MEMBER REPORT

ESCAP/WMO Typhoon Committee
9th Integrated Workshop

REPUBLIC OF KOREA

20-24 October 2014
ESCAP – UN Conference Center, Bangkok, Thailand

CONTENTS

I. Overview of tropical cyclones which have affected/impacted Member's area in 2014 (as of 10 October)

1. Meteorological Assessment (highlighting forecasting issues/impacts)

The figures below show the track of typhoons such as NEOGURI (1408), HALONG (1411) and NAKRI (1412) that impacted on the Korean Peninsula and KMA's jurisdictional sea area in 2014. NEOGURI (1408) and NAKRI (1412) made direct impacts on the Peninsula on July 8~10 and August 1~3, respectively. Meanwhile, HALONG (1411) affected the eastern part of KOREA and the East Sea after it passed JAPAN on August 10.

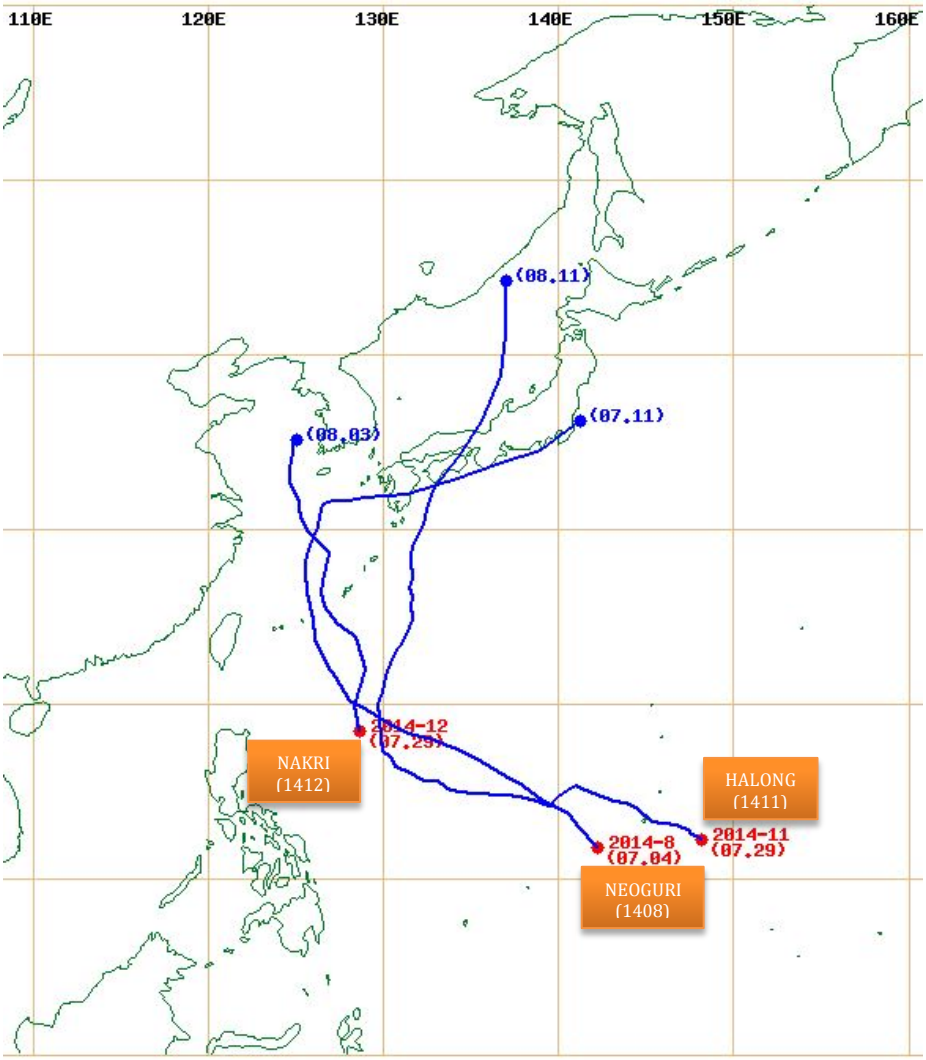

Fig. 1-1. TC track that affected the Korean Peninsula in 2014

At the time when the Korean Peninsula was under the influence of three Typhoons, the amount of precipitation reached more than 300mm, especially it recorded 1129.5mm in Jeju mountain area during the impact of NAKRI (1412). However, the intensity was not that strong during those three Typhoons, because each Typhoon itself influenced on the Korean Peninsula at central pressures above 980hPa even though the gusts recorded 41.9m/s in Jeju Island and were stronger than 20m/s in the coastal regions.

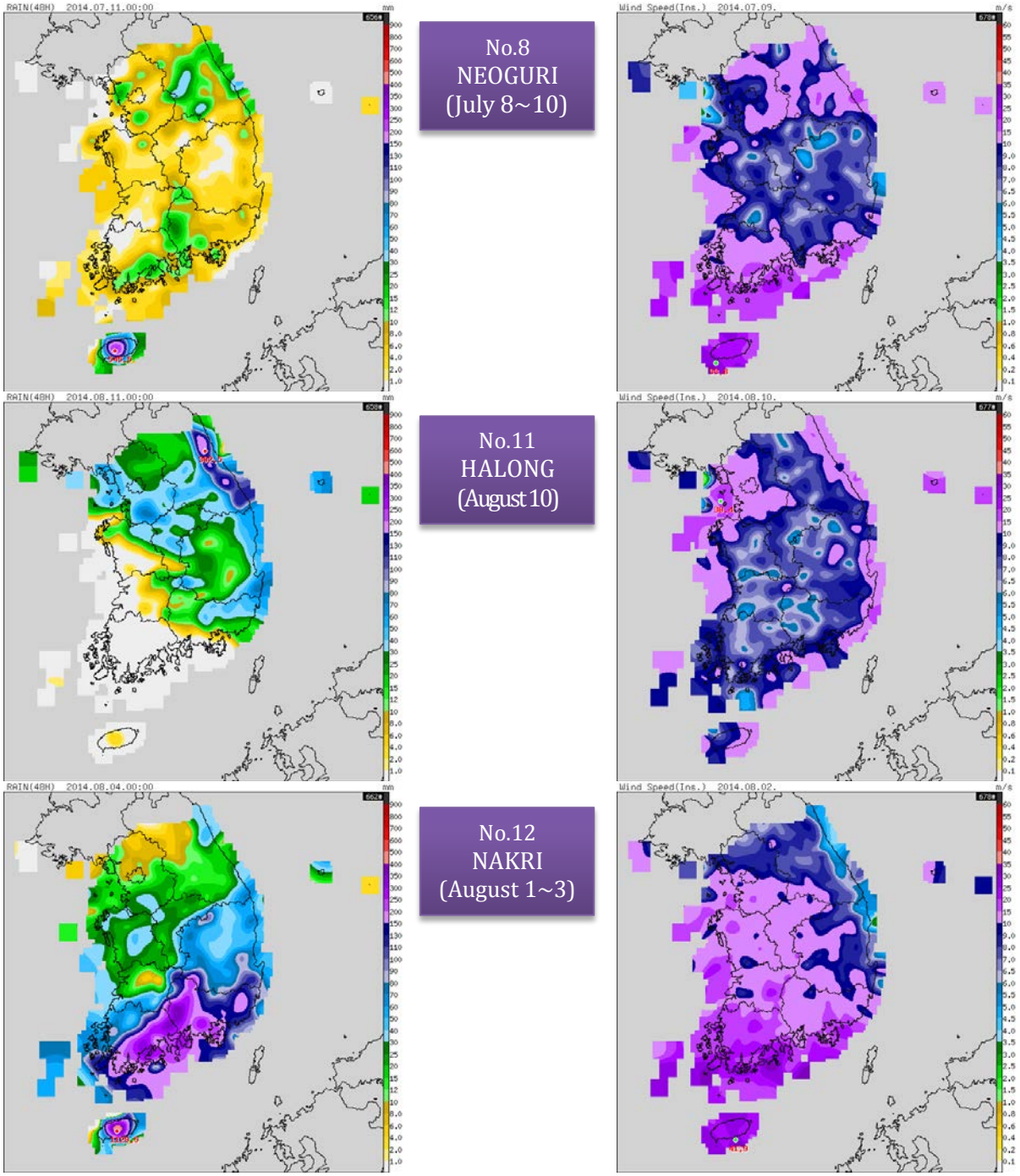

Fig. 1-2. Spatial distribution of rainfall (left) and wind gust (right) on the Korean Peninsula affected by typhoons

Typhoon No.8 NEOGURI (July), No.11 HALONG (August) and No.12 NAKRI (August) have passed through the Korean Peninsula or KMA's jurisdiction areas. The size and intensity of these typhoons were smaller and weaker compared with other years' events, so that flood watching or warning was not issued and there were few damages even though there were significant rain events in some leeward side of mountain areas where running water is very smooth.

