MEMBER REPORT

ESCAP/WMO Typhoon Committee
42nd Session

25 – 30 January 2010
Singapore

(Hong Kong, China)

"Annual activities covering the period from 1 January 2009 to 31 December 2009"

CONTENTS

I. Overview of tropical cyclones which have affected/impacted Member's area in 2009

1. Meteorological Assessment (highlighting forecasting issues/impacts)

Eight tropical cyclones affected Hong Kong from 1 January to 31 December 2009. They were:

(a) Severe Tropical Storm Linfa (0903)
(b) Tropical Storm Nangka (0904)
(c) Tropical Storm Soudelor (0905)
(d) Typhoon Molave (0906)
(e) Severe Tropical Storm Goni (0907)
(f) Tropical Storm Mujigae (0913)
(g) Typhoon Koppu (0915)
(h) Typhoon Ketsana (0916).

The highest tropical cyclone warning signal issued in the year was the Increasing Gale or Storm Signal No. 9 during the passage of Molave in July. Goni and Koppu necessitated issuance of the No. 8 Gale or Storm Signal while Nangka, Soudelor and Mujigae necessitated issuance of the No. 3 Strong Wind Signal in Hong Kong. Details are given in the following paragraphs. Figure 1 shows the tracks of these tropical cyclones.

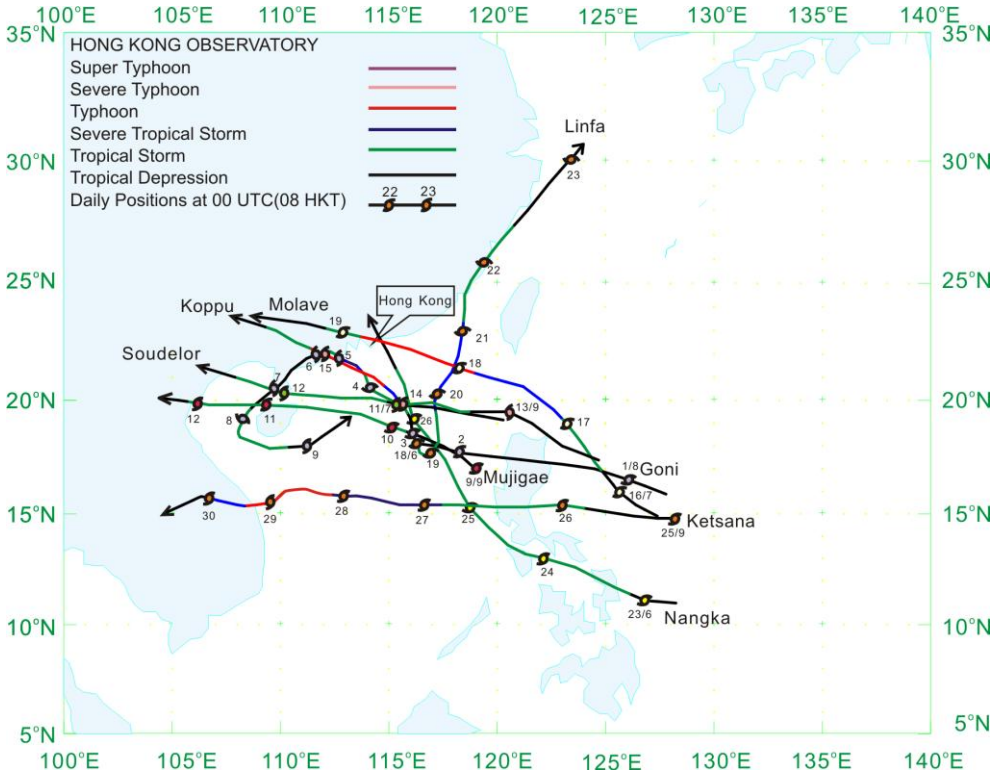


Figure 1 Hong Kong Observatory best tracks of tropical cyclones that affected Hong Kong, China from 1 January to 31 December 2009.

Severe Tropical Storm Linfa (0903)

Linfa formed over the northern part of the South China Sea on 17 June and became a severe tropical storm on 19 June. The track of Linfa is shown in Figure 2. Early on 20 June, Linfa moved towards the south China coast and posed a threat to Hong Kong. Local winds were light, mainly from the west to northwest on that day. Linfa was closest to Hong Kong at around 2 p.m. that day when it was about 380 km to the east-southeast. Linfa gradually moved away from Hong Kong on 21 June.

The weather in Hong Kong was hot with sunny periods on 20 June, but there were isolated showers in the New Territories that evening. It was mainly cloudy with isolated thundery showers the next day.

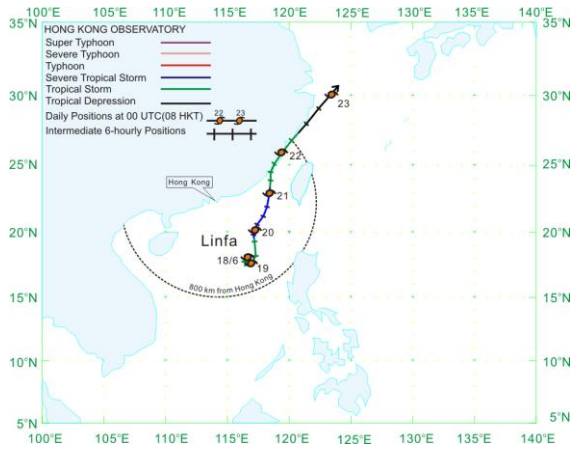


Figure 2 Track of Linfa (0903) on 17 - 23 June 2009.

