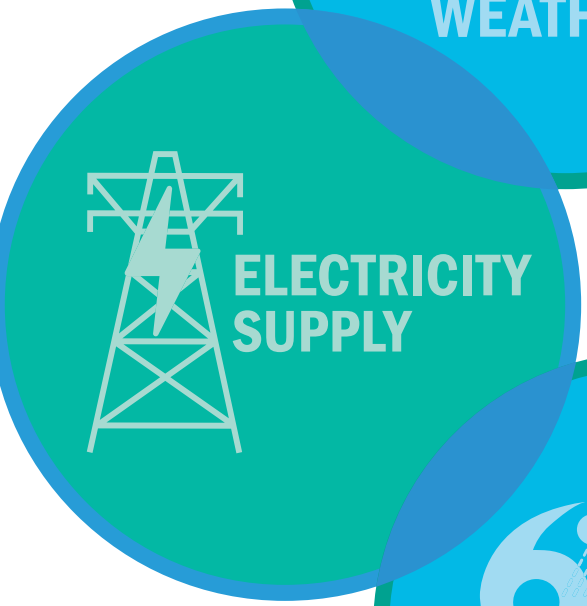
CARe 2018 HONG KONG CONFERENCE

SUMMARY REPORT AND POLICY RECOMMENDATIONS

DECEMBER 2018



Climate Ready@HK 氣候變化香港行動

CARe 2018
HONG KONG CONFERENCE

HKUST Co-organisers:
Institute for the Environment
Division of Environment & Sustainability
The HKUST Energy Institute
GREAT Smart Cities Center
Institute for Public Policy

Supporting Organisations:
Development Bureau, HKSAR Government
Environment Bureau, HKSAR Government
Civil Engineering and Development Department, HKSAR Government
Drainage Services Department, HKSAR Government
Environmental Protection Department, HKSAR Government
Hong Kong Observatory, HKSAR Government
Water Supplies Department, HKSAR Government

PREFACE

Climate Adaptation and Resilience Conference 2018 (CARe2018) was designed to bring a broad range of expertise together to discuss climate adaptation and resilience of subtropical regions, with particular attention to Hong Kong and South China. The broad and deep discussions would not have been possible without the participation of government officials, academic experts, and professionals from many sectors.

The purpose of CARe2018 was to focus on knowledge gaps, and how society could collaborate to face climate adaptation and resilience challenges in a multi-and-transdisciplinary manner. The organisation of the conference in three distinct parts over three days – plenaries, workshops and a policy feedback session – was designed to engage as many stakeholders as possible. Our hope is that HKUST can help to build a platform for the community of people and institutions who can continue to work together in the long-term on climate change-related issues.

This report is for the HKSAR Government's Steering Committee on Climate Change (Steering Committee), as it is the body that coordinates climate change related actions within the government. We hope the committee will find this short document arising from CARe2018 useful since the government plays a leadership role in providing major public infrastructure, dealing with urban and land use planning, as well as in organising Hong Kong's emergency preparedness as a result of severe weather events. We look forward to continue to support the HKSAR Government's efforts.

We also worked with many of Hong Kong's key stakeholders relevant to climate change adaptation in the private sector. Their active participation was crucial to CARe2018. We also look forward to continue to support them in their efforts too.

Christine Loh
Chairperson
CARe2018 Organising Committee

EXECUTIVE SUMMARY

THE CHALLENGE

The best available evidence points strongly to continuous rising global temperatures that is altering the climate. Typhoons Hato and Mangkhut have delivered timely reminders to Hong Kong of its vulnerabilities despite longstanding, admirable preparedness. CARe2018 brought together leading experts on climate science and policy to explore solutions.

Moving forward, in considering its climate vulnerabilities, Hong Kong must deal with not only the most visible and immediate challenges for a coastal city, including sea level rise, intensification of storms, and extreme temperatures, but also the economic and social repercussions to society, including disadvantaged groups, and also of the climate impacts in the increasingly integrated surrounding region.

In order to meet the challenges, CARe2018 identified four key themes for the Steering Committee's consideration:

1. **PRACTICE** Practice integrated cross-and-transdisciplinary systems thinking
2. **INCREASE** Increase climate literacy and decision capacity to solve problems
3. **IMPROVE** Improve communication and coordination; and de-risk political resistance
4. **DEVELOP** Develop culture to support learning on climate change

Climate change is an unprecedented, existential challenge, and a successful future will require careful attention on how to build and craft a climate-ready Hong Kong. Achieving climate-readiness will require careful long-term planning and management from administration to administration, and investment of financial and human capital – and of time and attention.