There was no Typhoon as a tropical storm or stronger which landed on Korea. However, there was one Typhoon named as NAKRI which crossed through the Korean Peninsula as a tropical depression after KMA declared the Typhoon to be a tropical depression in the Western Sea. The 12th Typhoon NAKRI was formed around

860 km south of Okinawa on July 30 and was expected to head north-northwest. Typhoon NAKRI headed north and passed by the western part of Korea. Also, it brought heavy rain and strong winds to the southwestern part of Korea. However, there were no significant damages and losses to Korea even though some people became casualties of the Typhoon. Total damages by Typhoon NAKRI were as follows:

(Facility) Farmland flooding: 3,379 ha, Fishing port loss: 15 points
(Road) Rockslide: 13 points
(Street trees) 178 street trees fallen
(Damage of human life) 10: 2 deaths, 8 injuries

2. Hydrological Assessment (highlighting water-related issues/impact)

There were 3 typhoons that directly/indirectly affected Korea in 2014: the 8th "NEOGURI," the 11th "HALONG," and the 12th "NAKRI." This figure exceeds the number from the former years (the average number in the past 30 years is 2.2). The typhoon "NEOGURI" occurred in the ocean near 330 km west–southwest of Guam in the morning of July 4, 2014. It reached Kyushu, Japan around at 7 a.m. on July 10, and Korea got out of its influence. The typhoon "NAKRI" occurred in the ocean about 860 km off the south of Okinawa at around 3 a.m. on July 30, 2014. The southern part of Korea as well as its Jeju coastal regions came under its direct/indirect influence since the afternoon of July 31, 2014. The typhoon "HALONG" developed in the ocean near Guam at around 12 p.m. on July 29, 2014. It was feared that the said typhoon would cause serious damage to Korea given its speed and scale, which are more than two times than that of typhoon "NAKRI." However, it brought rain only in Jeju Island and in the small part of the south coastal regions. In Korea, the 14th flood warnings, changes and releases were issued at the 37 warning stations from the four flood control offices at Han River, Geum River, Yoengsan River, and Nakdong River, but no flood warnings were issued in the Korean Peninsula due to the typhoon landings.

3. Socio-Economic Assessment (highlighting socio-economic and DRR issues/impacts)

Nil

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

It is evaluated that the governmental long-term disaster risk reduction programs (e.g. Comprehensive plan for storm and flood damage reduction, etc.) have been conducted since Typhoon RUSA in 2002 helped local communities build capacity against typhoon-induced disasters. Also, the changes in public awareness of the natural disaster and disaster prevention by information sharing network using social media such as twitter, blogs, and SNS, as well as central governmental disaster broadcast system were considered as good practices.

II. Summary of progress in Key Result Areas

TC Members' Report
Summary of Progress in KRAs

Title of item 1: Begin to provide the seasonal typhoon activity outlook for TC members

Main text:

The Korea Meteorological Administration (KMA) has begun to provide the seasonal typhoon activity outlook since May 2014 through the website operated by the National Typhoon Center (NTC)/KMA (Internet address: http://gtaps.kma.go.kr/TSP/index.php). The information about the number of typhoon genesis and track pattern is produced based on the results of three types of models: multi-regression model, global dynamical model, and hybrid model of statistical and dynamical method.

Users can find a variety of information about the tropical seasonal prediction in the website, including prediction products, model information, model verification, and climate monitoring. The model or agency's products from ECMWF and TSR for summer (June to August) and fall (August to October) season are available, too. It also provides time series of the climatological indicators which are related with typhoon seasonal activity such as ENSO, Arctic Oscillation Index (AOI), Pacific Decadal Oscillation (PDO), etc.

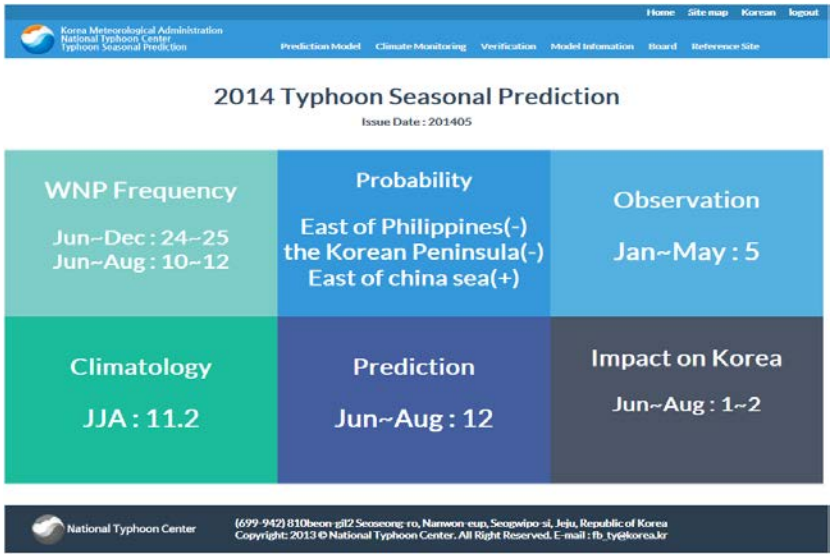

Fig. 2. Front page of the website for the KMA's seasonal typhoon activity outlook

Identified opportunities/challenges, if any, for further development or collaboration:

KMA plans to keep providing the seasonal typhoon activity outlook for the summer and fall of 2015 through the website for TC members. The website will be upgraded and typhoon seasonal prediction systems will be improved in order to expand service provision.

Summary Table of relevant KRAs and components (Please tick boxes. You can tick more than one as appropriate):

KRA =	1	2	3	4	5	6	7
Meteorology		√				√	
Hydrology							
DRR							
Training and research							
Resource mobilization or regional collaboration							

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Title of item 2:
7th Korea-China Joint Workshop on Tropical Cyclones

Main text:

The NTC/KMA and the Shanghai Typhoon Institute (STI) of CMA have co-hosted a joint workshop on tropical cyclones since 2008. As the 7th event, the NTC/KMA and STI/CMA held the workshop on 26-29 May 2014, at Seogwipo KAL hotel in Jeju, Korea. There were over 60 experts of typhoon and related fields from KMA, CMA, the Global Loss Control Center in Samsung, and four Korean universities. The participants made 14 presentations in a keynote speech and 4 sessions: typhoon modeling, typhoon analysis and forecast, and typhoon prediction and climate. They made presentations on a wide range of topics, such as predictability and improvement of operational numerical models, introduction of new prediction systems and typhoon related technologies, typhoon analyses based on satellite and observation, and socio-economic impacts, etc.

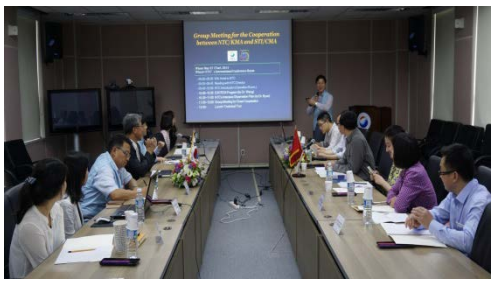

Fig. 3. Group photos of participants in the 7th Korea-China Joint Workshop on Tropical Cyclones, Segwipo KAL hotel (left), and future cooperation meeting in the National Typhoon Center, Jeju (right)

Identified opportunities/challenges, if any, for further development or collaboration:

Delegates from the NTC and STI had an intensive discussion for the future collaboration activities. During this meeting, KMA introduced an observation plan using the aircraft for the targeted observation scheme in 2015 and showed strong interest in the EXOTICA project which was introduced by STI delegates. They also agreed to exchange experts on sharing the technology of typhoon formation detection and the methodology about best-track data generation, depending on the interests of each organization. The 8th workshop will be held in China on the last week of May in the upcoming year.