Tropical Storm Nangka (0904)

Nangka formed over the western North Pacific on 23 June and intensified into a tropical storm that afternoon. The track of Nangka is shown in Figure 3. Tropical Storm Nangka weakened slightly after entering the South China Sea but continued to move closer to the south China coast, posing a threat to Hong Kong. Local winds were moderate to fresh easterlies at first on 26 June and strengthened in the afternoon to become occasionally strong offshore and on high ground. The winds gradually turned to the northwest at night. Nangka was closest to Hong Kong between about 11 p.m. on 26 June and 1 a.m. the following day when it passed about 60 km to the northeast of the Hong Kong Observatory. Local winds subsided as Nangka made landfall and weakened over Guangdong.

The weather in Hong Kong was cloudy at first with squally showers developing during the day on 26 June. There was occasional heavy rain and a few squally thunderstorms on 27 June.

Figure 3 Track of Nangka (0904) on 23 - 27 June 2009.

Tropical Storm Soudelor (0905)

Soudelor formed over the South China Sea on 10 July and intensified into a tropical storm on 11 July. The track of Soudelor is shown in Figure 4. In Hong Kong, winds were light to moderate westerlies on 10 July. Winds strengthened on 11 July becoming fresh easterlies that afternoon and up to strong offshore and on high ground. Soudelor was closest to Hong Kong at about 2 p.m. that day when it passed about 240 km to the south. Soudelor gradually moved away from Hong Kong and local winds weakened that evening, although there were still occasionally strong winds offshore and on high ground. Soudelor moved further away from Hong Kong and local winds gradually moderated on 12 July.

The weather in Hong Kong was fine and very hot on 10 July. Under the influence of the outer rainbands of Soudelor, there were occasional squally showers the next day. With showers easing off, it became mainly fine and hot on 12 July.

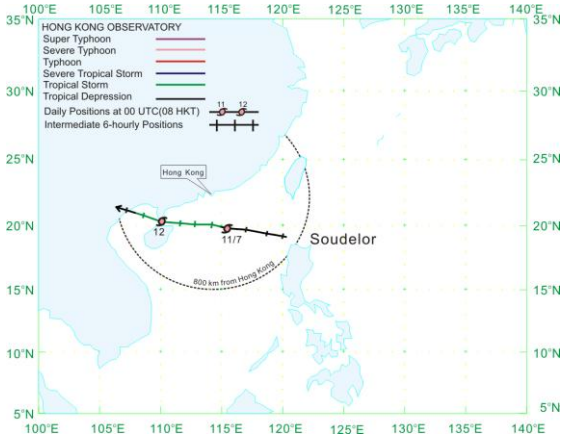


Figure 4 Track of Soudelor (0905) on 10 - 12 July 2009.

Typhoon Molave (0906)

Molave formed over the western North Pacific on 15 July and became a typhoon on 18 July. The track of Molave is shown in Figure 5. In Hong Kong, winds were mainly light to moderate west to northwesterlies on 17 July. Local winds freshened from the northwest and strengthened gradually on 18 July. They became generally strong, reaching gale force on high ground towards midnight. Winds strengthened significantly in the early hours of 19 July. Gale force winds from the west to northwest generally affected Hong Kong, reaching storm force offshore and on high ground. Molave was closest to Hong Kong between about 2 a.m. and 3 a.m. on 19 July when it passed about 40 km to the north-northeast of the Hong Kong Observatory. Molave started to move away from Hong Kong thereafter and local winds changed to gale force southwesterlies, reaching storm force offshore and on high ground. Gales gradually subsided around dawn. As Molave continued to move further away from Hong Kong and weakened, local winds gradually moderated that morning.

The weather in Hong Kong was sunny and very hot on 17 and 18 July. There was some haze on 18 July. Under the influence of the outer rainbands of Molave, squally showers and a few thunderstorms affected Hong Kong that evening. Heavy rain with squalls affected Hong Kong on the morning of 19 July.

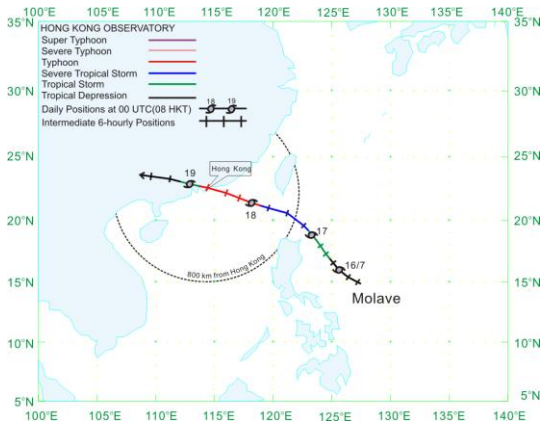


Figure 5 Track of Molave (0906) on 15 19 July 2009.