THE OPPORTUNITY

The opportunity for the Steering Committee is that major stakeholders have all expressed a desire and willingness to cooperate with the HKSAR Government through some kind of institutionalised co-learning engagement platform to meet the climate challenge. Existing government or even non-government platforms may be adapted for such a purpose. However, to play such a role, the institution will need good coordination and engagement skills, and a strong understanding of the issues involved.

Storms, Storm Surges and Sea Levels (Chapter 2)

Over the next century, Hong Kong is likely to see more intense typhoons. These, combined with a predicted rise in sea level will put the city at increased risk for storm surges and flooding. In order to avoid catastrophic impacts, Hong Kong must:

- Enhance monitoring, rapid analysis, and learning;
- Reduce systematic vulnerability, including capability to identify small failures and correct them, as well as be prepared for major failures; and
- Research implications of sea level rise locally and in the Greater Bay Area, and implications for infrastructure and development.

Excess Water Challenges from Flooding and Landslides (Chapter 3)

Climate change is expected to cause more severe and extreme rainfall events in Hong Kong. Increased development increases both the likelihood and consequence of systems failure. Excess water risks can lead to multiple, concurrent failures in high risk Hong Kong, which can in turn lead to catastrophic results especially if they occur where there are dense population. Hong Kong needs better early warning systems, improved infrastructure, and better public understanding of the risks in order to improve emergency preparedness.

Hong Kong must consider:

- Supporting cross-disciplinary research and experimentation in dealing with excess water problems to make Hong Kong more climate-ready;
- Giving priority to enable Hong Kong to develop a science-based, data-driven landslide forecasting system that is based on better understanding of where and under what circumstances failures might occur; as well as the interaction between resisting barrier, excess water, soil and vegetation;
- Supporting “blue-green” approaches to designing infrastructure; and
- Empowering communities to improve their disaster preparedness through well-designed public education using new tools, such as Massive Open Online Courses (MOOC) aimed at unlimited participation and open access with appropriate visualization and interactive components.

Oceans (Chapter 4)

Hong Kong has more sea area than land, but the impacts of climate change on the ocean ecosystem are not as well known or studied, compared to other impacts. Yet, they will be of vital importance to the local maritime and fisheries sectors. Guangdong’s shaping of an ‘Ocean Economy’ requires knowledge of the impacts that climate change bring with it. As a starting point for understanding and future planning, Hong Kong should:

- Reduce Hong Kong’s own water pollution, which will require funding sewage treatment projects, especially in the New Territories, along with improved monitoring;
- Develop collaboration between all relevant departments to manage the marine environment at an ecosystem level;

- Establish vehicles for cross-boundary collaboration for water pollution control across the Greater Bay Area, to underpin an ecosystems approach; and
- Support research to increase understanding of the mechanisms that determine acidification, eutrophication and hypoxia.

Dealing with Fresh Water (Chapter 5)

Water management will be increasingly crucial for Hong Kong. Climate change will make Hong Kong wetter overall, but may also bring longer dry spells. Hong Kong will need to consider its overall fresh water management system, including supply and consumption, as well as issues of drainage. In order for Hong Kong's water system to be resilient to climate-related challenges, Hong Kong must:

- Encourage measures to reduce water usage, including lowering per capita consumption, increasing use of reclaimed water, reducing wastage from leaks, and making use of desalinization;
- Foster hand-in-glove policy and implementation between the WSD and DSD for joined-up outcomes; and
- Contribute to sustainable management of the Dongjiang and the Pearl River Basin with the mainland authorities.

Changing Risks to Public Health (Chapter 6)

The changes in weather conditions have implications for public health and safety. Extreme weather events can tax the health system, bring increased risks for vulnerable populations. New demands will be placed on health and social workers to respond to these challenges. In order to deal with the health and public safety challenges stemming from climate change, Hong Kong must:

- Review the capacity of the health system to respond to surges in use from extreme weather events (storms, hot and cold spells, etc);
- Train the health and social work workforce to quantify and respond appropriately to the health impacts of climate change;
- Upgrade the weather information warning system to help facilitate self-help and care behaviour;
- Integrate built-environment knowledge to improve urban ventilation, working with property developers, built-environment professionals and districts; and
- Identify and help vulnerable populations who do not have access to heating and/or cooling during extreme weather events.

