MEMBER REPORT

ESCAP/WMO Typhoon Committee
9th Integrated Workshop

(Macao, China)

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

1. Meteorological Assessment (highlighting forecasting issues/impacts)

Three tropical cyclones affected Macao in the calendar year of 2014, including Rammaun (1409), Tropical Depression (no name) and Kalmaegi (1415) successively. The annual number of tropical cyclones was lower than the annual average of 6.0, while one of these tropical cyclones, Kalmaegi, necessitated the hoisting of Tropical Cyclone Signal No. 8 (gale wind signal). (Figure 1)

Typhoon Rammsun (1409)

On the 11th July 2014, a tropical depression was formed in the east of the Philippines over the Pacific Ocean and moving westerly. This tropical depression intensified into a tropical storm on the 12th July and was named Rammsun (1409). Rammsun intensified into a severe tropical storm moving westerly at around 22 km/h at 08:00 L.T. on the 14th July, and it intensified further into a typhoon at 20:00 L.T.. On the afternoon of the 15th July, it made landfall along the central part of the Philippines and turned to move northwestwards. After crossing the Philippines, it entered the South China Sea in the morning on the 16th July. This typhoon entered the 800 km alert radius of Macao at 01:00 L.T. on the 17th July moving towards the Hainan Island.

Typhoon Rammsun was closest to Macao at 13:00 L.T. on the 18th July, passing by at about 340 km away southwest of Macao, making landfall along the coast of Hainan province Wenchong city at 16:00 L.T.. After crossing the Hainan Island, Rammsun then made landfall again at the coast of Guangxi at 07:00 L.T. on the 19th July. Finally, it dissipated overland.

The highest signal being hoisted was No. 3 as strong winds were recorded over Macao for 20 hours on the bridges.

Date	Time*	Hoisted Signal
17th July	01:30	No.1
18th July	01:30	No.3
19th July	01:00	All signals were lowered

Tropical Depression (no name)

At 08:00 L.T. on the 7th September 2014, a tropical depression was developed to the east of Hainan Island over the northern part of the South China Sea, with central pressure of 1000hPa and maximum sustained wind speed near its center reaching 54 km/h, moving northwestward at 15km/h towards the western coast of Guangdong province. It was located closest to Macao at 06:00 L.T. on the 8th September passing by about 310 km southwest of Macao, and made landfall near Zhanjiang at 16:00 L.T. while dissipating inland during nighttime.

Signal No. 1 had been hoisted for 26 hours and moderate to fresh winds were recorded over Macao on the bridges.

Date	Time*	Hoisted Signal
7th September	11:00	No.1
8th September	13:00	All signals were lowered

Typhoon Kalmaegi (1415)

At 08:00 L.T. on the 12th September 2014, a tropical depression was developed to the east of the Philippines over the Pacific Ocean and moving west-northwesterly. This tropical depression intensified into a tropical storm at 14:00 L.T and was named Kalmaegi (1415). Kalmaegi intensified into a severe tropical storm at 08:00 L.T. on the 13th September and then intensified further into a typhoon at 20:00 L.T. moving towards Luzon Island.

After crossing Luzon Island, it entered the 800km alert radius of Macao at 04:00 L.T. on the 15th September moving west-northwesterly at around 30 km/h towards the Hainan Island. It was closest to Macao at 05:00 L.T. on the 16th September, passing by at about 330 km away southwest of Macao and made landfall along the coastal of Hainan province Wenchang city at 10:00 L.T.. After crossing the Hainan Island, Kalmaegi then made landfall again near Zhanjiang. Finally, it made landfall at Vietnam and dissipated overland.

The highest signal being hoisted was No. 8 as gale winds were recorded over Macao for 12 hours on the bridges.

Date	Time*	Hoisted Signal
15th September	05:00	No.1
15th September	19:30	No.3
16th September	01:15	No.8SE
16th September	13:00	No.3
17th September	01:00	All signals were lowered

*All time mentioned above is local time

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

Nil.