Severe Tropical Storm Goni (0907)

Goni formed over the western North Pacific on 1 August and became a severe tropical storm in the late afternoon of 4 August. Under the influence of Typhoon Morakot over the western North Pacific, Goni changed its direction of movement abruptly during the night of 8 August. Figure 6 shows the track of Goni. Winds in Hong Kong were moderate to fresh easterlies, occasionally strong offshore and on high ground on 3 August. As Goni moved closer to

Hong Kong on 4 August, winds strengthened in the afternoon and became generally strong east to southeasterlies, occasionally reaching gale force offshore and on high ground in the evening. Goni strengthened into a severe tropical storm and continued to move closer to Hong Kong that evening. Winds were strongest in the western part of Hong Kong with gales offshore and on high ground. Goni was closest to Hong Kong between about 8 p.m. and 10 p.m. when it passed about 110 km to the southwest. With Goni moving gradually away from Hong Kong thereafter, local winds became southeasterlies and gradually subsided. Goni weakened into a tropical storm overland in the afternoon of 5 August and local winds continued to subside.

The weather in Hong Kong was mainly fine and very hot at first on 3 August. Under the influence of the outer rainbands of Goni, there were squally showers and thunderstorms in the afternoon. It was mainly cloudy with squally showers on 4 August and the following day. Heavy rain affected Hong Kong during the evening of 5 August.

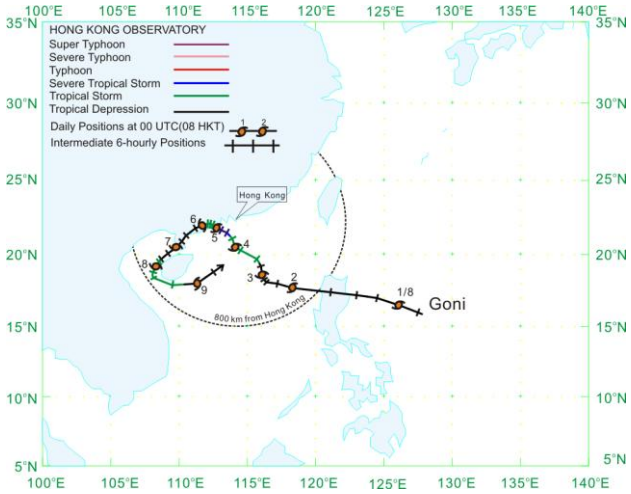


Figure 6 Track of Goni (0907) on 1 - 9 August 2009.

Tropical Storm Mujigae (0913)

Mujigae formed over the central part of the South China Sea in the morning of 9 September and intensified into a tropical storm on 10 September. Figure 7 shows the track of Mujigae. Winds in Hong Kong were moderate to fresh northeasterlies, strong offshore and on high ground in the morning of 10 September. Mujigae was closest to Hong Kong at about 2 p.m. passing about 330 km to the south. Local winds strengthened from the east in the afternoon. Winds became generally strong in the late afternoon and at night, occasionally reaching gale force offshore and on high ground. Local winds gradually moderated in the small hours of 11 September as Mujigae moved away from Hong Kong.

The weather in Hong Kong was mainly cloudy at first on 10 September. Scattered squally showers started to affect Hong Kong during the day. The weather remained cloudy with occasional rain and isolated squally thunderstorms on 11 September.

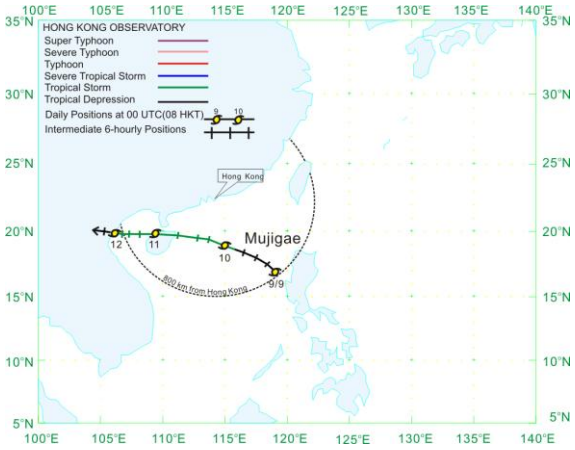


Figure 7 Track of Mujigae (0913) on 9 - 12 September 2009.

Typhoon Koppu (0915)

Koppu formed over the western North Pacific on 12 September and became a typhoon in the afternoon of 14 September. Figure 8 shows the track of Koppu. Winds in Hong Kong were moderate easterlies in the night of 13 September. Local winds freshened from the northeast in the morning of 14 September and were occasionally strong offshore and on high ground. As Koppu continued to move closer to Hong Kong, the northeasterlies became generally strong in the afternoon, with occasional gales offshore and on high ground. Easterly gale affected the territory at night, wind strength reaching storm force offshore and on high ground. Winds gradually changed its direction to the southeast in the small hours of 15 September. Koppu was at its closest to Hong Kong at around 1 a.m. that day at about 130 km to the south-southwest. Gales from the southeast persisted until around dawn and gradually subsided in the morning. Winds subsided further thereafter.

The weather in Hong Kong was sunny on 13 September but squally thunderstorms affected Hong Kong in the evening. It was cloudy with squally showers on 14 September. Heavy squally showers affected Hong Kong on 15 September.