The Built Environment – Critical Infrastructures and Vegetation (Chapter 7)

Extreme weather events can disrupt and damage the critical infrastructure of Hong Kong, posing a threat to health, safety and livelihoods. Infrastructure planning needs to be forward looking to ensure that the investments made now are able to function properly in warmer, wetter, and more extreme conditions. In addition, the impacts of climate change on existing infrastructure must be considered to ensure appropriate adaptation and resilience. In particular, Hong Kong must:

- Use design assumptions and standards for infrastructure investments that take climate change into account;
- Identify and perform risk assessments on critical infrastructures, including transport, water, sewage, drainage, electricity, ICT, banks, hospitals, etc;
- Work at the district level to identify vital local infrastructures, and fine-tune district communication and emergency plans (including coordination with other local actors, NGO's, etc.);
- Include climate readiness in plans to support repairs and retrofits of aging buildings;
- Assess the risks of disadvantaged vulnerable communities to climate risks and exposures; and
- Take stock and comprehensive cross-departmental practices in regards to management of Hong Kong's vegetation, including best practices for urban planting and care, and strategies for removal and disposal after major weather incidents.

Finance, Insurance and Philanthropy (Chapters 8)

In financing a climate-ready society in Hong Kong, the public, private and philanthropic sectors all have roles to play. Indeed, Hong Kong can become Asia's Green Finance and Insurance Hub with government shepherding dialogue and collaboration within the financial services sector.

Regional Resilience (Chapters 9)

Finally, Hong Kong's overall resilience will be tightly tied in with the overall resilience of the Greater Bay Area. Development of connections between stakeholders across the region will be vital, including joint research, co-learning, data and resource sharing (e.g. food, energy, water sharing), and collaborating in emergency response. ■

CONTENTS

1 ADAPTING TO EXTREME CLIMATE

Making better decisions and building resilient communities

Climate change, with its broad impacts, is one of the world's major challenges and demands substantive responses from governments, corporates and individuals on an on-going, long-term basis.

RISKS AND DAMAGE

The damage caused by climate change is a function of:

1. **Climate Change Risks**
   For sub-tropical Hong Kong and the Greater Bay Area, these include:
   a. Stronger typhoons, more intense rainstorms with strong wind, as well as flooding and landslide.
   b. Increased coastal flooding due to higher storm surges coupled with the rising sea level for the long-term.
   c. Higher temperatures overall with cold spells.
   d. Occasional droughts.

2. **Exposure of People and Property to Climate Change**
   Consideration needs to be given to identify various exposure risks and how they could be most appropriately reduced in the short, medium and longer-term.

3. **Vulnerability to Injury, Damage and Loss**
   Vulnerability can be reduced through various means, such as early warning systems, emergency preparedness, as well as appropriate defensive engineering works, such as to prevent landslides and floods. There will, however, be times when Hong Kong's systems are unable to cope. Thus, it is important that government action is complemented by the well-coordinated preparedness of many stakeholders and districts. Vulnerability is further reduced by community capability in speeding-up recovery after a severe weather event.

This report aims to assist Hong Kong to achieve stronger climate resilience. Hopefully, it complements the work of the Steering Committee, chaired by the Chief Secretary. This report takes Hong Kong's *Climate Action Plan 2030+* (CCAP 2030) as the starting point and addresses those aspects that require filling out. In doing so it considers changes in the three dimensions listed above.

OVERARCHING ISSUES

CARe2018 has helped to pinpoint gaps in Hong Kong's work to access risk, and reduce exposure and vulnerability. It has also identified research and perspectives from local and international sources that are relevant to Hong Kong.

Specifically, the Steering Committee should consider the following overarching themes:

1	Stepping-up multi-and-transdisciplinary collaboration both between government departments and with a wide group of experts, professionals and stakeholders to make Hong Kong truly climate-ready.	An institutionalised protocol for communication and deliberation between government and others will help decision-makers to arrive at the most optimal solutions and action plans.
2	Including community and district-based leaders and institutions in understanding climate risks and to encourage people to help each other and the government during emergencies, including paying attention to the most vulnerable groups of people.	While climate changes over the long-term, the impacts of this change come with extreme weather events, such as a severe typhoon. The cost-effective way of reducing vulnerability to such events is well-coordinated cooperation between government departments, stakeholders and communities.

