MEMBER REPORT

ESCAP/WMO Typhoon Committee
44th Session

6 – 11 February 2012
Hangzhou, China

(Hong Kong, China)

"Annual activities covering the period from 1 January 2011 to 31 December 2011"

CONTENTS

I. Overview of tropical cyclones which have affected/impacted Member's area in 2011

1. Meteorological Assessment (highlighting forecasting issues/impacts)

Five tropical cyclones affected Hong Kong during 2011. They were:

(a) Tropical Storm Sarika (1103)
(b) Tropical Storm Haima (1104)
(c) Severe Tropical Storm Nock-ten (1108)
(d) Typhoon Nesat (1117)
(e) Severe Typhoon Nalgae (1119)

The No. 8 SE Gale or Storm Signal was issued during the passage of Typhoon Nesat, the highest tropical cyclone warning signal in Hong Kong during 2011. Tropical Storm Haima, Severe Tropical Storm Nock-ten and Severe Typhoon Nalgae necessitated the issuance of the No. 3 Strong Wind Signal while Tropical Storm Sarika only necessitated the issuance of the Standby Signal No. 1 in Hong Kong.

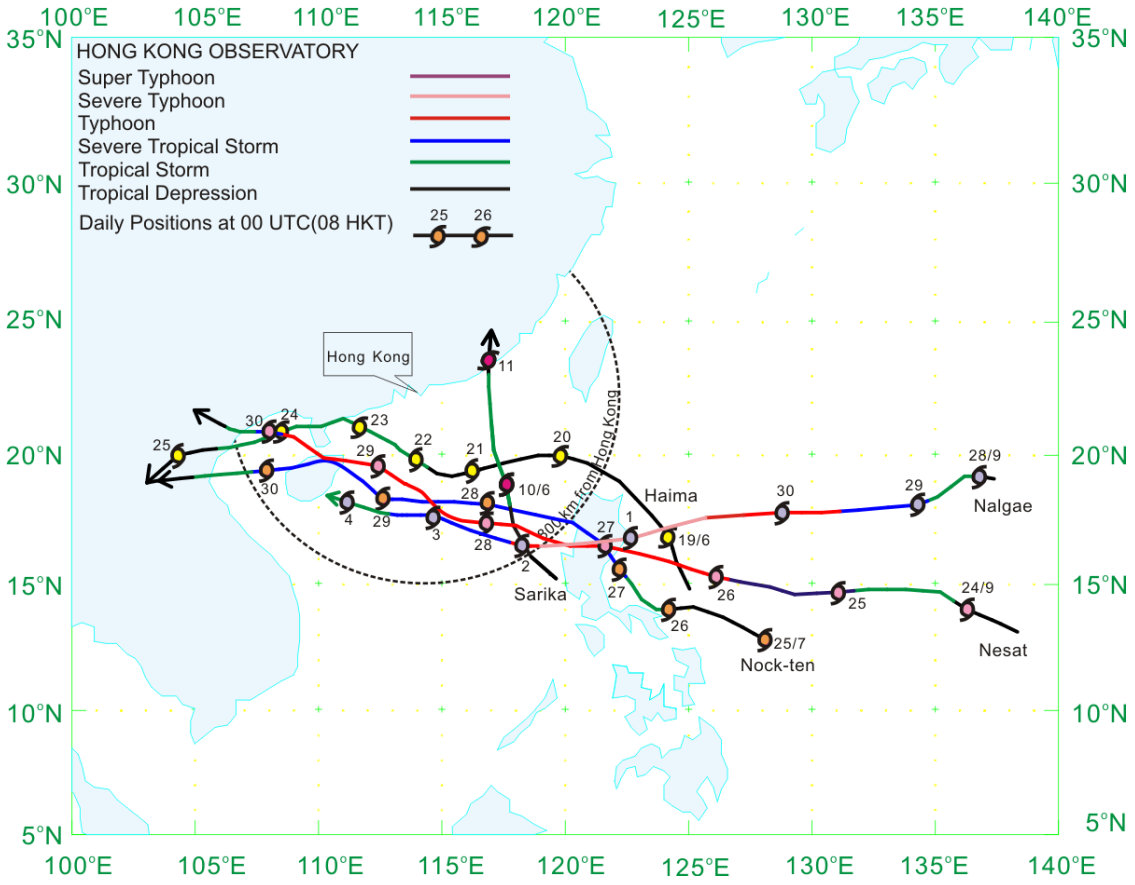


Figure 1 Hong Kong Observatory best tracks of tropical cyclones that affected Hong Kong, China from 1 January to 31 December 2011.

Tropical Storm Sarika (1103)

Sarika formed as a tropical depression over the central part of the South China Sea on 9 June and moved towards the south China coast. It intensified into a tropical storm in the morning of 10 June, reaching its peak intensity with an estimated maximum sustained wind of 65 km/h near its centre. Sarika made landfall near Shantou in the morning of 11 June and dissipated over Fujian that afternoon. Figure 2 shows the track of Sarika.

In Hong Kong, winds were mainly light to moderate from the southeast on 10 June. Sarika was closest to Hong Kong at around 3 a.m. on 11 June passing about 280 km to the east-northeast and winds turned to moderate southwesterlies, occasionally gusty that morning. The weather was mainly fine and very hot on 10 June. Squally showers affected Hong Kong on the morning of 11 June. There were occasional heavy showers with squally thunderstorms that afternoon and evening.

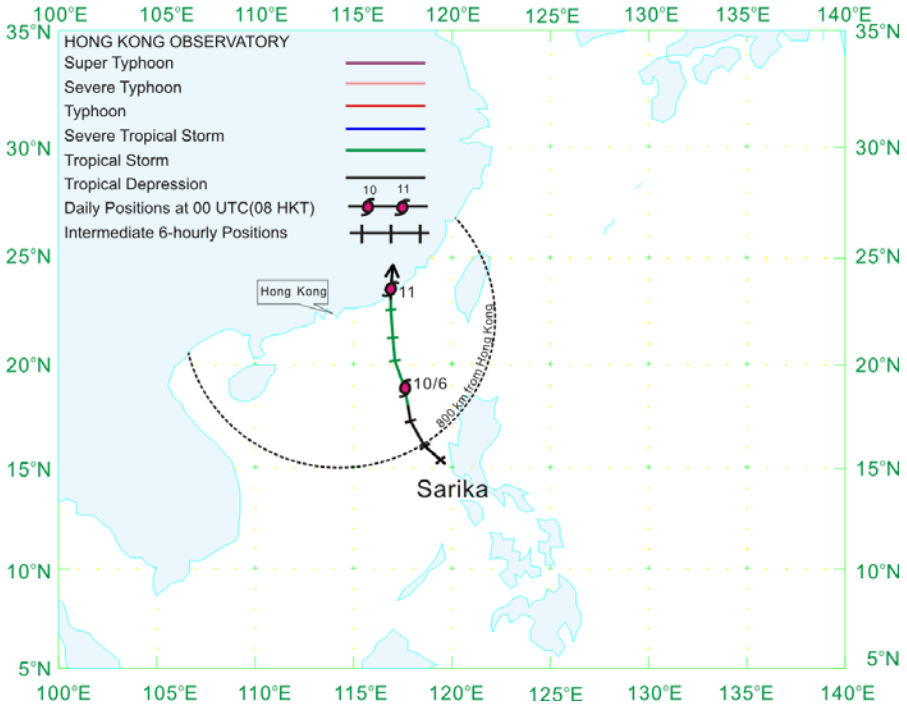


Figure 2 Track of Sarika (1103) on 9 – 11 June 2011.

Tropical Storm Haima (1104)

Haima formed as a tropical depression over the western North Pacific on 18 June. It intensified into a tropical storm over the South China Sea on 22 June, reaching its peak intensity with an estimated maximum sustained wind of 85 km/h near its centre that evening. Haima made landfall over the coast of western Guangdong in the morning of 23 June and skirted the coastal

region of western Guangdong that afternoon. It dissipated inland over Laos in the evening of 25 June. Figure 3 shows the track of Haima.

In Hong Kong, the winds were light to moderate from the east in the evening of 20 June, becoming fresh easterlies, occasionally strong offshore and on high ground the following day. As Haima moved gradually closer to Hong Kong, winds strengthened further to become fresh to strong east to southeasterlies on 22 June, occasionally reaching gale force offshore and on high ground. Haima was closest to Hong Kong at around 8 p.m. that evening passing about 240 km to the south-southwest. Winds turned to the southeast on the small hours of 23 June and remained generally strong, reaching gale force offshore and on high ground. The winds weakened gradually in the morning as Haima moved away.

The weather in Hong Kong was fine and very hot apart from a few showers on 20 June. It was mainly fine at first the following day, with a few squally showers in the afternoon. There were squally heavy showers on 22 June. A few squally showers still affected Hong Kong on 23 June, mainly in the western part of the territory.

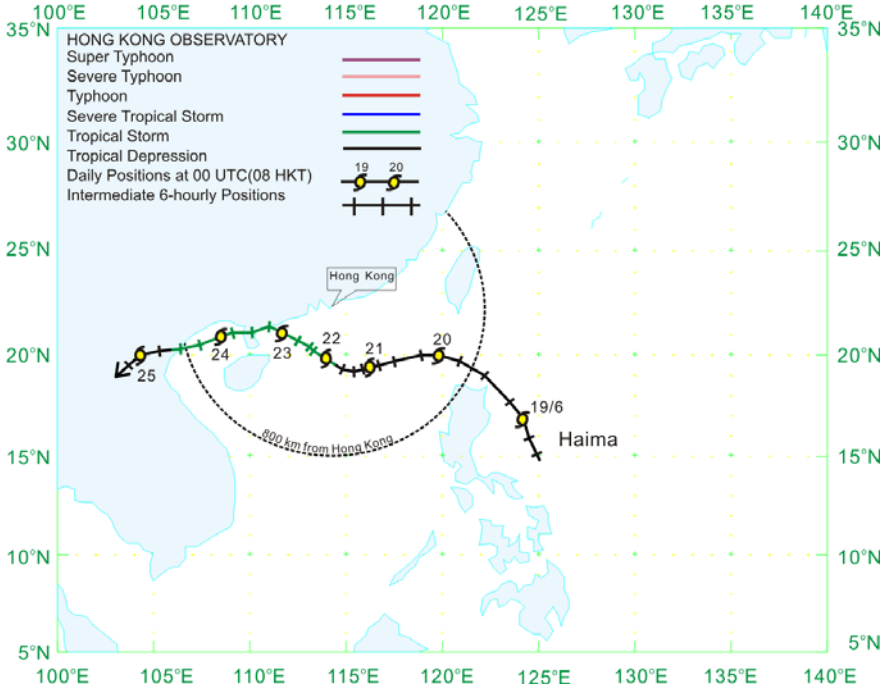


Figure 3 Track of Haima (1104) on 18 – 25 June 2011.

Severe Tropical Storm Nock-ten (1108)

Nock-ten formed as a tropical depression over the western North Pacific on 25 July. It intensified into a severe tropical storm over the Pacific on the morning of 27 July, crossed Luzon in the afternoon and entered the

South China Sea that evening. Nock-ten moved generally west to west-northwestwards across the northern part of the South China Sea for the following two days, reaching its peak intensity with an estimated maximum sustained wind of 105 km/h near its centre. It made landfall near Wenchang, Hainan Island on 29 July and subsequently dissipated inland over Laos on 31 July. Figure 4 shows the track of Nock-ten.

In Hong Kong, the winds were generally moderate east to northeasterlies on 28 July, becoming strong over offshore waters, occasionally reaching gale force on high ground that evening. Generally strong easterlies affected the territory on the morning of 29 July, with occasional gales observed on high ground. Nock-ten was closest to Hong Kong at around 2 p.m. that day passing about 440 km to the southwest. Local winds moderated gradually and became east to southeasterlies that afternoon.

