

## Chapter 5

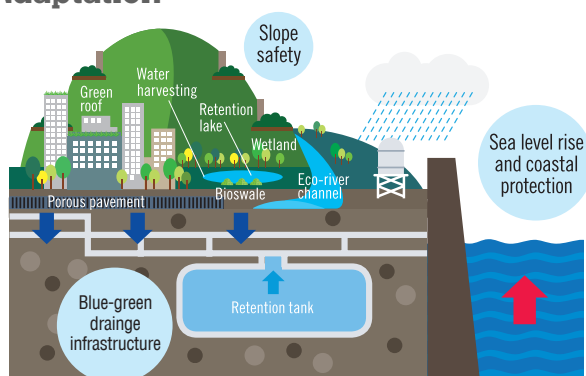
# CLIMATE CHANGE ADAPTATION AND RESILIENCE





5.1 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. We will, on the basis of the Hong Kong's Climate Action Plan 2030+, explore the measures Hong Kong must take before 2050 to enhance the adaptation and resilience capability.

## Adaptation



## Resilience



**Prepare for emergencies**



**Deal with extreme heat**



**Raise community awareness**

5.2 Hong Kong, being a coastal city, is susceptible to weather-related threats such as tropical cyclones, rainstorms and storm surges. Super Typhoons Hato and Mangkhut hit Hong Kong in 2017 and 2018 respectively, causing extensive damage, such as severe backflow of sea water in some low-lying areas and damage to waterfront facilities, etc. Furthermore, climate change has resulted in a continuous rise in the sea level, posing a potential threat to certain low-lying areas in the long run. In the face of more frequent extreme weather events, the Government must strengthen its critical public infrastructure, step up coastal protection, and continue to enhance the flood resilience of the city and stabilise slopes, etc., in order to brace for more frequent extreme weather events in the future.



Hundreds of civil servants, volunteers and contractors worked together to remove the fallen trees after the onslaught of Super Typhoon Mangkhut in 2018

## Adaptation

5.3 With the accumulation of experience in combating extreme weather events, including tropical cyclones and rainstorms, Hong Kong has laid a solid foundation for strengthening the design of buildings and infrastructure facilities, and enhancing drainage management and landslip preventive measures. The public has become increasingly aware of climate change, and is supportive of more government investment in measures to adapt to climate change. In fact, with the advancement in technologies and approaches in combating climate change, projects that aim to adapt to extreme weather can also beautify the environment. For instance, incorporating the concept of revitalising water bodies with green and ecological conservation elements into drainage works can also promote greening, biodiversity and beautification of the environment while maintaining effective drainage.

5.4 Hong Kong has been actively participating in international organisations on climate change to keep updated of the latest developments in policies and technologies for combating climate change. The Government will continue to formulate policies and plans to enhance the adaptive and resilience capabilities of the city in the light of the latest developments in climate science and relevant international standards, including the assessment reports published by the Intergovernmental Panel on Climate Change (IPCC) of the United Nations (UN), projections of temperature and rainfall in Hong Kong, and projections of change in mean sea level. Stakeholders in various sectors should also implement relevant adaptation and resilience measures on their premises and facilities to minimise the impacts and losses caused by extreme weather.

## Strengthening Infrastructure

- 5.5 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 Working Group 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 report its work plans and progress to the Steering Committee on Climate Change and Carbon Neutrality chaired by the Chief Executive.
- 5.6 The CCWGI updates the design standards for various types of infrastructure in a timely manner, taking into account the relevant climate change parameters. With reference to the Fifth Assessment Report published by the IPCC, the relevant government departments had in the past few years updated the design manuals and guidance notes, including Port Works Design Manual, Stormwater Drainage Manual, Guidance Notes on Road Pavement Drainage Design and the design guide for drainage installation for government buildings.
- 5.7 With the progressive release of the Sixth Assessment Report by the IPCC since August 2021, the CCWGI will take into account the relevant assessment reports to review and update the relevant design standards for infrastructure in a timely manner as and when necessary.
- 5.8 The CCWGI also conducts a number of studies, such as the resilience study of government CI in 2017, covering coastal structures, government buildings, drainage, water supply and sewerage facilities, etc. The resilience study included strategic assessment and review to formulate scopes of enhancement works. The study was completed in 2020. The relevant government departments will formulate measures and implementation plans to enhance their CI's resilience with reference to the recommendations of the study. The CCWGI also shares relevant experience and findings with public organisations and public utility undertakers through the relevant government departments, thereby facilitating the enhancement of the overall infrastructure resilience of our society.