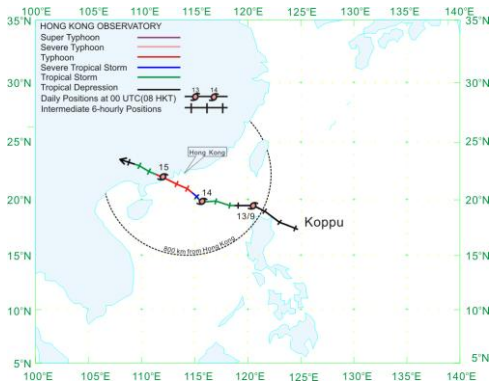


Figure 8 Track of Koppu (0915) on 12 - 16 September 2009.

Typhoon Ketsana (0916)

Ketsana formed over the western North Pacific on 25 September and became a typhoon in the morning of 28 September. Figure 9 shows the track of Ketsana. Under the combined effect of Ketsana and the northeast monsoon, winds in Hong Kong were moderate to fresh northeasterlies, occasionally strong offshore and on high ground, with rough seas and swells over Hong Kong waters on 27 September. Ketsana was closest to Hong Kong at about 2 a.m. on 28 October when it passed about 720 km to the south. Ketsana gradually moved away from Hong Kong during the day.

The weather in Hong Kong was mainly cloudy with sunny intervals during the day on 27 September. Under the influence of the outer rainbands of Ketsana and the northeast monsoon, it was cloudy with rain on 28 September and the rain was heavy at times in the afternoon.

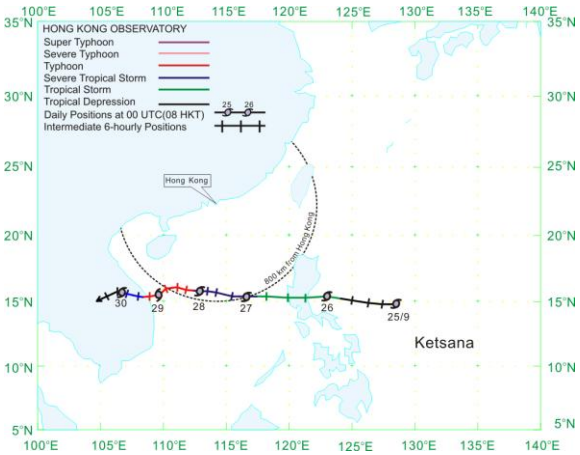


Figure 9 Track of Ketsana (0916) on 25 - 30 September 2009.

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

During their passages, Typhoon Molave, Severe Tropical Storm Goni and Typhoon Koppu each brought over 100 millimetres of rainfall to Hong Kong and necessitated the issuance of rainstorm warnings. The storm surge of Koppu coincided with high tide and caused flooding in low-lying areas. On the other hand, Tropical Storms Soudelor and Mujigae brought only about 20 millimetres of rainfall to the southern part of Hong Kong.

During the passage of Linfa, only a few millimeters of rainfall were recorded in most parts of Hong Kong but over 100 millimetres of rainfall were recorded in Mui Wo on Lantau Island in the southwestern part of Hong Kong on 21 June.

Around 50 millimetres of rainfall were recorded over most parts of Hong Kong during the passages of Nangka and Ketsana.

During the passage of Koppu, heavy squally showers affected Hong Kong on 15 September and brought more than 100 millimetres of rainfall to many parts of Hong Kong. The storm surge of Koppu arriving during high tide raised the sea level to a maximum of 3.43 metres at Tai Po Kau in the northeastern part of Hong Kong, which was one of the highest sea levels recorded in the past decade. Eight reports of flooding were received, with Tai O, a small fishing village in western Lantau Island, being worst hit. At Tai O, storm surge and heavy rain together with high tide resulted in flood waters reaching 1.5 metres deep, bringing damage to goods and equipment in the shops there. Around ten people had to be evacuated. There were also many incidents of vehicles being affected by flooding. In urban Kowloon, four drivers had to be rescued by firemen when their taxis were affected by flood waters.

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

No significant damages were reported in Hong Kong during the passages of Linfa, Nangka and Ketsana.

There were 20 reports of fallen trees in Hong Kong during the passage of Soudelor. A large 20-metre tall tree fell in urban Kowloon and caused temporary disruptions to the traffic.

Five people were injured during the passage of Molave. There were at least 425 reports of fallen trees and three reports of collapsed scaffolding. In the New Territories over the northern part of Hong Kong, a 10-metre tall tree toppled and damaged the roof of a dwelling nearby. Six people were forced to evacuate their wooden house after it was damaged by a fallen 14-metre tall tree.

Another large tree fell on private vehicles parked there. In Kowloon, a 20-metre tall tree collapsed and damaged the electric cables and rooftop of a house, interrupting the electricity supply to seven households nearby. The windscreens of a bus and a lorry were smashed by a collapsing tree in the urban areas and the New Territories respectively. Three yachts ran aground in Hong Kong waters. At the Hong Kong International Airport, 11 flights were cancelled, 31 flights were delayed and one flight was diverted.

Four people were killed and ten people were injured during the passage of Goni. Two men were drowned and one was injured when a barge capsized during squally thunderstorms. Two other men were killed when they fell off from a scaffolding. A tree was reported collapsed in the New Territories but no one was injured. At the Hong Kong International Airport, 4 flights were cancelled and 17 flights were delayed.

A glass sheet fell from a building in the urban areas during the passage of Mujigae and a passer-by was injured by the debris of glass.

