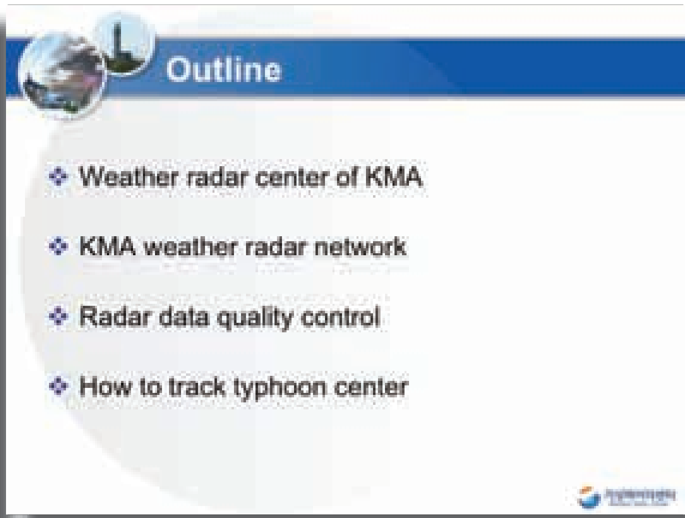
- We plan and prepare to follow the data service policy implemented by the current satellite operators, i.e in real time and with free of charge.
- The Level 1B data (geo-located and radiometerically calibrated) is going to be disseminated in real time (within 15 minutes after the acquisition of data) through both direct broadcasting and internet
- The operational service is planned to be starting late March or early April

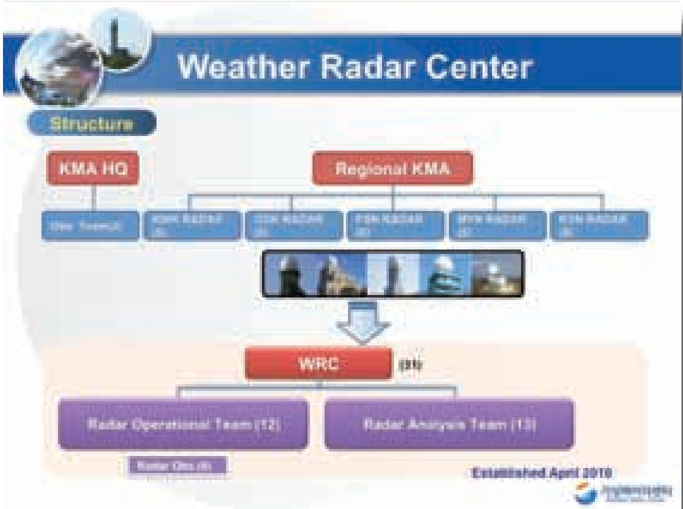

COMS Coverage
❖ Covering the Asia Pacific region with about 2.2 billion potential users in 30 countries


COMS Data Dissemination
COMS
H/LRIT
MDUS/SDUS
H/LRIT
H/LRIT (backup)
TM/TC
Raw data
Raw data
TM/TC (backup)
Users
KMA
NWP
NMSC/KMA
KARI
Users
HRIT: High Rate Information Transmission
LRIT: Low Rate Information Transmission

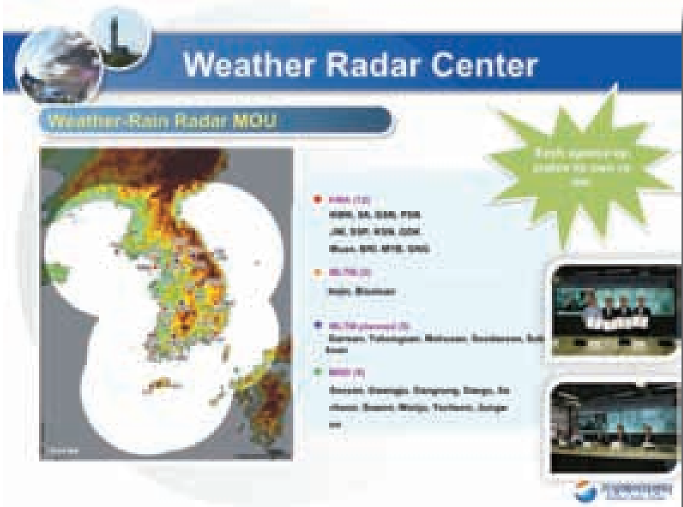

Summary
◆ A new geostationary meteorological satellite in the Asia Pacific region is successfully launched and is about to start operational utilization.
◆ The preliminary results from the In Orbit Test show the performance of the new system is comparable with the current operational geostationary meteorological satellite.
◆ The observation data will be disseminated through the direct broadcasting(HLIT & LRIT) and land-line in real time basis with free of charge
◆ The data service is expected to begin from late March or early April

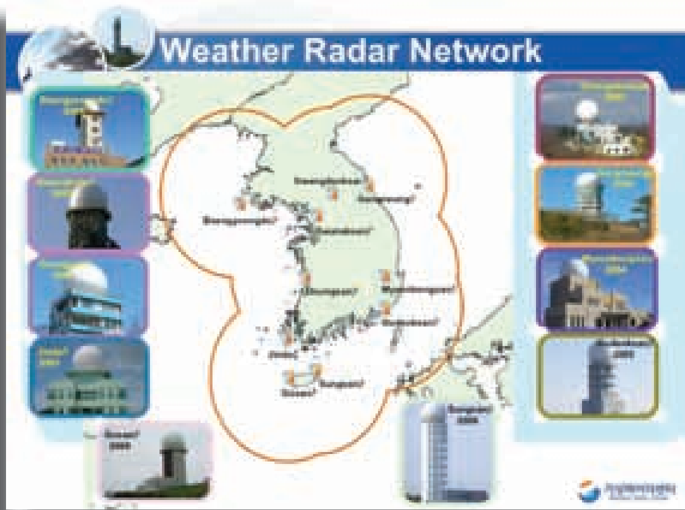

How Weather Radars Can Track Typhoons?
2011. 1. 20.
Weather Radar Center Cheol-Hwan You
The goal for 3S(Smart, Speed, Soul) 3Q(QC, QPE, QPF)

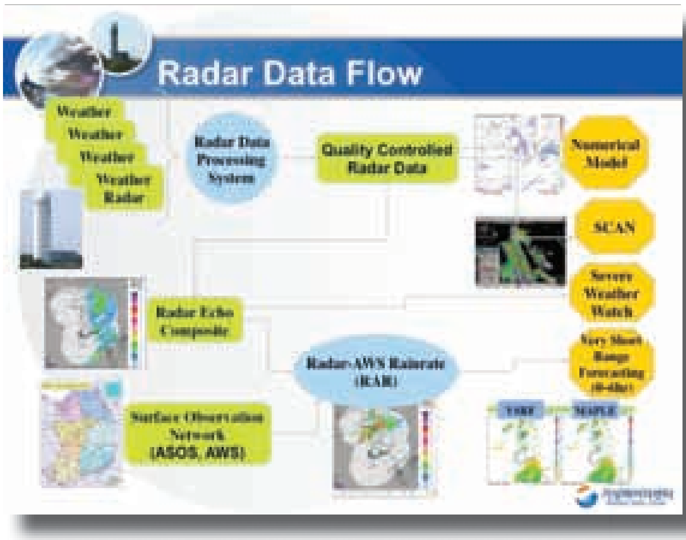

Outline
Weather radar center of KMA
KMA weather radar network
Radar data quality control
How to track typhoon center

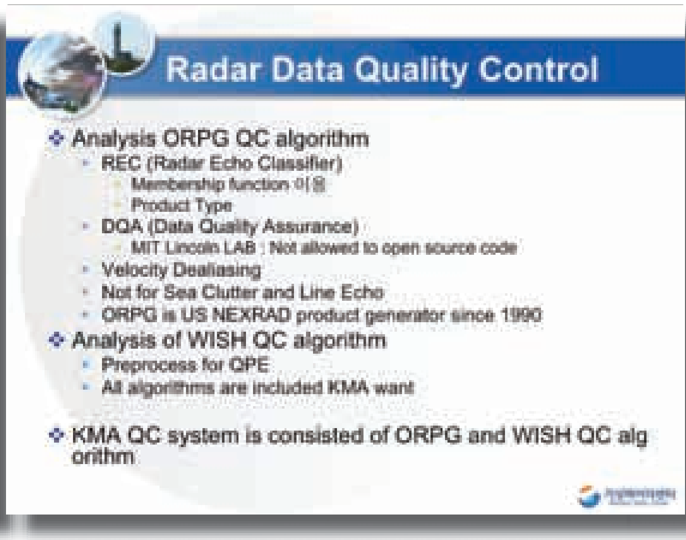

Weather Radar Center
Structure
KMA HQ
Regional KMA
WRC
(31)
Radar Operational Team (12)
Radar Analysis Team (13)
Established April 2010

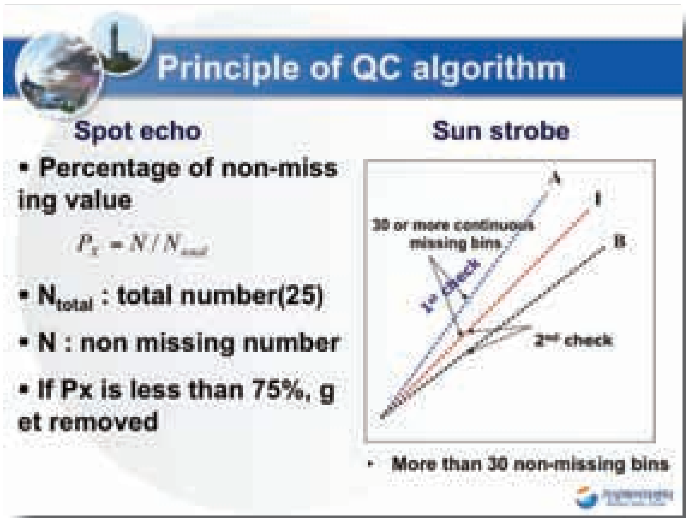

Weather Radar Center
Modernization
Purchase of New tech. Radar
Replace current single pol. Radar to S-band dual pol. Radar for 6 years
Management and Maintenance expense reduce
Life cycle 9 year to 20 years
Standardized Operation Procedure
Standard scan strategy for Tri-agency weather radar
Rapid scan
Scan interval 10 to 5 min.