Aberdeen South Breakwater



## Combating Sea Level Rise and Marine Protection

- 5.9 Sea level rise will increase flood risk at coastal and low-lying locations. To enhance the capability of coastal areas to withstand strong waves in the long run, CEDD commenced a consultancy study in 2019 to comprehensively review the low-lying coastal or windy locations in Hong Kong, and to carry out investigations of related storm surges and waves in order to assess the impacts of extreme weather and climate change at those locations. The Government plans to implement suitable improvement works and formulate management measures for some of the concerned low-lying coastal or windy locations in order of priority.
- 5.10 CEDD also plans to commence a strategic study on shoreline management to analyse the impacts of climate change on the development of coastal areas, so as to formulate suitable long-term strategies and protection measures, and to strengthen the capabilities of the Government and relevant stakeholders in coping with climate change.
- 5.11 Some coastal cities like Copenhagen and Amsterdam are considering the option of developing sponge cities and suitable artificial islands in their strategies for combating sea level rise and coastal floods arising from climate change. We will closely monitor the international strategies and developments that can provide useful reference.

## Combating Extreme Rainstorms and Tropical Cyclones

- 5.12 Climate change increases rainfall intensity and aggravates the pressure on the drainage system. Enhancing flood prevention and drainage management can reduce flood risks. DSD has updated the Stormwater Drainage Manual by including the impacts on the drainage system design caused by rainfall increase and sea level rise due to climate change. DSD will continue to review the Drainage Master Plan of various districts in Hong Kong to assess the flood risk, and allocate resources for implementing drainage improvement works.
- 5.13 DSD has adopted the “three-pronged flood prevention strategy”, i.e. stormwater interception at upstream, flood storage at midstream, and drainage improvement at downstream, to formulate appropriate flood prevention and drainage management measures. It has completed a number of major flood prevention projects, including four drainage tunnels in Hong Kong Island West, Lai Chi Kok, Tsuen Wan and Kai Tak; four stormwater storage schemes in Tai Hang Tung, Sheung Wan, Happy Valley and On Sau Road; and improvement works for rivers in the New Territories with a total length of over 100 kilometres, as well as the implementation of 27 village flood protection schemes in low-lying villages for combating extreme weather events such as tropical cyclones and rainstorms. Since 1995, DSD has eliminated 127 flooding

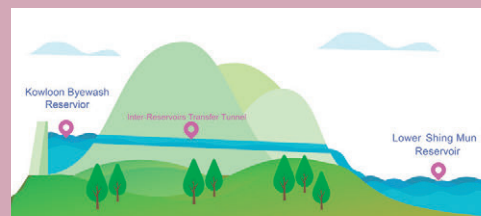


Chai Wan Breakwater

blackspots. For the remaining four flooding blackspots, the drainage improvement works at Pokfulam Village in Southern District have commenced and are expected to complete in 2024. The remaining three flooding blackspots are located at Shek Wu Wai in San Tin, Yuen Long, Lam Tsuen Valley Basin in Tai Po and on Chatham Road South in Tsim Sha Tsui. Improvement works will be carried out as soon as the planning and design works are completed. To further enhance the flood prevention and flood resilience capabilities of the city, DSD is also planning, designing and constructing a number of drainage improvement works such as the Inter-reservoirs Transfer Scheme and the Yuen Long Barrage Scheme, as well as actively promoting the introduction of stormwater storage tank, flood lake, floodable area, river revitalisation, bioretention system, and other sustainable drainage systems, etc. in new development areas.

### Inter-reservoirs Transfer Scheme

Through the construction of a 2.8 kilometres long water tunnel, the Inter-reservoirs Transfer Scheme connects Kowloon Byewash Reservoir and Lower Shing Mun Reservoir, reducing the flood risk caused by the overflow from Kowloon Byewash Reservoir to the downstream areas such as the Lai Chi Kok, Cheung Sha Wan and Sham Shui Po areas. The project can also collect an average of around 3.4 million m<sup>3</sup> of additional fresh water annually to achieve the dual goals of flood prevention and water conservation.