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

Macao was hit by two typhoons and one tropical depression in 2014, yet only Typhoon Kalmaegi was strong enough to warrant the hoisting of typhoon signal no. 8. During the passage of Kalmaegi, a total of 89 cases were reported to Civil Protection Operational Centre ranging from fallen trees to swinging advertising structures and unstable bamboo scaffolding and cranes at construction sites. Moreover, there was flooding in downtown areas with water levels reaching 0.8 metres in some places. Seven people were slightly injured, while two of them sought medical treatment. In addition, 16 flights departing from Macau International Airport were cancelled, and ferry connections between Macao and Hong Kong were suspended, leaving hundreds of passengers stranded in Outer Harbour Ferry Terminal and Macau International Airport respectively.

Date/Time		Name	The Highest Signal Hoisted	Incidents (cases)							
Start	End			Flooding	Landslide	Felled Trees	Billboards/ Awnings/ Windows/ Walls (Collapsed/ Tottering)	Scaffoldings/ Fencings/ Crane (Collapsed/ Tottering)	Power cables/ Lampposts (Collapsed/ Tottering)	Death / Injuries	Others
17-07-14 01H30	19-07-14 01H00	RAMMASUN (1409)	3	0	0	4	9	2	0	0	2
07-09-14 11H00	08-09-14 13H00	Tropical Depression (---)	1	0	0	0	0	0	0	0	2
15-09-14 05H00	17-09-14 01H00	KALMAEGI (1415)	8	3	0	28	33	6	3	7	16

Table 1: Damages caused by tropical cyclones in Macao during 2014

Five rainstorm warnings were issued in 2014. The following table shows that the heavy downpours triggered sporadic fallen trees, landslides, as well as slight flooding in low-lying areas.

Date	Duration	Incidents (cases)									
		Flooding	Felled Trees	Buildings collapsed/ Concrete spalling	Billboards collapsed or tottering	Scaffoldings collapsed or tottering	Windows collapsed or tottering	Awnings collapsed or tottering	Landslide	Deaths / Injuries	Others
09-05-14	06H45-11H20	0	0	0	0	0	0	0	0	0	1
11-05-14	18H35-20H10	12	0	0	0	0	0	0	0	0	1
21-05-14	02H30-07H15	2	0	0	0	0	0	0	0	0	0
22-06-14	03H20-05H00	1	0	0	0	0	0	0	0	0	0
27-07-14	00H40-01H35	3	0	0	0	0	0	0	0	0	0

Table 2: Damages caused by rainstorms during 2014

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

Nil.

II. Summary of progress in Key Result Areas

TC Members' Report
Summary of Progress in KRAs

Item 1: Improved the ability of weather forecast and nowcasting

The new generation of dual-polarization S-band Doppler radar has been placed into operation in early March this year. This weather radar provides high quality meteorological products in terms of enhancing the quality of weather nowcasting and instantaneous location of weather systems, in addition to locate precipitation, calculate its motion, estimate its type (rain, hail, etc.), and forecast its future position and intensity. The determination for the structure of storms and their potential to cause severe weather can also be analyzed. The real-time radar images are available in the Macao Meteorological and Geophysical Bureau (SMG) website, which enables the public to get the latest weather information.

Remarkable results have been achieved during these months since its installation, such as the hail case that took place in March (Figure 2), and typhoon Kalmaegi recently came across in September (Figure 3).

Because of the stricken by severe thunderstorm, the 3km wind profiler radar in SMG was broken since 2013. A brand new 3km wind profiler radar is being purchased which aims to strengthen again the wind profile monitoring capacity in Macao when the tropical cyclone is approaching.

On the other hand, SMG cooperates with Guangdong to obtain the products of Global / Regional Assimilation and Prediction System (GRAPES), and enhanced the development of numerical forecasting as well as the ability of weather nowcasting in the region.

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

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: Macao, China

Name of contact for this item: Mr. Leong Weng Kun

Telephone: (853) 88986270

Email: wkleong@smg.gov.mo

Item 2:
Enhanced public weather service and public education

Due to the improvement of severe weather forecast technology and experience accumulation, the weather forecast becomes more accurate. Therefore, SMG has been optimizing its warning system for severe weather, by means of strengthening the communication and coordination with relevant departments, issuing pre-warning message within 2-3 hours prior to possibility of heavy rainfall in the website, extending the effective time for thunderstorm warning, and to upload all relevant real-time information to our website including flooding conditions, precipitation amount and radar images. The information will help the public to arrange in advance their planning and minimize the Social and Economic Impacts. SMG also enhanced the communication with the government departments during severe weather, especially tropical cyclones and rainstorm to promote better awareness and preparedness.