Moreover, non-government experts should play a role in helping the community to understand that systems failure is possible under extreme weather events. While the government is duty-bound to enhance monitoring of risks and being transparent about them, it would be helpful for there to be a 'no blame' or at least a 'less blame' culture to encourage speedy reporting and analysis of failure. ■

IPCC AND GLOBAL CLIMATE CHANGE SCIENCE

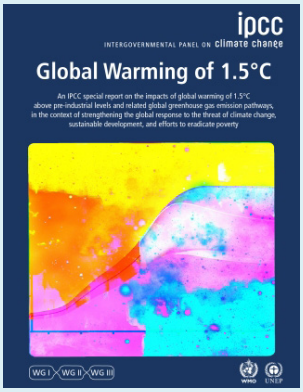
In 2015, the Paris Agreement pledged signatories to holding the increase in temperatures above pre-industrial levels to well below 2˚C and to pursue efforts to limit the increase to 1.5˚C recognising that this would significantly reduce the risks to human well-being, ecosystems and sustainable development.

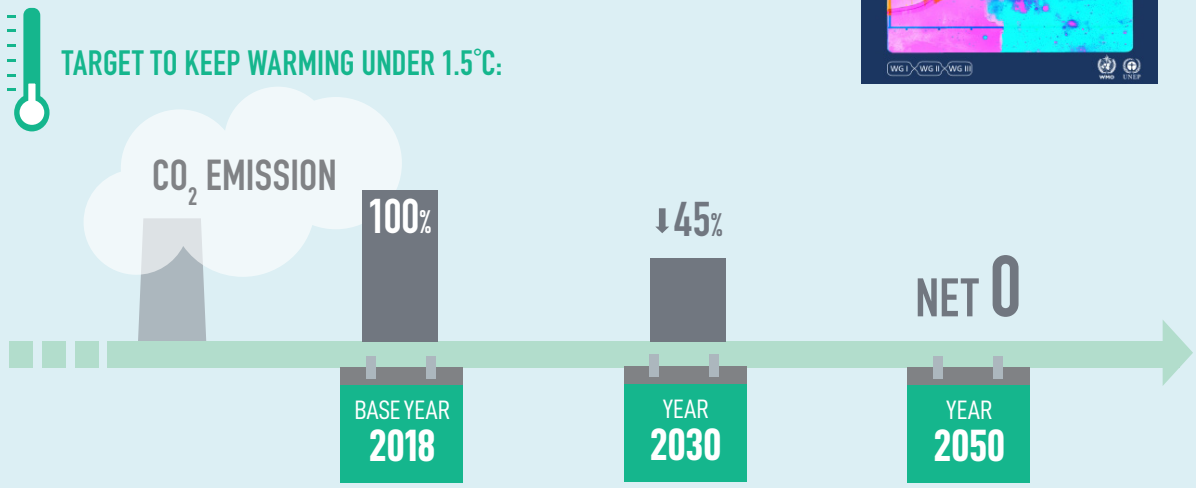
In October 2018, the Inter-governmental Panel on Climate Change (IPCC) special report, *Global Warming of 1.5˚C,* notes global average temperature has already been raised 1˚C. Further, that the observable changes to the climate all around the world even at 1˚C global warming provide a warning that the changes are much broader and deadlier than previously estimated. It shows that, at the current rate of emissions, the world will reach 1.5˚C warming possibly as early as 2030; and that allowing the temperature to rise to 2˚C would cause considerably more damage than 1.5˚C. This latest report is also a sobering reminder that the world has, in fact, been on a much higher trajectory than 2˚C since the Paris Agreement. The pledges made by the signatories to the Paris Agreement so far, if fulfilled, would still lead to temperature rise by about 3.5˚C.

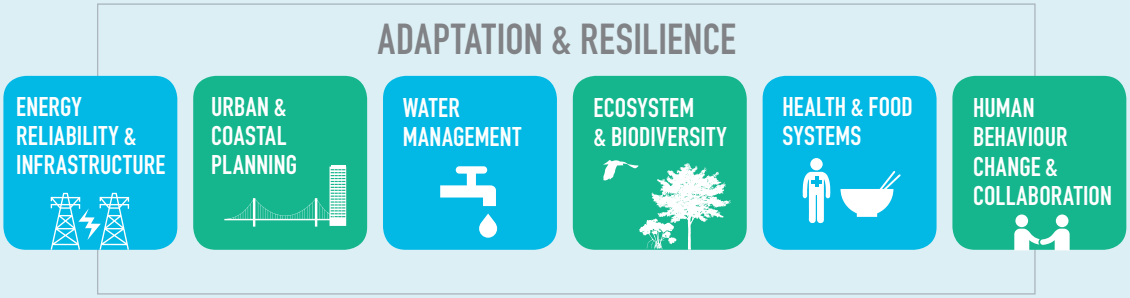
This leads to two obvious overarching conclusions.