The weather in Hong Kong was fine and very hot apart from a few squally showers and thunderstorms in the afternoon of 28 July. It became cloudy on 29 July. The outer rainbands of Nock-ten also brought squally showers and thunderstorms to the territory that day.

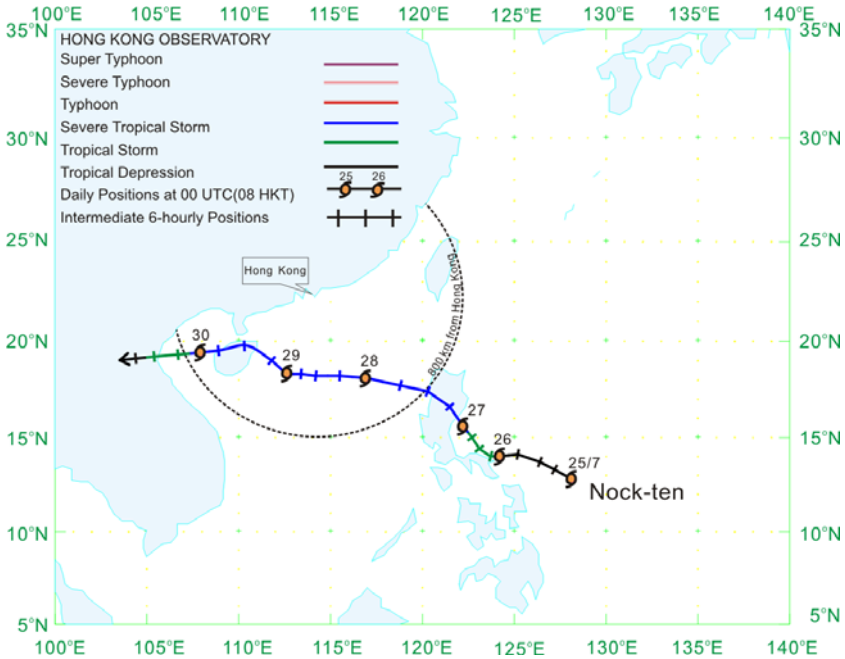


Figure 4 Track of Nock-ten (1108) on 25 – 31 July 2011.

Typhoon Nesat (1117)

Nesat formed as a tropical depression over the western North Pacific on 23 September. It intensified into a typhoon over the western North Pacific on 26 September, reaching its peak intensity with an estimated maximum sustained wind of 145 km/h near its centre. It moved west-northwestwards

across the northern part of the South China Sea on 28 September but took up a northwesterly track that night, moving closer to the south China coast. It made landfall over the northeastern part of Hainan Island on 29 September and dissipated over northern Vietnam on 1 October. Figure 5 shows the track of Nesat.

In Hong Kong, the winds were moderate east to northeasterlies on the night of 27 September, freshening from the northeast and becoming strong on high ground on 28 September as Nesat moved closer. Local winds strengthened from the east that evening and strong winds were recorded over most areas in Hong Kong, occasionally reaching gale force offshore and on high ground. As Nesat continued to move closer in the early hours of 29 September, local winds continued to strengthen. Nesat was closest to Hong Kong at around 7 a.m. that day passing about 350 km to the south-southwest. Under the influence of the large circulation of Nesat, gale force easterlies affected many parts of Hong Kong especially the southern part that morning, occasionally reaching storm force on high ground. As Nesat moved further away from Hong Kong and made landfall over Hainan Island in the afternoon that day, local winds turned to the southeast and gradually weakened. Local winds remained generally strong during the evening and gradually weakened later that night.

The weather in Hong Kong was mainly fine and hot with some haze on 27 September. It continued mainly fine on the morning of 28 September, but became cloudy with squally showers in the afternoon. Squally showers affected Hong Kong on 29 September. Under the influence of the outer rainbands of Nesat, the weather remained mainly cloudy with a few showers on 30 September.

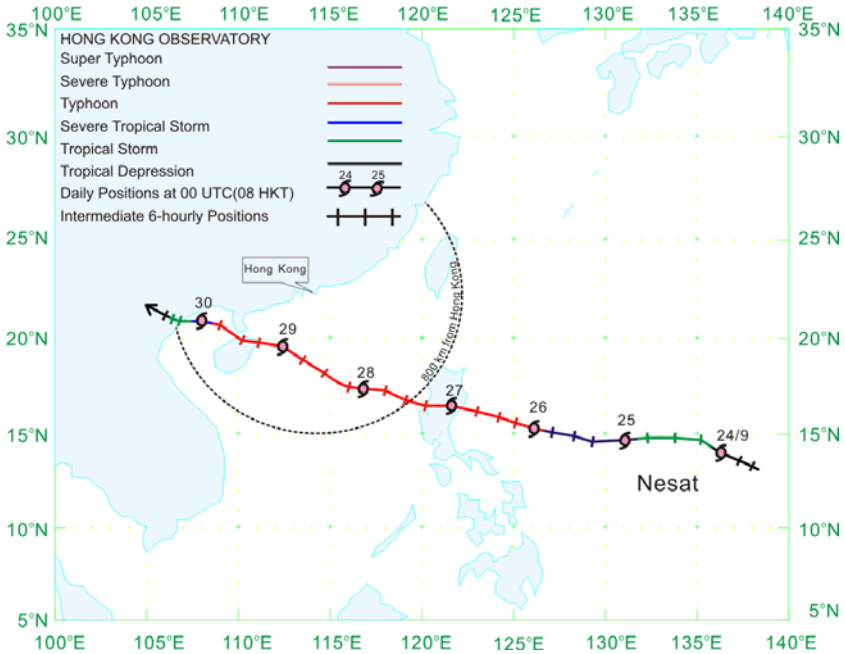


Figure 5 Track of Nesat (1117) on 23 September - 1 October 2011.

Severe Typhoon Nalgae (1119)

Nalgae formed over the western North Pacific on 27 September. It intensified into a severe typhoon over the Pacific on the evening of 30 September, attaining its peak intensity with an estimated maximum sustained wind of 175 km/h near its centre over the seas about 300 km northeast of Manila on the morning of 1 October. Nalgae weakened into a typhoon in the early hours on 2 October and a severe tropical storm that afternoon. It weakened further into a tropical storm on 4 October and crossed the southern part of Hainan Island that afternoon. Nalgae dissipated over the seas near Hainan on 5 October. Figure 6 shows the track of Nalgae.

In Hong Kong, the winds were moderate to fresh northeasterlies on 2 October, strong on high ground during the afternoon and evening. Under the combined effect of the northeast monsoon and Nalgae, local winds strengthened in the morning of 3 October and were strong at times offshore, occasionally reaching gale force on high ground. Nalgae was closest to Hong Kong between about 10 a.m. to 5 p.m. that day passing about 510 km to the south. As Nalgae weakened slightly and moved gradually away, Hong Kong came increasingly under the influence of the northeast monsoon that evening. Under the influence of the outer rainbands of Nalgae, the weather in Hong Kong was cloudy with some rain on 2 and 3 October.

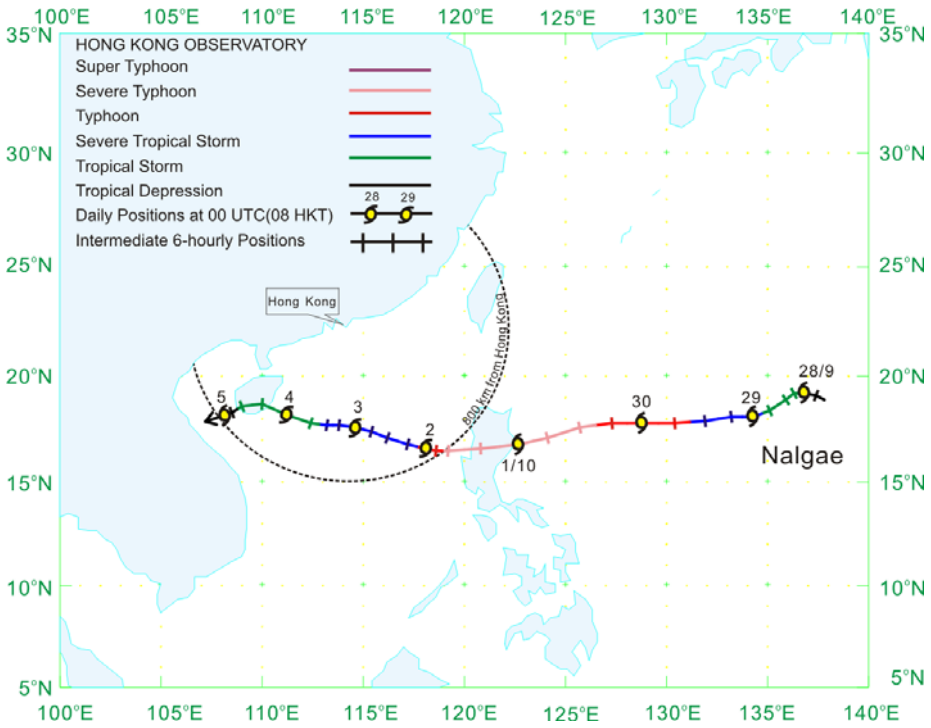


Figure 6 Track of Nalgae (1119) on 27 September - 5 October 2011.

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

During the passage of Sarika in June 2011, parts of Hong Kong recorded over 25 millimetres of rainfall with more than 100 millimetres of rainfall over parts of Lantau Island and the northwestern part of the New Territories. The Amber Rainstorm Warning Signal was in force from 5:50 p.m. to 8:05 p.m. on 11 June 2011.

Over 100 millimetres of rainfall were recorded over parts of Hong Kong during the passage of Haima and Nesat during June and September 2011 respectively. Nock-ten brought over 50 millimetres of rainfall to parts of the territory during its passage in July 2011.

During the passage of Nalgae in October 2011, only a few millimetres of rainfall were generally recorded over Hong Kong. Under the combined influence of the northeast monsoon and Nalgae, there were reports of sea water backflow in low-lying areas in Hong Kong such as Tai O, Sha Tin and Tai Po (Figure 7) during the early hours of 2 October and 3 October, resulting in minor flooding in these areas.

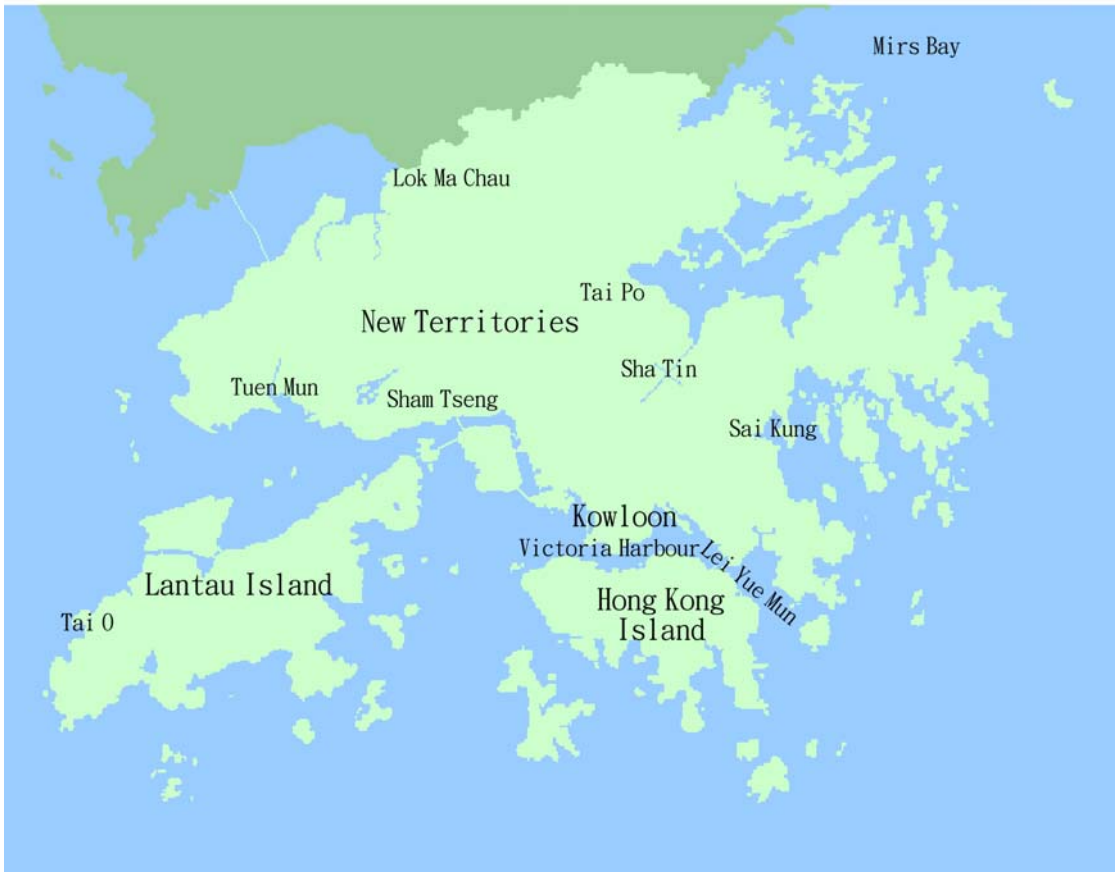


Figure 7 Map of Hong Kong showing the various locations mentioned in this report

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

During the passage of Sarika, a minibus was trapped by flood waters in Lok Ma Chau (Figure 7) during the downpour on the afternoon of 11 June. No one was injured during the incident.