At least 74 people were injured, four of them seriously during the passage of Koppu. There were 48 reports of fallen trees. There were also five reports of loose scaffoldings and one report of a fallen external wall. In the New Territories, a large tree fell and damaged a warehouse nearby. A scaffolding was blown off by strong winds, damaging four vehicles nearby. In the urban areas, strong winds damaged the door of a commercial building and a person was injured by pieces of broken glass. At the Hong Kong International Airport, eight flights were diverted.

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

   A web-based application for automatic Dvorak analysis of tropical cyclones over the northwest Pacific and South China Sea was developed and on trial use as additional tools for forecasters in the operational analysis of tropical cyclones intensity.

The Tropical Cyclone Information Display and Processing System (TIPS) was enhanced:

i) to support the construction of multi-model ensemble forecast track using the 'Motion Vector Consensus' method as an alternative to position-based consensus to cater for incomplete forecasts from individual ensemble members;

ii) to incorporate the ensemble mean track predictions by the Typhoon Ensemble Prediction System (EPS) of JMA; and

iii) to allow the overlay of tropical cyclone strike probability information derived from the JMA One-week EPS, in addition to ECMWF EPS, to facilitate the formulation of the subjective warning track.

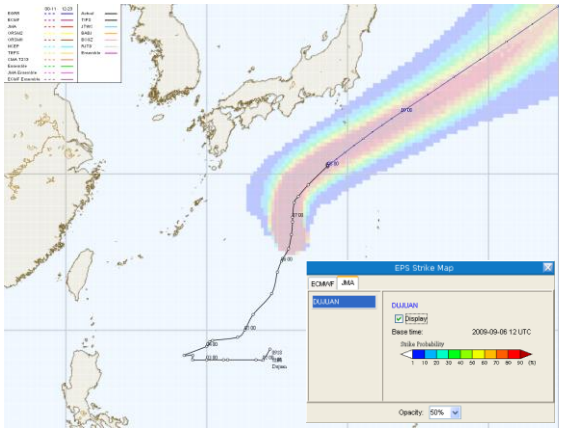


Figure 10 An overlay of the tropical cyclone strike probability map derived from the JMA One-week EPS on Hong Kong Observatory's warning track

Tropical cyclone predictions from CMA EPS encoded in CXML format and made available under the THORPEX GIFS-TIGGE project were routinely acquired and processed. Retrieval of EPS tropical cyclone products from other centres, such as NCEP and KMA, was underway and would be incorporated into TIPS to support tropical cyclone operations.

With dual wind sensors put in place at all the reference anemometer stations for operation of the local tropical cyclone warning system, a composite data stream for each site was derived and presented to the forecasting office in a reliably and timely fashion. The Integrated Weather Monitoring Panel (IWMP) was also enhanced to assimilate the combined data stream for tropical cyclone monitoring.

b. Hydrological Achievements/Results

Since 1997, about HK$8 billion worth of major river-training works and flood-control projects had been completed in the New Territories over the

northern part of Hong Kong. As a result, the flooding situation in the New Territories had improved significantly.

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 26 km of drainage channels and 5 km of stormwater drains were in progress. Major flood prevention works under planning and design included 14 km of drainage channels.

For the urban area in West Kowloon, 43 km of stormwater drains and 2 km of drainage tunnel had been completed. Plan was also in hand to construct another 3 km of drainage tunnel.

For other urban areas, the construction of 32 km of stormwater drains and 11 km of drainage tunnel were underway. Further major flood prevention works under planning and design included 5 km of stormwater drains.

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

Over 2,000 km of drains, engineered channels, culverts and watercourses were inspected and maintained in 2008 (2009 figure to be available after the end of the year). 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. To effectively and precisely alert the residents and shop-keepers in a local low-lying urban district on Hong Kong Island for possible flooding due to coincidence of high tide and heavy rainstorm, an automated flooding information dissemination system had been implemented since the 2006 wet season. When the forecast or recorded hydrological data reach the triggering criteria, advisory flood alerts would be sent to registered users via mobile phone Short Message Service (SMS) messages or pre-recorded voice phone calls. A list of flooding blackspots was also compiled to facilitate the deployment of resources to carry out immediate relief measures during adverse weather situations. (Key Result Areas 2, 4)

To enhance typhoon rainfall forecast, a new forecast tool "QMORPH Tropical Cyclone Rainfall Forecast" was developed and launched for operational use in the 2009 typhoon season. The tool provides rainfall predictions up to 3 days ahead by extrapolating the microwave satellite rain rate estimate "QMORPH" from NOAA Climate Prediction Center along the subjective forecast track.