Summary Table of relevant KRAs and components (Please tick boxes. You can tick more than one as appropriate):

KRA =	1	2	3	4	5	6	7
Meteorology						√	√
Hydrology							
DRR							
Training and research							
Resource mobilization or regional collaboration							

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Title of item 3:
Capacity building of typhoon analysis and forecasting through the typhoon research fellowship program

Main text:

The 2014 Typhoon Research Fellowship Program, as part of the Training and Research Coordination Group (TRCG) Fellowship Program of the ESCAP/WMO Typhoon Committee was successfully completed. Three typhoon forecasters who are from the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA), Vietnam National Center for Hydro-Meteorological Forecasting (NCHMF), and the Shanghai Typhoon Institute (STI) of the China Meteorological Administration (CMA) were trained during two months (12 May to 11 July 2014) by the staff of NTC/KMA. The trainees received training and conducted research on optimizing typhoon forecast using TAPS (Common training field) as well as three research topics

(typhoon-mid latitude pressure system interaction, study on the typhoon recurvature and moving speed, and study on the relationship between the central pressure and maximum sustained winds for typhoon). They enthusiastically performed their missions, drafting a training report in spite of the short period. They improved their typhoon analysis and forecast skill as well as shared their ideas and plans for applying the TAPS system. Some of them have been preparing for journal papers to submit, based on the results of their researches, after finishing the program. Since 2001, the NTC/KMA has carried out the Fellowship Program for a number of typhoon experts from Asian countries.

Fig. 4. Three experts were awarded the Typhoon Research Fellowship in 2014

Identified opportunities/challenges, if any, for further development or collaboration:

The Fellowship Program will be continued in the next year in the Jeju island, Republic of Korea where the NTC/KMA are located (the period may be from May to June). Overall expenses (including round-trip ticket and living expense during their stay (if available, accommodation) will be supported by KMA. The circular letter or the KMA's fellowship offer will be sent to the members by the TCS at least one month before its commencement. Anyone who has an operational experience of TC forecast can apply for the fellowship.

Summary Table of relevant KRAs and components (Please tick boxes. You can tick more than one as appropriate):

KRA =	1	2	3	4	5	6	7
Meteorology						√	
Hydrology							
DRR							
Training and research						√	
Resource mobilization or regional collaboration						√	

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Title of item 4:
Implementation of Typhoon Analysis and Prediction System (TAPS) to Department of Meteorology and Hydrology (DMH), Lao PDR

Main text:

The National Typhoon Center (NTC) of KMA has provided the transfer of the technology of Typhoon Analysis and Prediction System (TAPS) including the training of the typhoon forecasters to TC members hoping to get support for the operational forecasting of tropical cyclones from 2011. Following the successful TAPS technological assistance to Vietnam in 2012 and the construction of TAPS data supporting system server in 2013, the web-based TAPS package that user can access remotely in the server was developed this year (Internet address: http://gtaps.kma.go.kr).

NTC/KMA also carried out the TAPS technology transfer to Lao PDR from Sept. 29 to Oct. 2, 2014. It included three lectures and two practice classes for staff of the Weather Forecast and Aeronautical Meteorology division of the Department of Meteorology and Hydrology (DMH) in Lao PDR, which showed that typhoon forecast process and the Typhoon Analysis and Prediction System (TAPS). During the visit period, Dr. KiRyong Kang, senior scientist of NTC/KMA, and Ms. Yumi Cha, junior scientist of NTC/KMA, introduced the main duty of NTC/KMA and typhoon forecast process including analyzing the track, intensity, briefing procedure and discussion, and released the final products on Sept. 30, 2014. Ms. Cha did introduce the TAPS and related program like TAPS data supporting system, and helped members to install the TAPS on each machine, and performed demonstration of typhoon forecasts using TAPS on Oct. 1 - 2, 2014.

Fig. 5. Photos of visit to DMH, Lao PDR

Identified opportunities/challenges, if any, for further development or collaboration:

Summary Table of relevant KRAs and components (Please tick boxes. You can tick more than one as appropriate):

KRA =	1	2	3	4	5	6	7
Meteorology	√						
Hydrology							
DRR							
Training and research						√	
Resource mobilization or regional collaboration							

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Title of item 5:
Recent advance of estimation of the radius of 15 m/s wind speed of Tropical Cyclones using COMS and Microwaves imagery in KMA/NMSC

Main text:

The objective methods estimating the radius of 15m/s wind speed of tropical cyclones (TCs) are developed using infrared (IR) imagery of geostationary satellite. The estimating methods of radius of 15m/s wind speed are based on the characteristic structure of the eye wall of TCs. The radius of 15m/s is dependent upon the radius of the eye and the distance from the center to the area of the most developed convective cloud. In order to test these methods, brightness temperature of Korean geostationary satellite, COMS (Communication, Ocean, and Meteorological Satellite) IR, is utilized in this study. The estimated radius of 15 m/s wind is compared with surface winds of ASCAT (Advanced Scatterometer) of a polar orbiting satellite.

Fig. 6 shows an example of estimated radius of 15m/s and 25m/s wind speed of 28th Typhoon 'LEKIMA' in 2013 using COMS IR. From the MetOp/ASCAT data, the radius of 15m/s wind at 23:39UTC on 24 October was estimated approximately as 280k m(Fig. 6(b)). According to the wind algorithm using COMS IR at 23:45UTC on 24 October, the radius of 15m/s wind can be estimated as 300 km for the same Typhoon.

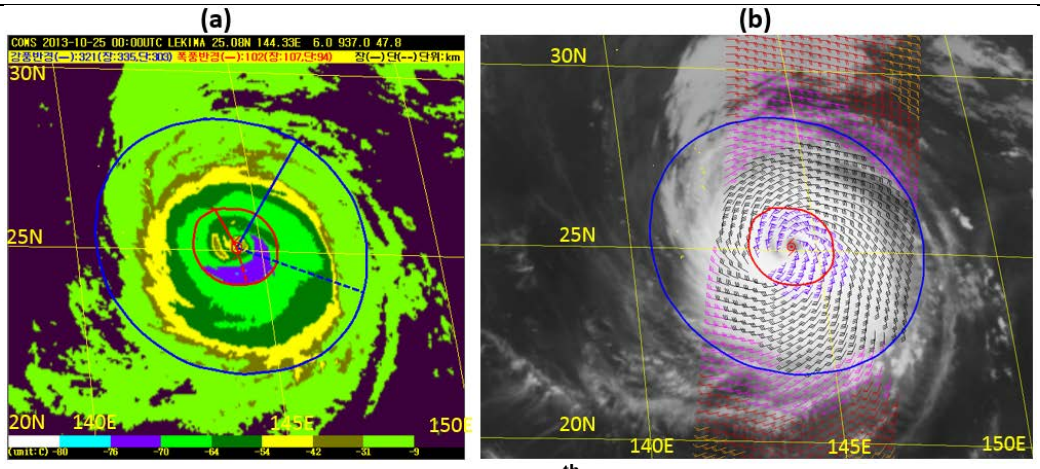

Fig. 6. Radius of 15 m/s and 25 m/s wind of 28th Typhoon LEKIMA in 2013. (a) COMS IR at 23:45UTC on 24 October 2013 and (b) Superimposed image of surface wind speed from MetOp/ASCAT at 23:39UTC and COMS IR at 23:45UTC on 24 October 2013. Blue and red ellipses denote radius of 15 m/s and 25m/s wind, respectively. Shading in (a) denotes the color scale of brightness temperature adopted from Dvorak (1984).

COMS has observed TCs using 1 visible and 4 infrared spectral bands since 2011. The inner structure of TCs, such as rain rates and surface wind speeds, is indirectly estimated from the COMS data because of the physical limitations of those bands. Thus, KMA/NMSC is developing an algorithm for retrieving sea surface wind speed under rain-free and rain conditions using the low frequency bands (6.9GHz and 10.8GHz) of passive microwave satellite observations such as GCOM-W/AMSR-2 and TRMM/TMI.

Fig. 7 shows an example of TC size analysis. In this case, 24th typhoon 'DANAS' in 2013 was considered. From the ASCAT data, the radius of 15m/s wind speed at 12:00UTC 7 October, 2013 is estimated approximately as 250km. According to the wind algorithm using AMSR-2 data at 17:10UTC Oct. 7, 2013, the radius of 15m/s wind is estimated as 240km for the same TC. Therefore, the microwave wind algorithm is very useful to estimate the size of TCs for operational viewpoint and an alternative when the ASCAT data are not available.

The newly developed radius of 15m/s wind speed algorithms based on COMS IR and multi Microwave data have been adopted operationally in NMSC/KMA for analyzing the TCs since 2014 summer.