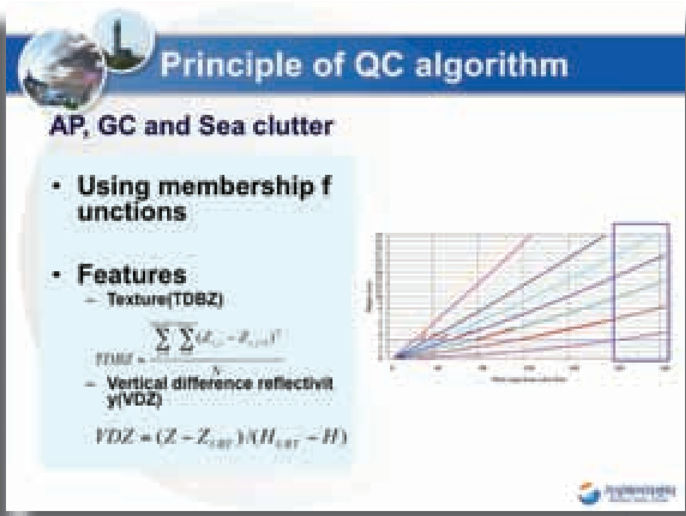

Weather Radar Center
Weather-Rain Radar MOU

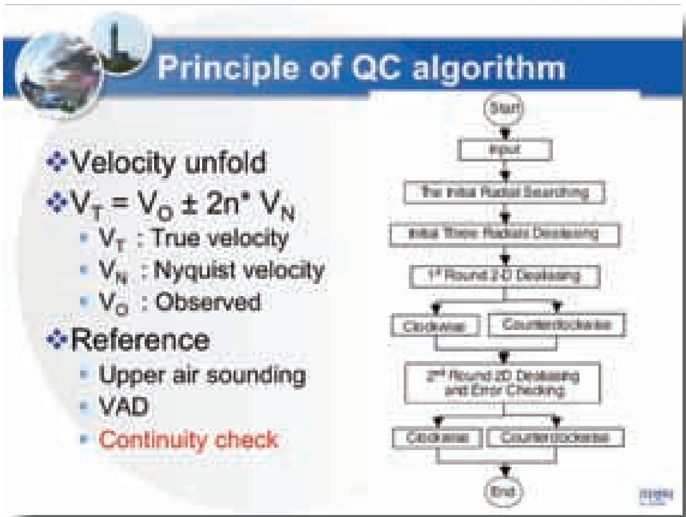

Weather Radar Network

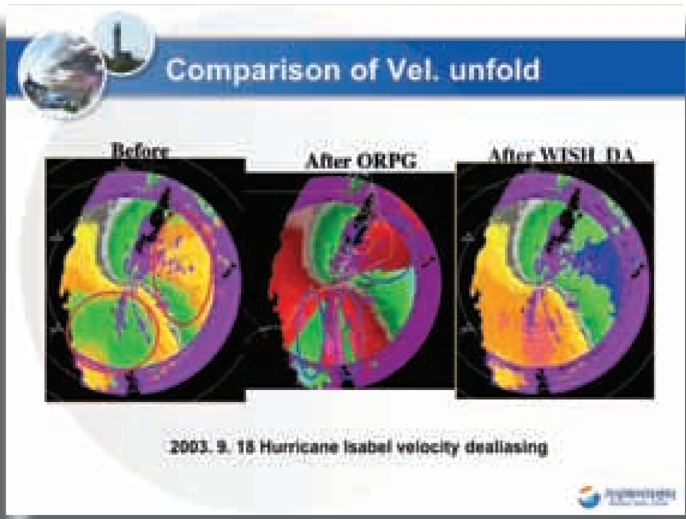

Radar Data Flow
Weather
Weather
Weather
Weather Radar
Radar Data Processing System
Quality Controlled Radar Data
Numerical Model
SCAN
Severe Weather Watch
Very Short Range Forecasting (0-6hr)
Radar Echo Composite
Radar-AWS Rainrate (RAR)
Surface Observation Network (ASOS, AWS)

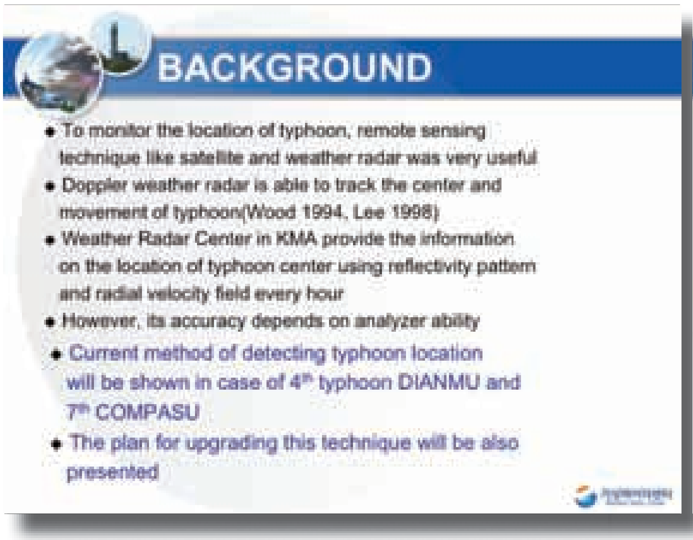

Radar Data Quality Control
Analysis ORPG QC algorithm
REC (Radar Echo Classifier)
Membership function 이용
Product Type
DQA (Data Quality Assurance)
MIT Lincoln LAB : Not allowed to open source code
Velocity Dealiasing
Not for Sea Clutter and Line Echo
ORPG is US NEXRAD product generator since 1990
Analysis of WISH QC algorithm
Preprocess for QPE
All algorithms are included KMA want
KMA QC system is consisted of ORPG and WISH QC alg orithm

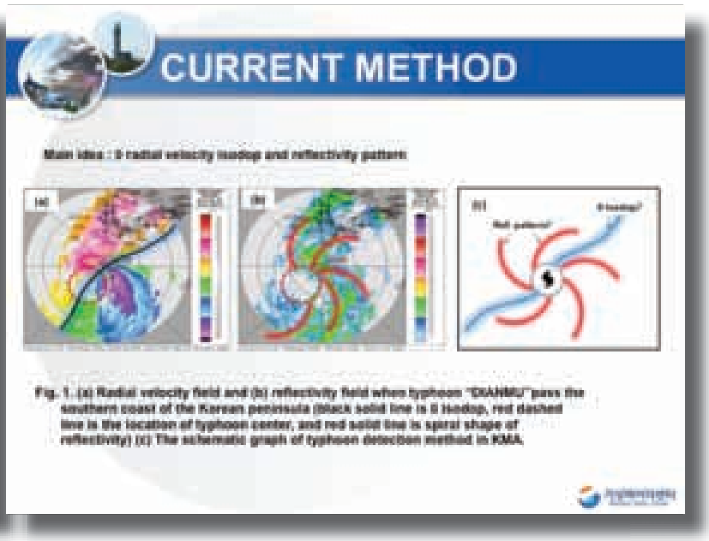

Principle of QC algorithm
Spot echo
Percentage of non-miss ing value
$P_x = N / N_{total}$
N_{total} : total number(25)
N : non missing number
If Px is less than 75%, g et removed
Sun strobe
30 or more continuous missing bins
1st check
2nd check
A
B
More than 30 non-missing bins

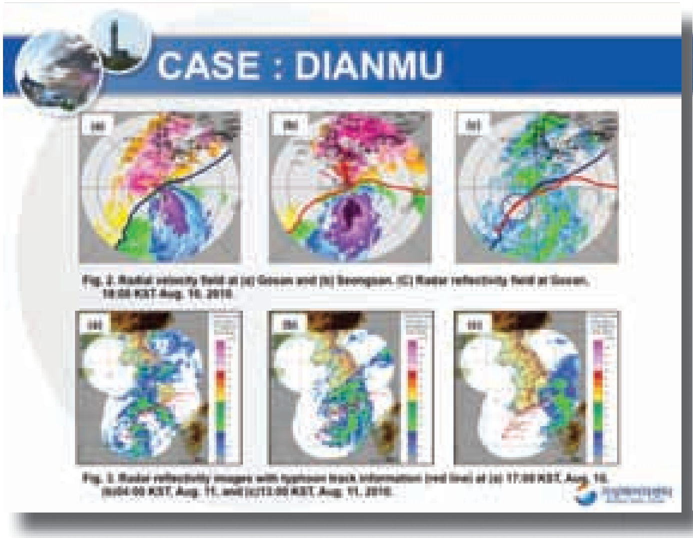

Principle of QC algorithm
AP, GC and Sea clutter
Using membership f unctions
Features
Texture(TDBZ)
Vertical difference reflectivit y(VDZ)
$VDZ = (Z - Z_{UP})/(H_{UP} - H)$

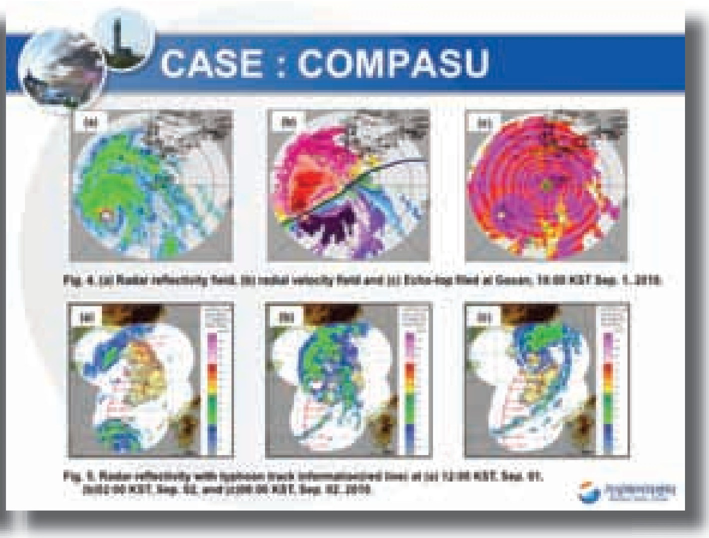

Principle of QC algorithm
Velocity unfold
$V_T = V_O \pm 2n^* V_N$
V_T : True velocity
V_N : Nyquist velocity
V_O : Observed
Reference
Upper air sounding
VAD
Continuity check
Start
Input
The Initial Radial Searching
Initial Three Radials Dealiasing
1st Round 2-D Dealiasing
Clockwise
Counterclockwise
2nd Round 2D Dealiasing and Error Checking
Clockwise
Counterclockwise
End

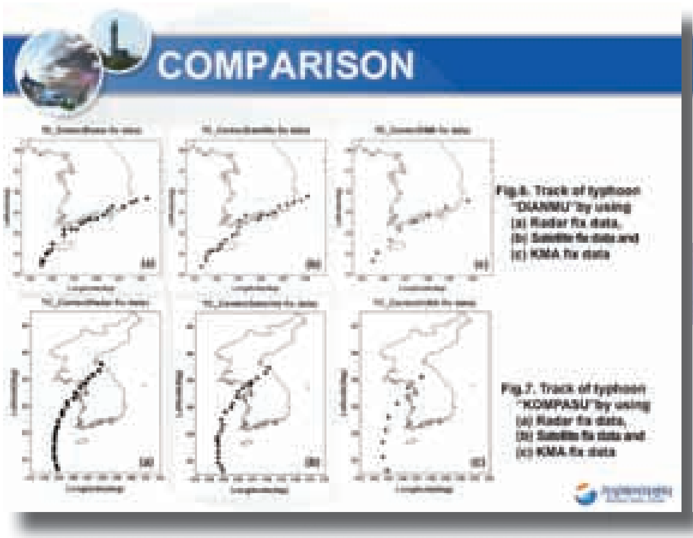

Comparison of Vel. unfold
Before
After ORPG
After WISH DA
2003. 9. 18 Hurricane Isabel velocity dealiasing

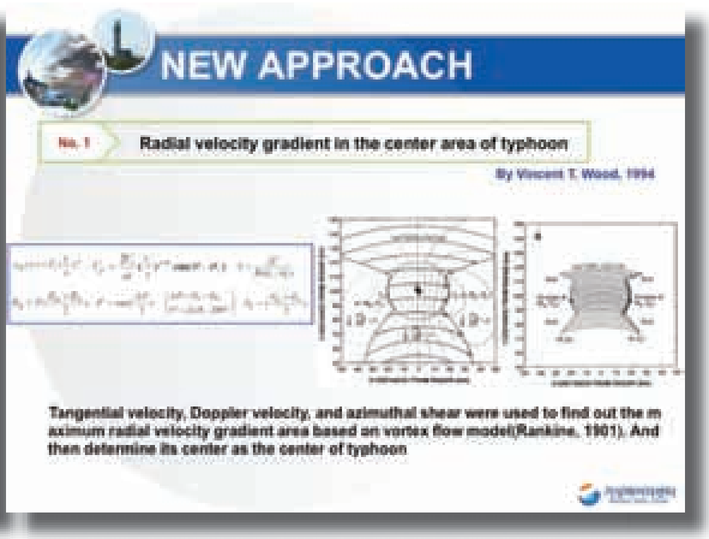

BACKGROUND
To monitor the location of typhoon, remote sensing technique like satellite and weather radar was very useful
Doppler weather radar is able to track the center and movement of typhoon(Wood 1994, Lee 1998)
Weather Radar Center in KMA provide the information on the location of typhoon center using reflectivity pattern and radial velocity field every hour
However, its accuracy depends on analyzer ability
Current method of detecting typhoon location will be shown in case of 4th typhoon DIANMU and 7th COMPASU
The plan for upgrading this technique will be also presented

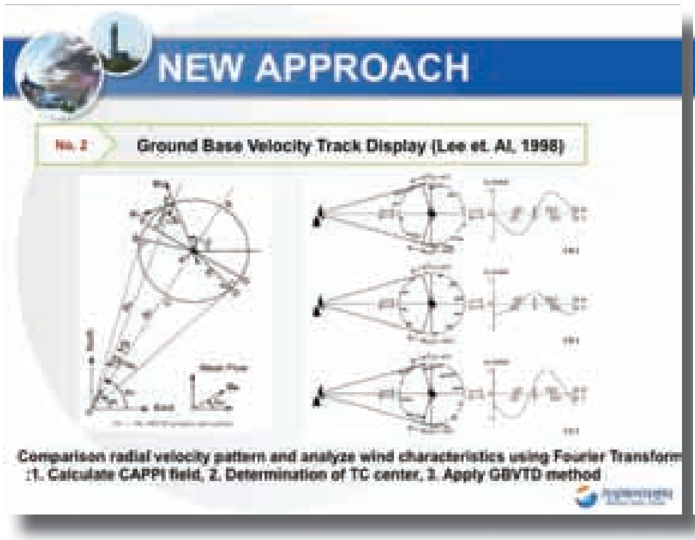

CURRENT METHOD
Main idea : 0 radial velocity isodop and reflectivity pattern
Fig. 1. (a) Radial velocity field and (b) reflectivity field when typhoon "DIANMU" pass the southern coast of the Korean peninsula (black solid line is 0 isodop, red dashed line is the location of typhoon center, and red solid line is spiral shape of reflectivity) (c) The schematic graph of typhoon detection method in KMA.