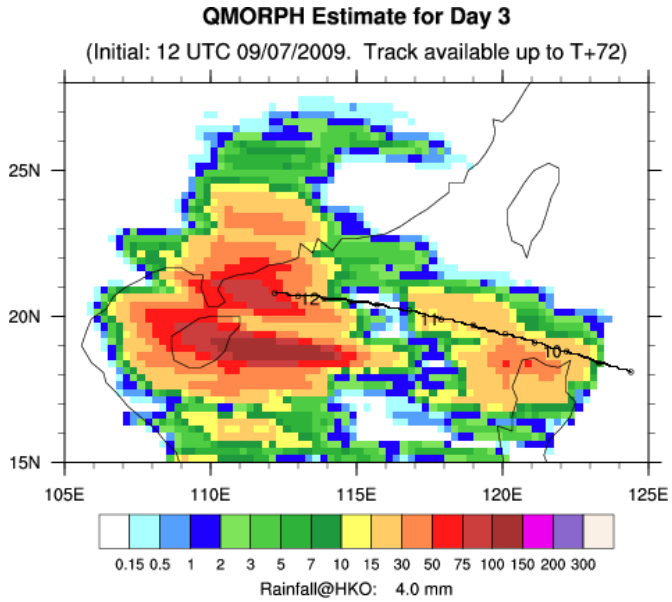


Figure 11 Forecast rainfall accumulation for day 3 ending 12 UTC, 9 July 2009 output by the QMORPH Tropical Cyclone Rainfall Forecast tool during Tropical Storm Soudelor (0905).

c. Disaster Prevention and Preparedness Achievements/Results

Talks and booth displays on disaster prevention and preparedness were conducted by the Hong Kong Observatory for students and the general public.

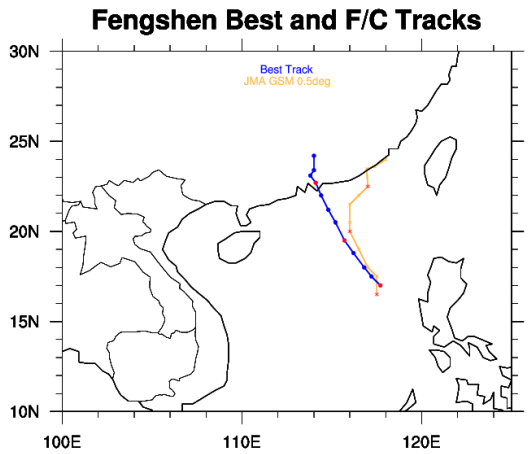
d. Research, Training, and Other Achievements/Results

A training course on radar meteorology was provided to 10 meteorologists from 10 WMO Members by Hong Kong Observatory during 30 November to 4 December 2009 covering, amongst other topics, applications of weather radar in tropical cyclone monitoring.

An inter-comparison of WRF and an adapted version of the NHM from JMA was conducted for a number of tropical cyclone cases that affected Hong Kong in 2008. Preliminary results revealed that the forecast skill of both models, in terms of the track and intensity of tropical cyclone, were in general comparable. Nevertheless, WRF was found to be computationally more efficient than NHM.

Significant eastward biases were registered with nearly all the global models in the forecast track of Fengshen (0806). In a numerical study using WRF, with the introduction of a suitably constructed tropical cyclone bogus, the bias was largely corrected. The results highlighted the importance of proper initialization of tropical cyclone in NWP models to track predictions.

(a)



(b)

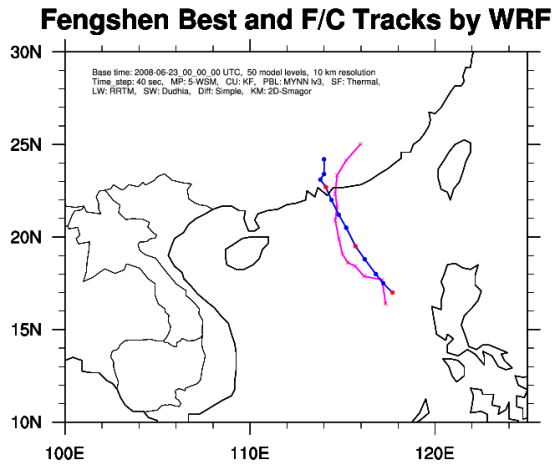


Figure 12 Hong Kong Observatory best track of Fengshen (blue) during 00 UTC 23 June 2008 to 00 UTC 26 June 2008 and the corresponding forecast tracks by (a) JMA GSM; and (b) WRF, both initialized at 00 UTC 23 June 2008.

A study was conducted to examine the potential application of EPS tropical cyclone track information for probability forecast of heavy rain using QMORPH. Results showed that the EPS tracks could provide some hints on the uncertainty of the rainfall predictions but a gross over-confidence was apparent in the probability forecasts thus generated.

A meteorologist of the Observatory served as a resource person for the Typhoon Committee Roving Seminar 2009 held in Nanjing, China from 16-19

November 2009 to share with the participants his expertise and experience in the analysis and forecasting of high-impact weather associated with tropical cyclones.

A multiple regression model to correlate tropical cyclone wind structure parameters including strong/gale/storm/hurricane wind radii in different quadrants to the tropical cyclone intensity, latitudinal position, 6-hour speed of movement and the radius of maximum wind was developed based on the multi-platform satellite surface wind analysis data generated by the National Oceanic and Atmospheric Administration (NOAA) for tropical cyclones over the western North Pacific and the South China Sea during 2006-2008. Coupled with the tropical cyclone forecast track and intensity as well as surface characteristics information, the model could help generate wind forecasts at specific locations during the passage of the tropical cyclone. Its performance in forecasting surface wind at the Hong Kong International Airport was evaluated using tropical cyclone datasets for 2008 and 2009. Verification results showed that the mean RMS error for 24-hour forecast was about 13 km/h (7 knots). This tool would be put into operational trial in 2010.

e. Regional Cooperation Achievements/Results

Attachments to the Hong Kong Observatory were arranged for meteorologists from Vietnam and Malaysia. (Key Result Area 2)

f. Identified Opportunities/Challenges for Future Achievements/Results

Efforts would be expended by the Hong Kong Observatory to further improve the forecast of tropical cyclone intensity.