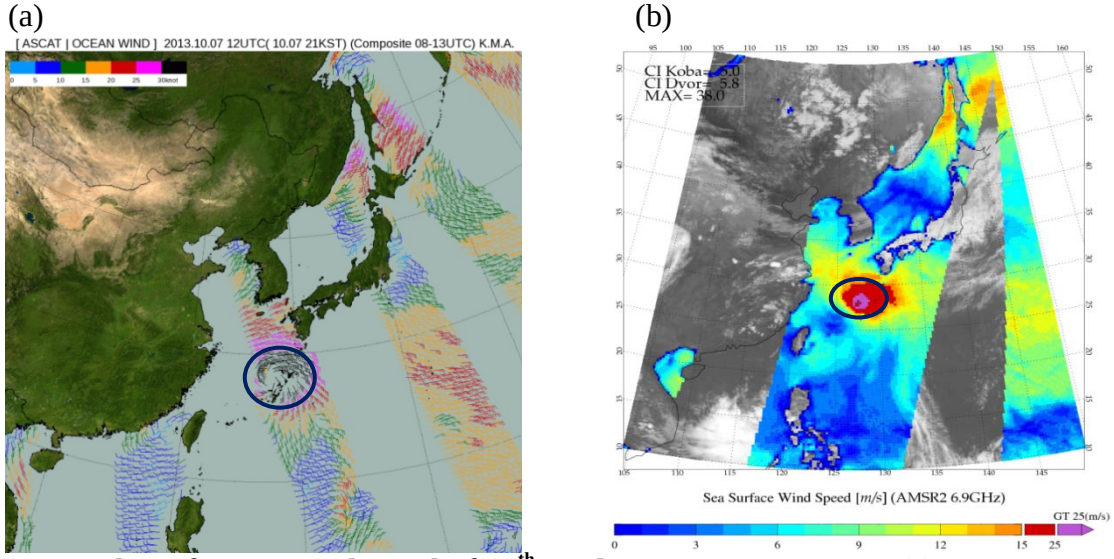

Fig. 7. Radius of 15m/s wind speed of 24th Typhoon DANAS in 2013. (a) MetOp/ASCAT at 12:00UTC 7 on October 2013 and (b) estimated wind using AMSR-2 6.9GHz at 17:10 UTC on 7 October 2013. Blue ellipse denotes radius of 15m/s wind speed.

Identified opportunities/challenges, if any, for further development or collaboration:

Summary Table of relevant KRAs and components (Please tick boxes. You can tick more than one as appropriate):

KRA =	1	2	3	4	5	6	7
Meteorology	√			√		√	
Hydrology							
DRR							
Training and research							
Resource mobilization or regional collaboration							

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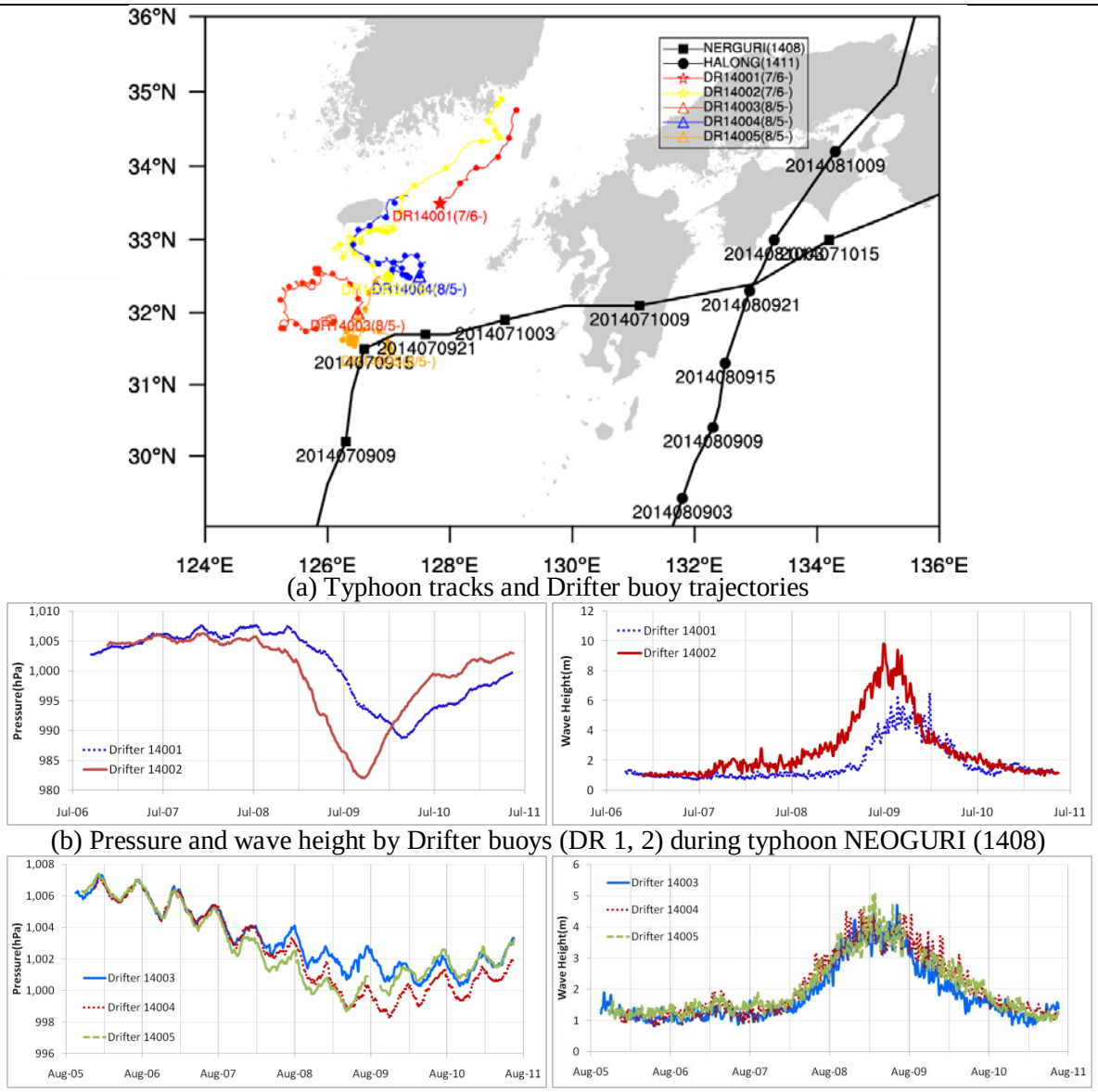
Title of item 6: Typhoon Monitoring by Drifting Buoys around the Korean Peninsula

Main text:

According to prediction that the Typhoon NEOGURI (1408) and HALONG (1411) would approach to the Korean Peninsula, KMA performed measurements by drifter buoys for monitoring typhoon track and strength in order to support typhoon forecast. The drifter buoy measured wave height, sea surface temperature and pressure with 20 minutes interval, and it transmitted data by IRIDIUM satellite communication. The 2 drifter buoys (14001 and 14002) were deployed by KMA's GISANG 1 vessel on 6. July 2014 for NEOGURI and 3 drifters (14003, 14004 and 14005) on 5 Aug 2014 for HALONG.

Fig. 8(a) shows typhoon path and trajectories of drifter buoys. The plots (b) and (c) show pressure and wave height measured by the drifter buoys during NEOGURI and HALONG. During NEOGURI, the drifters were close to typhoon path and the measured pressures were in excess of 980hPa and wave heights were 10m at DR14002. It showed typhoon's strength and locations very well. Since the HALONG tracked along southern Japan, measured pressures were in excess of 998hPa and wave heights were 5m.



(a) Typhoon tracks and Drifter buoy trajectories

(b) Pressure and wave height by Drifter buoys (DR 1, 2) during typhoon NEOGURI (1408)

(c) Pressure and wave height by Drifter buoys (DR 3, 4 and 5) during typhoon HALONG (1411)

Fig. 8. Typhoon path and trajectories of drifter buoys (a), pressure (left) and wave height (right) during NEOGURI (1408) and HALONG (1411) (b and c)

Identified opportunities/challenges, if any, for further development or collaboration:

Summary Table of relevant KRAs and components (please tick boxes, can be more than one, as appropriate):

KRA =	1	2	3	4	5	6	7
Meteorology	√						
Hydrology							
DRR							
Training and research							
Resource mobilization or regional collaboration							

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Title of item 7:
Structural and Nonstructural Measurements (AOP2) to Extreme Floods

Main text

Republic of Korea is leading the research of suggesting the integrated alternatives that prevent the extreme flood in the Typhoon Committee member countries. The annual field survey was conducted to investigate and assess the occurrence of extreme floods and flood preparedness systems of pilot application countries (Thailand, Philippines, and Laos) from 2012 to 2014. And the results of field survey were shared to TC member at the WGH meeting and workshop. In 2014, the 3rd field survey was conducted to investigate the methods of structural flood response that experienced extreme flood events in the past, identify the status of dams, embankments, and drainages, the flood design standards of the member countries, and the floods that exceeded the standards. The nonstructural flood control measures were analyzed in the flood warning, dam operation rules and law, institutional related to flood control. Results of the preparedness and framework to respond to extreme flood are expected to use in actual work in the TC region's flood warning system and reduce the casualties and flood damages.