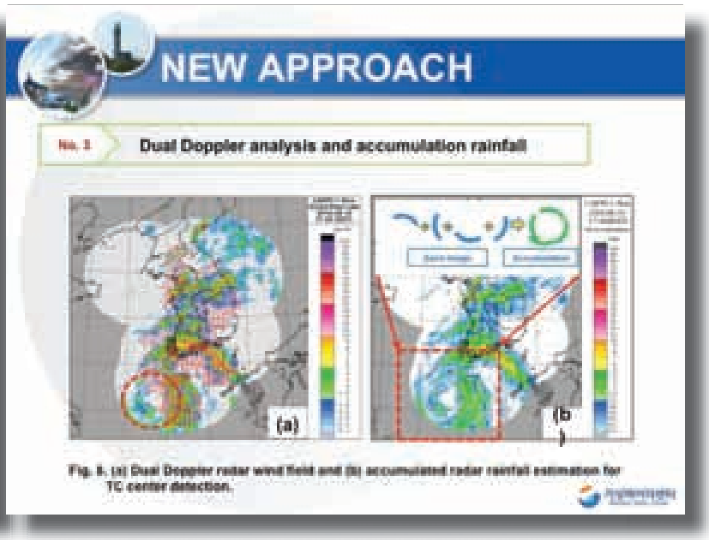

CASE : DIANMU
Fig. 2. Radial velocity field at (a) Gosan and (b) Seongsan. (C) Radar reflectivity field at Gosan. 18:00 KST Aug. 10, 2010.
Fig. 3. Radar reflectivity images with typhoon track information (red line) at (a) 17:00 KST, Aug. 10, (b)04:00 KST, Aug. 11, and (c)13:00 KST, Aug. 11, 2010.


CASE : COMPASU
Fig. 4. (a) Radar reflectivity field, (b) radial velocity field and (c) Echo-top filed at Gosan, 18:00 KST Sep. 1, 2010.
Fig. 5. Radar reflectivity with typhoon track information(red line) at (a) 12:00 KST, Sep. 01, (b)02:00 KST, Sep. 02, and (c)08:00 KST, Sep. 02, 2010.

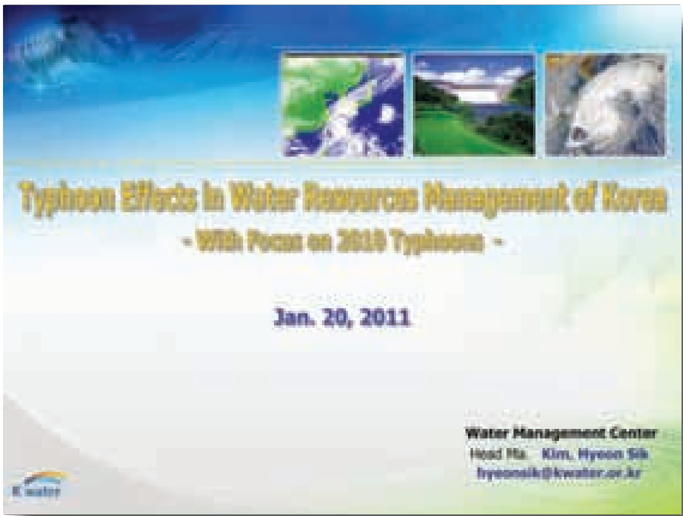

COMPARISON
Fig.6. Track of typhoon "DIANMU" by using (a) Radar fix data, (b) Satellite fix data and (c) KMA fix data
Fig.7. Track of typhoon "KOMPASU" by using (a) Radar fix data, (b) Satellite fix data and (c) KMA fix data


NEW APPROACH
No. 1
Radial velocity gradient in the center area of typhoon
By Vincent T. Wood, 1994
Tangential velocity, Doppler velocity, and azimuthal shear were used to find out the m aximum radial velocity gradient area based on vortex flow model(Rankine, 1901). And then determine its center as the center of typhoon

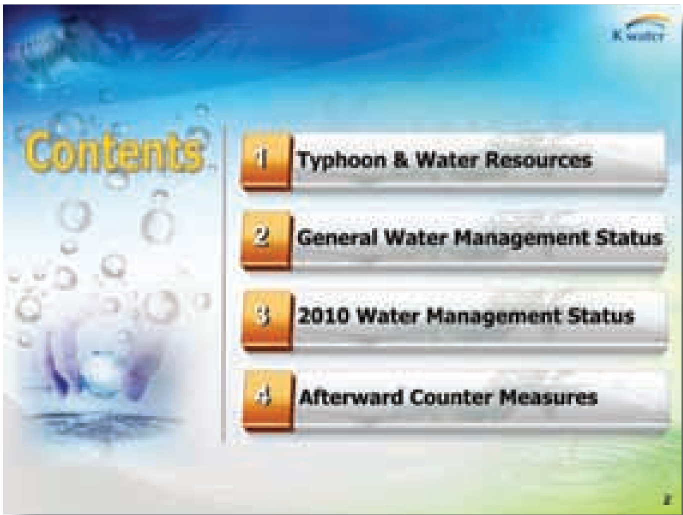

NEW APPROACH
No. 2
Ground Base Velocity Track Display (Lee et. Al, 1998)
Comparison radial velocity pattern and analyze wind characteristics using Fourier Transform
:1. Calculate CAPPI field, 2. Determination of TC center, 3. Apply GBVTD method

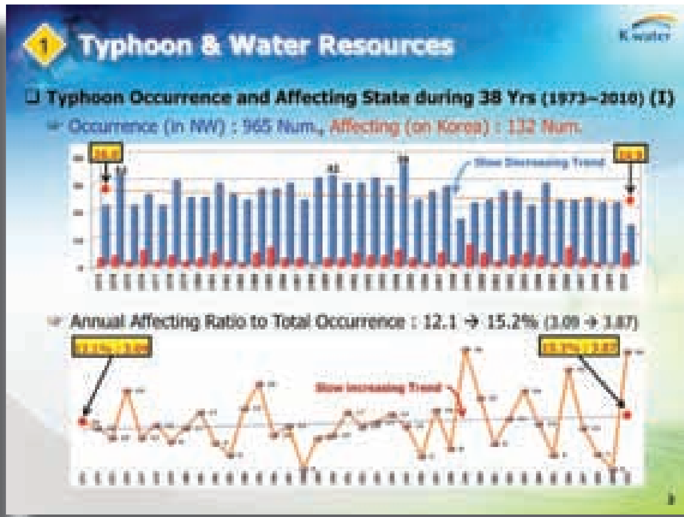

NEW APPROACH
No. 3
Dual Doppler analysis and accumulation rainfall
(a)
(b)
(a) Dual Doppler radar wind field and (b) accumulated radar rainfall estimation for TC center detection.

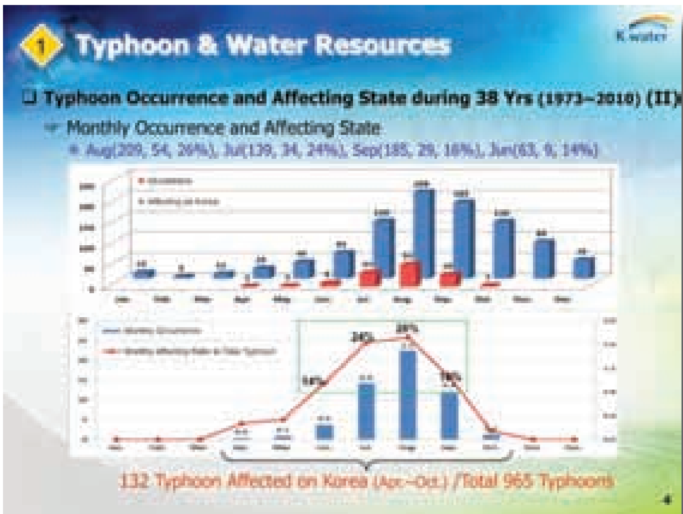

Thank You!

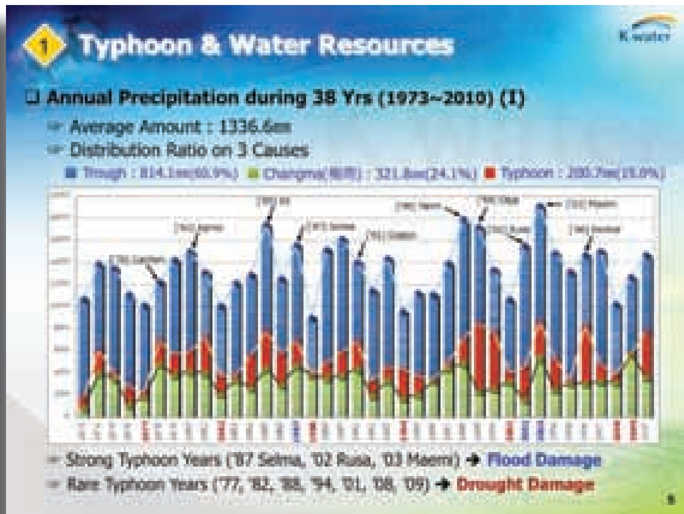

Typhoon Effects in Water Resources Management of Korea
- With Focus on 2010 Typhoons -
Jan. 20, 2011
Water Management Center
Head Mg. Kim, Hyeon Sik
hyeonsik@kwater.or.kr

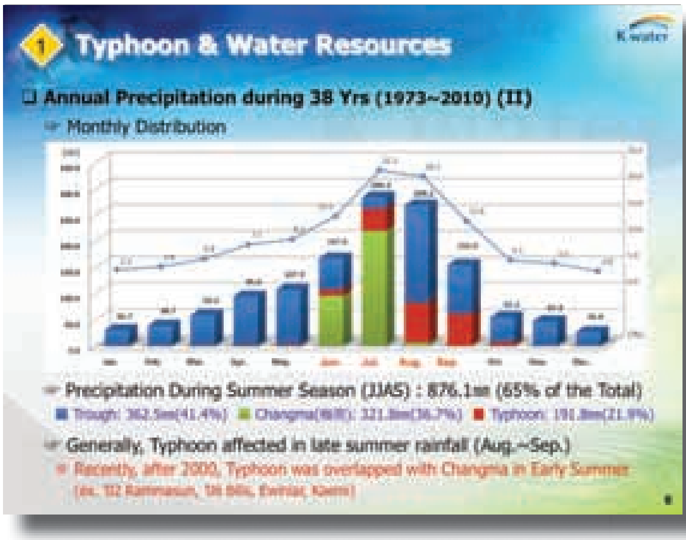

Typhoon!
Natural Disaster? or Natural Gift?