Over 170 cases of fallen trees were reported in various parts of Hong Kong during the passage of Haima with two people injured. There were also many incidents of fallen scaffoldings and damage to curtain walls. There was also a report of a collapsing wall in a construction site and the sinking of a sampan in Hong Kong.

During the passage of Nock-ten, there were at least 11 reports of fallen trees and two reports of collapsed scaffoldings in Hong Kong. A total of four people were injured. At the Hong Kong International Airport, four aircraft were diverted due to adverse weather on 29 July.

During the passage of Nesat, there were 418 reports of fallen trees and 15 reports of collapsed scaffoldings in Hong Kong. A total of 25 people were injured. Over the Victoria Harbour (Figure 7), a crane barge drifted across the harbour after its anchor cable was snapped. The barge first hit a pier at an oil storage depot and then slammed into a sea wall. At one point, the barge's extended crane arm came close to an apartment block, prompting the evacuation of more than 50 residents. At the Hong Kong International Airport, over 40 flights were cancelled, around 490 flights affected and 44 aircraft were diverted due to adverse weather.

During the passage of Nalgae, a fishing boat collided with a tugboat in Mirs Bay (Figure 7) and a fisherman was injured. A person was reported to have been trapped in a beach at Lantau Island during high tide. No one was injured during the incident.

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 provisional tropical cyclone position forecast errors for the warnings issued by the Hong Kong Observatory (HKO) in 2011 are shown in Table 1. The long-term trend for the position forecast errors was generally decreasing (Figure 8), with the latest 72-hr and 48-hr position forecast accuracy reaching the respective levels of accuracy of the 48-hr and 24-hr position forecasts about a decade ago.

Table 1 Provisional performance summary of tropical cyclone position forecasts issued by the Hong Kong Observatory in 2011 (for tropical cyclones within Hong Kong Tropical Cyclone Warning Area for Shipping)

	24-hr position	48-hr position	72-hr position
Position forecast error (km)	93	147	246

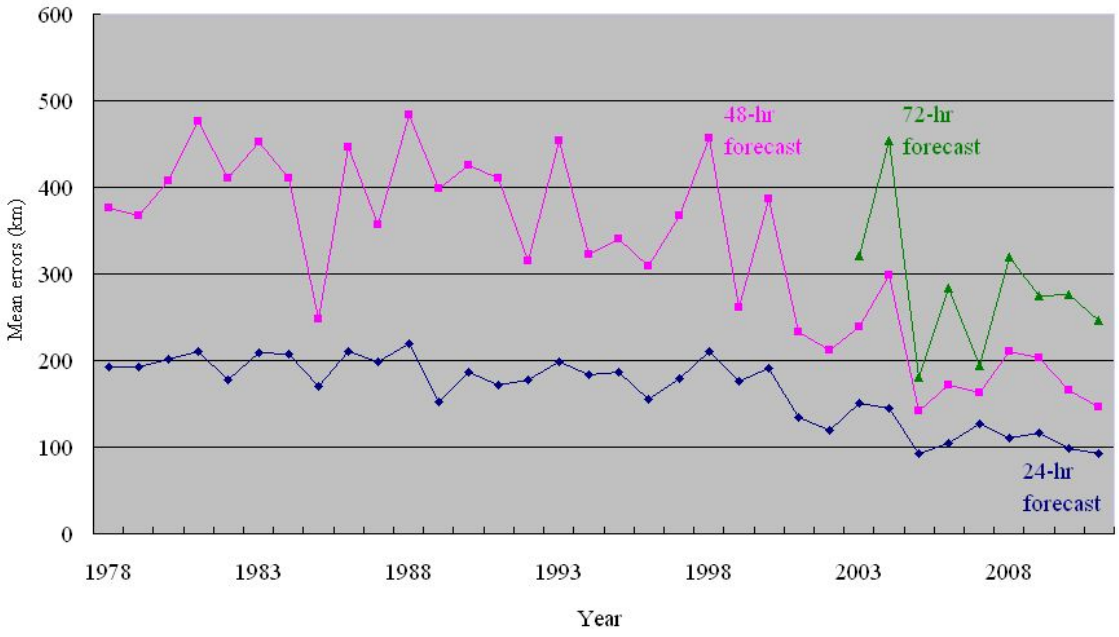


Figure 8 Long term trend of mean errors of tropical cyclone position forecasts issued by the Hong Kong Observatory

HKO carried out historically the first reconnaissance flight specifically around the tropical cyclones over the South China Sea in collaboration with the Hong Kong Government Flying Service (GFS). The flights were conducted for Tropical Storm Haima (1104) on 20 and 22 June 2011, and for Typhoon Nesat (1117) on 28 September 2011. Up to 20 observations of wind, pressure, temperature and humidity measurements were recorded per second, providing high spatial-temporal resolution of observation along the flight routes. They provided very useful reference (Figure 9) in determining the strength of the storm and supporting decision-making in the provision of tropical cyclone warning service. The flight observation data were further processed for

ingestion into the data assimilation system of the HKO's Non-Hydrostatic Model (NHM). Positive impacts were obtained on the analysis of low-level winds and moisture around the tropical cyclones, as well as reduction of forecast track errors in the model simulation. HKO would continue to collaborate with GFS to collect meteorological data using aircraft, in order to fill in the data void over the northern part of the South China Sea.

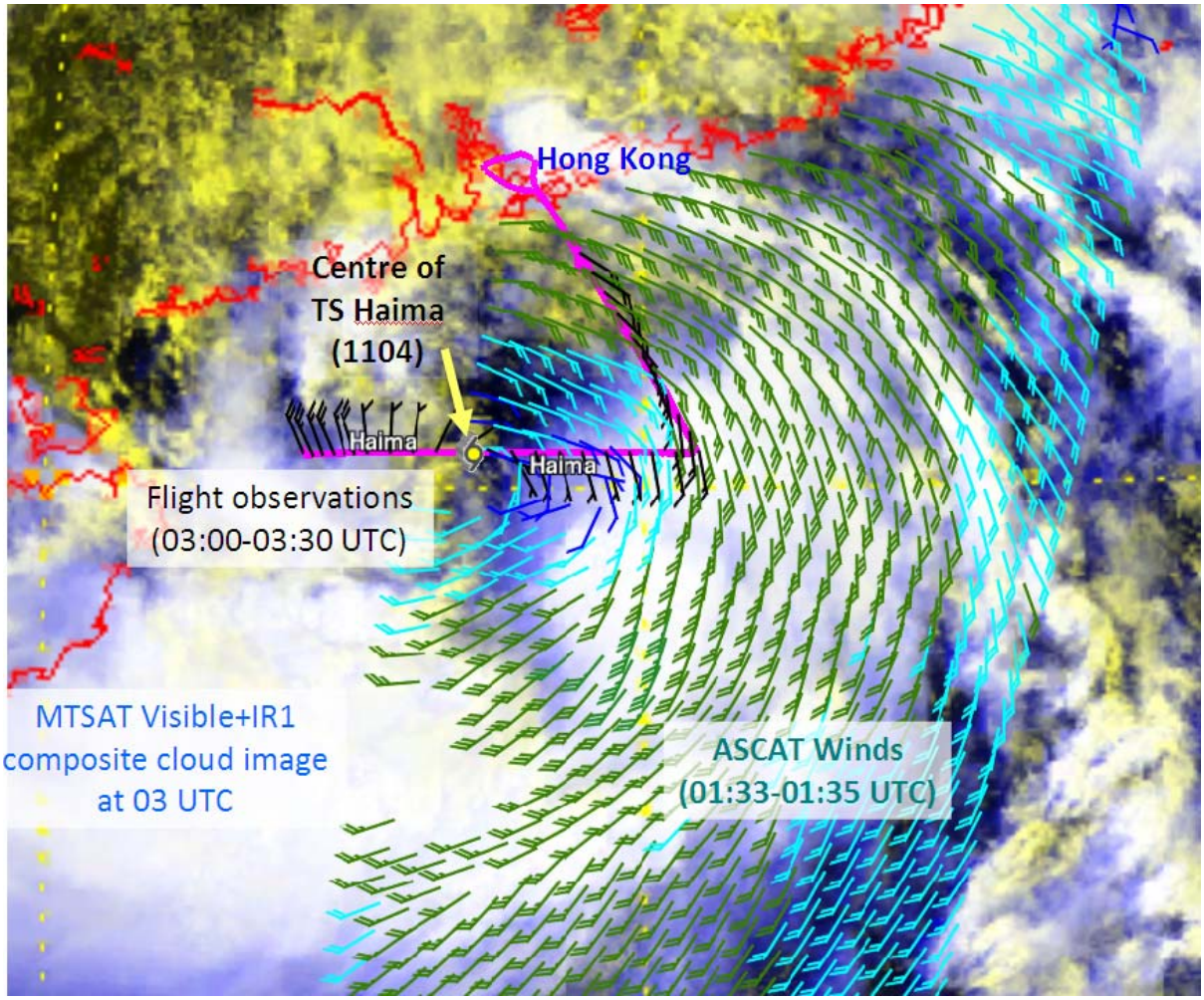


Figure 9 Wind observations recorded by GFS flight for TS Haima (1104) during 0300-0330 UTC on 22 June 2011 (wind barbs reduced to 10m above sea level in black and flight path in magenta). ASCAT sea surface winds and MTSAT composite cloud image are overlaid to delineate wind flow and convection around Haima.

The Tropical Cyclone Information Display and Processing System (TIPS), the major system for tropical cyclone forecast operations, was enhanced in 2011. Its storm surge forecast module was improved by ingesting tropical cyclone forecast track of higher temporal resolution.

HKO began to acquire full-resolution ECMWF data in April 2011. Forecast tools such as time series, time cross-section, EPSgrams, charts of probabilistic forecast and extreme forecast index were developed using the

new data to help forecasters better predict the change of wind and rainfall due to tropical cyclones.

b. Hydrological Achievements/Results

HKO provided support to the Drainage Services Department (DSD) in their review of the Drainage Master Plans in the flood prone areas in the northern part of the territory and feasibility study of applying real-time flood forecasting. Results showed that direct output from SWIRLS (Short-range Warning of Intense Rainstorms in Localized Systems) nowcasting system agreed reasonably well with the rainfall 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.