Fig. 9. The 3rd field survey

Identified opportunities/challenges, if any, for further development or collaboration:

Summary Table of relevant KRAs and components (please tick boxes, can be more than one, as appropriate):

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Meteorology							
Hydrology	√						
DRR							
Training and research							
Resource mobilization or regional collaboration							

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Title of item 8:
Flood Control Measures Assessment System (AOP1) Manual

Main text

It is reported that flood vulnerability is increased because of the increase of rainfall intensity, flood frequency caused by climate. Especially, estimation of typhoon precipitation is very difficult work and flood related to typhoon result to big damages in socio-economic aspects.

Republic of Korea established the ASFCM (Assessment System of Flood Control Measures) in order to pre-assess the flood vulnerable aspects.

In addition, the structural flood measures assessment guidelines and the ASFCM user manual are written and will publish and distribute them at the 47th session that will be held in 2015.

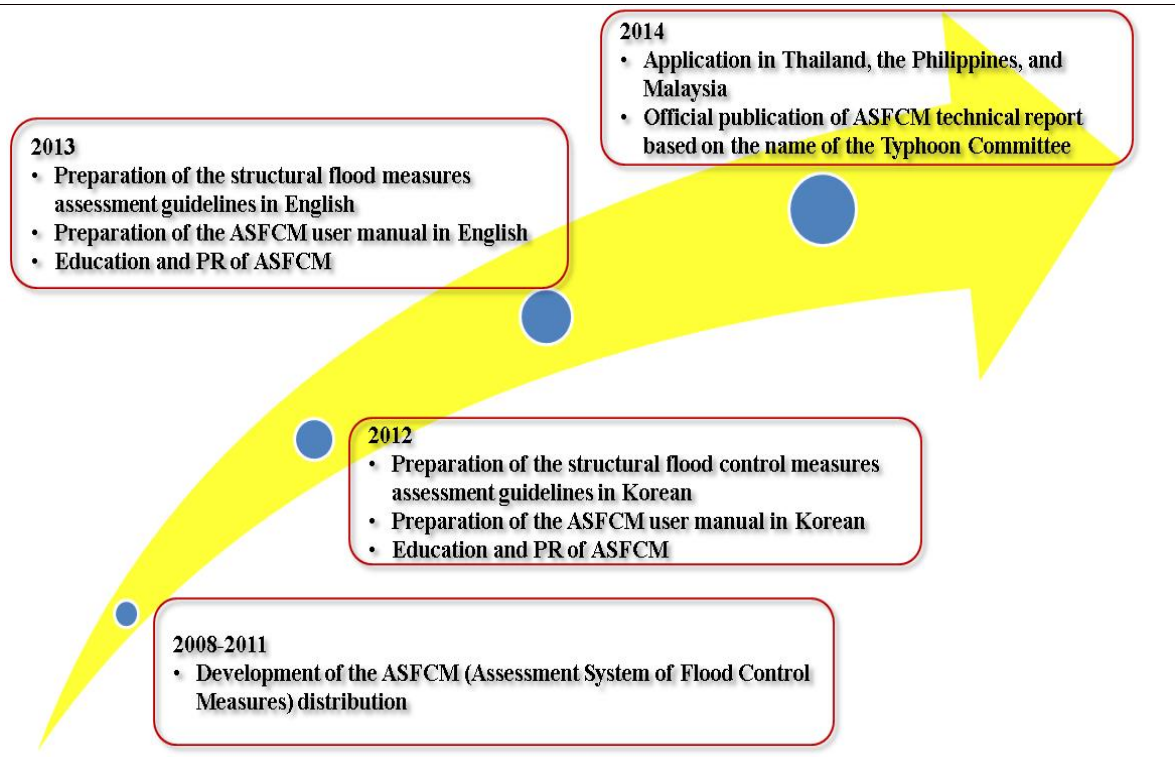

Fig. 10. Annual research contents on extreme flood forecast system (AOP1)

Identified opportunities/challenges, if any, for further development or collaboration:

Summary Table of relevant KRAs and components (please tick boxes, can be more than one, as appropriate):

KRA =	1	2	3	4	5	6	7
Meteorology							
Hydrology		√					
DRR							
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Resource mobilization or regional collaboration							

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Title of item 9:
Extreme Flood Control Guidelines

Main text

For the effective use the radar data in national level, the Ministry of Land, Infrastructure and Transport; the Ministry of Defense; and the Korea Meteorological Administration signed an MOU. This is resulted to increase the synergy through the joint use of the data and the establishment of optimum joint observation strategy and system, removing the blind observation spots, and increase the accuracy in flood and severe weather forecast.

The MOLIT has operated to Imjin River, Biseul Mountain and Sobaek Mountain, etc. rainfall radars and established test strategies and is now carrying out the test operation. In this year, it is planning the test operation for the Seodae Mountatin, Mohu Mountain rainfall radar. Related to rainfall radar research, if a large S-Band radar is installed in Bonghwang Mountain in Jeollanam-do province to resolve the blind observation spots in Korean south coastal regions, the low-level observation is expected to be possible. A research on the extreme flood management (AOP6) included the extreme flood management with using the radar data, and this research result is possible to apply to resolve the blind observation spots, disaster forecast, flood response system, and the method of inputting radar data in TC member countries.

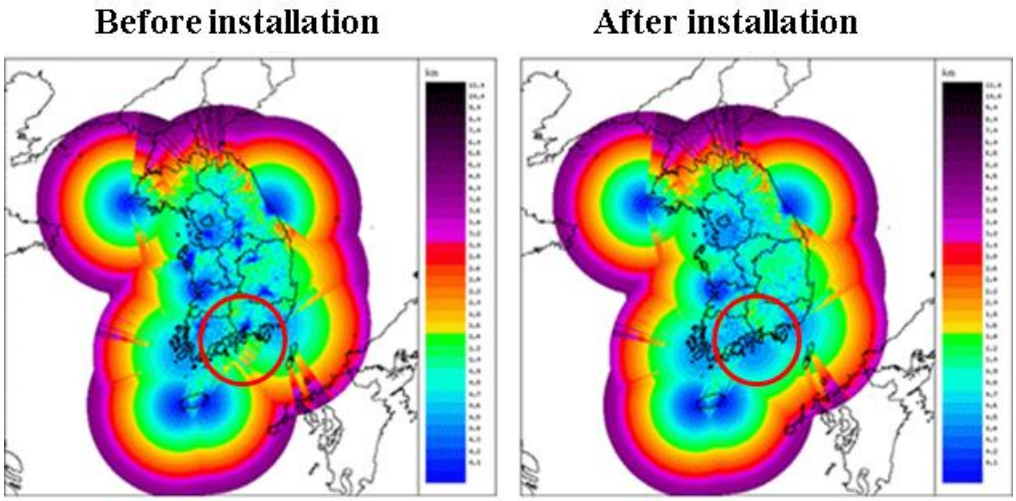

Fig. 11. Annual research contents on extreme flood forecast system (AOP1)

Identified opportunities/challenges, if any, for further development or collaboration:

Summary Table of relevant KRAs and components (please tick boxes, can be more than one, as appropriate):

KRA =	1	2	3	4	5	6	7
Meteorology							
Hydrology				√			
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Title of item 10:
Developing the smart phone application for flood information dissemination

Main text

The Han River Flood Control Office, Ministry of Land, Infrastructure and Transport of Republic of Korea has developed and distributed the mobile flood information system (http://m.flood.go.kr) through smartphones. People can easily and conveniently access information about the approaching typhoon and flood-related events using the major points flood information, flood text message and nearby flood information provided by the system. When a flood occurs, the distribution of flood warning is also as important as the accurate forecast of the flood. Accordingly, the provision of the flood text message and the nearby flood information will serve as the most accurate system that can enable people to evacuate as quickly as possible.