To better enhance our public weather service, we have re-structured SMG's official website. This new template enables a higher level of stability, functionality and accessibility for the delivering of meteorological information to the public, especially severe weather warnings. The implementation of this migration took place in different stages. During the first stage, which was started in March, we offered primarily the Chinese version of the website, while doing optimizations necessary to better enhance its performance based on the feedbacks we received from the public in due course. Other languages versions, such as Portuguese and English, of the site will be constructed based on the skeleton of work we have done on the previous stage. We expect this new look and feel of the website enables a better delivery of meteorological information, as well as severe weather warnings, to the general public.

In addition to that, SMG is going to provide an official account on "WeChat". From this account, users can acquire weather information provided by SMG, including weather warnings, weather forecasts, air quality forecasts, tropical cyclone information, etc. Since "WeChat" is a mobile app which could be found in various mobile operating system, such as the iOS and Android, by providing meteorological information through its broadcasting mechanism can better enhance the awareness and preparedness of the public, especially during tropical cyclones and rainstorm scenario.

To increase the knowledge and interest of students in meteorology, SMG will give lectures on different topics in schools every year, each topic will be prepared in two versions, one for primary schools and the other for secondary schools. Schools can choose between Chinese, Portuguese and English as their preferred language for lectures. To comply with the schools' schedule, the lectures this year will be arranged from September 2014 to June 2015. Up to September, there are over 3000 people from 15 schools registered for the lectures, and the lectures have been ongoing in different schools. Meanwhile, the program of Automatic Weather Station in schools has been launched, by providing schools with the automatic meteorological instruments, technical support, basic knowledge on meteorology and organizing events, the program can increase students' knowledge and interest in natural science.

In order to let citizens have a better understanding our operations as well as the meaning of different warnings, around 650 students and citizens were recorded visiting the SMG headquarter up to September 2014.

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

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: Macao, China

Name of contact for this item: Mr. Leong Weng Kun

Telephone: (853) 88986270

Email: wkleong@smg.gov.mo

Item 3: Reinforcement of urban flood monitoring

In order to reinforce the capability of urban flooding monitoring in Macao, SMG is cooperating with the Land, Public Works and Transport Bureau and Civic and Municipal Affairs Bureau to construct 8 brand new water level monitoring stations(WLMS), which are distributed in Macao peninsula, Taipa and Coloane, respectively. Different from the existing 9 WLMS, except the function of real-time water level monitoring, the new stations also include the module of automatic weather station and webcam.

Moreover, the expansion project of the existing water level monitoring stations was finished before the rain season in 2014. As a result, there are currently a total of 17 water level monitoring stations in Macao (Figure 4). During the impact of typhoon "Kalmaegi"(1415) from the 15th to 16th September 2014, severe flooding occurred in many low areas in Macao. Besides achieving the latest water level information, the real-time photo of instant flooding condition is now available on our website (Figure 5). Therefore, with our water level monitoring stations, which provides information on detailed water level conditions, real-time photo and meteorological data, we can have a comprehensive monitoring on severe weather in Macao.

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

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:	Macao, China	Name of contact for this item:	Ms. Chang Sau Wa
Telephone:	(853) 88986250	Email:	swchang@smg.gov.mo

Item 4:
Zhuhai-Macao Cooperate to establish an integrated meteorological monitoring network in the estuary of Pearl River

Macao, China is located in the west bank of Pearl River Delta in South China. In order to reinforce the monitoring capacity on the estuary of the Pearl River when the approach of tropical cyclone from South China Sea, SMG is cooperating with Zhuhai Meteorological Bureau to establish an integrated meteorological monitoring network on the estuary of the Pearl River from 2014 to 2016. Several specific islands distributed in the estuary are selected to install automatic weather station, wind profiler, weather camera, lightning detector and tide gauge appropriately.