HKO also provided DSD 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/emergency 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 nowcasting system and historical rainstorm data.

c. Disaster Prevention and Preparedness Achievements/Results

HKO participates in regular exercises and drills with relevant government departments and organizations for preparedness against tropical cyclones with the view of minimizing casualties and damage (Figure 10). These exercises and drills range from table-top exercises to full-scale operational drills to test the communication among different departments, provision of alerts to members of the public, command and control as well as search and rescue operations. A full-scale operational drill on storm surge flooding at a rural village community was conducted in July 2011 with the participation of 10 departments and organizations (Figure 11). The drill allowed government departments and local communities to familiarize themselves with the related emergency response plan so that they would be able to act swiftly to evacuate residents and minimize the impacts caused by flooding upon the issuance of an early alert by HKO.

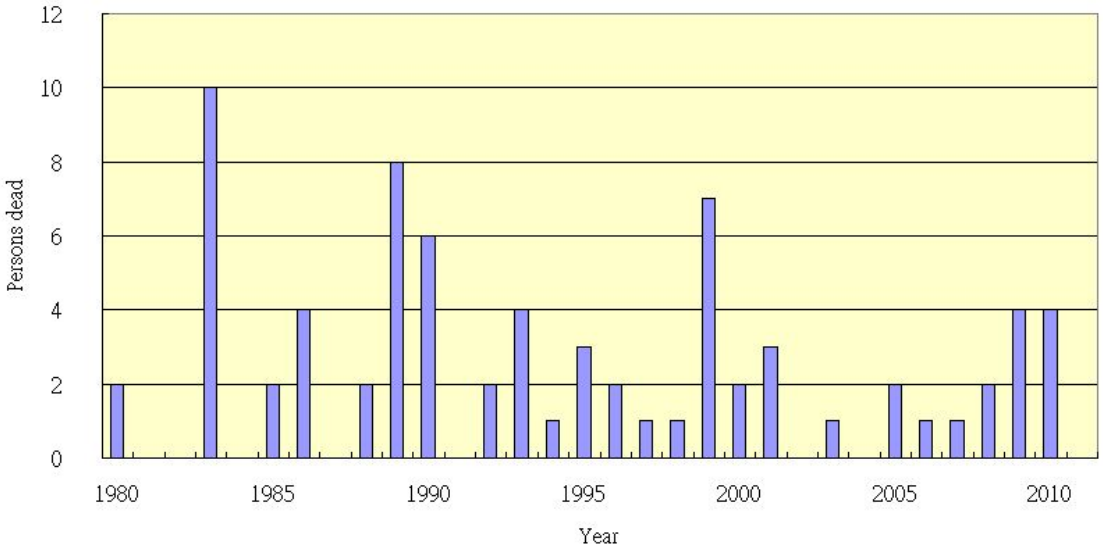


Figure 10 Number of fatalities in Hong Kong, China during the passage of tropical cyclones from 1980 to 2011

In 2011, localized storm surge alerts were activated promptly during the approach of tropical cyclones Nock-ten (1108), Nesat (1117) and Nalgae (1119). Appropriate precautions were taken in time against possible flooding caused by storm surge.

Figure 11 Various government departments participating in an operation drill for storm surge flooding at Tai O, a rural village community, on 5 July 2011.

d. Research, Training, and Other Achievements/Results

HKO and the World Meteorological Organization (WMO) jointly hosted a training workshop on forecasting and warning services for severe weather, including tropical cyclone, at HKO from 4 to 15 July 2011 under the Severe Weather Forecasting Demonstration Project (SWFDP). Representatives

from national meteorological services and disaster management authorities of five Asian countries, namely Cambodia, Laos, Thailand, Vietnam and the Philippines, attended the workshop.

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

DSD liaised closely with other relevant Government departments and persons in charge of construction sites/maintenance 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.

DSD 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 Maintenance Management Information System / Complaints Management Module 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.

In addition, the Early Alert System for Predicted Storm Surges was set up which was jointly established by HKO, Home Affairs Department and DSD in Year 2010 following the severe sea flooding incidents at low-lying areas during Year 2009 typhoons and heavy rainstorms. The system targets for 5 coastal low-lying areas which are prone to sea flooding, namely Luen On San Tsuen and Kar Wo Lei in Tuen Mun, Nam Wai in Sai Kung, Sham Tseng and Lei Yue Mun (Figure 7).

Under the alert system, at tropical cyclone signal No. 3 or above, HKO would provide the predicted storm surges reaching respective trigger levels of these low-lying areas. HKO would issue storm surge alerts to District Offices

of Home Affairs Department and DSD. DSD would take emergency flood mitigation actions and District Offices would inform concerned villagers to take necessary precautionary measures.

c. Disaster Prevention and Preparedness Achievements/Results

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 (Figure 12). The results were provided in the annual tropical cyclone publication of HKO.

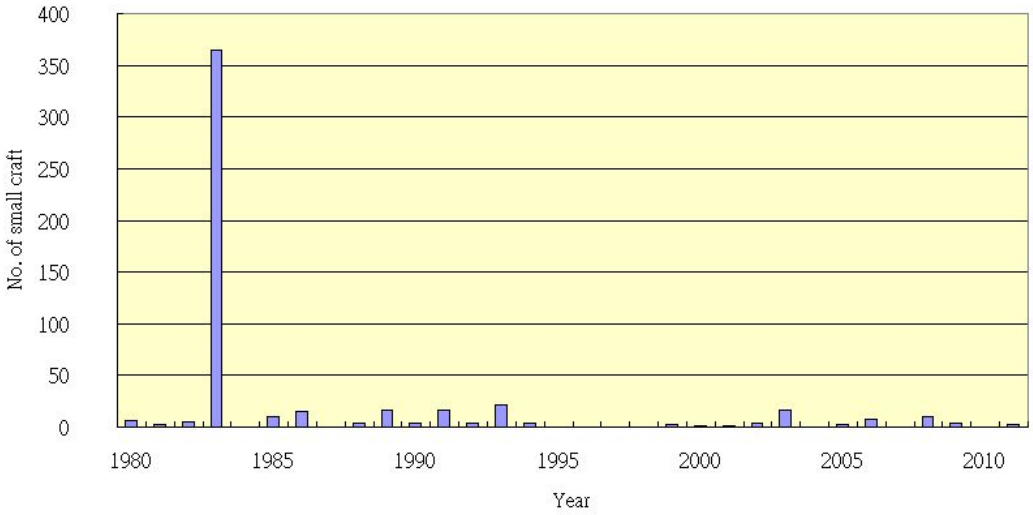


Figure 12 Small craft sunk, wrecked or damaged in Hong Kong during the passage of tropical cyclones from 1980 to 2011. 360 small crafts were sunk, wrecked or damaged during the passage of Typhoon Ellen in 1983.

d. Research, Training, and Other Achievements/Results

Nil.

e. Regional Cooperation Achievements/Results

To assist the Shenzhen Meteorological Bureau in providing refined weather forecast and warning services during the Summer Universiade, HKO supplied various types of weather observations and forecast products generated from its nowcasting system SWIRLS and 2-km Non-Hydrostatic Model in real-time to the Bureau. HKO also participated in the joint weather conferences via video link with the experts from the China Meteorological Administration to discuss in detail the weather processes that might affect the opening and closing ceremonies of the Universiade.

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, HKO provided the Shanghai

Typhoon Institute with comments on their draft questionnaire for general public on typhoon forecast services.

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

A study on the benefits from typhoons from the Hong Kong perspective was completed in late 2010 and the paper has been accepted for publication in the journal "Weather".

e. Regional Cooperation Achievements/Results
Nil.

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

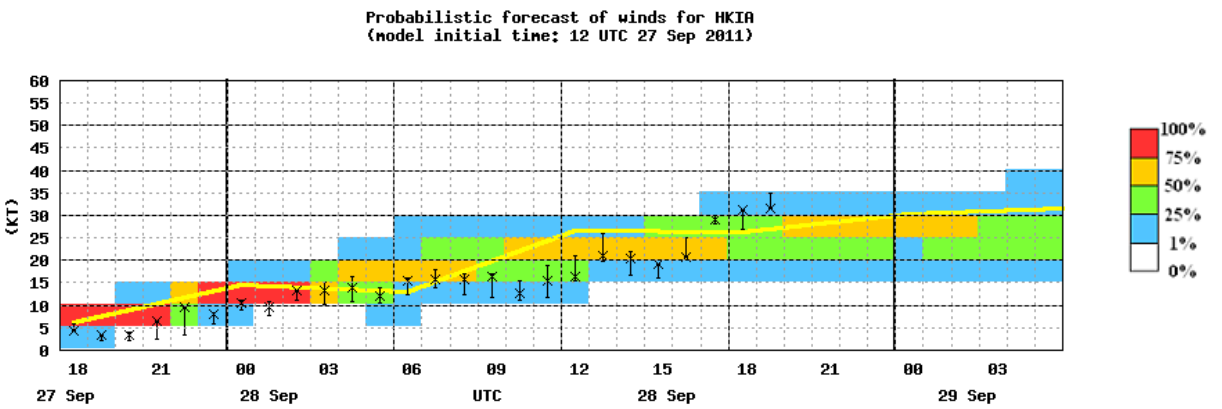
4. **Progress on Key Result Area 4**: Improved Typhoon-related Disaster Risk Management in Various Sectors. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

High crosswind may have adverse impact on flight operations. To facilitate aviation users' application of probabilistic wind speed and crosswind forecasts for the Hong Kong International Airport (HKIA) and their understanding of the uncertainty in wind forecasts, a new product showing the probabilistic tropical cyclone distance from HKIA was developed based on ECMWF EPS outputs and put to trial use during the tropical cyclone season of

2011, in addition to objective probabilistic wind speed and crosswind forecasts for HKIA developed earlier in 2010. Figure 13 shows the probabilistic products during the passage of Typhoon Nesat (1119) in September 2011. As for the onging work, the Kalman-filtering method for post-processing model wind speed forecast was being tested using past data. Generation of probability of maximum wind speed and crosswind for the entire life cycle of tropical cyclone would also be explored.