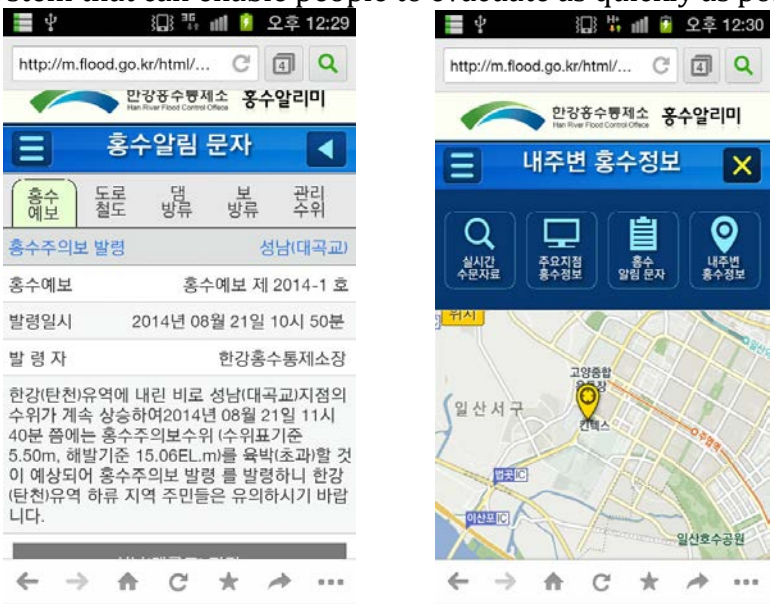

Fig. 12. Flood text message and nearby flood information (m.flood.go.kr)

Identified opportunities/challenges, if any, for further development or collaboration:

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Hydrology						√	
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Title of item 11: 3rd WGH meeting and TC WGH web-page

Main text

After the 1st WGH Meeting in 2012, UNESCAP/WMO Typhoon Committee Meeting of TC WGH is held every year at Han River Flood Control Office of the Republic of Korea And 3rd meeting will be held from October 13–17, 2014. With the theme, 'Extreme flood and Structural Flood Control Measures in TC', it will be participated by the 20 delegates from the member countries (Korea, China, Laos, Malaysia, Philippine, Thailand, Vietnam), Typhoon Committee Secretariat. An in-depth discussion is going to be on about the status of flood management and AOP activities. It is expected that the results of the meeting will make a big contribution in the water resource management and disaster forecast of the member countries.

The developed TC WGH web-page (http://tcwgh.hrfco.go.kr) has been operated and contributed to share opinions and exchange data among TC member countries.

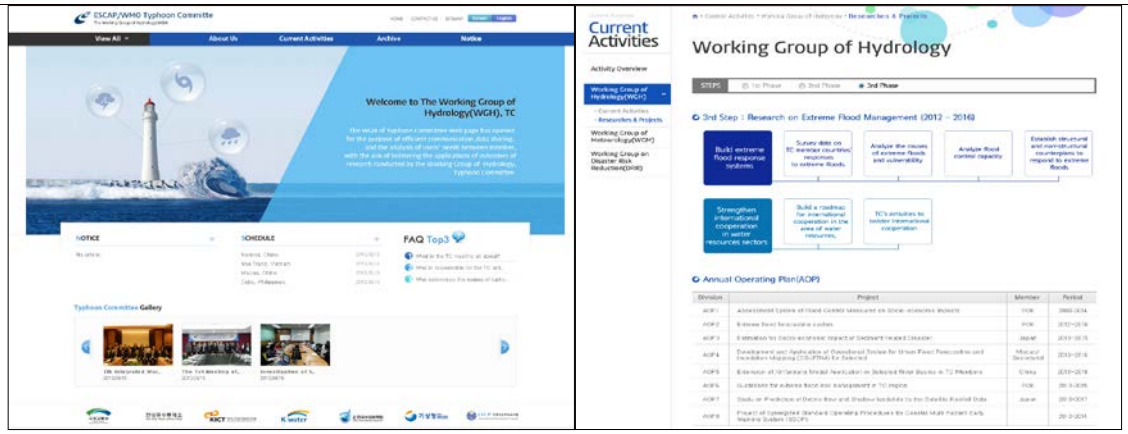

Fig. 13. TC WGH Web-page

Identified opportunities/challenges, if any, for further development or collaboration:

Summary Table of relevant KRAs and components (please tick boxes, can be more than one, as appropriate):

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Meteorology							
Hydrology							√
DRR							
Training and research							
Resource mobilization or regional collaboration							

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Title of item 12:
Empirical experiment for Typhoon and heavy rainfall response

Main text:

National Disaster Management Institute (NDMI) of the Republic of Korea conducted empirical experiments to simulate dangerous conditions which could be occurred by heavy rainfall and strong wind. Throughout the empirical experiments, it presented safety countermeasures for each dangerous condition with various experimental cases.

Empirical experiments consist of three different cases. In the first experiment, "Impacts of heavy rain and strong wind on pedestrian and drivers" simulated the condition which could affect pedestrians and drivers through heavy rain and strong wind. The second experiment of "Cross-sectional impacts of rapid stream on pedestrian and drivers" represented a risk of crossing rapid stream caused by heavy rain or steep slope in mountainous areas. In the third experiment of "Inundation of car", it was simulated that car was flooded during rainy season.

Fig. 14. Empirical experiment for Typhoon and heavy rainfall response

Identified opportunities/challenges, if any, for further development or collaboration:

The results of the experiments were made available as video clip and used as a public education material. Throughout the education material, this study expects that the public could be well-informed of the dangerousness of flash flood, heavy rainfall, and high-speed wind.

Summary Table of relevant KRAs and components (please tick boxes, can be more than one, as appropriate):

KRA =	1	2	3	4	5	6	7
Meteorology							
Hydrology							
DRR			√		√		
Training and research							
Resource mobilization or regional collaboration							

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Title of item 13:
Value Improvement Project-8 (VIP-8)

Main text:

In the Republic of Korea, main objective of R&D on emergency management is to build a resilient country for various disasters including natural disasters. Goals and strategic plans of R&D on emergency management could be expressed as 1) To reduce the national cost with regarding to the disaster by 10%, 2) To keep up with disaster prevention technology in advanced countries, 3) To promote VIP-8, 4) To enhance satisfaction of the public on disaster and safety service, 5) To increase the investment in emergency management R&D by the percent of five hundreds. This report introduces Value Improvement Project-8 (VIP-8) which is a primary issue in R&D on emergency management in the Republic of Korea.

VIP-8 includes 8 contents as follow;

Fig. 15. Value Improvement Project-8Center

Identified opportunities/challenges, if any, for further development or collaboration:

Throughout VIP-8, it is expected to improve disaster prevention technologies and the quality of R&D on emergency management. Also, developed technologies or disaster policies could be transferred to member countries by WGDRR Expert Mission or NDMI's ODA project.

Summary Table of relevant KRAs and components (please tick boxes, can be more than one, as appropriate):

KRA =	1	2	3	4	5	6	7
Meteorology							
Hydrology							
DRR				√			
Training and research							
Resource mobilization or regional collaboration							

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Title of item 14:
2014 Northern Mindanao Project in Philippines by NDMI and PAGASA

Main text:

The period of Northern Mindanao Project is 3 years and it was launched in 2013. The first year's project focused on the selection of the pilot area, the installation of Automatic Rainfall Warning System, test operation of Flash Flood Alert System which was installed in PAGASA, Manila, education and training of the systems for the public officers in Cagayan de Oro, Mindanao Island.

In 2014, NDMI and PAGASA decided to expand the systems to other area and also, it was recommended to install the intelligent CCTV developed by NDMI on Cagayan de Oro River Basin to monitor the flooding.

In order to set up the warning criteria, it was very important to develop hydrologic model for Cagayan de Oro River Basin. However, there was not enough data for developing the model. To conduct computational hydraulic-hydrologic simulation and develop the hydrologic model for Cagayan de Oro River, NDMI and PAGASA conducted the river survey of Cagayan de Oro River Basin with the installation of ARWS and intelligent CCTV. From 15 through 23, September 2014, NDMI and PAGASA carried out the installation of ARWS (1 rainfall gauge, 1 warning post), intelligent CCTV, and river survey.