Firstly, unprecedented efforts need to be made on climate mitigation to limit carbon emissions. The IPCC latest report is clear that to keep warming under 1.5˚C, global emissions will have to fall by 45% by 2030 and reach net zero by 2050.

Secondly, climate change adaptation is a clear necessity. Delaying adaptation will only make it costlier and more challenging. Efforts are needed to protect lives and assets, including increasing resilience in health and food systems, urban and coastal planning, energy reliability and infrastructure, water management, as well as ecosystems and biodiversity.







ACTION IN HONG KONG

The HKSAR Government's aim is for Hong Kong to exceed the national carbon reduction target under the Paris Agreement, as well as to take climate change risks into account in its adaptation plans. Following the Paris Agreement timeline, the government will have to report on all relevant mitigation and adaptation efforts to date in 2020, as well as commit to new pledges.

Environment Bureau (ENB) has tasked the Council for Sustainable Development (SDC) to conduct public engagement and make recommendations to the government on a long-term decarbonisation strategy up to 2050 for Hong Kong. The SDC is expected to report at the of 2019 or early 2020.

CARe2018 provides insights on additional adaptation and resilience strategies beyond those in CCAP 2030. The government may consider these when crafting its new commitments in 2020 under the Paris Agreement timeline.

Hong Kong plays a part to help fulfill the obligations that China has under the Paris Agreement. As such, Hong Kong will need to review its climate change efforts every 5 years and align them with the submission timelines under the Paris Agreement. The timeline for review up to 2030 for Hong Kong is expected to be as follows:

LOCAL AND REGIONAL CLIMATE CHANGE-RELATED STUDIES

Hong Kong Observatory (HKO), the HKSAR Government's climate change science authority, has an excellent reputation. It stays close to development on the subject and participates in World Meteorological Organisation and other relevant national and international bodies and events. It conducts and commissions research, and has a long history of working with local and overseas universities.

The IPCC reports are important references, and government departments conduct or commissions specific studies that are directly relevant to the solutions needed in Hong Kong – such as in infrastructure (especially in dealing with slope and flood management – see Chapter 3). There are, however, areas that have yet to be studied more thoroughly for cost-effective, local policy-making. CARe2018 highlighted the need for more focussed studies in 6 areas in light of a changing climate:

1. Sea level rise
2. Ocean acidification, eutrophication and hypoxia
3. Built environment mitigation and adaptation opportunities
4. Vulnerable populations and their living conditions
5. Public health issues
6. Energy, water and food security

Dealing with climate change requires multi-and-transdisciplinary approaches that can firstly, integrate an array of expertise into policy deliberation; and secondly, enable judicious choices to be made by taking risks and socio-economic impacts into account, including the populations or areas that are most at-risk.

2 EXTREME WEATHER AND CHANGING RISKS

Storms, storm surges and sea level rise

As the world warms, it is triggering many changes to the Earth's climate. Recent experience in subtropical Hong Kong included super typhoons and heavy downpours. In addition, storm surges during typhoons caused serious flooding and coastal damage in some areas. When taken together, climate change is altering many types of risks associated with weather conditions.