(a)



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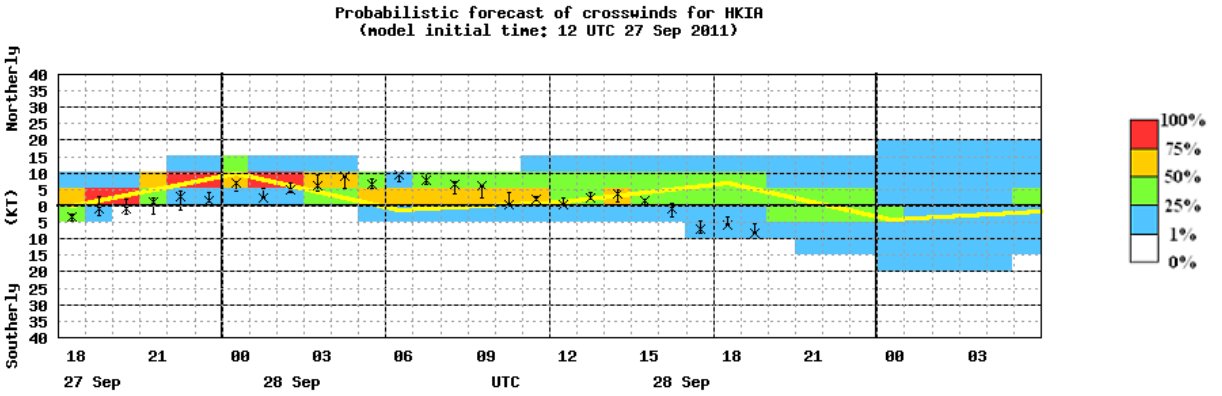

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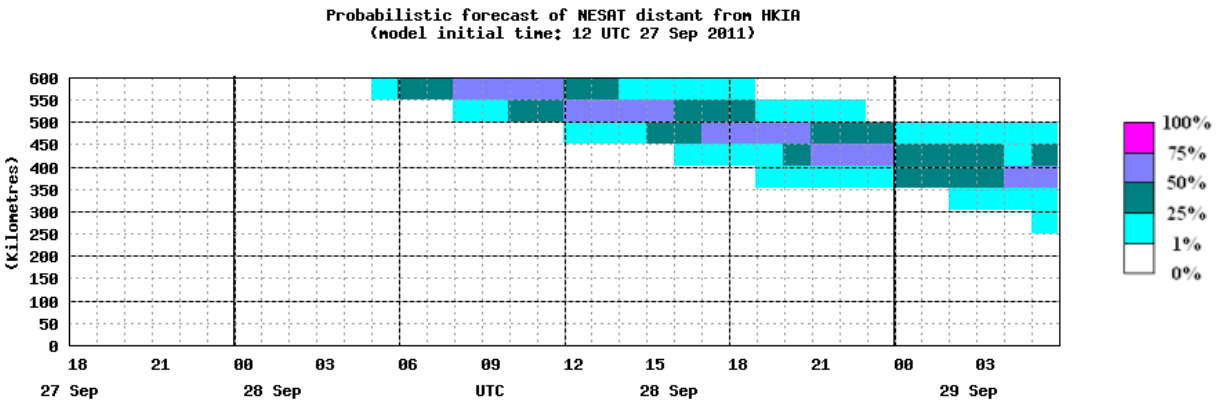


Figure 13 Objective probabilistic forecast of (a) wind speed; (b) crosswind; and (c) tropical cyclone distance from HKIA during the passage of Typhoon Nesat in September 2011. In 13(a) and 13(b), the yellow line shows the ECMWF deterministic model forecast. For comparison, the 10-minute mean wind observations ending on the hour from the six anemometers on the two runways are overlaid and denoted by vertical black segments spanning the range of wind speed observations

from all six anemometers. The wind observation used in METAR reports is marked by a cross.

Extensive convective development associated with tropical cyclones over busy flight routes may disrupt air traffic. To facilitate air traffic flow management by the Air Traffic Control (ATC) in Hong Kong, significant convection forecasts for key ATC areas within the Hong Kong Flight Information Region have been provided for trial use by ATC personnel since June 2010. A satellite convection cloud prediction system was developed to assist the forecaster to fine tune the significant convection forecasts generated from NWP model outputs. The system produces forecast positions of deep convection cloud clusters at hourly intervals up to 12 hours ahead by using multi-grid optical flow method and advection technique. Figure 14 shows the satellite-based deep convection forecast for the case of Typhoon Nesat in 2011.

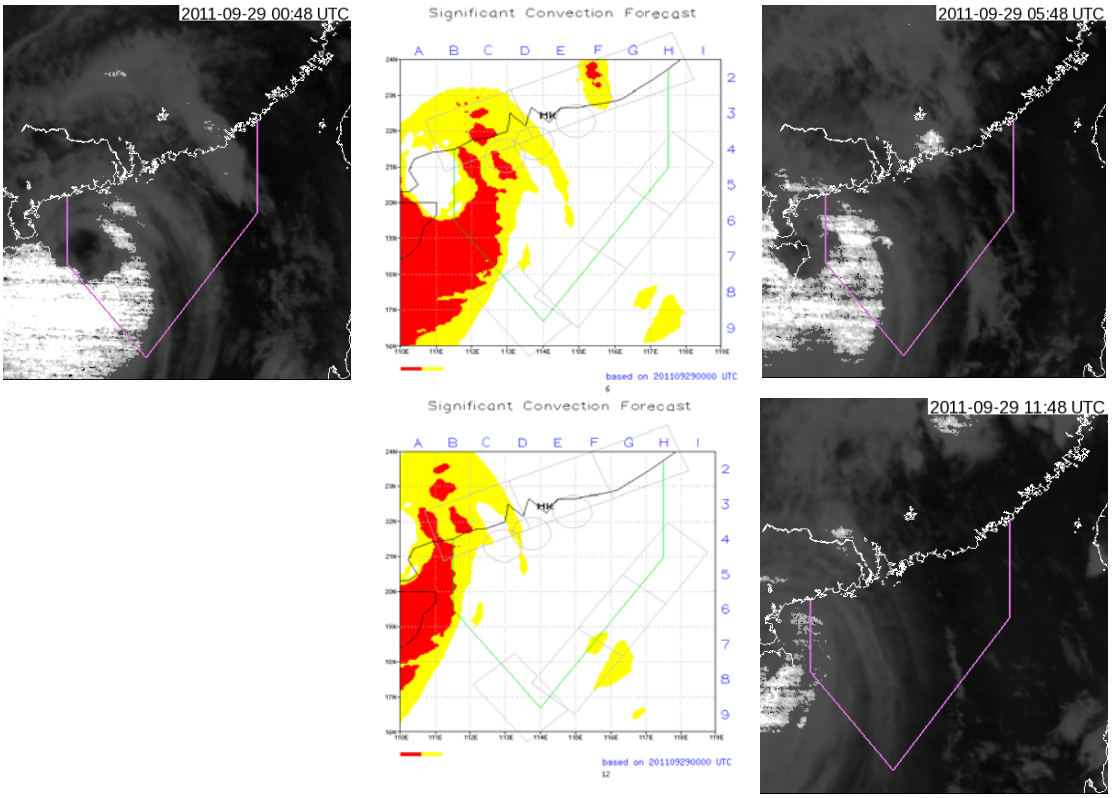


Figure 14 6-hour forecast (upper middle) and 12-hour forecast (lower middle) of convective cloud clusters generated by HKO's satellite convection cloud prediction system based on the deep convection satellite image at 00 UTC on 29 September 2011 (left) when Typhoon Nesat was moving across the northern part of the South China Sea. The red regions represent deep convection in the forecast. On the right are satellite images taken at the respective forecast times where deep convection is shown in bright white.

b. Hydrological Achievements/Results

Dynamic hydrological and hydraulic computer models for the drainage systems in Hong Kong managed by DSD were developed to provide information on the risk of flooding, impacts of development and the performance of various flood protection options. In particular, all the trunk and major branch river channels within the river basins in the northern and north-western part of Hong Kong had been digitized into the computational hydraulic models. Raingauges were installed in the concerned area for the monitoring of the hydrological data for the release of basin-wide flood warning in the region. In the past year, DSD 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

To enhance the weather services for the fishermen, HKO launched the "Weather information for Fishermen" website (Figure 15) in late 2010. The portal includes weather information particularly relevant and useful for fishermen. This should assist them to better understand the latest weather situation before operation at sea, especially during the approach of tropical cyclones over the South China Sea or the western North Pacific.

Figure 15 The portal site "Weather information for Fishermen" facilitating the fishermen to better understand the latest weather situation before operation at sea.

d. Research, Training, and Other Achievements/Results

Nil.

e. Regional Cooperation Achievements/Results

A pilot project on "Aviation Weather Disaster Risk Reduction" (ADRR) was established in the WMO Commission for Aeronautical Meteorology (CAeM) session in 2006 with a focus on tropical cyclone hazards. An ADRR website has been developed under the lead of the HKO as a regional Pilot Project in RAII and RA V under CAeM. Noting the success of the pilot project, the ADRR website was put into operation in April 2011.

Under the project, products beyond the current requirements of the ICAO, with particular focus on tropical cyclone and enhanced meteorological services for a wider terminal area (examples are in Figure 13 and 14), were developed and provided on the ADRR website (adrr.caem.wmo.int). The project serves to demonstrate to aviation stakeholders the benefits of such information in the planning of airport operations and collaborative decision making with common situational awareness, thereby enhancing aviation safety.

Corresponding training was included in the "Regional Seminar on Aeronautical Meteorology Services in Asia" organized by WMO in Beijing in April 2011 for sharing experience with Members. A pamphlet introducing the ADRR products had also been published jointly by WMO and HKO.

f. Identified Opportunities/Challenges for Future Achievements/Results

Research and development are underway to enhance the future forecast supports in severe weather related to tropical cyclones for betterment of disaster risk preparedness and management. They include: (i) data assimilation of ground-based remote sensing observations over wider coverage including weather radar and GPS water vapour data in the region through real-time data exchange, for improving the analysis and forecast of significant convection using HKO's NHM system; and (ii) development of the Aviation Model (AVM) running at sub-kilometre horizontal resolution in order to better simulate the wind flow and weather conditions over Hong Kong, especially in the vicinity of HKIA.

The interpretation of probabilistic forecasts and their combined use with forecasters' subjective forecasts may pose a challenge to the users in their weather-related decision-making process. Communication with users should be enhanced so as to acquire a better understanding of how they utilise the weather information and the thresholds of significant weather they are operating. This will help improve the presentation and effectiveness of the probabilistic forecast products.

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

The "Digital Weather Forecast" on HKO's web page was enhanced to provide time series charts showing hourly to three-hourly temperature, wind speed, wind direction and relative humidity forecasts for the next three days (Figure 16), at grids of 10-km resolution around Hong Kong. Members of the public can select their own specific regions of interest to appreciate the expected changes in the weather there for better planning of their activities which may be sensitive to severe weather including tropical cyclones.

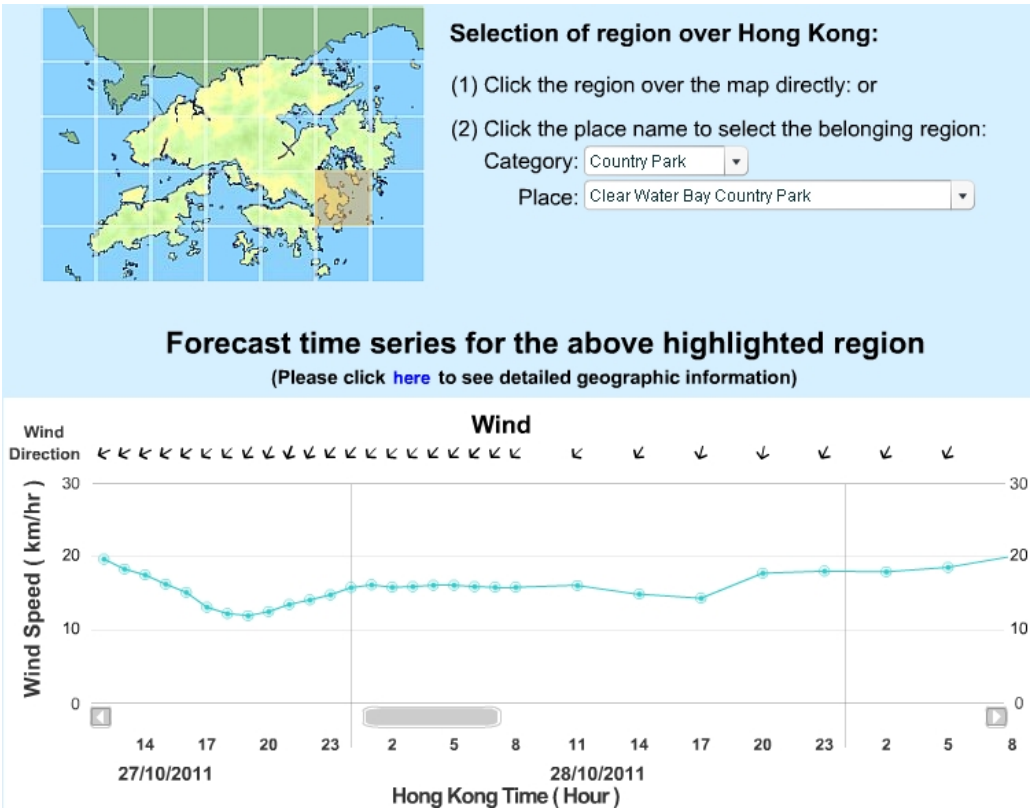


Figure 16 "Digital Weather Forecast" webpage showing the forecast time series for winds over the region selected by user

Real-time weather photos from another two strategic sites in Hong Kong were launched on HKO website in 2011, making the total of such sites to 17. The weather photos allow the public to better appreciate the weather conditions in real time particularly during the approach of tropical cyclones when local weather begins to deteriorate. All real-time weather photos are updated more frequently, from every 15 minutes to every five minutes, and the photos are available from 5 a.m. to 9 p.m. every day.