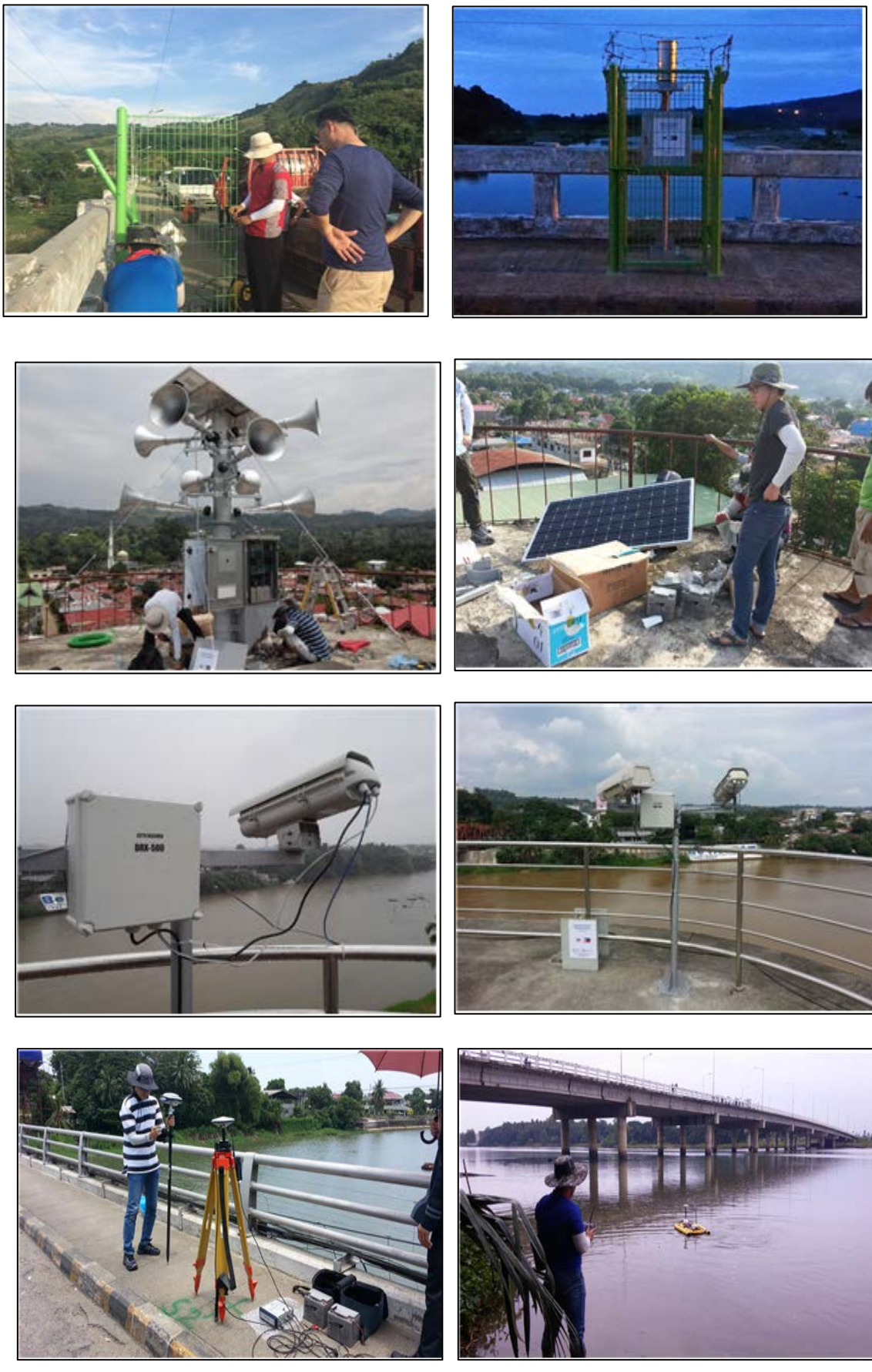

Fig. 16. 2014 Northern Mindanao Project by NDMI and PAGASA

Identified opportunities/challenges, if any, for further development or collaboration:

Main goal of the project is to reduce the World disaster risk and strengthen the global network for disaster risk reduction. Northern Mindanao Project will be continued in 2015 for Philippines and NDMI's project also will be expanded to other member countries after 2015.

Summary Table of relevant KRAs and components (please tick boxes, can be more than one, as appropriate):

KRA =	1	2	3	4	5	6	7
Meteorology							
Hydrology							
DRR					√		
Training and research							
Resource mobilization or regional collaboration					√		

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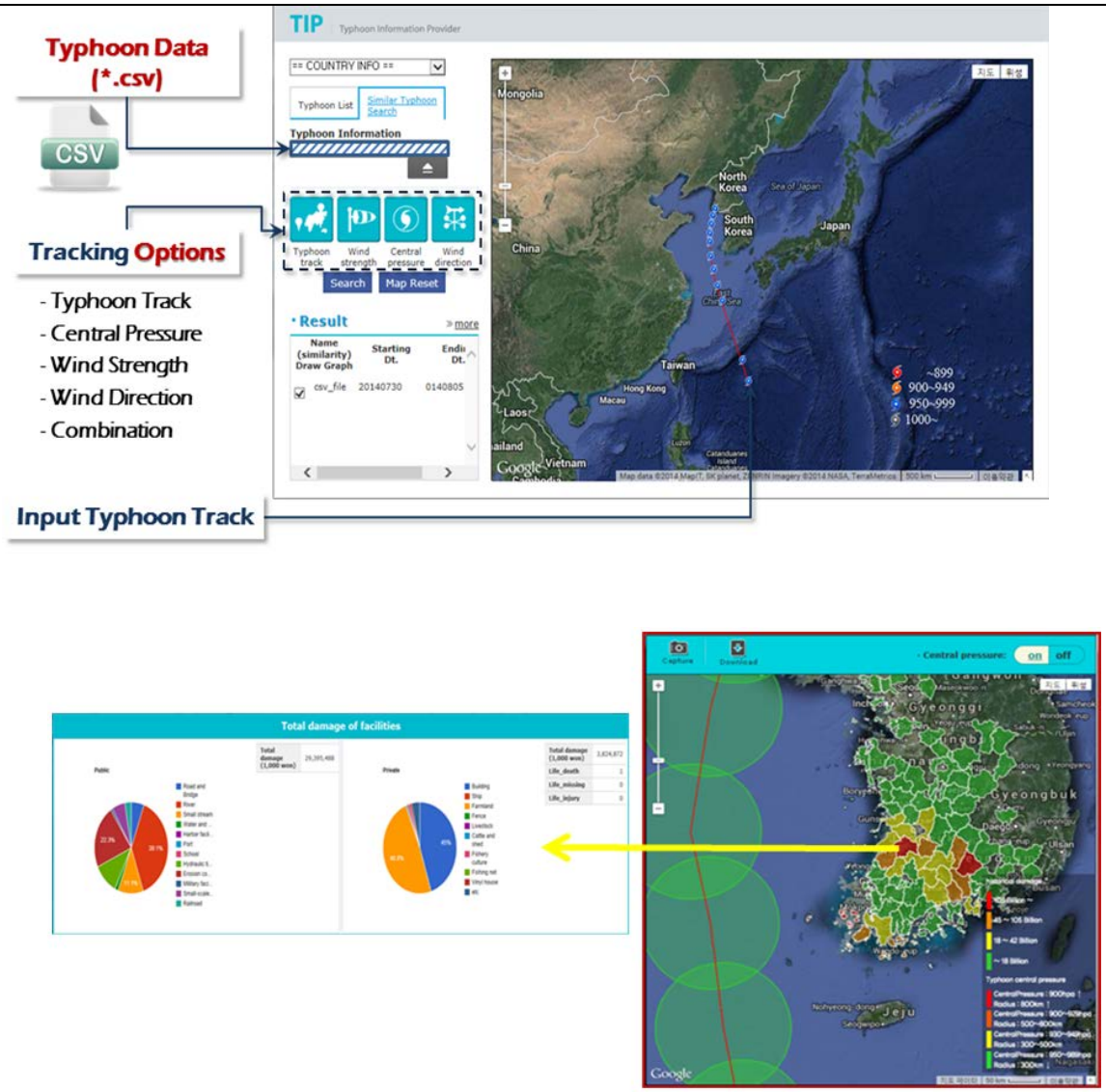
Title of item 15:
Upgrade of the function in Typhoon Committee Disaster Information System

Main text:

A search function of past similar Typhoon is a primary tool in TCDIS. However, in the TCDIS, it had its limitation due to low speed by overload of the system, limited web browsing. Also, in the past TCDIS, data of past Typhoon included all Typhoons since the 1950's and this made the speed and accuracy of the system low. So, in the renewed TCDIS, the affected Typhoons are defined to each member country and it uses different past Typhoon information for different member country to reduce the overload of the system. In case of search algorithm in past TCDIS, it used 4 data of central pressure, wind speed, location of Typhoon, and direction. However, in this case, because of the combination of various parameters, it might cause a problem of the accuracy for finding similar past Typhoon. For this reason, in the renewed TCDIS, users can choose each data. For example, if a user would like to consider only a direction out of the four options to search similar past Typhoon, the user can choose only a direction.