MULTIPLE CHALLENGES

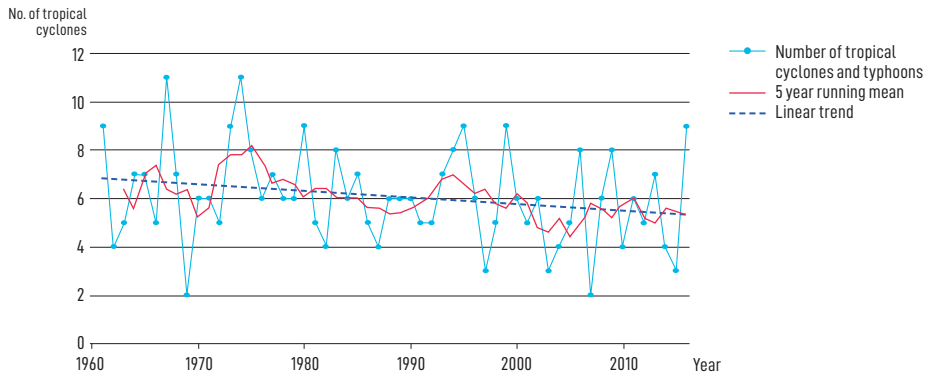
There is a significant increase in the average intensity of storms even if their frequency might be slightly less. Stronger and wetter typhoons present multiple challenges for Hong Kong. This chapter deals with the latest thinking relating to rising sea level, storm surges and the altered risks for Hong Kong, and the next chapter deals with excessive water problems, landslides and floods.

FIGURE 2-1

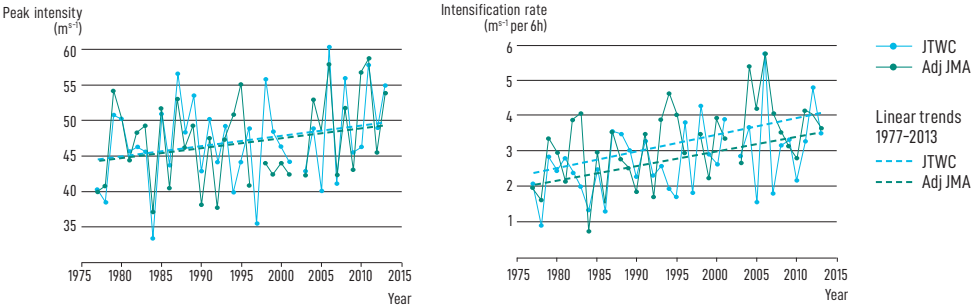
INCREASING INTENSITY TYPHOONS

Source: Hong Kong Observatory

Annual number of tropical cyclones and typhoons crossing within 500km of Hong Kong (1961-2017)



Annual mean typhoon lifetime peak intensity and annual mean typhoon intensification rate as a function of time using two different TC datasets (JTWC[a] and adjusted JMA[b] dataset*)



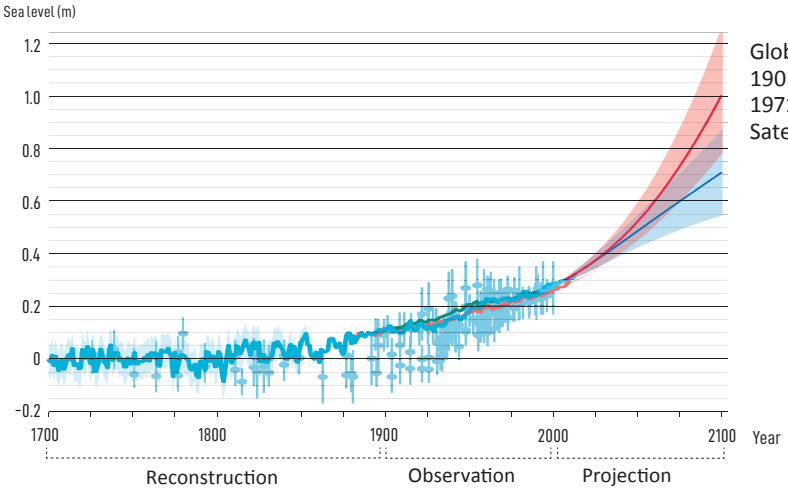
[a] JTWC: Joint Typhoon Warning Center
[b] JMA: Japan Meteorological Agency
* Analysis using adjusted datatset to cater for the changes in the JMA analysis methodology (Mei and Xie, 2016) from 1977 to 2013

Rising seas will have increasingly dramatic impacts on coastal areas. The rate of global sea level rise has increased in recent decades and is accelerating incrementally at about 3.2mm per year. The two major causes are thermal expansion caused by warming of the ocean and increased melting of glaciers and ice sheets in Greenland and the Antarctic. With ocean and atmospheric warming continuing, sea levels will continue to rise for a very long time.