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

Early notification of issuance of tropical cyclone signal for increasing gale force winds was communicated to the major transport operators. Regular signal change assessment was also relayed to the container terminal to facilitate their operational planning. An enhanced level of preparedness in the transport and logistics infrastructure ensured an orderly response to the threats of tropical cyclones and facilitated more efficient traffic management to minimize the potential societal and economic impact.

b. Hydrological Achievements/Results

Please refer to Key Result Area 1(b).

c. Disaster Prevention and Preparedness Achievements/Results

The Drainage Service Department was provided with the probability of Amber Rainstorm Warning (widespread and persistent heavy rain with hourly rainfall at 30 mm or higher) in the next couple of hours to facilitate their flood control operations.

Rainfall and wind information on a district by district basis were provided to the Home Affairs Department through specialized web pages to allow them to prepare for relief operations in their districts.

As a continuing effort to promote awareness and preparedness of natural disasters, courses, lectures, briefings and visits to the Observatory were held for the general public, government departments, various stakeholders and private organizations such as transport operators, container terminal operators, insurance sectors to promote the effective use of the weather forecasting and warning services provided by the Observatory.

d. Research, Training, and Other Achievements/Results

A series of public talks on "Weather and Everyday Life" was held at various districts in Hong Kong between 25 May and 9 June 2009. The talks elaborated on weather phenomena affecting the daily life and the precautionary measures to be taken during tropical cyclones and severe weather. (Key Result Areas 4, 5)

e. Regional Cooperation Achievements/Results

Please refer to Key Result Area 1(e).

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

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

a. Meteorological Achievements/Results
Nil.

b. Hydrological Achievements/Results
Nil.

c. Disaster Prevention and Preparedness Achievements/Results

Nil.

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

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
Nil.

b. Hydrological Achievements/Results

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

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

c. Disaster Prevention and Preparedness Achievements/Results
Nil.

d. Research, Training, and Other Achievements/Results

An officer of the Hong Kong Observatory attended the Training Course on "Multi-hazard Early Warning" held in Nanjing, China, on 8 – 26 June 2009. (Key Result Area 7)

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

e. Regional Cooperation Achievements/Results

The WMO Commission for Aeronautical Meteorology (CAeM) pilot project on "Aviation Weather Disaster Risk Reduction" (ADRR) in RA II, established in its 13th session in 2006 and with a focus on tropical cyclone hazards, was making steady progress.

In 2009, the dedicated website (http://adrr.weather.gov.hk) developed by the Hong Kong Observatory for the pilot project was further enhanced to include tropical cyclone strike probability maps generated from NWP ensemble prediction system of the China Meteorological Administration (CMA), in addition to that of ECMWF. The geographical coverage of the tropical cyclone forecast on the website was also extended eastward from 125°E to 140°E to cover a larger part of the Pacific Ocean in response to feedback from aviation users.

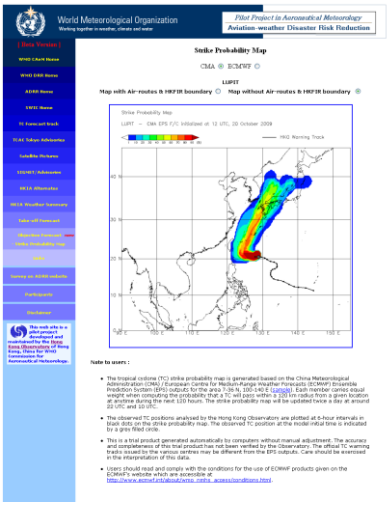


Figure 13 Strike probability of tropical cyclone Lupit (from CMA) shown on the ADRR pilot project website.

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

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

a. Meteorological Achievements/Results

A sensitivity analysis was conducted by the Hong Kong Observatory on the magnitude of storm surge as a result of a change of tropical cyclone track.

b. Hydrological Achievements/Results

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

c. Disaster Prevention and Preparedness Achievements/Results

A local alert system on storm surge flooding for a small village community on Lantau Island in Hong Kong, operated in collaboration with other key government departments and emergency response units, was implemented. The village was severely flooded during the passage of Typhoon Hagupit in 2008. Early alerts with lead time of a few hours were communicated to key operational personnel as well as to the community leaders using SMS. The early alert system proved very effective in its first season of operation and favourable feedback was received from users and residents.

Fig. 14 Hong Kong Observatory staff, in collaboration with other key government departments and emergency response units, gave a media briefing on the alert system on storm surge flooding.

Fig. 15 A large-scale drill on the alert system on storm surge flooding was conducted in collaboration with other key government departments and emergency response units.

A pamphlet on Storm Surge was published in 2009 providing information on the cause and effect on storm surge, monitoring and forecasting of storm surge and the precautions to take.

d. Research, Training, and Other Achievements/Results

Please refer to Key Result Area 2(d).

e. Regional Cooperation Achievements/Results

Enhancements to the "Aviation Weather Disaster Risk Reduction" pilot website, to extend coverage of tropical cyclone forecasts to Indian Ocean as well as evaluation of tropical cyclone strike probability forecasts would be considered for implementation in the coming year.

