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LEGISLATIVE COUNCIL
PANEL ON ENVIRONMENTAL AFFAIRS

Enhancing Capabilities in Meteorological Forecasting and Coping with Extreme Weather

Purpose

Chapter 5 of Hong Kong's Climate Action 2050 says "to combat climate change effectively, apart from implementing ambitious decarbonisation strategies, we also need to adopt a comprehensive strategy on climate change adaptation and resilience to protect the life, health and property of the people from extreme weather and strengthen the resilience of the community". This paper reports on the latest progress of the Government's major measures for enhancing the capabilities in meteorological forecasting and coping with extreme weather in order to continuously strengthen Hong Kong's overall climate resilience.

Background

2. According to the announcement from the World Meteorological Organization (WMO), 2023 was the hottest year on record. Global warming and extreme weather events caused by climate change have been intensifying. Like other cities, Hong Kong is facing problems such as rising temperatures and more frequent extreme weather events. For Hong Kong, 2023 was an eventful year with the hottest summer on record from June to August, the ferocious strike by Super Typhoon Saola on 1 and 2 September and the record-breaking rainstorm on 7 and 8 September.

3. To mitigate global warming, the Government has set the targets to reduce Hong Kong's total carbon emissions by half from the 2005 level before 2035 and achieve carbon neutrality before 2050. To this end, the Government announced Hong Kong's Climate Action Plan 2050 setting out the four major decarbonisation

strategies and measures, namely, net-zero electricity generation, energy saving and green buildings, green transport and waste reduction, with a view to leading the city towards carbon neutrality. As discussed in paragraph 1, we need to adopt an effective strategy on climate change adaptation and enhance our handling capabilities continuously to minimise the impact on society, with protecting people's safety as our priority.

Strategies for Combating Climate Change

4. Hong Kong has been actively participating in international organisations on climate change to keep itself updated on the latest developments in policies and technologies for combatting climate change. The Government will continue to keep in view the latest development in climate science and the latest assessment reports regularly published by the United Nation's Intergovernmental Panel on Climate Change (IPCC). The Hong Kong Observatory (HKO) provides climate data and scientific support to relevant departments for research on climate change and extreme weather events. With the release of the IPCC's Sixth Assessment Report (AR6), HKO updated its projections for future temperature, rainfall, and mean sea level in Hong Kong under different greenhouse gas emissions scenarios in end-2021. Based on the latest climate data and projections, relevant departments conduct impact assessments and develop adaptation policies and plans to enhance the city's adaptation and resilience ability.

Strengthening Weather Forecast

5. Accurate weather forecasting requires sufficient meteorological data and appropriate meteorological instruments. HKO has made ongoing efforts to exchange real-time meteorological data with neighbouring regions and other members of the United Nations World Meteorological Organization to keep track of weather patterns and analyse their development trends. In addition to regular enhancements of its surface observation network, HKO also acquires new instruments to strengthen its meteorological monitoring capabilities. For example, in 2021, HKO installed an advanced Phased Array Weather Radar (PAWR) in Sha Lo Wan of Lantau Island. The PAWR can quickly perform three-dimensional scans and monitor localised and rapidly changing severe weather that has a high impact on the public, such as waterspouts, hail, and squalls caused by intense thunderstorms. HKO has recently replaced the Tai Mo Shan weather

radar, which has been serving Hong Kong since 1999. The new radar will be put into service in the rainy season of this year to monitor various types of severe weather including thunderstorms, rainstorms, and tropical cyclones. HKO will continue to strengthen its weather forecasting capabilities and strive to issue warning information to the public about severe weather as early as possible.

6. Located in the subtropics, Hong Kong is vulnerable to heavy downpours in rainy seasons. For that reason, HKO has developed the Rainstorm Nowcasting System to predict rainfall. In view of the increasingly frequent extreme rainfall events due to climate change, HKO launched the Localised Heavy Rain Advisory service in 2021 incorporating rainfall forecast from the nowcasting system to alert the public of imminent localized heavy rain for taking precautionary measures well before the rainfall extends generally over Hong Kong which necessitates the issue of a rainstorm warning signal. While the average lead time of the rainstorm warning signal has increased over the past few years, rainstorms develop stochastically and may change drastically within a short period of time. Therefore, predicting rainstorms and extending the lead time of warning has remained a major challenge for the global scientific community. Notwithstanding this, with its internationally renowned technical capabilities as one of the three WMO-designated Regional Specialized Meteorological Centres for Nowcasting, HKO remains committed to exploring the use of the latest technologies such as artificial intelligence (AI) in rainstorm nowcasting. Moreover, to step up the dissemination of information under inclement weather conditions, HKO gives hourly video briefings to the media and the public on the latest weather conditions when the Black Rainstorm Warning Signal is in force.