Happy Valley Underground Stormwater Storage Scheme: The stormwater storage tank has a capacity of 60 000 m<sup>3</sup>, which is equivalent to 24 standard swimming pools. It greatly reduces the flood risk to the low-lying areas of Wan Chai and Happy Valley

### MTRCL's flood prevention measures

EMSD requires MTRCL to formulate measures to cope with various emergencies, and conducts regular site inspections. To tackle the threats of flooding at MTR stations and underwater tunnels caused by inclement weather, MTRCL has implemented the following measures:

- The entrances/exits of most MTR stations are by design at least 450 mm above street level and equipped with 1.2 m high flood boards; waterproof doors are installed at the underground entrances/exits connecting MTR stations and other facilities as needed; intercepting ditches or floodgates are also installed at the entrances/exits connecting depots and railway tunnels where necessary to prevent ingress of flood water
- Underground stations and tunnels are equipped with water pumps
- Emergency procedures for coping with catastrophic floods have been formulated to evacuate passengers from MTR stations as soon as possible in case of emergency, and drills are conducted on a regular basis

### New technologies to cope with extreme rainstorm events

CEDD proactively makes use of new technologies to collect data to enhance the efficiency of slope works and landslide warning and emergency actions.



CEDD has conducted airborne light detection and ranging surveys to produce territory-wide digital terrain models to identify landslide hazards



CEDD has introduced and developed quadruped robotic dogs, to assist engineers in conducting site exploited inspections and collecting field data at landslide sites. The collected data can be used for analysing the cause of landslides and assessing residual landslide risk, so as to facilitate the design of emergency repair works

5.14 With regard to railway and road infrastructure, MTRCL carries out the design, construction and maintenance of the flood protection and drainage systems of the railway and its facilities in accordance with the requirements stipulated by DSD. MTRCL also reviews and formulates the preventive measures regularly, and strengthens the protective equipment as needed. As for road facilities, the Highways Department (HyD) regularly reviews and updates relevant design manuals and guidance notes. Public road facilities such as road tunnels and pedestrian subways under the purview of HyD should be equipped with proper drainage systems in accordance with the relevant design manuals and guidance notes to drain water ingress from various sources.

5.15 More frequent and intense rainstorm events increase landslide risk. CEDD will continue to implement the Landslip Prevention and Mitigation Programme to upgrade government man-made slopes and to mitigate natural terrain landslide risk. CEDD also endeavours to enhance the slope drainage design standard to improve the slope surface drainage system with the aim of strengthening the resilience of the slopes against extreme rainstorms.



Rainstorms increase the landslide risk of natural terrain



## Combating Extreme Droughts and Safeguarding Water Supply

- 5.16 WSD has updated the Total Water Management Strategy to cater for the forecast water demand up to 2040. The updated Strategy adopts a two-pronged approach with emphasis on containing fresh water demand growth and building resilience in the fresh water supply to cope with the extreme effects of climate change with diversified water resources.
- 5.17 To achieve the goal of reducing the average fresh water per capita consumption by 10% in 2030, using 2016 as the base year, and containing the fresh water demand at the level of around 1 billion m<sup>3</sup> per annum before 2040, WSD is taking forward three major water demand management initiatives, namely water conservation, water loss management and expansion of the use of lower grade water (viz. seawater and recycled water) for non-potable purposes.
- 5.18 WSD enhances implementation of various water demand management initiatives through wide adoption of smart technologies, including establishment of the Water Intelligent Network and installation of the Automatic Meter Reading, etc. Construction of the relevant infrastructure for expanding the use of lower grade water for non-potable purposes, including the reclaimed water supply system in Sheung Shui and Fanling and the grey water recycling supply system at the Anderson Road Quarry Development site, is in progress for supplying recycled water to the public in phases starting from 2024. WSD will continue to expand the use of recycled water to other new development areas and areas where fresh water is supplied for flushing wherever it is technically feasible and cost-effective.
- 5.19 On the other hand, WSD is enhancing resilience in the fresh water supply to cope with the impacts of climate change by constructing the first stage of the desalination plant in Tseung Kwan O.

### Shek Wu Hui Effluent Polishing Plant and Water Reclamation Plant

DSD is implementing the reconstruction of the existing Shek Wu Hui Sewage Treatment Works in phases to increase the treatment capacity to 190 000 m<sup>3</sup> per day, and to upgrade the sewage treatment level to tertiary standard for upgrading to a “Shek Wu Hui Effluent Polishing Plant”.