In order to provide better, high-quality, face to face communication in weather forecasting, SMG purchased a new video conferencing system. It allows our forecasters to have a weather discussion with Zhuhai Meteorological Bureau immediately, especially during the typhoon.

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

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:	Macao, China	Name of contact for this item:	Mr. Leong Weng Kun
Telephone:	(853) 88986270	Email:	wkleong@smg.gov.mo

Item 5:
Disaster Risk Reduction

Concerning the prevention of landslides, Slope Safety Working Group which is comprised of Land, Public Works and Transport Bureau (DSSOPT), Civic and Municipal Affairs Bureau (IACM) and Macau Laboratory of Civil Engineering (LECM) was established in 1995. Its scope of work includes regular inspection and survey of slopes; assessing the risk level of slopes; providing recommendations on slope reinforcement and maintenance; and preparing annual assessment reports.

The following table demonstrates the distribution of slopes in Macao in 2014 according to landslide risk level. Ongoing reinforcement and related works by DSSOPT have been conducted to ensure slope safety. (Figure 6)

	High Risk	**Medium Risk**	**Low Risk**	**Total**
Macao Peninsula	2	18	62	82
Taipa	1	17	36	54
Coloane	2	22	41	65
Total	5	57	139	201

Table 3: Distribution of slopes in Macao according to the landslide risk level

In order to enable the public to better grasp the slope information, DSSOPT in conjunction with Cartography and Cadastre Bureau established "Slope Safety Information Network" website (http://slope.dssopt.gov.mo), the public can learn about the position of the slopes, their degree of risk, ownership, monitoring and evaluation assessment. The website aims to arouse the awareness of private slope owners with the purpose that they will take the initiative to check and repair the slopes.

Moreover, the construction of Taipa Hill Slope Automatic Monitoring System (Figure 7) was completed this year. The system enables remote monitoring on the slope surface cracks, surface displacement, deep displacement, sliding mass, groundwater and rainfall of Taipa Hill. With wireless transmission reception system, on-site information will be collected in a timely manner in order to achieve real-time monitoring, and forecast possible scale of destruction, so that DSSOPT will be able to take appropriate preventive measures to reduce landslides.

Regarding the prevention of falling trees, IACM carries out regular tree inspection in order to detect the diseases affecting the trees and remove those which are deemed dangerous. According to IACM, about 50 trees need pruning every year to reduce their height. (Figure 8)

As typhoon will bring strong wind and heavy rain which will cause accidents on construction sites, Labour Affairs Bureau has formulated "Safety Guidelines for Construction Sites during Typhoon Season" for construction industry, aiming to urge contractors and sub-contractors to take relevant preventive measures to protect the safety of workers and the public.

Concerning flood prevention, several upgrade initiatives for the drainage system were proposed. These include: reconstructing drainage system in old districts, involving the renewal of existing pipes and dividing them into two separate systems to handle rainwater and sewage respectively; installing pumping stations near the sea to cope with sudden rainstorms (Figure 9); as well as constructing an embankment in Inner Harbour, where is one of the flooding blackspots in Macao. This embankment, together with water barriers and mobilised floodgates aim to mitigate the effect of flooding, astronomical tides and saltwater intrusion.

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

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:	Macao, China	Name of contact for this item:	Mr. Ho Su Hon
Telephone:	(853) 87997553/ 87997538	Email:	copc@fsm.gov.mo

Item 6:
Drill and Emergency Plan with Government Departments and Organizations in Preparation for Severe Weather

The SMG Emergency Plan was revised and rehearsed in 2014 to ensure the provision of meteorological services, including tropical cyclone forecasts and warnings, in all-weather.