With the rapid increasing popularity of smartphones in the market, HKO developed a smartphone application MyObservatory (Figure 17 (a)) in 2010 to provide personalized weather service for people on the move. MyObservatory, available on iPhone and Android platforms (www.weather.gov.hk/myobservatory_e.htm), automatically detects the user's location and provides the latest location-specific information from the weather stations closest to the user. In addition, the application also provides tropical cyclone forecast track, which is implemented on Google map with rich geographical information (Figure 17 (b)). In early 2011, the iPhone version of MyObservatory was enhanced with warning notification to notify users of any change in the warning status (Figure 17 (c)). MyObservatory has been well received by the public. It has attracted over one million downloads and its total visit figures in 2011 exceeded 1,500 million.

Figure 17 (a)
Sample display of main screen of MyObservatory

Figure 17 (b)
Sample display of tropical cyclone forecast track on MyObservatory

Figure 17 (c)
Sample display of warning notification on MyObservatory

To reach out to a wider population, in particular the younger generation, HKO makes use of social networking services for the dissemination of weather warnings and information. The HKO Twitter service (mobile.twitter.com/ObservatoryHK) was launched in late 2010 and the service was extended to a popular Micro-blog website, Weibo (weibo.com/observatoryhk), in early 2011. Tropical cyclone warnings, as well as other weather warnings, information on hazardous weather and earthquake messages worldwide, are published on HKO's profile "ObservatoryHK" on Twitter and "HongKongObservatory" on Weibo and distribute to all users subscribing to receive messages delivered by HKO. 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 millions of international travellers coming to Hong Kong.

b. Hydrological Achievements/Results

Since 1997, about HK$8.5 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 about 20km of drainage channels and stormwater drains were in progress. For the urban area, the construction of about 22 km of stormwater drains was also in progress. The construction of about 2 km of drainage tunnels and associated intakes were underway.

Data from rain gauges operated by DSD and Geotechnical Engineering Office were relayed to HKO 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. About 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 2 050 km of drains and watercourses were inspected and about $111 million was spent on such maintenance works in 2009-2010. 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).

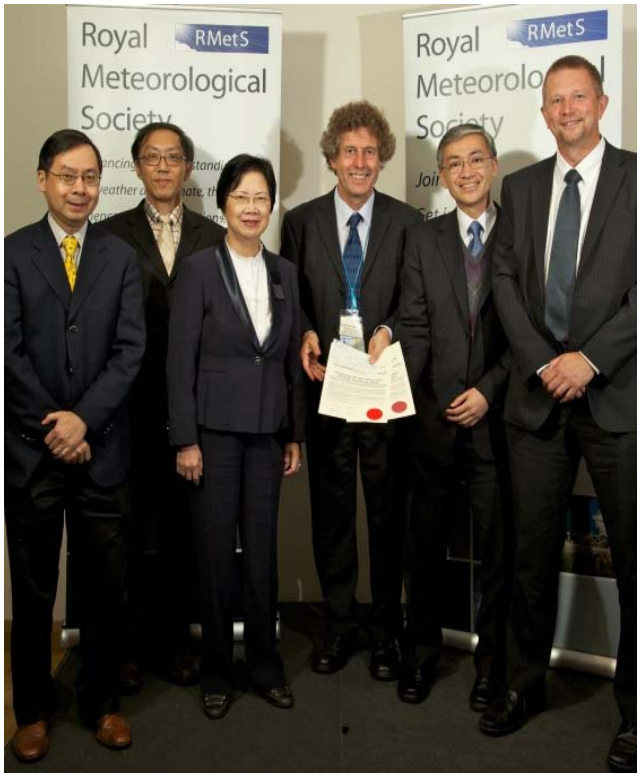
Staff of DSD attended various training classes, workshops and conferences (both local and overseas) to acquire the latest knowledge on advanced technology relating to flood prevention, including flooding caused by tropical cyclones. Overseas experts were also invited to Hong Kong to provide in-house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

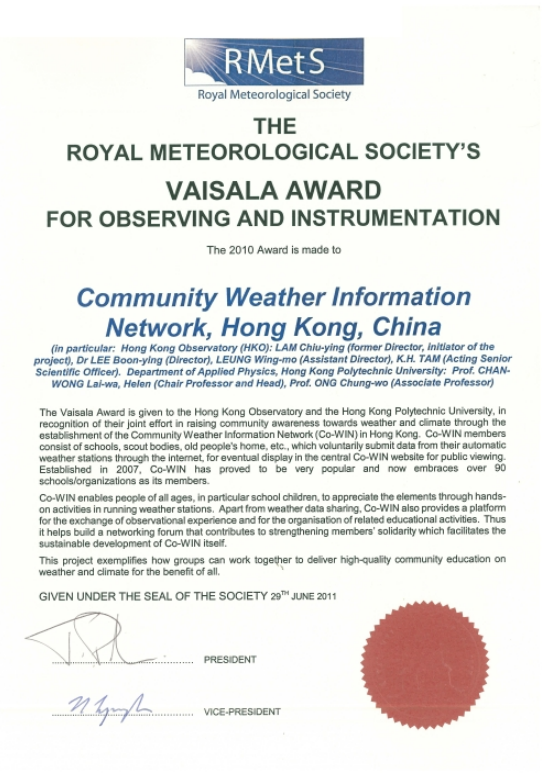
c. Disaster Prevention and Preparedness Achievements/Results

To enhance public awareness of mountaineering safety, the Civil Aid Service joined hands with 17 government departments and non-governmental organizations to hold the Mountaineering Safety Promotion Day 2011 (Figure 18). As in the past years, HKO 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.

Figure 18 Honourable guests officiating at the opening ceremony of the Mountaineering Safety Promotion Day 2011, including the Director of the Hong Kong Observatory Mr. C.M. Shun (second from the right)

The "Community Weather Information Network (Co-WIN)", started in 2007 in collaboration with the Hong Kong Polytechnic University, saw further expansion in the number of community weather stations to over 100, with relevant weather data made available to the public via the Internet. Weather data obtained through Co-WIN are applied by school children in various educational projects and studies. The network also helps raise awareness of severe weather, including tropical cyclones. In recognition of the effort in raising community awareness towards weather and its societal impacts through the Co-WIN platform, Co-WIN was awarded the prestigious "2010 Vaisala Award for Weather Observing and Instrumentation" by the Royal Meteorological Society (Figure 19a and 19b).





RMetS
Royal Meteorological Society

THE
ROYAL METEOROLOGICAL SOCIETY'S
VAISALA AWARD
FOR OBSERVING AND INSTRUMENTATION

The 2010 Award is made to

Community Weather Information Network, Hong Kong, China

(in particular: Hong Kong Observatory (HKO): LAM Chiu-ying (former Director, initiator of the project), Dr LEE Boon-ying (Director), LEUNG Wing-mo (Assistant Director), K.H. TAM (Acting Senior Scientific Officer). Department of Applied Physics, Hong Kong Polytechnic University: Prof. CHAN-WONG Lai-wa, Helen (Chair Professor and Head), Prof. ONG Chung-wo (Associate Professor)

The Vaisala Award is given to the Hong Kong Observatory and the Hong Kong Polytechnic University, in recognition of their joint effort in raising community awareness towards weather and climate through the establishment of the Community Weather Information Network (Co-WIN) in Hong Kong. Co-WIN members consist of schools, scout bodies, old people's home, etc., which voluntarily submit data from their automatic weather stations through the internet, for eventual display in the central Co-WIN website for public viewing. Established in 2007, Co-WIN has proved to be very popular and now embraces over 90 schools/organizations as its members.

Co-WIN enables people of all ages, in particular school children, to appreciate the elements through hands-on activities in running weather stations. Apart from weather data sharing, Co-WIN also provides a platform for the exchange of observational experience and for the organisation of related educational activities. Thus it helps build a networking forum that contributes to strengthening members' solidarity which facilitates the sustainable development of Co-WIN itself.

This project exemplifies how groups can work together to deliver high-quality community education on weather and climate for the benefit of all.

GIVEN UNDER THE SEAL OF THE SOCIETY 29TH JUNE 2011

PRESIDENT

VICE-PRESIDENT

(a) (b)

Figure 19 Director of the Hong Kong Observatory (second from the right in (a)) receiving the Vaisala Award (b) from the President of Royal Meteorological Society, Professor Tim Palmer (third from the right in (a)).

To celebrate the World Meteorological Day on March 23, HKO was opened to the public on 26 and 27 March, 2011. The theme of the Open Day was "Climate for you". Around 10 000 people of all ages visited HKO headquarters. Through words, pictures and exhibits, various topics, including climate, extreme weather, geophysical science, radiation monitoring and others, were introduced to the public.

d. Research, Training, and Other Achievements/Results

Nil.

e. Regional Cooperation Achievements/Results

Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

To further strengthen resilience of communities to typhoon-related disaster, HKO plans to enhance the MyObservatory with location-based forecasts on winds and rainfall. These features would help the public better appreciate the likely change in weather conditions, enabling them to plan their activities that are sensitive to weather.

To meet the increasing needs of the public, HKO will continue to enhance the digital weather forecast webpage by adding more weather elements and exploring the integration of digital weather forecast with positioning technology, so as to provide hourly and location-specific weather forecasts for users with mobile devices.

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 from NCEP and CMC were continued to be made available under the THORPEX/TIGGE project. Forecast products were generated in real time for reference of the forecasters.

Following the commissioning of the 10-km Non-Hydrostatic Model (Meso-NHM) in mid-2010, an upgrade of the associated tropical cyclone tracker was pursued in 2011 to rectify the problem of occasional mis-identification of lee-lows over rugged terrain (such as Taiwan and Luzon) as the centres of tropical cyclones that led to incorrect forecast tracks. Figure 20 illustrates the problem using the case of Typhoon Chanthu (1003). In the new high-resolution Meso-NHM, the lee-low over Luzon became very prominent (Figure 20c) and was mis-identified by the old tropical cyclone tracker as the centre of Chanthu (Figure 20a). By taking into consideration the 850 hPa vorticity (Figure 20d) in addition to mean sea level pressure, the new tropical cyclone tracker was able to identify the centre of Chanthu correctly (Figure 20b). With this new tracker, the dissemination of the Meso-NHM-based tropical cyclone forecast guidance bulletins via GTS commenced on 1 June 2011.