7. As for tropical cyclone warnings, progressive improvements made in the HKO's tropical cyclone track forecasts over the past few years have resulted in fewer errors in general. HKO has been running AI weather forecast models on a trial basis since mid-2023, which provide forecasts for wind direction, wind speed, temperature, and mean sea-level pressure, as a reference for formulation of nine-day weather forecasts or tropical cyclone track forecasts. HKO also launched the "Pangu-Weather Model" weather forecast maps on its website and app, to enable users to anticipate future weather changes. In addition, to address flood risk in low-lying coastal areas due to storm surges, HKO provides storm surge forecasting and warning services to relevant government departments to support emergency preparedness and implementation of emergency response plans. To cope with the greater risks caused by storm surges due to climate

change, HKO continues to step up its storm surge forecasting and warning services in response to the latest demands from relevant government departments regarding forecast locations and warning thresholds.

8. In addition, to cope with increasingly high temperatures from global warming, HKO enhanced the Very Hot Weather Warning service in 2022 and 2023 by providing push notifications on special alerts for "Prolonged Heat" and "Extremely Hot Weather" through mobile phones, as well as updating the warning precautions.

Strengthening Infrastructure

9. The Government attaches great importance to the capability of Government's infrastructure in combating climate change and extreme weather and established in 2016 the Climate Change Working Group on Infrastructure (CCWGI) under the leadership of the Civil Engineering and Development Department (CEDD) to coordinate the efforts of the works departments in adapting to climate change. The CCWGI will report its work plans and progress to the inter-departmental Steering Committee on Climate Change and Carbon Neutrality[1] chaired by the Chief Executive. The CCWGI has coordinated studies relating to the potential effects of extreme temperatures, extreme storm surges and super typhoons on Government critical infrastructure (CI). The CCWGI will take into account the climate change parameters to update the relevant design standards for infrastructure in a timely manner. With reference to the AR6 published by the IPCC, the works departments under CCWGI updated the relevant design manuals, guidance notes and practice notes[2] in the past few years. The CCWGI completed the resilience study review for about 350 numbers of Government CI, covering Government buildings, coastal structures, drainage and sewerage, transport, water supplies, waste management, fill management. By taking into account the recommendations of the resilience study, the relevant departments responsible for

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[1] To align with our country's commitment to achieve carbon neutrality before 2060, Hong Kong strives to achieve carbon neutrality before 2050. The inter-departmental Steering Committee on Climate Change and Carbon Neutrality chaired by the Chief Executive formulates the overall strategy and oversees the coordination of various actions.

[2] The updated design manuals, guidance notes and practice notes include Port Works Design Manual, Stormwater Drainage Manual, Guidance Notes on Road Pavement Drainage Design, Structures Design Manual for Highways and Railways, Enhanced Design Standards of Aboveground Drainage System, Updated Provision for Slope Drainage Design, Design Guide for Drainage Installation for Government Buildings, etc.

the Government CI continue to formulate necessary works and measures to enhance their CI's resilience, and implementation plans in an orderly manner. The CCWGI also shares relevant experience and findings with public organisations and utility undertakers through the relevant government departments, thereby facilitating the enhancement of the overall infrastructure resilience of our society.

Stormwater Drainage System Improvement

10. Climate change will increase rainfall, which will add extra loading on the existing stormwater drainage system. Considering Hong Kong's topographical features, the Drainage Services Department (DSD) has been adopting a multi-pronged approach, including stormwater interception, flood storage, and drainage improvement, to enhance the flood protection capacity across the territory. Over the years, more than 90 drainage improvement projects were completed and have been in operation, including 4 drainage tunnels at Hong Kong Island West, Lai Chi Kok, Tsuen Wan and Kai Tak; 5 stormwater storage schemes at Tai Hang Tung, Sheung Wan, Happy Valley, On Shau Road and Anderson Road; over 100 kilometres of river training works in the New Territories, and 27 village flood protection schemes at low-lying villages in order to cope with extreme weather, such as typhoons and heavy rains.