Macao Security Forces Coordination Office conducted the yearly typhoon exercise in April to test coordination and communication among members of Civil Protection System in dealing with typhoon-related incidents. The whole exercise lasted almost 4 hours and involved more than 1,200 participants from 27 public and private entities. (Figure 10)

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

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: Macao, China
Name of contact for this item: Mr. Leong Weng Kun
Telephone: (853) 88986270
Email: wkleong@smg.gov.mo

Item 7:
Strengthened Resilience of Communities to Typhoon-related Disasters

Aside from holding regular meetings with community groups to discuss options and exchange opinions on how to improve Macao's flooding problems, government departments like IACM also held a community forum to introduce Fai Chi Kei Rainwater Pumping Station Project to community representatives and residents of the concerning areas (Figure 11). Moreover, display boards were set up in recreational areas to enable the residents to understand the project (Figure 12). The public consultation lasted about a month and residents were encouraged to reflect their views to IACM through hotline, email and fax.

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

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: Macao, China
Name of contact for this item: Mr. Ho Su Hon
Telephone: (853) 87997553/ 87997538
Email: copc@fsm.gov.mo

Item 8:
Improved Capacity to Generate and Provide Accurate, Timely and understandable Information on Typhoon-related Threats.

In 2014, Macao Security Forces Coordination Office continued to distribute disaster prevention brochures to the public through government departments and community associations in order to promote public awareness on disaster prevention for the purpose of saving lives and reducing its impacts.

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

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: Macao, China
Name of contact for this item: Mr. Ho Su Hon
Telephone: (853) 87997553/ 87997538
Email: copc@fsm.gov.mo

Item 9:
Enhanced Typhoon Committee's Effectiveness and International Collaboration.

In 2014, Macao Security Forces Coordination Office delegated representatives to participate in the 9th Meeting of WGDRR which was organised by National Disaster Management Institute of Korea as well as co-organised by Typhoon Committee (TC). The meeting was held between 26 and 27 May 2014 in Seoul, Korea.

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

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:	Macao, China	Name of contact for this item:	Mr. Ho Su Hon
Telephone:	(853) 87997553/ 87997538	Email:	copc@fsm.gov.mo

Others

The Macao SAR Government continued contributing the Endowment Fund to support the operation of Typhoon Committee Secretary from 2011 to 2014.

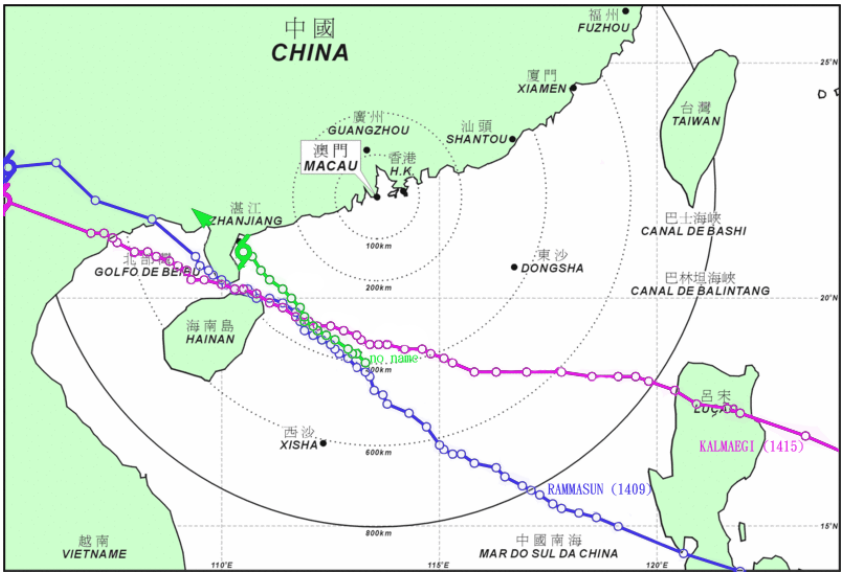

Figure 1 Tropical cyclone tracks in 2014.