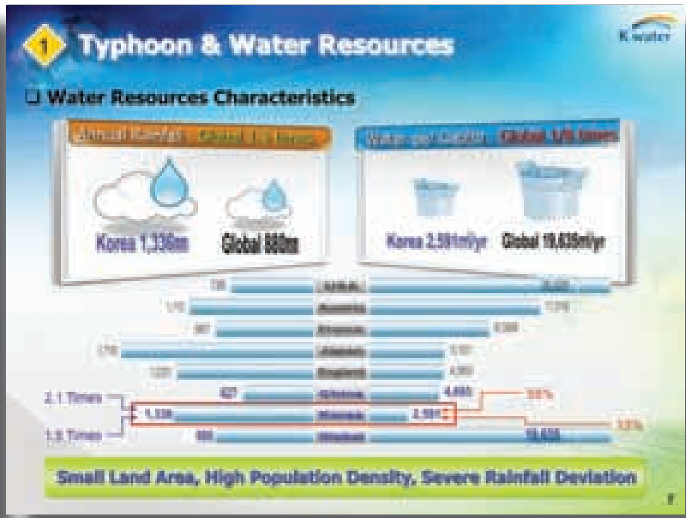

Contents
1 Typhoon & Water Resources
2 General Water Management Status
3 2010 Water Management Status
4 Afterward Counter Measures

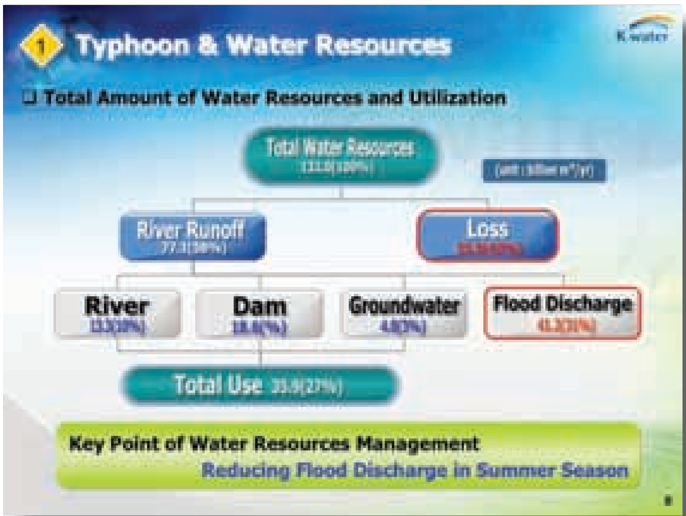

Typhoon & Water Resources
Typhoon Occurrence and Affecting State during 38 Yrs (1973~2010) (I)
Occurrence (in NW) : 965 Num., Affecting (on Korea) : 132 Num.
Slow Decreasing Trend
Annual Affecting Ratio to Total Occurrence : 12.1 → 15.2% (3.09 → 3.87)
Slow Increasing Trend


Typhoon & Water Resources
Typhoon Occurrence and Affecting State during 38 Yrs (1973~2010) (II)
Monthly Occurrence and Affecting State
Aug(209, 54, 26%), Jul(139, 34, 24%), Sep(185, 29, 16%), Jun(63, 9, 14%)
26%
24%
16%
14%
132 Typhoon Affected on Korea (Apr~Oct.) /Total 965 Typhoons


Typhoon & Water Resources
Annual Precipitation during 38 Yrs (1973~2010) (I)
Average Amount : 1336.6㎜
Distribution Ratio on 3 Causes
Trough : 814.1㎜(60.9%) Changma : 321.8㎜(24.1%) Typhoon : 200.7㎜(15.0%)
Strong Typhoon Years ('87 Selma, '02 Rusa, '03 Maemi) → Flood Damage
Rare Typhoon Years ('77, '82, '88, '94, '01, '08, '09) → Drought Damage

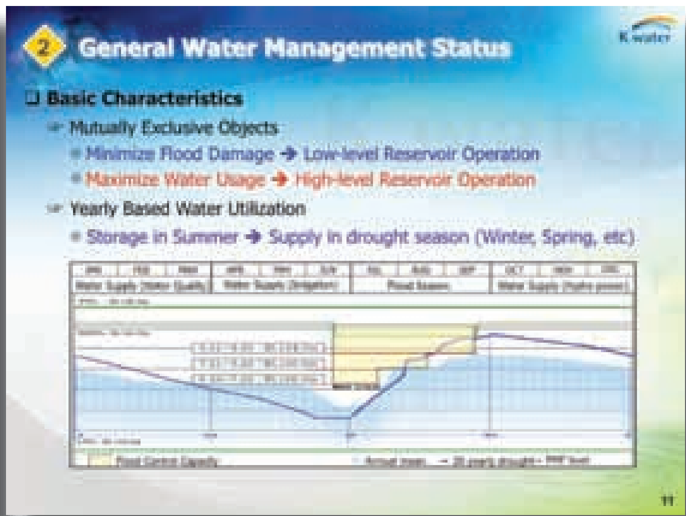

1 Typhoon & Water Resources
❑ Annual Precipitation during 38 Yrs (1973~2010) (II)
Monthly Distribution
Precipitation During Summer Season (JJAS) : 876.1㎜ (65% of the Total)
Generally, Typhoon affected in late summer rainfall (Aug.~Sep.)
Recently, after 2000, Typhoon was overlapped with Changma in Early Summer

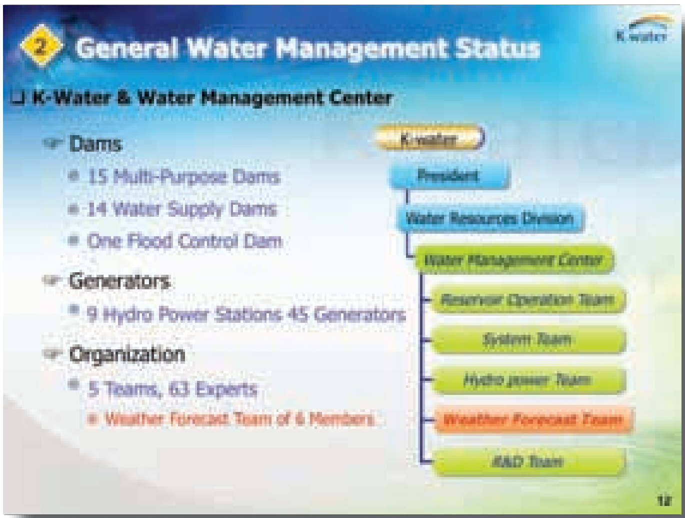

1 Typhoon & Water Resources
❑ Water Resources Characteristics
Korea 1,336㎜
Global 880㎜
2.1 Times
1.5 Times
Small Land Area, High Population Density, Severe Rainfall Deviation

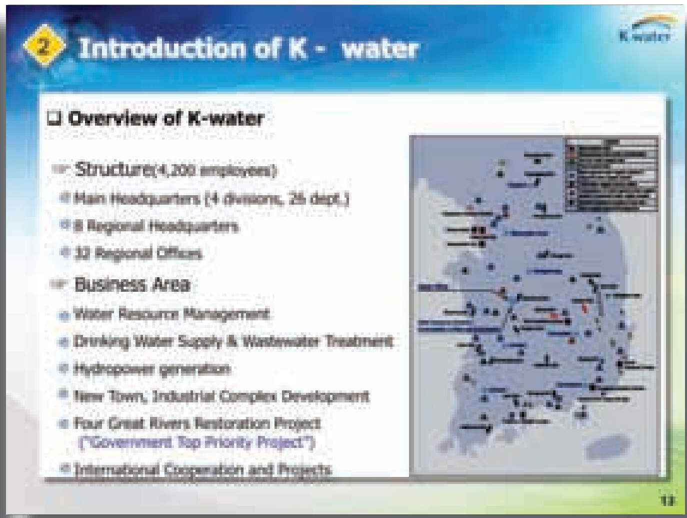

1 Typhoon & Water Resources
❑ Total Amount of Water Resources and Utilization
Total Water Resources
River Runoff
Loss
River
Dam
Groundwater
Flood Discharge
Total Use
Key Point of Water Resources Management
Reducing Flood Discharge in Summer Season

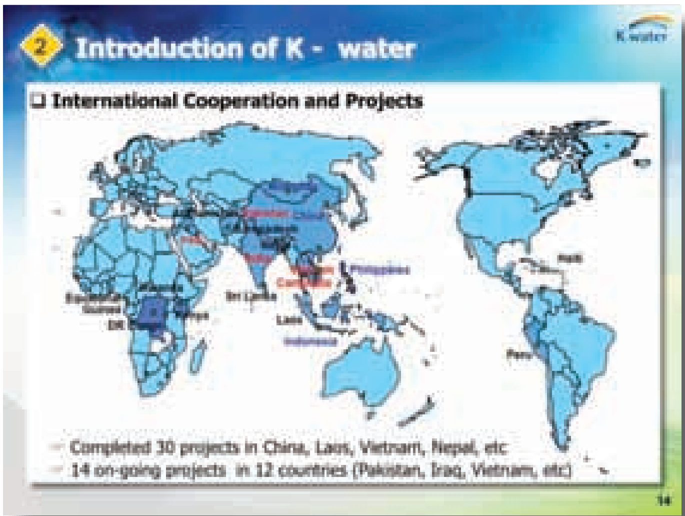

2 General Water Management Status
❑ Basic Concept
Rainfall
Runoff
Water (Dam) Management
Flood Drought
Water Use
Water Management Core Tool : DAM
Water Management ≒ Dam Management

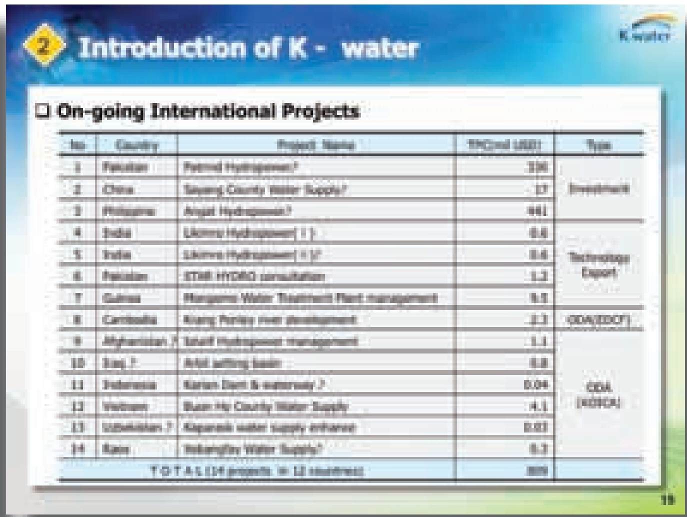

2 General Water Management Status
❑ Objects : Maximization of Water Usage Efficiency
Minimizing Flood Damage
Maximizing Water Utilization
Rainfall (Typhoon)
Storage (Dam)
Maximization of Water Use Efficiency


2 General Water Management Status
❑ Basic Characteristics
Mutually Exclusive Objects
Minimize Flood Damage → Low-level Reservoir Operation
Maximize Water Usage → High-level Reservoir Operation
Yearly Based Water Utilization
Storage in Summer → Supply in drought season (Winter, Spring, etc)