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

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

a. Meteorological Achievements/Results

To enhance public awareness on the potential threats of intense typhoons, as well as for the documentation and analysis of tropical cyclone long-term intensity trends in the face of climate change, typhoons were sub-divided into three intensity categories, namely: typhoon, severe typhoon and super typhoon. The new intensity classification, as shown in the table below, incorporating such changes was launched in the 2009 tropical cyclone season.

Classification of Tropical Cyclones	Maximum sustained wind speed near the centre (km/h)
Tropical Depression	41 - 62
Tropical Storm	63 – 87
Severe Tropical Storm	88 – 117
Typhoon	118 – 149
Severe Typhoon*	150 – 184
Super Typhoon*	185 or above

* New categories starting 2009

A recent analysis of tropical cyclone activity in western North Pacific and South China Sea reveals that the annual total number of tropical cyclones decreased from about 35 in the 1960s to about 27 after 2000. Closer to Hong

Kong, the annual number of tropical cyclones making landfall along the south China coast within 300 km of the Observatory Headquarters in the past 40 years or so (1961–2008) had decreased from about 3 tropical cyclones in the 1960s to about 2.5 between 1990 and 2008, but the rate of change is not statistically significant. The total number of typhoons, severe typhoons and super typhoons making landfall within 300 kilometers of Hong Kong remained unchanged at around one per year during the period 1961-2008.

b. Hydrological Achievements/Results

The Observatory provided support to the Drainage Service Department in their review of the Drainage Master Plans in Yuen Long & North Districts and feasibility study of applying integrated water resources management system in real-time flood forecasting. Results showed that direct output from SWIRLS (Short-range Warning of Intense Rainstorms in Localized Systems) nowcasting system agreed reasonably well with the measurement at the nearest rain gauge but did not serve as a good predictor of flooding over a small catchment due to spatial variation and time fluctuation. Further studies would be conducted to establish a better correlation between actual rainfall over the catchment area and flooding. Rainfall nowcast data would be used as an input later.

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

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

use of local rainfall forecasts to mobilize maintenance staff to deal with flooding, and a study to identify the critical input parameters of the MIKE11 model and to quantify their uncertainties and sensitivities on the flood risk assessment.

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

c. Disaster Prevention and Preparedness Achievements/Results

A network camera with Pan-Tilt-Zoom capability was installed at a popular beach in Hong Kong in June 2008. Making use of recent communication and web technology, real-time weather photos were made available to forecasters for remote monitoring of the weather and sea conditions at the site. This had demonstrated its usefulness, in particular during the approach of tropical cyclones in 2009. Installation of cameras at other coastal areas which are commonly affected by high waves and swells is being planned.

d. Research, Training, and Other Achievements/Results

Drills and exercises on operational procedures during severe weather and tropical cyclone situations were conducted to reinforce the Observatory forecasters' competence in carrying out relevant forecasting duties.

An officer of the Observatory attended the RA IV Workshop on Hurricane Forecasting and Warning held in Miami, Florida, USA, from 23 March to 3 April 2009.

e. Regional Cooperation Achievements/Results

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

The Severe Weather Information Centre (SWIC) website, operated by Hong Kong, China for WMO, continued to serve as a major and authoritative channel for dissemination of real-time tropical cyclone warnings and information worldwide. The total page view exceeded 13 million in the 12-month period since October 2008.

f. Identified Opportunities/Challenges for Future Achievements/Results

The weather wizard gadget provided to the public for monitoring and displaying the latest hourly temperature/relative humidity readings and weather warnings from the Observatory's website was very popular. The Observatory proposed to adapt this gadget in providing weather warnings to the public worldwide through the SWIC platform based on the warning data from WMO Members. To begin with, a pilot project among Hong Kong, China; Macau, China; and Guam was under testing in 2009.

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 1(e).

b. Hydrological Achievements/Results
Nil.

c. Disaster Prevention and Preparedness Achievements/Results
Nil.

d. Research, Training, and Other Achievements/Results

Two technical papers summarizing the project findings of the Typhoon Committee Research Fellowship Scheme in 2006 and 2007 respectively were finalized and submitted to the Typhoon Committee Annual Review for publication.

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

e. Regional Cooperation Achievements/Results

The WMO RA II Pilot Project on the Provision of City-Specific Numerical Weather Prediction (NWP) Products to Developing Countries was making steady progress. 18 RA II Members, 4 of which were Typhoon Committee Members, participated in the project. Forecast time series for a total of 160 cities were being provided to 13 participating Members.

Based on numerical experiments of several tropical cyclone cases in 2008, it was found that NHM showed promising results in simulating the structure of intense tropical cyclones like Typhoon Hagupit. A new scheme of surface flux exchange coefficients and roughness length over sea surface was developed. It was demonstrated that the scheme had positive impact on the forecast of wind distribution of tropical cyclones.

A meteorologist from the China Meteorological Administration was attached to the Observatory under the TCRFS from 29 October to 28 December 2009 to study the tropical cyclone bogus in NHM and its impact on forecast track and intensity.

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

III. Resource Mobilization Activities

Nil.

IV. Update of Members' Working Groups representatives

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5. Resource Mobilization Group
Nil.