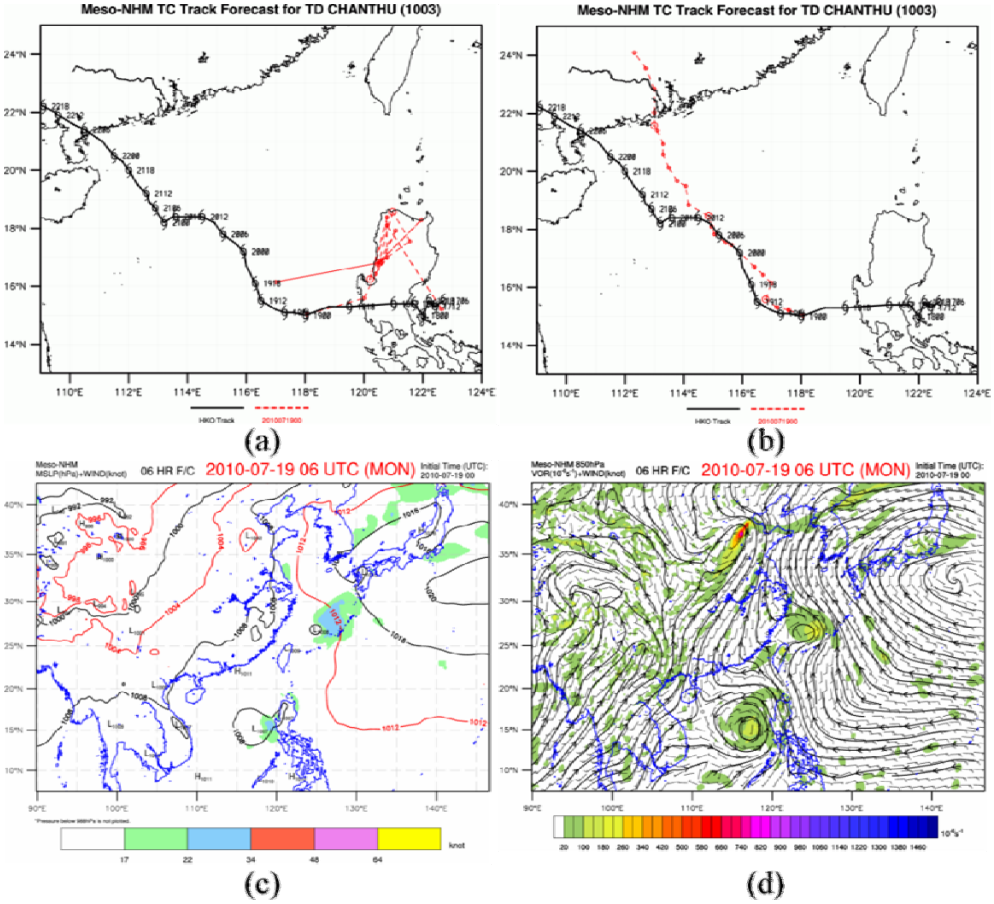


Figure 20 HKO's warning track (black solid line) and the forecast track (red broken line) of Typhoon Chanthu generated with (a) the old tropical cyclone tracker and (b) the new tropical cyclone tracker; and the corresponding T+6 h forecast of (c) the mean sea level pressure field and (d) the 850 hPa streamline and vorticity field.

A real-time tropical cyclone track verification tool was developed and put into operation for the 2011 tropical cyclone season. The tool helps the forecasters monitor the development of any tropical cyclone track biases of different models so that they can take that information into account when formulating their tropical cyclone track forecasts. Its application during the passage of Tropical Storm Haima (1104) in June 2011 is illustrated in Figures 21 and 22. The real-time verification (Figure 21) suggested that : (i) the TC track forecasts from the model in question (HKO's Meso-NHM) displayed a persistent east bias (and less apparently, a north bias); and (ii) the bias increased with forecast hour. Such information would be helpful to the forecasters to adjust the model forecast tropical cyclone track (Figure 22) taking into account the persistent bias of the model.

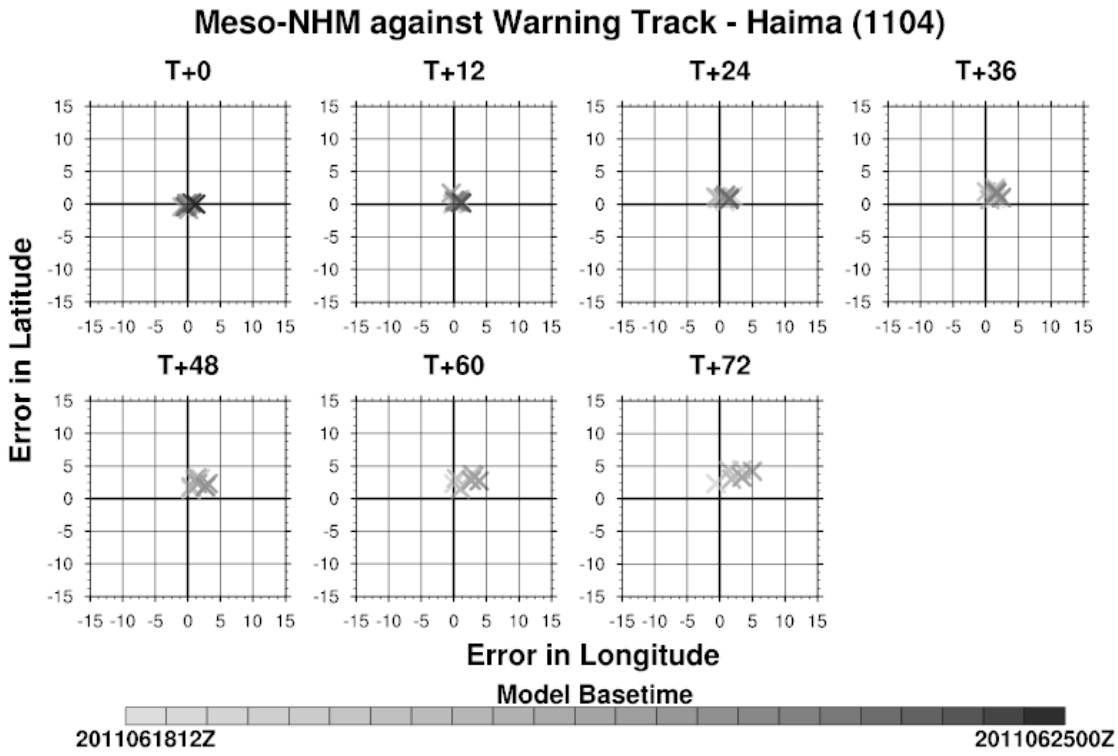


Figure 21 Scatter diagram of the deviations of Meso-NHM TC forecast positions from HKO's warning positions for Tropical Storm Haima (1104).

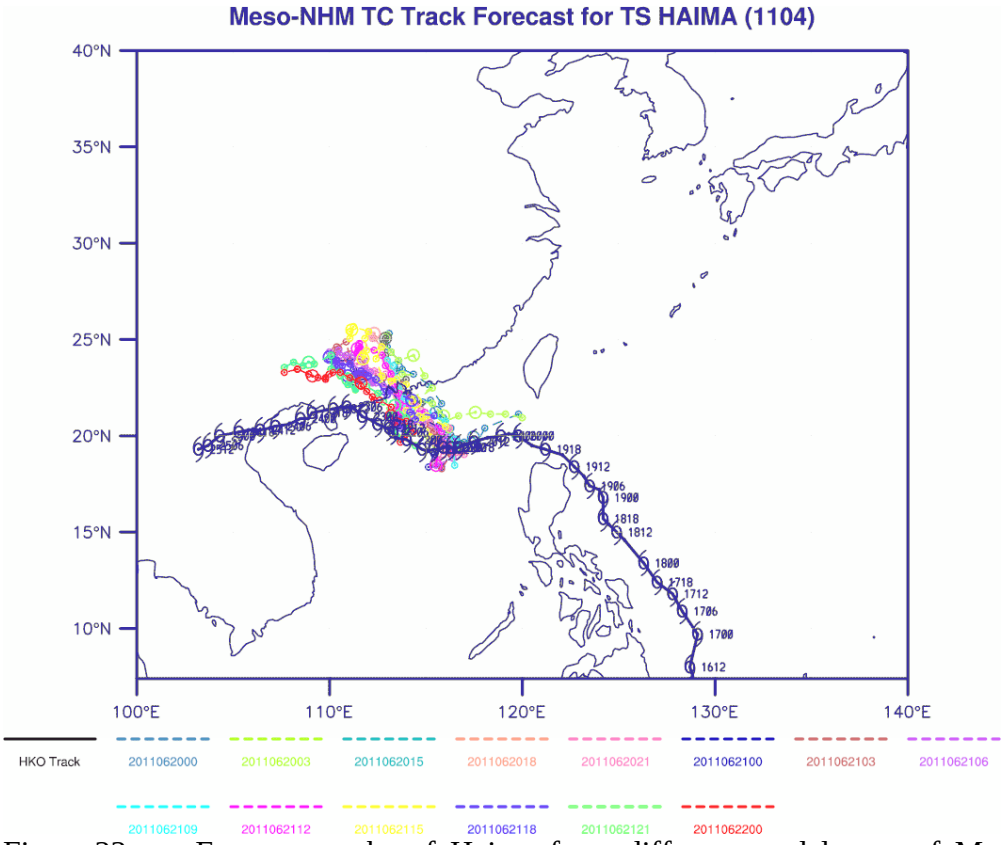


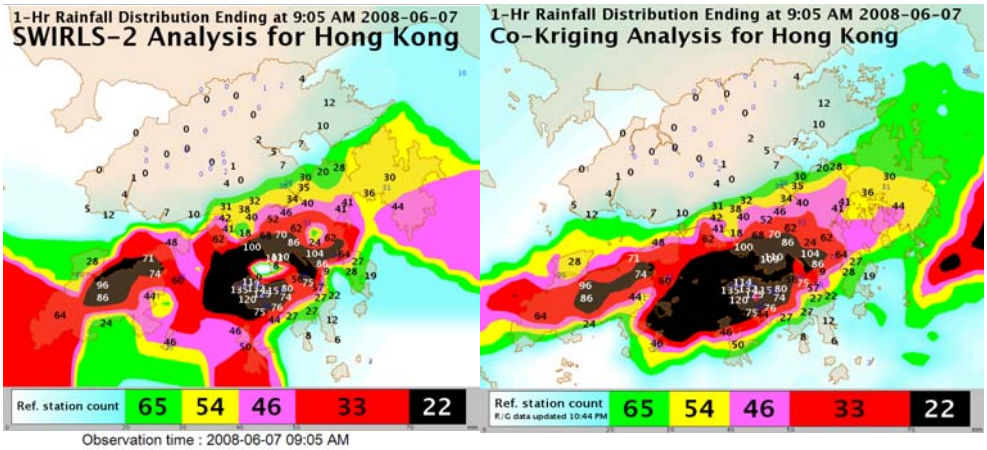
Figure 22 Forecast tracks of Haima from different model runs of Meso-NHM (red the latest). The black line denotes the HKO's warning track.

b. Hydrological Achievements/Results

RAPIDS, the HKO's nowcast-NWP QPF blending system, was upgraded with the non-hydrostatic NWP model component enhanced from 5-km to 2-km resolution. Real-time verification results showed that due to improved QPF from the model, RAPIDS became generally more skillful than its predecessor.

The rainstorm nowcasts of SWIRLS in 2008-2010 were reviewed with a view to fine-tuning the warning criteria for fewer false alarms. The original scheme only asked for a minimum percentage of land coverage by the storms for a warning to be triggered. Under the revised scheme, an additional criterion was introduced, namely the predicted number of rain gauges with the respective rainfall thresholds exceeded should also reach a prescribed set of thresholds. Based on data since 2008, the revised scheme could reduce the total warning duration by more than 20% while maintaining virtually the same level of probability of detection (POD).

For better rain gauge data quality control and rainfall analysis in support of hydrological applications, a QPE technique based on radar-rain gauge co-Kriging was implemented and put under operational trial in 2011. Under the new technique, the raw rain gauge data in Hong Kong are checked in real-time and will be rejected if found inconsistent with the underlying spatial structure of the rain systems as indicated by the neighbouring rain gauges and radar reflectivity data. The resulting set of acceptable rain gauge data is then fed, along with the radar reflectivity data, into the co-Kriging QPE system for gridded rainfall analysis (Figure 23). The QC system was proved robust for both the rainfall cases during the trial and selected historical extreme events. The co-Kriging QPE provides in general a more realistic rainfall maps, especially over gauge-sparse areas.