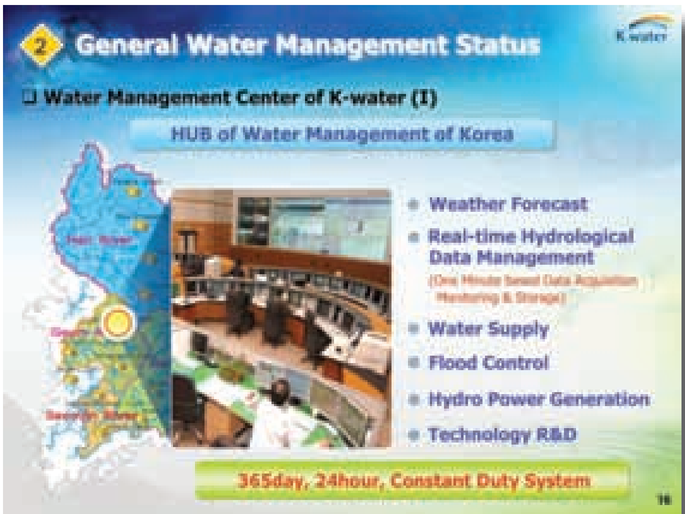


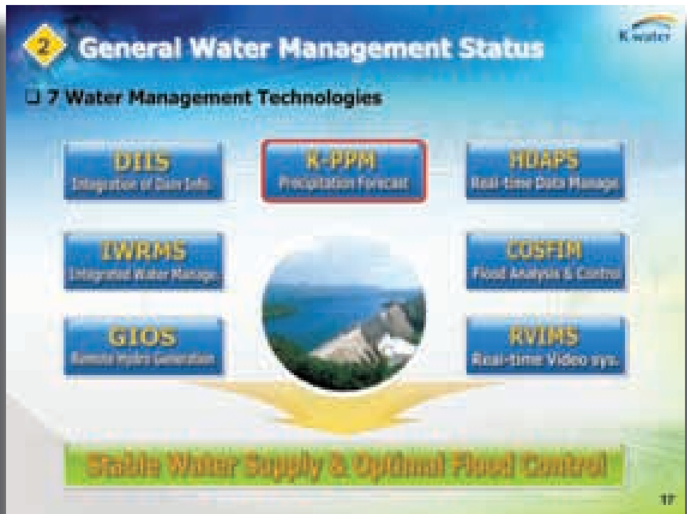


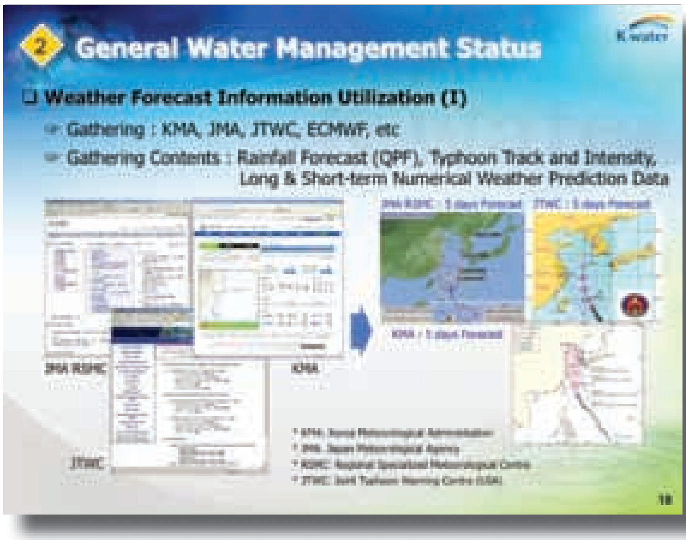


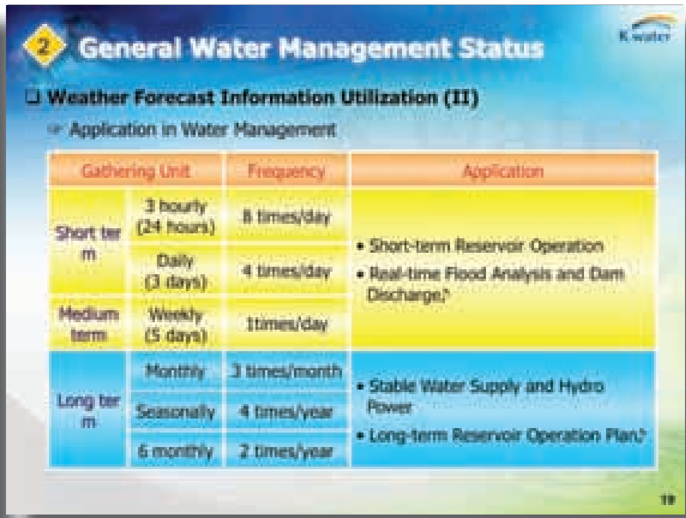


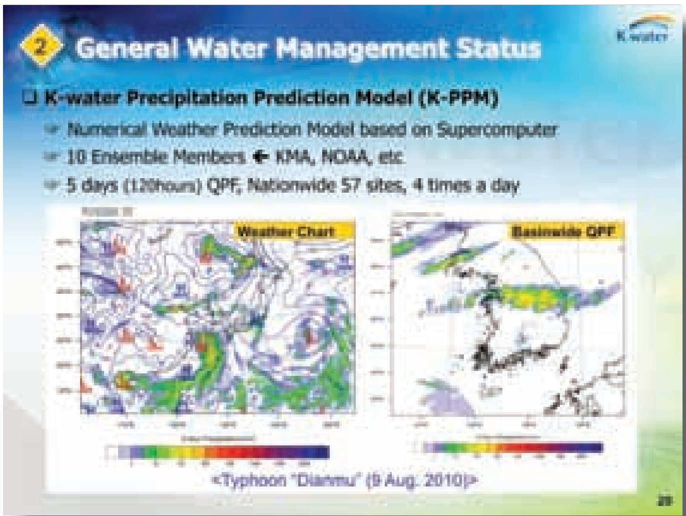
No.	Country	Project Name	TPC(mil USD)	Type
1	Pakistan	Patrind Hydropower	330	Investment
2	China	Sayang County Water Supply	17	
3	Philippine	Angat Hydropower	441	
4	India	Likimro Hydropower(I)	0.6	Technology Export
5	India	Likimro Hydropower(II)	0.6	
6	Pakistan	STAR HYDRO consultation	1.2	
7	Guinea	Mangamo Water Treatment Plant management	0.5	
8	Cambodia	Krang Ponley river development	2.3	ODA(EDCF)
9	Afghanistan	Istalif Hydropower management	1.1	ODA (KOICA)
10	Iraq	Arbil setting basin	0.8	
11	Indonesia	Karian Dam & waterway	0.04	
12	Vietnam	Buon Ho County Water Supply	4.1	
13	Uzbekistan	Kaparask water supply enhance	0.03	
14	Laos	Vebangfay Water Supply	0.3	
TOTAL (14 projects in 12 countries)			809	

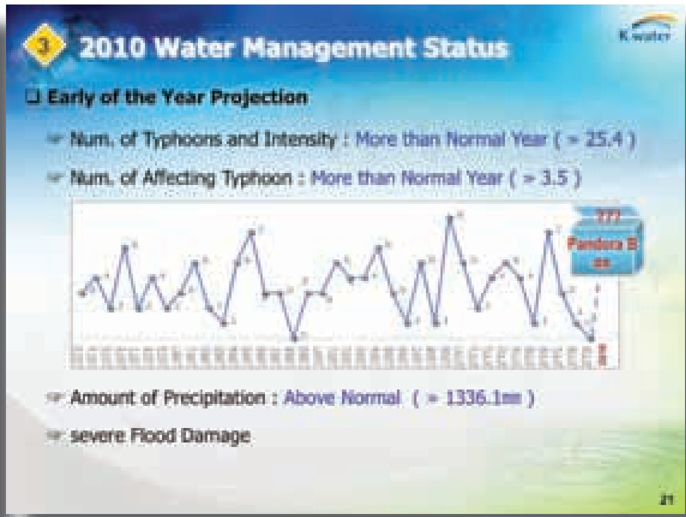


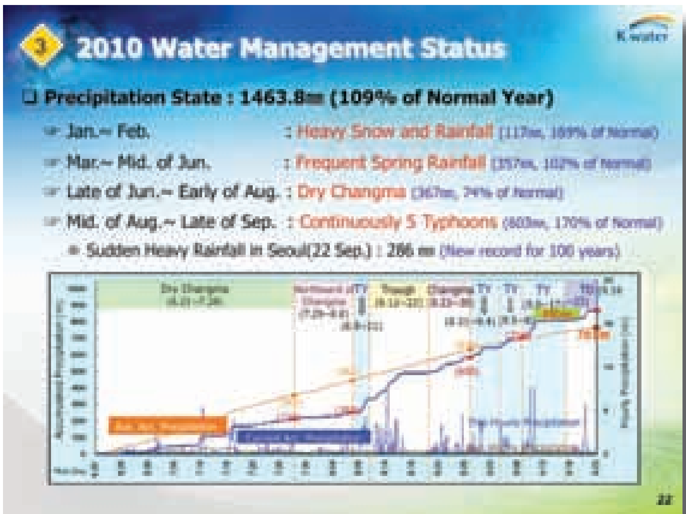


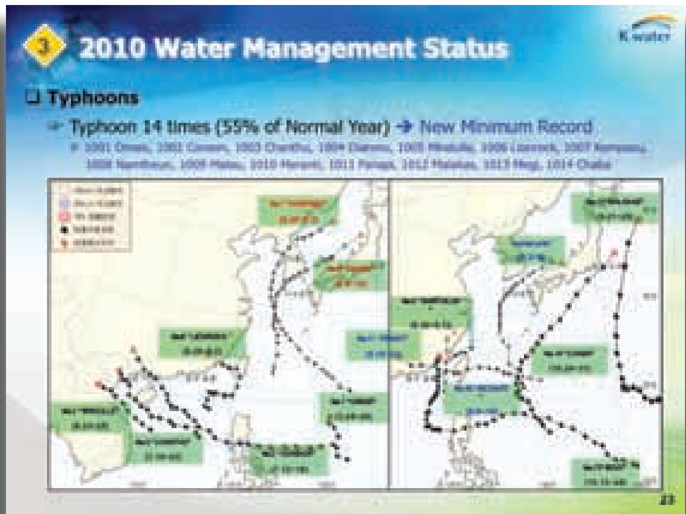

2 General Water Management Status
K-water
❑ Weather Forecast Information Utilization (I)
Gathering : KMA, JMA, JTWC, ECMWF, etc
Gathering Contents : Rainfall Forecast (QPF), Typhoon Track and Intensity, Long & Short-term Numerical Weather Prediction Data
JMA RSMC
KMA
JTWC
18

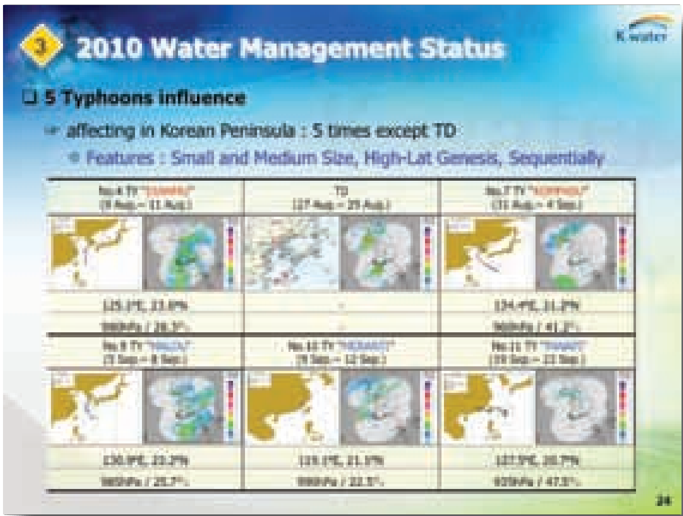

2 General Water Management Status
K-water
❑ Weather Forecast Information Utilization (II)
Application in Water Management
Gathering Unit
Frequency
Application
Short term
3 hourly (24 hours)
8 times/day
Daily (3 days)
4 times/day
Medium term
Weekly (5 days)
1times/day
• Short-term Reservoir Operation
• Real-time Flood Analysis and Dam Discharge
Long term
Monthly
3 times/month
Seasonally
4 times/year
6 monthly
2 times/year
• Stable Water Supply and Hydro Power
• Long-term Reservoir Operation Plan
19