11. To further enhance the flood prevention and resilience of the city, DSD is currently implementing 11 stormwater drainage improvement projects including "Drainage Improvement Works in Tsim Sha Tsui" and "Yuen Long Barrage Scheme". In addition, DSD will take forward 7 drainage improvement projects in 2024, covering Wong Tai Sin, Hong Kong Island East and other areas hit by severe flooding before. DSD will continue to review the drainage master plans for various districts to assess the flooding risk across the territory, and to allocate resources for taking forward drainage improvement works.

12. In addition, DSD actively makes use of innovative technologies in drainage works. For example, DSD developed the Hydrometric Information System, remote sensors were installed at various locations to collect real-time data on water levels at rivers/channels, rainfall and tide levels, in order to facilitate the relevant staff to monitor the conditions of relevant rivers/channel and rainfall in real-time through smartphone and computer and to take appropriate emergency responses swiftly. DSD also adopted new technologies including the use of river

desilting robots and remotely operated pipeline inspection robots to assist in the maintenance works to enhance the working efficiency.

13. In the long run, climate change is a challenge across the globe. Hong Kong needs a forward-looking strategy to proactively respond to this challenge. DSD is undertaking "Strategic Planning Study on Flood Management Against Sea Level Rise and Extreme Rainfall". The study will make reference to the experiences and advice of other cities and professional disciplines in formulating long-term flood prevention strategy for the territory. It is expected that the study will be completed in 2024.

14. Extreme rainstorms will also have an impact on public roads. The Highways Department (HyD) is taking forward a series of preventive measures including the inspection of roads with high risks, drainage facilities of structures and pumping facilities in road tunnels/ pedestrian subways. It will also step up the inspection and clearance works of the outfalls and drains of public roads with the relevant government departments to ensure that they are free from blockage. HyD has completed a review of the resilience of 75 critical road infrastructures under its purview against the threat of flooding. It is now conducting a technical assessment and drawing up an implementation plan for the relevant countermeasures, which is expected to be completed in the second quarter of 2024, with the implementation works expected to commence from 2025 onwards in phases. Meanwhile, HyD will also install flood warning systems for some pedestrian subways along Shing Mun River in Sha Tin, Lam Tsuen River in Tai Po and Tai Po River in phases from 2024 to 2025.

Continuously Enhancing Resilience in Coping with Landslide

15. In order to cope with the landslide risk caused by more frequent extreme rainstorms under climate change, the Geotechnical Engineering Office (GEO) of CEDD will keep enhancing the capability of existing slopes in coping with landslide risk through the following strategies:

(a) carrying out regular inspection and preventive maintenance for government slopes, requiring private owners to fulfill their duties in maintaining their slopes, and exercising geotechnical control on public works and private development projects to ensure slope safety;

(b) continuing the Landslip Prevention and Mitigation Programme (LPMitP) for strengthening slopes against inclement weather according to a risk-based approach; and

(c) reviewing the slope management in Hong Kong and advising the Government on technical aspects by international experts regularly, with the aim of continuously improving the quality of slope management.

16. For man-made slopes, relevant government departments and private owners responsible for their maintenance should inspect the slopes every one to two years and carry out necessary maintenance according to the Guide to Slope Maintenance published by GEO. GEO has been providing technical assistance and advice to them. In addition, GEO selects private slopes for safety screening studies every year. Based on the slope condition, GEO will recommend relevant owner carry out proper maintenance works or, when a private man-made slope is found to have major signs of distress or be liable to become dangerous, recommend the Buildings Department (BD) to issue Dangerous Hillside Orders to the relevant owner.

17. Moreover, GEO further systematically upgrade man-made slopes and natural hillside catchments according to a risk-based approach. All man-made slopes with relatively high potential impacts in the Slope Catalogue[3] have been upgraded in the early years. At present, GEO continues the LPMitP to deal with the remaining man-made slopes with moderate potential impacts and implement risk mitigation measures for the identified natural hillside catchments in an orderly manner[4].