Upon the completion of the facility, WSD will produce reclaimed water by further processing a portion of the tertiary treated sewage effluent and supply to the north-eastern part of the New Territories, including Sheung Shui and Fanling, for non-potable purposes.



Shek Wu Hui Effluent Polishing Plant and Water Reclamation Plant (artist's impression)

### Grey water recycling system for Anderson Road Quarry Development

WSD is constructing a centralised grey water recycling system where grey water (viz. water collected from baths, showers, wash basins, kitchen sinks and washing machines etc.) collected from inhabitants at the Anderson Road Quarry Development site will be treated and supplied for on-site flushing and other non-potable purposes. The system will have a treatment capacity of 3 300 m<sup>3</sup> per day.



Grey Water Treatment Plant for Anderson Road Quarry Development (artist's impression)

### Tseung Kwan O Desalination Plant

Hong Kong is a coastal city where seawater supply is abundant. To cope with the possible extreme dry weather, WSD is constructing the first stage of Tseung Kwan O Desalination Plant to exploit alternative water resources other than rainfall. The plant, targeted to be commissioned in 2023, will adopt the latest reverse osmosis technology in producing potable water that complies with the Hong Kong Drinking Water Standards. It will have a daily capacity of about 135 000 m<sup>3</sup> that will meet around 5% of the overall fresh water demand in Hong Kong, with provision for future expansion to a daily capacity of up to 270 000 m<sup>3</sup>.



Desalinated water is a strategic water resource for Hong Kong that is not susceptible to the impacts of climate change. The above photo is Tseung Kwan O Desalination Plant (artist's impression)

## Combating Extreme Heat

5.20 We will continue to enhance building design and promote urban forestry with a view to alleviating and coping with temperature rise. Based on the recommendations of the Study of Design Considerations for Government Infrastructures under Extreme Temperatures, ArchSD is coordinating with relevant departments to follow up and review the design standards relating to public infrastructure and government buildings. The work is expected to be largely completed in 2023. The Buildings Department (BD) is also reviewing the technical requirements on thermal expansion joints of building components in anticipation of extreme temperature in the future.

5.21 To further promote green buildings and to foster a quality and sustainable built environment, BD has commissioned a consultant to review the room to tighten the current mechanism of granting gross floor area (GFA) concessions for green and amenity features in new private development projects. BD is working closely with stakeholders to formulate the implementation details of the new GFA concession mechanism which is targeted to be launched in 2022.

5.22 Promoting urban forestry and increasing tree planting can lower urban temperature and attenuate the heat island effect. The Development Bureau is studying and exploring feasible measures to improve the growing environment of urban trees, which include the application of smart technologies in tree management, review of soil volume for new roadside trees and improvement of soil quality for existing planting areas. The Government will continue to promote active planting, proper maintenance and preservation practices with a view to achieving a sustainable and healthy urban forest.



Kwun Tong Promenade



Hong Kong Velodrome Park in Tseung Kwan O



# Resilience

## Contingency Plan for Natural Disasters

- 5.23 Extreme weather conditions are expected to become more frequent due to climate change. The Government will continue to strengthen preparation for and response to natural disasters, and to enhance capabilities in post-disaster recovery. Relevant departments will enhance arrangements on the dissemination of information so that the public can make preparation for appropriate response to, and recovery from, natural disasters, with a view to mitigating the potential threats.
- 5.24 According to the Contingency Plan for Natural Disasters formulated by the Security Bureau, the Government will act in preparedness, response and recovery to guard against natural disasters by enhancing situation assessment at the early stage, devising the response strategy and plan as well as redeploying resources and manpower in a timely manner. In the event of natural disasters of a substantial scale, such as severe rainstorm and serious flooding where extensive government emergency response operations are required, the Emergency Monitoring and Support Centre will be activated to provide a holistic response.
- 5.25 After the onslaught of Super Typhoon Mangkhut in Hong Kong in September 2018, the Government has conducted an inter-departmental review of the handling mechanism to improve Hong Kong's preparedness for, emergency response to, and recovery from future super typhoons or other natural disasters of a substantial scale. One of the new measures requires that in the event of a super typhoon or other natural disasters of a substantial scale, a high-level inter-departmental Steering Committee chaired by the Chief Secretary for Administration (CS) will be set up, as and when necessary, to oversee the work of relevant bureaux and departments and to set priorities in a coordinated manner. Should a super typhoon or other natural disasters of a substantial scale cause damages that paralyse the city and seriously affect the working public to resume work, the CS, having regard to the views of the Steering Committee, may make a territory-wide "Extreme Conditions" announcement to extend the time for resumption of work so as to minimise possible injuries to members of the public.