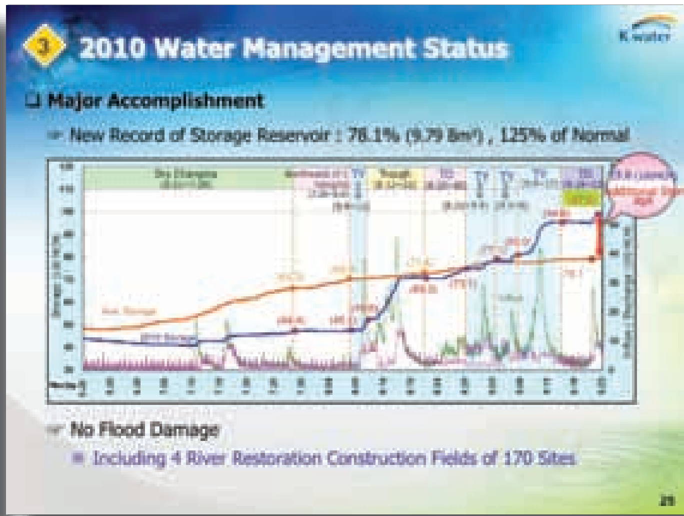

2 General Water Management Status
K-water
❑ K-water Precipitation Prediction Model (K-PPM)
Numerical Weather Prediction Model based on Supercomputer
10 Ensemble Members ← KMA, NOAA, etc
5 days (120hours) QPF, Nationwide 57 sites, 4 times a day
Weather Chart
Basinwide QPF
<Typhoon "Dianmu" (9 Aug. 2010)>
20

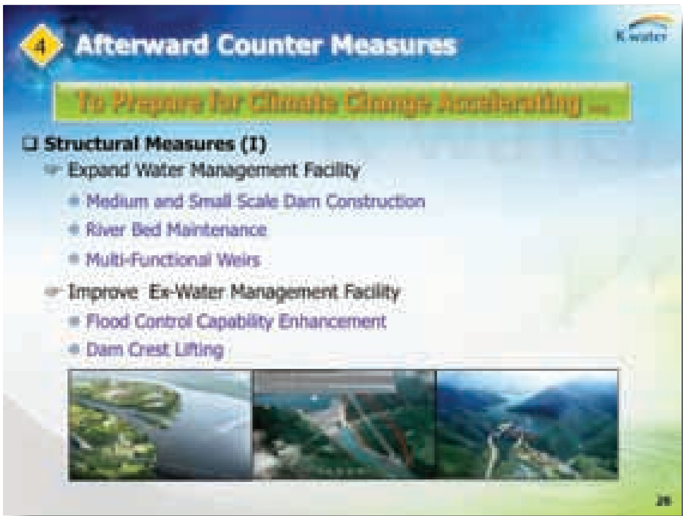

3 2010 Water Management Status
K-water
❑ Early of the Year Projection
Num. of Typhoons and Intensity : More than Normal Year (> 25.4)
Num. of Affecting Typhoon : More than Normal Year (> 3.5)
Amount of Precipitation : Above Normal (> 1336.1mm)
severe Flood Damage
21

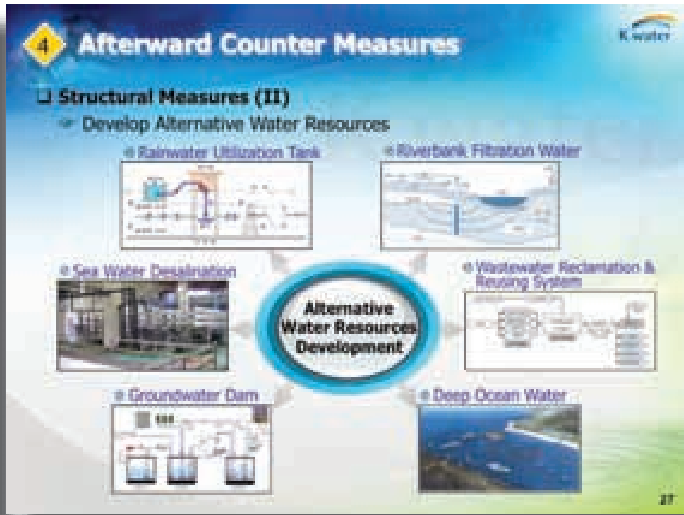

3 2010 Water Management Status
K-water
❑ Precipitation State : 1463.8mm (109% of Normal Year)
Jan.~ Feb. : Heavy Snow and Rainfall
Mar.~ Mid. of Jun. : Frequent Spring Rainfall
Late of Jun.~ Early of Aug. : Dry Changma
Mid. of Aug.~ Late of Sep. : Continuously 5 Typhoons
Sudden Heavy Rainfall in Seoul(22 Sep.) : 286 mm
22

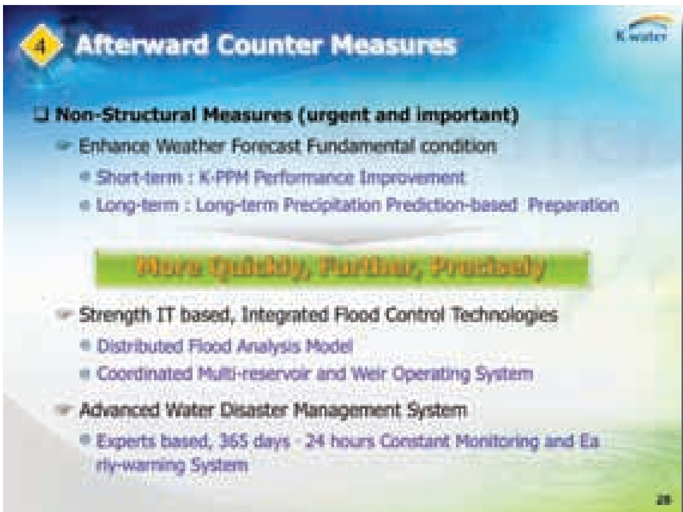

3 2010 Water Management Status
K-water
❑ Typhoons
Typhoon 14 times (55% of Normal Year) → New Minimum Record
23


3
2010 Water Management Status
K-water
❑ 5 Typhoons influence
affecting in Korean Peninsula : 5 times except TD
Features : Small and Medium Size, High-Lat Genesis, Sequentially
24


3
2010 Water Management Status
K-water
❑ Major Accomplishment
New Record of Storage Reservoir : 78.1% (9.79 Bm³) , 125% of Normal
No Flood Damage
Including 4 River Restoration Construction Fields of 170 Sites
25


4
Afterward Counter Measures
K-water
To Prepare for Climate Change Accelerating ...
❑ Structural Measures (I)
Expand Water Management Facility
Medium and Small Scale Dam Construction
River Bed Maintenance
Multi-Functional Weirs
Improve Ex-Water Management Facility
Flood Control Capability Enhancement
Dam Crest Lifting
26


4
Afterward Counter Measures
K-water
❑ Structural Measures (II)
Develop Alternative Water Resources
Rainwater Utilization Tank
Riverbank Filtration Water
Sea Water Desalination
Wastewater Reclamation & Reusing System
Alternative Water Resources Development
Groundwater Dam
Deep Ocean Water
27


4
Afterward Counter Measures
K-water
❑ Non-Structural Measures (urgent and important)
Enhance Weather Forecast Fundamental condition
Short-term : K-PPM Performance Improvement
Long-term : Long-term Precipitation Prediction-based Preparation
More Quickly, Further, Precisely
Strength IT based, Integrated Flood Control Technologies
Distributed Flood Analysis Model
Coordinated Multi-reservoir and Weir Operating System
Advanced Water Disaster Management System
Experts based, 365 days - 24 hours Constant Monitoring and Early-warning System
28


Preciously!!!
Till the Last Drop!!!
Thank you!
K-water Water Management Center
Name: Kim, Hyeon Sik
Email : hyeonsik@kwater.or.kr
Tel. : +82-42-629-3451

WMO TROPICAL CYCLONES NEWS 2010

4.1 Decisions and Guidances from Executive Council

The WMO Executive Council, at its sixty-second session (EC-LXII, Geneva, June 2010) discussed implementation of the Tropical Cyclone Programme and provided guidance under the Expected Results (ERs) 1, 6 and 9 of the WMO Strategic Plan.

While recognizing that ensemble prediction techniques, including the multi-model consensus forecast, had added a valuable contribution to the accuracy in tropical cyclone track forecasting, the Council noted that there was an increasing need for including uncertainty information in the forecasts for more effective disaster risk assessment. It strongly encouraged Members to enhance the application of ensemble techniques and probabilistic forecasts in tropical cyclone forecasting and warning services. In this respect, the Council underlined the two recent projects which TCP and WWRP had jointly implemented in the Typhoon Committee region: the *North Western Pacific Tropical Cyclones Ensemble Forecast Project* and the *Typhoon Landfall Forecast Demonstration Project*, and recommended developing similar projects for other TCP regional bodies.

The Council recognized that operational tropical cyclone forecasting, particularly intensity forecasting, was still a serious challenge to the tropical cyclone warning centres in all the basins. It noted that among other things, forecasting rapid changes in tropical cyclone intensity and movement in the proximity of a coast is critical, because the situation often represents an enormous threat to the public beyond expectation. To improve the forecasting of these situations, the Council recommended that R&D, and technology transfer to operational forecasting be pursued, as well as ensuring interactions between researchers and operational forecasters through international forums, such as the International Workshop on Tropical Cyclones (IWTC), the International Workshop on Tropical Cyclone Landfall Processes.

The Council recognized that many Members benefited from space-based information for their operational services. It reiterated that such information was essential to NMHSs, particularly Small Island Developing States (SIDS), and should be continually provided. The Council thanked the satellite operating Members and EUMETSAT for their provision of the vital information and urged them to maintain and upgrade the service for the countries including those in the South-West Indian Ocean (SWIO). In this connection, the Council noted that Chinese satellites cover the central Indian Ocean and appreciated China's offer to provide their observations for the SIDS in that part of the ocean.

The Council noted various measures that support tropical cyclone forecasters had been undertaken by TCP targeting particularly those of developing countries. The Council also noted that the *Global Guide to Tropical Cyclone Forecasting* would be updated for a multi-hazard perspective, and would be provided on a web basis for cost saving and easier access, and closely linked to the *WMO Tropical Cyclone Forecasters' Website*. The Council therefore recommended TCP to complete the update of the *Global Guide* as early as possible and emphasized the need for establishing links with other WMO Websites containing related information, especially on flooding and storm surge

The Council emphasized the importance of a comprehensive and integrated approach for marine multi-hazard forecasting and warning system, for improved coastal risk management, and:

(i) Noted that development of Storm Surge Watch System (SSWS) would be a first step, noting with satisfaction activities of the Tropical Cyclone Programme (TCP) regional bodies for their respective regions such as preparation of distribution maps and time-series charts of storm surges to be provided by RSMC Tokyo for the Typhoon Committee Members and recommended strengthening of the capacity building in the operational storm surge forecasting through training courses and workshops;

(ii) Stressed the importance of the implementation of the Coastal Inundation Forecast Demonstration Project (CIFDP), noting the importance of coupling between meteorological, oceanographic, hydrological and tropical cyclone forecasting models to result in an end-to-end comprehensive coastal inundation forecast and warning systems, in reference to existing guidelines such as the UNESCO/IOC on Hazard Awareness and Mitigation in Integrated Coastal Area Management (ICAM). It reinforced the necessity for development of software with multi-disciplinary components for improved coastal inundation forecasting products and services in basins and delta regions;

(iii) Noted the important role of the TCP regional bodies as platforms for developing regional cooperation in multi-hazard EWS through providing guidance for dissemination and exchange of information and warnings as well as a useful forum for the Members and relevant regional and international agencies to explore links among tsunami, tropical cyclone, storm surgeand coastal inundation matters. Examples include the RA IV Hurricane Committee and the Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE EWS) and the WMO/ESCAP Panel on Tropical Cyclones and the Pacific and Indian Ocean Tsunami Warning and Mitigation Systems (ICG/PTWS and ICG/IOTWS).