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[3] According to the Slope Catalogue of GEO, there are about 61 000 registered man-made slopes in Hong Kong. About 45 000 are government man-made slopes and about 16 000 are private man-made slopes.

[4] Among all government man-made slopes, about 15 000 slopes with relatively high potential impacts (e.g. locating near residential buildings, hospitals, and schools) and moderate potential impacts (e.g. locating near major infrastructures, heavily used roads and footpaths) have been upgraded in the early years. About 13 000 remaining man-made slopes with moderate potential impacts are being dealt with. The remaining 17 000 slopes are with relatively low potential impacts (e.g. locating near lightly used access roads, remote places and country parks). At present, GEO has completed safety-screening for about 6 400 private man-made slopes. GEO also implements risk mitigation measures for about 3 300 identified natural hillside catchments in an orderly manner, based on their potential impacts to the surroundings.

18. Through the above measures, the number of landslides in recent years has been significantly reduced, and the casualties caused by landslides have also been noticeably reduced. In response to the extreme weather brought by climate change, the Government will adopt a more pre-emptive and strategic approach to continuously enhance the prevailing slope engineering design standard and preventive measures and to support slope safety and natural hillside risk management through the application of innovation and new technologies (e.g. remote sensing technology), advanced computer equipment and analysis of enormous data. The Government will also explore ways to use big data, artificial intelligence and other technologies to improve our landslide risk assessment capabilities. In addition, the Government is conducting systematic investigations and studies on major landslide incidents triggered by extreme rainstorms and devising focused measures of landslide mitigation for more natural hillsides.

Combating Sea Level Rise and Storm Surges

19. Climate change causes sea level rise, and the intensification of tropical cyclones leads to increased waves and storm surges, amplifying the impact on coastal and low-lying areas. Therefore, CEDD completed a coastal hazards study at end-2021. It identified 26 coastal low-lying or windy residential areas[5] with higher risks for the formulation of improvement works and management measures[6] to safeguard public safety. The improvement works have been progressively taken forward, with 6 areas already completed and 11 areas currently in progress. The improvement works in the remaining areas are being planned and designed. All improvement works are anticipated to be completed in an orderly manner by 2027.

20. To strategically address the potential risks associated with ongoing sea level rise and changes in storm surges, CEDD commenced a study on Shoreline Management Plan. This study aims to provide guidelines on planning and implementing urban coastal development and protection measures and formulate

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[5] The subject study adopted a risk management approach to assess the likelihood of coastal hazards and the severity of consequences, and made reference to the records of coastal damage caused by super typhoons in the past.

[6] The improvement works comprise various protective and adaptive options, which include constructing or raising wave walls along the coastline, installing flood barriers at suitable places behind the coastline to cut off water pathways towards inland areas, and/or installing demountable flood barriers at building frontages. Management measures involve the formulation of action plans on early alert systems and emergency preparedness.

the related long-term strategies and preventive measures in order to enhance the Government's and relevant stakeholders' capacities to combat climate change. It is expected that the study will be completed in 2024.

Response and Recovery

21. The Security Bureau has formulated the Contingency Plan for Natural Disasters (CPND), which sets out the Government's strategy, organisational framework and alerting system for responding to natural disasters, as well as the functions and responsibilities of Government bureaux/departments, utility companies and non-government organisations in the event of a natural disaster. In the event of super typhoons or other natural disasters of a substantial scale, the Chief Secretary for Administration will convene an inter-departmental Steering Committee meeting for the provision of high-level coordination and supervision in the various stages of preparedness, contingency, and recovery as well as the formulation of priority-setting for various tasks, thereby enabling the normal daily living of the community to resume as quickly as practicable. If a natural disaster has caused extreme and widespread impact, such as widespread flooding, severe landslides or severe disruption to public transportation services, the Steering Committee will consider making an "extreme conditions" announcement to allow members of the public to remain in their original safe locations. Last year, the Government activated the Steering Committee twice in response to natural disasters of a substantial scale, including during Super Typhoon Saola in August 2023 and the torrential rain in September 2023, to coordinate the contingency and recovery work of various fronts. To ensure the safety of public life and property, the Steering Committee made the first "extreme conditions" announcement in September 2023 when the rainstorm of the century hit Hong Kong. After that event, the Steering Committee has continued to lead the various departments to consolidate their experiences to continue to strengthen Hong Kong's overall capability in coping with extreme weather, and to prepare for the future rainy and typhoon seasons.