With regard to the search option for past similar Typhoon, NDMI developed TIP (Typhoon Information Provider) which could provide the function of tracking similar Typhoon in the past.



<Before> <After>

Fig. 17. Upgrade of the function of TCDIS

Identified opportunities/challenges, if any, for further development or collaboration:

TCDIS is one of the key points in WGDRR. NDMI will upgrade the TCDIS continuously

and expand the system to member countries. Also, throughout the Expert Mission, education and training program will be continued.

Summary Table of relevant KRAs and components (please tick boxes, can be more than one, as appropriate):

KRA =	1	2	3	4	5	6	7
Meteorology							
Hydrology							
DRR						√	
Training and research							
Resource mobilization or regional collaboration							

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Title of item 16:
The 9th WGDRR Annual Workshop

Main text:

The 9th Working Group on Disaster Risk Reduction Annual Meeting was held in Seoul, Republic of Korea from 26 May to 27 May. Total 7 member countries including Hong Kong, Malaysia, Macau, USA, Viet Nam, and Republic of Korea participated on the workshop. Also, there were participants from international organizations of ADRC (Mr. Junji Moriwaki), and UNESCAP (Mrs. Yejin Ha). Also, Dr. Yuichi Ono, professor in Tohoku University attended on meeting as a special guest. The workshop started with the welcome address by Dr. Yeo, Woon Kwang, president of NDMI and also, there was a silent tribute for disaster victims in the World. Specially, there was one more silent tribute Dr. Susan's passing away who had been worked in PAGASA, Philippines

The main theme of the 9th WGDRR Annual Workshop was “Past, Present, and Future of WGDRR”. In the workshop, the ways of strengthening on international cooperation for DRR were mainly discussed.

Fig. 18. The 9th WGDRR Annual Meeting

Identified opportunities/challenges, if any, for further development or collaboration:
WGDRR has been developing TCDIS (Typhoon Committee Disaster Information System) and conducting Expert Mission since 2009. Throughout WGDRR annual meeting, it is expected to promote new contents and projects to strengthen global network and collaboration for disaster risk reduction in member countries.

Summary Table of relevant KRAs and components (please tick boxes, can be more than one, as appropriate):

KRA =	1	2	3	4	5	6	7
Meteorology							
Hydrology							
DRR							√
Training and research							
Resource mobilization or regional collaboration							

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Title of item 17:
Memorandum of Agreement (MOA) Between NDMI and PAGASA

Main text:

On 22, Jan 2014, National Disaster Management Institute (NDMI, president: Dr. Yeo, Woon Kwang) in the Republic of Korea and Philippine Atmospheric, Geophysical & Astronomical Services Administration (PAGASA, acting administrator: Dr. Vicente B. Malano) in Philippines signed a Memorandum of Agreement (MOA) for international disaster prevention collaboration. Since 2013, NDMI is conducting Northern Mindanao Project for reducing disaster risk at Cagayan de Oro, Mindanao Island in Philippines. This project includes the installation of Flash Flood Alert System (FFAS) and Automatic Rainfall Warning System (ARWS). By signing a MOA between two agencies, it would be expected to increase the resilience on natural disasters in Philippines and strengthening the international collaboration and network to World's disaster risk reduction.

Fig. 19. Memorandum of Agreement between NDMI and PAGASA, 22, Jan 2014

Identified opportunities/challenges, if any, for further development or collaboration:

Throughout Northern Mindanao Project, it could be confirmed to make solid of the collaboration for DRR between PAGASA and NDMI. It is expected to expand the project to other member coutries.

Summary Table of relevant KRAs and components (please tick boxes, can be more than one, as appropriate):

KRA =	1	2	3	4	5	6	7
Meteorology							
Hydrology							
DRR							√
Training and research							
Resource mobilization or regional collaboration							

Member: Republic of Korea WGDRR

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Title of item 18:
2014 Expert Mission in Guam (USA)

Main text:

NDMI has been performing the expert mission for supporting disaster prevention technology, training-education of WGTCDIS, and strengthening the global network for disaster risk reduction since 2008. In 46th session, there were requests for expert mission from Guam. NDMI made a visit to Guam from 21 September to 25 September. The expert mission team consisted of 3 experts from NDMI (2) and TCS (1) who are involved in disaster prevention technology and policies. Main tasks of 2013 Expert Mission were as follow;

(1) Training on TCDIS (Typhoon Committee Disaster Information System)
(2) Urban flood analysis and Korea community safety map
(3) Introduction of DSI (Disaster Scientific Investigation) – an example of Typhoon -induced disaster response in 2013
(4) Use of radar measurement for rainfall-induced disaster response
(5) Introduction and education of FARD (Frequency Analysis for Rainfall Data)
(6) Introduction of disaster prevention policies and recovery system in Korea

Fig. 20. 2014 Expert Mission in Guam (USA)

Identified opportunities/challenges, if any, for further development or collaboration:

Since 2008, NDMI has been conducting Expert Mission to member countries including Viet Nam, Lao PDR, Thailand, and Guam. NDMI expects more members to join to the Expert Mission to share the disaster information, technologies, and policies.

Summary Table of relevant KRAs and components (please tick boxes, can be more than one, as appropriate):

KRA =	1	2	3	4	5	6	7
Meteorology							
Hydrology							
DRR							√
Training and research							
Resource mobilization or regional collaboration							

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Title of item 19:
Host of 8th WMO IWTC including 3rd IWTCLP

Main text:

KMA will host the 8th WMO International Workshop on Tropical cyclones (IWTC-VIII) including the 3rd International Workshop on Tropical Cyclone Landfall Process (IWTCLP-III) at Lotte Hotel in Jeju, Republic of Korea, in 2-10 December 2014.

This workshop is one of WMO's major quadrennial workshop series organized by its World Weather Research Program (WWRP) and Tropical Cyclone Program (TCP). It is a special and unique gathering of tropical cyclone researchers and warning specialists from all regions affected by tropical cyclones, including those from Members belonging to the WMO TCP regional bodies. During this workshop, it will be programed several keynote speeches as a main theme 'Quantifying and Communicating Forecast Uncertainty'. There will be also presented and discussed about 8 topics: 1. motion, 2. cyclogenesis, intensity and intensity change, 3. communication and effective warning systems, 4. structure and structure change and 5. beyond synoptic timescales, 6. track, structure and intensity changes at landfall, 7. storm surge and 8. rainfall. We hope that TC members show strong interest and participation in this workshop.

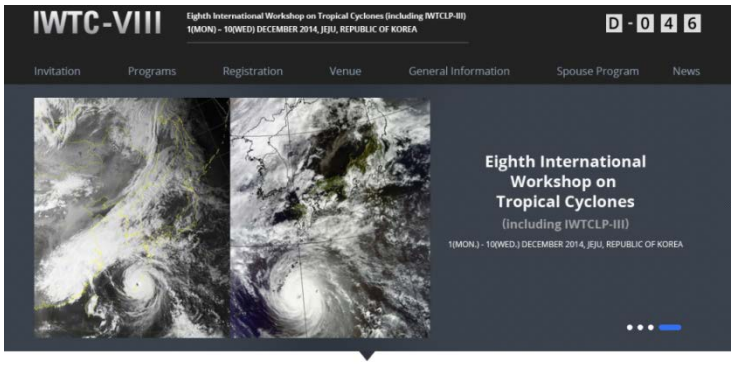

Fig. 21. Main page of 8th WMO IWTC website (http://www.iwtc8.org)

Identified opportunities/challenges, if any, for further development or collaboration:

Summary Table of relevant KRAs and components (please tick boxes, can be more than one, as appropriate):

KRA =	1	2	3	4	5	6	7
Meteorology						√	√
Hydrology							
DRR							
Training and research							
Resource mobilization or regional collaboration							

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