With regard to the capacity-building, the Council recognized that the developing countries, especially Small Island Developing States (SIDS) and the Least Developed Countries (LDCs) continue to be in urgent need of capacity building in forecasting and warning of tropical cyclone and associated storm surge. In this respect, the Council noted that the joint training activities by the Tropical Cyclone Programme (TCP) and the Public Weather Services (PWS) Programme such as the RA IV Workshop on Hurricane Forecasting and Warnings and Public Weather Services, the Southern Hemisphere Training Course on Tropical Cyclones and Workshop on Public Weather Services, and the RA I Training Course on Tropical Cyclones and Public Weather Services have an increasing role to meet this requirement through their integrated approach to the improvement of service delivery. The Council encouraged Members to include national Disaster Risk Managers in their training programmes to ensure the country received full benefits from the training. It also underlined the practical effectiveness of the attachment training at TC RSMCs and the Indian Institute of Technology (IIT) for the forecasting of tropical cyclones and storm surges, respectively. In view of the maximum use of these opportunities by developing countries, the Council requested the Secretary-General to continue to support these training activities and to flexibly implement them by involving participants across the regions.

4.2 Activities of TCP since TCAR-2009

The TCP comprises two components: a general component concerned with methodology and transfer of technology and a regional component devoted to the activities of five regional tropical cyclone bodies. The updated lists of the Members of these bodies are shown in Appendix I.

4.2.1 TCP events in the past year

For the period from 1 December 2009, the following events were organized or co-sponsored under the Programme:

- ESCAP/WMO Typhoon Committee Meeting of Chairs of Working Groups on Meteorology, Hydrology and Disaster Prevention area (Macao, China; 14 – 16 December 2009);
- ESCAP/WMO Typhoon Committee, Forty-second Session (Singapore, 25-29 January 2010);
- Tropical Cyclone Operational Forecasting Training at RSMC New Delhi – Tropical Cyclone Centre (New Delhi, India, 1 – 12 February 2010);
- WMO/ESCAP Panel on Tropical Cyclones, Thirty-seventh Session (Phuket, Thailand, 15 –19 February 2010);
- RA IV Hurricane Committee, Thirty-second Session (Bermuda, UK, 8-12 March 2010);
- RA IV Workshop on Hurricane Forecasting and Warning and Public Weather Services (Miami, Florida, USA, 15 – 26 March, 2010);
- RA V Tropical Cyclone Committee, 13th session (Bali, Indonesia, 19 – 22 April 2010);
- WMO TLFDP Training Workshop on Tropical Cyclone Forecasting (Shanghai, China, 24 to 28 May 2010);
- ESCAP/WMO Typhoon Committee Expert Meeting on Urban Flood Risk Management (Bangkok, Thailand, 19 – 20 July 2010);
- Attachment of Typhoon Forecasters from Hong Kong, China and Republic of Singapore for Typhoon Operational Forecasting Training at RSMC Tokyo-Typhoon Center (Tokyo, Japan, 21 to 30 July 2010);
- PTC Working Group on DPP (WG-DPP) Meeting to Finalize the Annual Operating Plan (AOP) 2010 and Training on Preparation of Disaster Management Drills and Observance of DDPM's National Crisis Management Drill 2010 (C-MEX 10) (Bangkok and Chantaburi Province, Thailand, 18 – 20 August, 2010);
- ESCAP/WMO Typhoon Committee Integrated Workshop on Urban Flood Risk Management in a Changing Climate: Sustainable and Adaptation Challenges (Macao, China, 6 – 10 September 2010);
- RA I Tropical Cyclone Committee, Nineteenth session (Nairobi, Kenya, 20 – 24 September 2010;
- The Third International Conference on Quantitative Precipitation Estimation (QPE) and Quantitative Precipitation Forecasting (QPF) and Hydrology (Nanjing, China, 18 – 22 October 2010);
- RA I Training Course on Tropical Cyclones (La Réunion, France, 2 – 13 November 2010);
- The Seventh International Workshop on Tropical Cyclones (La Réunion, France, 15 – 20 November 2010).

4.2.2 Activities under the general component

The main activities in the year under review under the general component continued to be directed towards the publication of manuals and reports, which provide information and guidance to Members to assist them in the increased application of scientific knowledge and technology for the improvement of warning and disaster prevention and preparedness systems corresponding ERs I and VI on enhanced capabilities of forecasting and warning service delivery and disaster risk reduction. Under this component, attention was also given to the broader aspects of training under the TCP.

Priorities were given to capacity-building to address the issue of sustainable development with emphases particularly on attachments of forecasters from developing countries at the different Regional Specialized Meteorological Centres (RSMCs) during the cyclone season and storm surge/wave experts at the Indian Institute of Technology in Kharagpur, India, a number of workshops and a joint training event in cooperation with the Public Weather Service Programme (PWSP), and a number of Working Group (Committee) sessions co-joint with Disaster Risk Reduction (DRR) Programme. These activities are in accordance with the Programme's objective to facilitate the transfer of knowledge and technology to improve the institutional efficiency of the NMHSs leading to the provision of better tropical cyclone track and intensity forecasts and associated flood and storm surge forecasts, and coordinated actions towards tropical cyclone disaster risk reduction.

The TCP home page within the WMO Website: http://www.wmo.int/pages/prog/www/tcp/index_en.html is continuously being updated. In addition, the TCP Forecaster's Website has been updated to provide more information/materials in respect of workshop presentations and observing data and products for forecasters.

WMO has concluded with the Systems Engineering Australia Pty Ltd (SEA) on reviews and assessments that would lead to the recommendation of suitable conversion factors between the WMO 10-minute standard average wind and 1-minute, 2-minute and 3-minute "sustained" winds. The outcome of the study, "GUIDELINES FOR CONVERTING BETWEEN VARIOUS WIND AVERAGING PERIODS IN TROPICAL CYCLONE CONDITIONS," which was endorsed by the group of experts during the Sixth Tropical Cyclone RSMCs/TCWCs Technical Coordination Meeting (Brisbane, Australia, 2-6 November 2009), with one page executive summary for the final review, has been published as WMO/TD-No.1555 and distributed to all the members of the five regional tropical cyclone bodies.

Tropical cyclone news for the WMO news website http://www.wmo.int/pages/mediacentre/news/index_en.html will be continuously provided for facilitating media outreach.

The Global Guide to Tropical Cyclone Forecasting has been undertaking updating, and was expected to have the web version before IWTC-VII to be held in La Reunion, France, in November 2010. After completion, it will be posted to the TCP Forecaster's website for widespread access by forecasters and researchers around the globe. The printing version will be completed soon afterwards.

WMO TLFDP (Typhoon Landfall Forecast Demonstration Project) Training Workshop on Tropical Cyclone Forecasting was held in Shanghai, China, from 24 to 28 May 2010. This training workshop is part of the implementation programme of the WMO TLFDP.

The Third International Conference on Quantitative Precipitation Estimation (QPE) and Quantitative Precipitation Forecasting (QPF) and Hydrology was held in Nanjing, China, 18 – 22 October 2010.

The Seventh International Workshop on Tropical Cyclones (IWTC-VII) was held in La Réunion, France, from 15 to 20 November 2010. It was attended by about 135 forecasters and researchers from all the five regional tropical cyclone bodies.

4.2.3 Activities under the regional component

Regional component is carried out through close regional cooperation and coordination. Major emphasis was placed on improvement in the accuracy of the forecasts, provision of timely early warnings and on the establishment of necessary disaster preparedness measures. Each of the regional tropical cyclone bodies has in place a formally adopted tropical cyclone operational plan or manual, aimed at ensuring the most effective tropical cyclone forecasting and warning system with existing facilities, through cooperative agreement on sharing of responsibilities and on coordinated activities within the respective region. Each of these bodies was giving attention to the implementation of their technical plan/strategic plan for future development of services to meet regional needs for upgrading forecasting and warning facilities and services for tropical cyclones and associated floods and storm surges, as well as for related disaster risk reduction measures and supporting activities in training and research.

The detailed activities of regional bodies are described as below.

4.2.3.1 ESCAP/WMO Typhoon Committee

- ESCAP/WMO Typhoon Committee Meeting of Chairs of Working Groups on Meteorology, Hydrology and Disaster Prevention area was held in Macao, China, from 14 to 16 December 2009.
- The Forty-second Session of the Committee was held in Singapore, from 25 to 29 January 2010. Decisions by the ESCAP/WMO Typhoon Committee at its Forty-second Session can be found in its final report which will be available in WMO/TCP website.
- ESCAP/WMO Typhoon Committee Expert Meeting on Urban Flood Risk Management was held in Bangkok, Thailand, 19 – 20 July 2010.
- Attachment of two typhoon forecasters from Hong Kong, China and Republic of Singapore was hosted by RSMC Tokyo-Typhoon Center for Typhoon Operational Forecasting Training from 21 to 30 July 2010.
- ESCAP/WMO Typhoon Committee Integrated Workshop on Urban Flood Risk Management in a Changing Climate: Sustainable and Adaptation Challenges (Macao, China, 6 – 10 September 2010).
- 4.2.3.2 WMO/ESCAP Panel on Tropical Cyclones
- The Thirty-seventh Session of the WMO/ESCAP Panel on Tropical Cyclones was held in Phuket, Thailand, from 15 to 19 February 2010. Decisions by the WMO/ESCAP Panel on Tropical Cyclones at its Thirty-sixth Session can be found in its final report which is available in WMO/TCP website.
- Also, attachment trainings for storm surge experts were organized in IIT, from 18 to 29 October 2010, at the IIT Delhi in the implementation and running of a PC-based high-resolution storm surge model.
- Attachment of two forecasters from Myanmar and Sri Lanka was arranged by WMO and the RSMC New Delhi, India, from 1 to 12 February 2010, for the on-the-job training at the RSMC on operational analysis and forecasting of tropical cyclones.
- PTC Working Group on DPP (WG-DPP) Meeting to Finalize the Annual Operating Plan (AOP) 2010 and Training on Preparation of Disaster Management Drills and Observance of DDPM's National Crisis Management Drill 2010 (C-MEX 10) (Bangkok and Chantaburi Province, Thailand, 18 – 20 August, 2010)

4.2.3.3 RA I Tropical Cyclone Committee

- The Nineteenth Session of the RA I Tropical Cyclone Committee was held in Nairobi, Kenya, from 20 to 24 September 2010. It was attended by members of the RA I Tropical Cyclone Committee and some regional and international organizations such as International Civil Aviation Organization (ICAO), IGAD Climate Prediction and Applications Centre (ICPAC), UNEP, UNISDR and representatives of the WMO Secretariat.
- Decisions by the RA I Tropical Cyclone Committee at its Nineteenth Session can be found in its final report which will be available in WMO/TCP website.
- RA I Training Course on Tropical Cyclones,

including a component on SWFDP in Africa, was held in La Réunion, France, 2 – 13 November 2010. It was attended by 14 participants from the RA I Tropical Cyclone Committee Members plus one from Zambia.

4.2.3.4 RA IV Hurricane Committee

- The Government of the USA hosted an RA IV Workshop on Hurricane Forecasting and Warning, and Public Weather Services in Miami, 15 - 26 March 2010. It was organized by the NWS/NOAA Tropical Prediction Center/National Hurricane Center in cooperation with WMO (TCP Division and PWS Division). The workshop was conducted in English with simultaneous interpretation into Spanish, and attended by 23 participants from nineteen Members of RA IV. And the next is in preparation, and plan to be held in Miami, USA, from 21 March to 1 April 2011.
- The Thirty-second Session of the Hurricane Committee was held in Bermuda, UK, from 8 to 12 March 2010. It was attended by members of the RA IV Hurricane Committee and some regional and international organizations.
- Decisions by the RA IV Hurricane Committee at its Thirty-second Session can be found in its final report which will be available in WMO/TCP website.