Observation time : 2008-06-07 09:05 AM

R/G	G (mm)	K (mm)	ξ (dB)	D (mm)	δ	σ (mm)	QC Flag
VP1	10.0	110.3	-10.4	-100.3	48.8	2.1	4
R01	7.5	87.3	-10.7	-79.8	35.9	2.2	4
H25	0.5	94.7	-22.8	-94.2	44.2	2.1	4
H10	132.0	89.8	1.7	42.2	22.6	1.9	2
K03	104.0	59.9	2.4	44.1	19.3	2.3	2
K10	100.5	54.6	2.6	45.9	17.8	2.6	2

Figure 23 An example of co-Kriging rain gauge data quality control (left) and one-hour co-Kriging rainfall analysis (right) valid at 9:05 a.m. on 7 June 2008. The rainfall isohyet map on the left was prepared based on the Barnes analysis method using raw rain gauge data with three seriously under-reported measurements (highlighted in red in the table underneath) included. The QC system successfully rejected the erroneous data and the QPE algorithm produced a much more reasonable depiction of the heavy rainfall distribution as shown on the right.

c. Disaster Prevention and Preparedness Achievements/Results

Nil.

d. Research, Training, and Other Achievements/Results

Three HKO officers separately attended (i) the International Training Course on "Satellite Meteorology" at WMO Regional Training Centre at Nanjing, China from 18 to 29 April 2011; (ii) the Seventh TCP/JCOMM Workshop on "Storm Surge and Wave Forecasting" at Macao, China from 10 to 14 October 2011; (iii) the International Training Course on "Tropical Cyclones" at WMO Regional Training Centre at Nanjing, China from 5 to 16 December 2011.

A research project on the mesoscale characteristics of rainstorms commenced in 2011. Historical rainstorms in Hong Kong directly or indirectly related to tropical cyclones during 1999-2010 were being reviewed and classified, with an aim to build a knowledge base and forecasting rules to facilitate forecasters' assessment and nowcasting of rainstorms. The rainfall pattern based on the radar climatology and orographic enhancement of tropical cyclone rainfall were among the themes of study. Preliminary findings

indicated that the enhancements were significant with details dependent on the height of mountain, wind speed and wind direction. Applications of the orographic enhancement factors to QPE/QPF will be further studied.

A study on probabilistic forecasting of high wind affecting Hong Kong during tropical cyclones using ECMWF EPS outputs was conducted. A post-processing technique combining multiple linear regression and rolling bias-removal to downscale model forecasts to various locations within the territory was developed. The technique successfully reduced the overall model biases according to the verification based on limited cases in 2011. Implementation of the technique for operational trial would be pursued upon further fine-tuning and testing.

HKO continued to support the Typhoon Committee's initiative in assessing the impacts of climate change on the tropical cyclone activities in the Typhoon Committee Region. A member of staff attended the Typhoon Committee Expert Team meeting for the assessment of the impact of climate change on tropical cyclone track and affected areas in the region. The outcome of the meeting would be compiled into the second Expert Team report to be published in 2012.

At the invitation of the Chief Editor of the Typhoon Committee's Journal - "Tropical Cyclone Research and Review", HKO contributed a paper "A review on the long term variations of tropical cyclone activity in the Typhoon Committee Region" in August 2011 for its inauguration issue.

e. Regional Cooperation Achievements/Results

Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

HKO issues tropical cyclone warning bulletins to the general public whenever a tropical cyclone is expected to affect or is affecting Hong Kong, China. The warning bulletin in general contains the latest position and forecast movement of the tropical cyclone, a brief diagnosis of the past and future development of the tropical cyclone, as well as the necessary precautions. The warning bulletin is written in layman terms for easy digestion and understanding of the public. In order to further facilitate the public to quickly learn about the latest situation related to the threats of the tropical cyclone, enhancement will be made on HKO's website to display those important and urgent messages in the warning bulletin in an eye-catching manner. Furthermore, concise and clear wordings will continue to be used and more important messages will be given at the front of the bulletins to enable the public to easily obtain timely, accurate and understandable information from HKO and through the media.

HKO participated in the Typhoon Committee's Expert Team meeting for the assessment of the impact of climate change on tropical cyclone track and affected areas in the region in Shanghai from 21-22 Nov 2011. During the meeting, the Expert Team came up with a number of recommendations for the Typhoon Committee and the research community to further improve the quality and homogeneity of the tropical cyclone best track datasets in the region, to better understand the attributions of the observed changes in tropical cyclone activity, and to enhance the capability in tropical cyclone impact assessment.

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

A meteorologist from HKO served as a resource person for the Typhoon Committee Roving Seminar 2011 held in Malaysia from 20-23 September 2011 to share with the participants his expertise and experience on operational quantitative precipitation forecast and its application to tropical cyclone conditions. Through the use of virtualization technology, a demonstration software for simulating the real-time operation of HKO's nowcasting system SWIRLS was developed and deployed for training at the Seminar. Another HKO staff also joined the Roving Seminar as an participant.

e. Regional Cooperation Achievements/Results

The findings from the simulation study of Typhoon Morakot in 2009 jointly conducted with a researcher from CMA under the Typhoon Committee Research Fellowship 2010 were summarized into a paper entitled "Can the extreme rainfall associated with Typhoon Morakot (0908) happen in Hong Kong?" and submitted to the new journal "Tropical Cyclone Research and Review" of Typhoon Committee.

A meteorologist from the Malaysian Meteorological Department attached to HKO under the Typhoon Committee Research Fellowship 2011 for 2 months starting from late October 2011. The research topic was "Implementation of Tropical Cyclone Intensity Forecast in the Tropical Cyclone Information Processing System (TIPS) of the Hong Kong Observatory". The study involved a comparison of the performance of various guidance techniques in forecasting the intensity of tropical cyclones over the South China Sea and the western North Pacific. The results will be applied in a new module on tropical cyclone intensity forecast as an enhancement of the TIPS.

The WMO RA II Pilot Project on the Provision of City-Specific Numerical Weather Prediction (NWP) Products to Developing Countries was officially launched on 7 July 2011. City-specific weather forecasts based on the new 10-km non-hydrostatic model of HKO were added to the project website. Uzbekistan and Bahrain joined the project in 2011. As at October 2011, there were 21 RA II Members, 8 of which are Typhoon Committee Members, participating in the project. City-specific forecasts covering various weather elements for the next few days for 215 cities were being provided to the participants via the Internet twice a day.

The Severe Weather Information Centre (SWIC) website (severe.worldweather.wmo.int), 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 HKO. 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 2011, warnings were available in near real time from five contributing weather services, viz Hong Kong, China; Macao, China; Guam, USA; Singapore and Republic of Korea. Development was underway to disseminate warnings from other Typhoon Committee members. More official weather services are planning or being invited to participate.

To raise public awareness on hazardous weather related to tropical cyclones around the globe, a project with cooperation between HKO, WMO and Google was launched in 2011 to enhance the presentation of tropical cyclone information in Google Earth (Figure 24). Tropical cyclone advisories issued by RSMC/TCWCs for all ocean basins collected by the SWIC were

converted into RSS format by HKO for incorporation into the Google Earth for display.

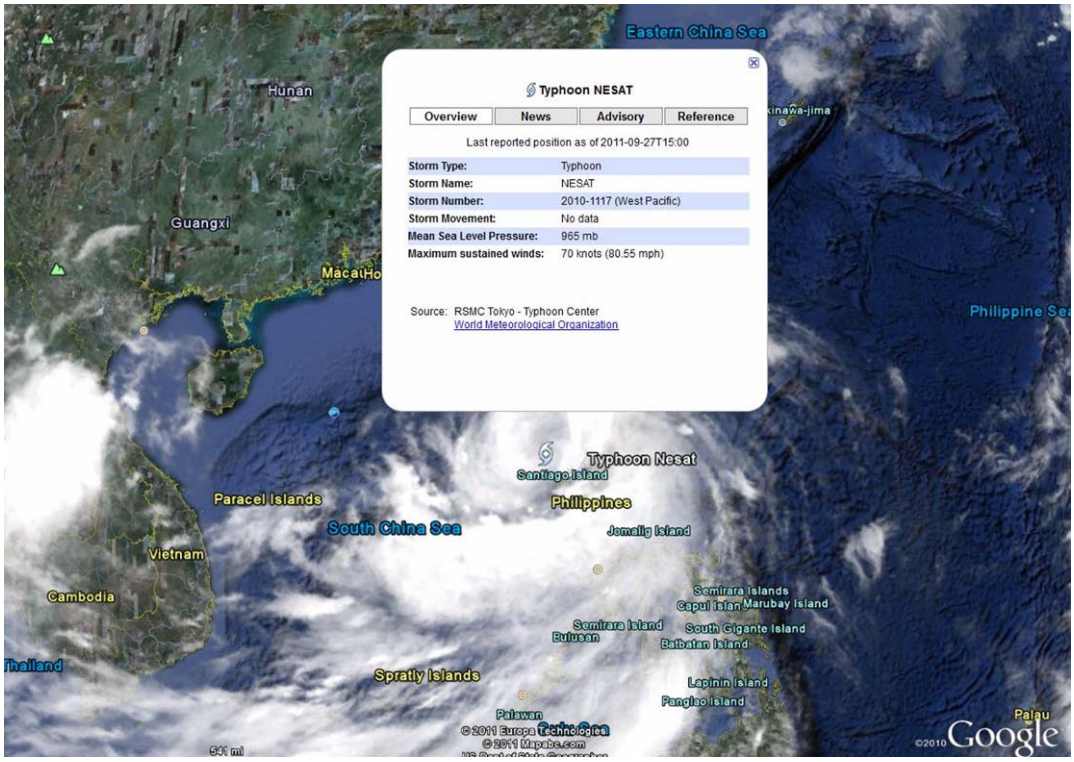


Figure 24 Sample display of Google Earth displaying tropical cyclone information

f. Identified Opportunities/Challenges for Future Achievements/Results

Following HKO's suggestion, the 43rd TC session decided to include a Technical Conference (TECO) in the 44th TC session in which the review of the activities of the RSMC and the 2011 typhoon season (by the RSMC - Tokyo), the Committee's activities during 2011 (Reports of the Members - Meteorological, Hydrological and DRR components), presentations and scientific lectures on pertinent technical issues will be presented so as to facilitate more efficient and effective deliberation at the ensuing TC session meeting.

HKO participated in the first WMO International Workshop on the Satellite Analysis of Tropical Cyclone (IWSATC) in Hawaii from 11 to 13 April 2011 and presented the current operational procedures in Hong Kong of satellite analysis of tropical cyclones. As a major outcome of the workshop, the key differences in the procedures between centres and their relevance to tropical cyclone intensity estimates were identified and documented. This paved the way towards a more coordinated approach in the derivation of tropical cyclone intensity estimates by different operational centres in the same tropical cyclone basin in future.

HKO is looking into the feasibility of providing local weather warnings, including tropical cyclone warning signals, in the Common Alert Protocol (CAP) format. Taking the advantage of CAP being a common XML-based data format adopted for timely exchange of public warnings, local weather warnings in CAP format can be disseminated to the community via more channels.

In face of globalization, there is increasingly demand for standardization of format of weather products such as tropical cyclone advisories to facilitate smooth exchange and effective interpretation of information. In this connection, there is a plan to develop a standardized format such as CAP for exchange of tropical cyclone advisories issued by RSMCs and TCWCs. This would make it easier to receive, decode and process tropical cyclone advisories from various centres and to display the tropical cyclone information around the globe graphically in a harmonized manner.

III. Resource Mobilization Activities

Nil.

IV. Update of Members' Working Groups representatives

1. Working Group on Meteorology –
   Dr. C.M. Cheng – email: cmcheng@hko.gov.hk
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   Telephone: 852 29268223

2. Working Group on Hydrology –
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3. Working Group on Disaster Risk Reduction –
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   Telephone: 852 29268222

4. Training and Research Coordinating Group –
   Mr. Edwin S.T. Lai - email: stlai@hko.gov.hk
   Facsimile: 852 23119448
   Telephone: 852 29268224

5. Resource Mobilization Group
   Nil.