22. In order to be adequately and comprehensively prepared for natural disasters of a substantial scale, the Security Bureau regularly organises the interdepartmental pre-typhoon tabletop exercise to strengthen the preparedness for and enhance interdepartmental collaboration in responding to threats arising from natural disasters. The Government will draw on the experience gained in

the handling of large-scale natural disasters to further enhance the relevant procedures, strengthen and synergise the overall response, and fine-tune the CPND where necessary. The Civil Engineering and Development Department is actively conducting a study on the enhancement of the "Common Operational Pictures", to incorporate more common spatial data into the system with a view to improving the Government's capability in responding to natural disasters and other major incidents.

23. The Home Affairs Department (HAD) and its District Offices carry out a series of work in response to adverse weather conditions. For instance, before the typhoon season, drills would be conducted with relevant government departments, owners' organisations and property management companies on the evacuation of residents, piling of sandbags and installation of water-stop boards, etc., at sites which are prone to flooding and seawater inundation. Prior to the issuance of Tropical Cyclone Warning Signal No. 8, District Offices would arrange for relevant government departments and contractors to inspect flooding black spots and clear blocked drains, and would remind residents through their district networks to stay alert. During a tropical cyclone, HAD's Emergency Coordination Centre together with the emergency hotline would be activated round-the-clock to provide assistance to those in need. District Offices would also open temporary shelters as necessary, and arrange Care Teams and volunteers to render assistance at the temporary shelters. Besides, during very hot weather and cold spells, HAD would also open its Community Halls/Community Centres as Temporary Heat/Cold Shelters to provide temporary accommodation to people who need to take refuge from the heat and cold.

Public Education

24. To strengthen Hong Kong's capabilities in coping with extreme weather, public participation is crucial. Stakeholders in various sectors need to render their support by adopting relevant adaptation and contingency measures in their properties and facilities to reduce the impact and losses caused by extreme weather. To promote public awareness of adverse weather and warnings, HKO will continue to publicise educational information on severe weather and warnings (such as "Cool Met Stuff" videos and social media posts that introduce tropical cyclone and rainstorm warning signals and corresponding response measures) through various channels including TV weather programmes, webpages, social media, open days, public talks, etc.

25. The Transport Department (TD) organises annual typhoon exercises to enhance the response capabilities of public transport operators during typhoons, and calls on the public to pay close attention to the latest traffic news during adverse weather, and disseminate real-time traffic information (such as special road traffic conditions, railway service disruptions, transport infrastructure accidents, etc.) to the public through radio, television, TD website and the mobile application "HKeMobility".

26. CEDD actively educates the public on the precautionary measures to be taken when landslip warnings are in force, and collaborates with communities to enhance public awareness of slope safety through public education, regular publicity campaigns and advisory services, and to remind private owners of the importance of slope maintenance in preventing landslides. CEDD has also established a Community Advisory Unit to provide outreach advisory services and advice to private owners to help them fulfill their duties in maintaining their slopes. In addition, through various promotional and educational activities including TV APIs and school talks, the public is reminded to pay attention to HKO's forecasts and warnings regarding storm surges and tropical cyclones, stay away from the shoreline, and refrain from engaging in water activities for their own safety.

27. DSD has been actively promoting to the public the daily works, river improvement and conservation works, and related flood prevention knowledge through the Government TV announcements in public interests (APIs), publications and other activities, such as drainage facilities open days, river revitalisation experience days and outreach education programmes, etc.

Advice Sought

28. Members are invited to comment on the above major measures to enhance the capabilities in meteorological forecasting and coping with extreme weather.

Development Bureau
Environment and Ecology Bureau
Security Bureau
Transport and Logistics Bureau

Civil Engineering and Development Department
Drainage Services Department
Highways Department
Home Affairs Department
Hong Kong Observatory
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