4.2.3.5 RA V Tropical Cyclone Committee

- Attachment training of two forecasters from Cook Islands and Samoa was arranged by WMO and the RSMC Nadi Tropical Cyclone Centre, from 23 November to 4 December 2009, for the on-the-job training at the RSMC Nadi on operational analysis and forecasting of tropical cyclones.
- The Thirteenth session of the RA V Tropical Cyclone Committee was held in Bali, Indonesia, 19 – 22 April 2010. It was attended by members of the RA V Tropical Cyclone Committee and some regional and international organizations such as SPREP and ICAO etc.
- Decisions by the RA V Tropical Cyclone Committee at its 13th session can be found in its final report which is available in WMO/TCP website.

4.2.3 Cooperation with other organizations

There has been close cooperation and collaboration with the Economic and Social Commission for Asia and the Pacific (ESCAP), the International Strategy for Disaster Reduction (ISDR) Secretariat, the Asian Disaster Reduction Center (ADRC), the International Federation of Red Cross and Red Crescent Societies (IFRC), the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), SOPAC and SPREP and other organizations, on a variety of matters of common concern. The main items include ESCAP's co-sponsorship of the Typhoon Committee and the Panel on Tropical Cyclones, as well as the ISDR Secretariat and the ADRC's involvement in the disaster risk reduction component of the TCP, in particular in the context of the ISDR.

As part of the cooperation between WMO and the International Civil Aviation Organization (ICAO), TC RSMCs and one Tropical Cyclone Warning Centre (TCWC) are designated as ICAO Tropical Cyclone Advisory Centres (TCAC) by ICAO Regional Air Navigation Agreements. Tropical cyclone (TC) advisories issued by TCACs play an important role for the safety and efficiency of international air navigation (para 8). There has been a growing demand from the aviation users to receive the TC advisories in a graphical format. At the 6th session of the TC RSMC/TCWC Technical Coordination Meeting held in October 2009, all the TCACs agreed to change the advisories from alpha numeric format to graphical format as early as possible. Cooperation has also been made to harmonize the information on tropical cyclones in the WAFS SIGWX forecasts and the TCAC advisories. The TCACs participated in a coordination session with World Area Forecast Centres (WAFCs) during the period from 2 to 31 March 2009. This session contributed not only to the reliability of WAFS products but also to the development of closer link between TCACs and WAFCs. Those TCACs listed below provide specialized tropical cyclone warning services for the aviation community:

TCAC	Area(s) of responsibility
Darwin (Australia)	South-eastern Indian Ocean, South-western Pacific Ocean
Honolulu (USA)	Central North Pacific
La Réunion (France)	South-western Indian Ocean
Miami (USA)	North Atlantic, Caribbean, Eastern North Pacific
Nadi (Fiji)	Southern Pacific
New Delhi (India)	Bay of Bengal and the Arabian Sea
Tokyo (Japan)	Western North Pacific, including the South China Sea

A cooperative relationship was established with the National climate Date Center of NOAA for their project - International Best Tracks Archive for Data Stewardship (IBTrACS) to develop a global best track data base. TC RSMCs and TCWCs provide regional best track data and adequate guidance for integration of the regional data.

On a regional basis, WMO, through its Tropical Cyclone Programme, has fostered and maintained close collaboration and fruitful coordination with regional bodies concerned with disaster risk reduction issues, in particular with the Asian Disaster Preparedness Center (ADPC), the Asian Disaster Reduction Center (ADRC), the Caribbean Disaster Emergency Response Agency (CDERA), and the South Pacific Regional Environment Programme (SPREP), and UN-ISDR.

WMO also collaborated with JICA to organize a joint JICA-FMS workshop in FMS, Nadi, Fiji, from 1 to 5 February 2010. Ten Small Island States of the South Pacific benefited from the workshop.

4.2.4 Action programme for 2011 and beyond

The TCP covers a wide range of activities which are of a continuing and long-term nature. Preceding sections of this report contain an overview of the ongoing activities and, in some instances, indicate the plans for the period ahead. The main parts of the planned activities for 2011 and beyond are set out below in a summary form:

General component

(a) Follow-up activities on the WMO Strategic Plan;

(b) Updating of the TCP home page within the WMO Web site, and the Tropical Cyclone Forecaster web site which will serve as a source for tropical cyclone forecasters to obtain forecasting and analytical tools and techniques for tropical cyclone development, motion, intensification, and wind distribution, and so on;

(c) Attachment of forecasters to all six TC RSMCs during the cyclone season;

(d) Continued support and coordination to update the Global Guide on Tropical Cyclone Forecasting in response to recommendation from the IWTCs. The web version of the Guide is due to be completed early 2011;

(e) Coordination of the services and activities of six TC RSMCs (Miami, Tokyo, Honolulu, New Delhi, La Réunion and Nadi) and TCWCs (Darwin, Perth, Brisbane, Wellington, Port Moresby and Jakarta) with a view to improving regional services of the centers. Review of the global standards in forecasting techniques and warning services including those for data exchange and forecasts verification.

(f) Outreach to media and general public by posting tropical cyclone information to the WMO news website, and responding by email to inquiries related to tropical cyclones around the globe.

(g) Development and establishment of a Storm Surge Watch Scheme in each of the regional tropical cyclone bodies.

(h) Implementation of the Landfall Typhoon Forecast Demonstration Project in East China.

(i) Implementation of the NW Pacific Tropical Cyclones Ensemble Forecast Project which was recommended at IWTCLP-II.

(j) Organization of the International Workshop on Dvorak Analysis in Honolulu, USA from 13 to 16 April 2011.

Regional component

Under the regional component, TCP will be mainly concerned with the activities undertaken by the five regional tropical cyclone bodies and the implementation of the decisions they make. A provisional schedule for the period from 1 December 2010 to 30 November 2011 of meetings and training events within or related to the TCP, is given below:

- The Forty-third Session of the ESCAP/WMO Typhoon Committee (Incheon, Republic of Korea, from 17 to 21 January 2011)
- Storm Surge Workshop for RA IV Hurricane Committee Members (Santo Domingo, Dominican Republic, 21 – 25 February 2011);
- The Thirty-eighth Session of the WMO/ESCAP Panel on Tropical Cyclones (New Delhi, India, 21 – 25 February 2011);
- RA IV Hurricane Committee, Thirty-third Session (Cayman, 2-12 March 2011)
- RA IV Workshop on Hurricane Forecasting and Warning, and Public Weather Forecast (Miami, USA, 21 March – 1 April 2011);
- Training Workshop on Wave and Storm Surge Forecasting in RA II (Macao, China, 10 – 14 October 2011);
- 9th Southern Hemisphere Training Course on Tropical Cyclones (Melbourne, Australia, 5 – 23 September 2011);
- International Workshop on Tropical Cyclone Unusual Behavior (Xiamen, China, 18 – 20 October);
- Training Workshop on Application of Superensemble Techniques into Typhoon Track Forecasting (dates and place to be determined), and,
- Forecaster Attachment Trainings in RSMC New Delhi, RSMC Nadi, RSMC Tokyo and Indian Institute of Technology Delhi (dates to be determined).

Other Important inter-sessional activities will include:

- As appropriate, preparation, editing, updating, publication and distribution of new editions or supplements to the Tropical Cyclone Operational Plans for the Bay of Bengal and Arabian Sea (English only), the South-West Indian Ocean (English and French), the South Pacific and the South-East Indian Ocean (English and French), the Hurricane Committee Region (English and Spanish) and the Operational Manual for the Typhoon Committee Area (English only);
- Distribution of updated technical plans for further development of the Regional Cooperation Programmes of the five regional tropical cyclone bodies;
- Publication in hardcopy with limited quantity and in web format with free access of the “Global Guide to Tropical Cyclone Forecasting;”
- Preparation and publication of the Typhoon Committee Annual Review for 2010 and Newsletter of 2010;
- Preparation and publication of Panel on Tropical Cyclones Annual Review for 2011 and Panel News.
- and, in more general terms:
- Activities for the implementation of the Tropical Cyclone Programme section of the WMO Strategic Plan;
- Implementation of activities within the

framework of the International Strategy for Disaster Reduction (ISDR);

- Continued activities for the implementation of the Regional Cooperation Programmes, Technical Plans and other work programmes of the regional tropical cyclone bodies;
- Work of study groups, sub-groups and rapporteurs established by the regional tropical cyclone bodies, e.g. training and research activities in the meteorological component of the Typhoon Committee's programme under the leadership of the Coordinator, typhoon Training and Research Coordinating Group (TRCG), and the rapporteur on updating of the Typhoon Committee Operational Manual, the Working Group on the Panel on Tropical Cyclones Coordinated Technical Plan, the implementation of satellite based telecommunications regional networks, and on regional activities on storm surges;
- Action on further proposals made by the Fifteenth WMO Congress (Cg-XV), the Executive Council, the Regional Associations concerned and the regional tropical cyclone bodies.

APPENDIX I

TCP REGIONAL BODIES

ESCAP/WMO TYPHOON COMMITTEE	WMO/ESCAP PANEL ON TROPICAL CYCLONES	RA I TROPICAL CYCLONE COMMITTEE FOR THE S.W. INDIAN OCEAN	RA IV HURRICANE COMMITTEE	RA V TROPICAL CYCLONE COMMITTEE FOR THE S. PACIFIC AND S.E. INDIAN OCEAN
(14 Members)	**(8 Members)**	**(15 Members)**	**(26 Members)**	**(18 Members)**
CAMBODIA	BANGLADESH	BOTSWANA	ANTIGUA & BARBUDA	AUSTRALIA
CHINA	INDIA@	COMOROS	BAHAMAS	COOK ISLANDS
DEM. PEOPLE'S REP. OF KOREA	MALDIVES	FRANCE@	BARBADOS	FIJI@
HONG KONG, CHINA*	MYANMAR	KENYA	BELIZE	FRENCH POLYNESIA*
JAPAN@	OMAN	LESOTHO	BRITISH CARIBBEAN TERRITORIES*	INDONESIA
LAO PDR	PAKISTAN	MADAGASCAR	CANADA	KIRIBATI
MACAO, CHINA*	SRI LANKA	MALAWI	COLOMBIA	MICRONESIA
MALAYSIA	THAILAND	MAURITIUS	COSTA RICA	NEW CALEDONIA*
PHILIPPINES		MOZAMBIQUE	CUBA	NEW ZEALAND
REPUBLIC OF KOREA		NAMIBIA	DOMINICA	NIUE
SINGAPORE		REP. OF SOUTH AFRICA	DOMINICAN REPUBLIC	PAPUA NEW GUINEA
THAILAND		SEYCHELLES	EL SALVADOR	SAMOA
USA		SWAZILAND	FRANCE	SOLOMON ISLANDS
VIET NAM, SOCIALIST REPUBLIC OF		UNITED REPUBLIC OF TANZANIA	GUATEMALA	TIMOR LESTE
		ZIMBABWE	HAITI	TONGA
			HONDURAS	UNITED KINGDOM
			JAMAICA	USA#
			MEXICO	VANUATU
			NETH. ANTILLES AND ARUBA*	
			NICARAGUA	
			PANAMA	**Non-Members of WMO (4):**
			ST. LUCIA	
			TRINIDAD AND TOBAGO	- MARSHALL ISLANDS
			UK	- NAURU
			USA@	- PALAU
			VENEZUELA	- TUVALU
@RSMC Tokyo - Typhoon Center	@RSMC-Tropical Cyclones-New Delhi	@RSMC La Réunion - Tropical Cyclone Centre	@RSMC Miami - Hurricane Centre	@RSMC Nadi - Tropical Cyclone Centre # RSMC Honolulu - Hurricane Centre

* Member Territory