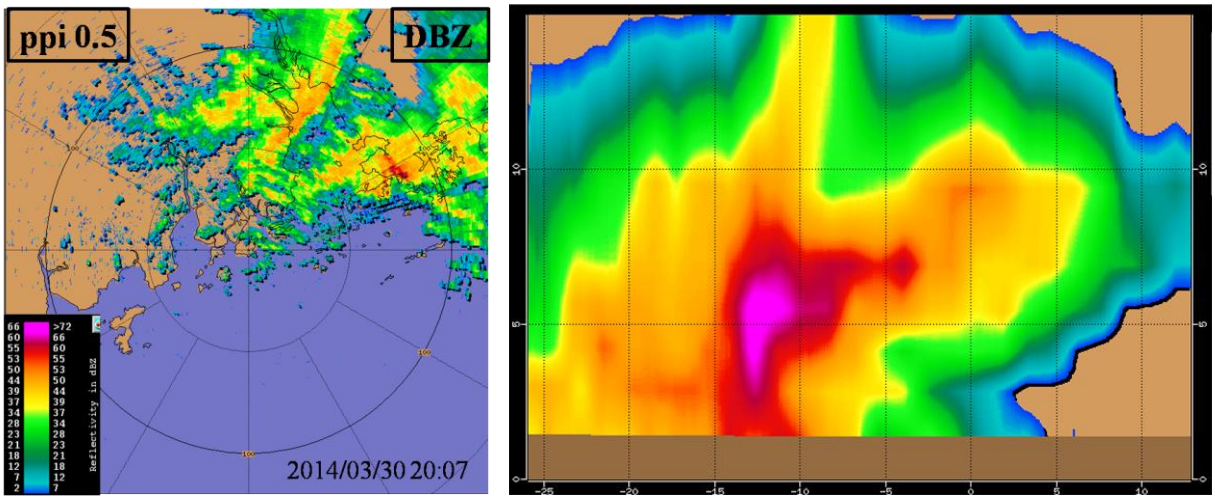

Figure 2 Radar reflectivity at 20:07 L.T. on 3rd March 2014 from S-band Doppler radar. a) PPI at 0.5° elevation, b) cross-section of the supercell.

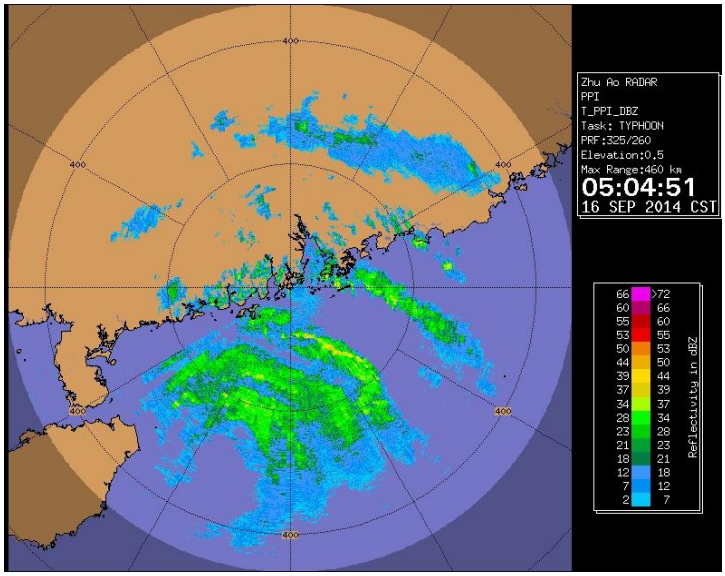

Figure 3 0.5° PPI Radar reflectivity of typhoon Kalmaegi at 05:04 L.T. on 16th September 2014.

Figure 4 Location of water level monitoring stations in Macao.

Figure 5 Real-time photo captured at "Hon-Kung" Temple water level monitoring station during the impact of typhoon "Kalmaegi" on 16th Sept 2014.

Figure 6 Ongoing reinforcement and related works have been conducted to ensure slope safety.

Figure 7 Construction of Taipa Hill Slope Automatic Monitoring System was completed in 2014.

Figure 8 IACM carries out regular tree inspection and monitoring to prevent falling of trees.

Figure 9 Pumping stations were installed near the sea to cope with sudden rainstorms.

Figure 10 Macao Security Forces Coordination Office conducted the yearly typhoon exercise in April.

Figure 11 IACM held a community forum to introduce Fai Chi Kei Rainwater Pumping Station Project to the residents.

Figure 12 Display boards were set up in recreational areas to enable the public to understand the Fai Chi Kei Rainwater Pumping Station Project.