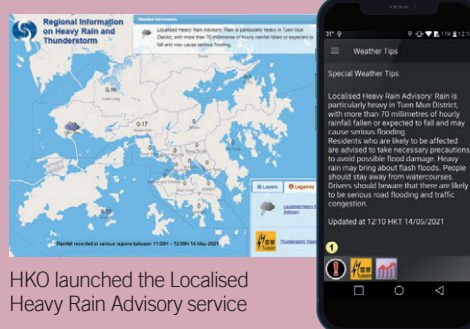
- 5.26 In order to safeguard the life and property of the public, relevant bureaux and departments will conduct regular exercises of various forms to enhance preparedness and collaboration among the units concerned to cope with natural disasters.

## Warning and Monitoring

- 5.27 The Hong Kong Observatory (HKO) closely monitors weather situation. HKO will issue weather warnings and bulletins for severe weather where necessary to remind members of the public, particularly those in vulnerable areas, to seek shelter in safe places and take corresponding precautionary measures to minimise losses.
- 5.28 Owing to the complex coastline of Hong Kong, the degree of impacts from storm surges associated with tropical cyclones can vary significantly across different locations. HKO, in collaboration with District Offices and DSD, has established an early alert mechanism.

### Rainstorm forecast

HKO has been disseminating rainfall information through various channels to help the public get prepared. In May 2021, HKO launched the Localised Heavy Rain Advisory service, providing early alert on heavy rain in individual districts based on recorded rainfall and forecast rainfall from the nowcasting system. HKO plans to provide local weather forecast in greater detail through the use of technologies such as higher performance computer systems and artificial intelligence.



HKO launched the Localised Heavy Rain Advisory service

When the water level is forecast to reach the corresponding alert level under the influence of tropical cyclones, HKO will issue SMS alert messages to relevant government departments. District Offices will inform local residents and property management offices to take appropriate preparatory and precautionary measures, while DSD will mobilise manpower to provide assistance to the residents in the areas that are more vulnerable to flood risk.

5.29 In addition, DSD has set up an Emergency Control Centre (ECC). The Flood Monitoring and Reporting System in the ECC will monitor rainfall and water level of major rivers and channels in real-time. DSD has installed telemetry systems in more than 140 locations to collect data such as tide level and water level at the sites and send them to the monitoring centre. It can facilitate speedy analysis of the flooding situation and timely notification of other departments as and when necessary, so that the departments can be well prepared for rescue, evacuation and opening of temporary shelter.

5.30 The Office of the Communications Authority has engaged local mobile network operators to set up an emergency alert system for dissemination of time-critical public announcements and messages by the Government via mobile networks to mobile service users during emergency situations, such as extreme weather, so that the public can adopt contingency measures quickly.

## Transport System

5.31 TD has formulated a series of contingency plans to handle various emergency situations at major transport infrastructure such as railways and road tunnels. In the event of an emergency, TD's Emergency Transport Coordination Centre will activate the relevant contingency plan to coordinate all parties concerned to implement temporary traffic and public transport arrangements in response to the closure of the relevant facilities and suspension of services.

5.32 EMSD also requires MTRCL to formulate measures to cope with various emergencies, including procedures for evacuating passengers from the stations as quickly as possible during emergency situations, such as catastrophic flood, and to conduct site inspections and drills on a regular basis. HyD also regularly reviews and updates the emergency response plans for public road facilities under its purview. The operators of government road tunnels and

control areas are responsible for the management, operation and maintenance of the tunnels and control areas, including the drainage facilities and equipment, to ensure their normal operation.



The Government conducts inter-departmental exercises to strengthen emergency responses



Water level sensor can provide real-time monitoring of the water level at rivers and channels



TD's Emergency Transport Coordination Centre monitors traffic conditions and handles various emergency situations