FIGURE 2-2

AVERAGE SEA LEVEL RISE IS OCCURRING AT AN INCREASING RATE AROUND THE WORLD

Source: IPCC 5th Assessment Report (in the presentation by Xuebin ZHANG at CARe2018)

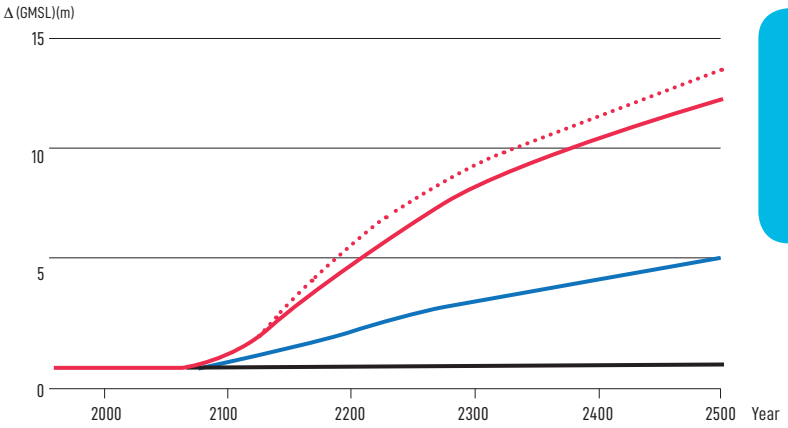


Global mean sea level rising rate:
1901 to 2010 1.7±0.2mm yr^{-1}
1971 to 2010 2.0±0.3mm yr^{-1}
Satellite 1993-2010 3.2±0.4mm yr^{-1}

FIGURE 2-3

AVERAGE SEA LEVEL RISE IS OCCURRING AT AN INCREASING RATE AROUND THE WORLD

Source: in the presentation by Xuebin ZHANG at CARe2018



The last time atmospheric CO_2 was at its current level was 3 million years ago. At that time, the temperature was 1.8˚C to 3.0˚C higher than pre-industrial level and sea level 10 to 30 metres above today.

While the geological record provides a relatively high confidence in the amount of sea level rise which will occur eventually for a given increase in temperature, there is great uncertainty on how rapidly the Greenland and Antarctic ice-sheets will disintegrate. The IPCC's summaries of scientific work on the rate of future sea level rise have repeatedly been adjusted upwards and it would be prudent to have plans which can cope with sea level rise being significantly faster than its current estimates. New York is planning on 120 cm by 2100. The report *Managing the Coast in a Changing Climate* published in

October 2018 by Britain's Committee on Climate Change focused on planning for 100 cm rise but noted higher rises have been predicted in the longer-term.[1]

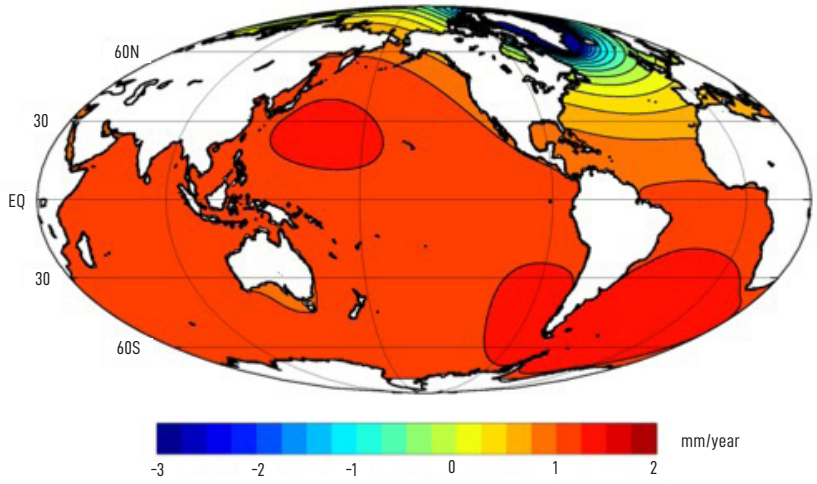
Sea level rise at specific locations may be more or less than the global average due to many factors, such as glacial isostatic adjustment,[2] land subsidence (for example Jakarta and Bangkok are sinking due to extracting ground water for human consumption) neither of which affect Hong Kong.

An important new insight, which does, however, affect Hong Kong is regional sea level rise, due to changes in ocean circulation and the gravitational pull of the mass of the Greenland and Antarctic ice-sheets. In particular, the current sea level next to Greenland is about 7 metres higher than average. As the Greenland ice sheet melts, this gravitational pull will weaken. Thus, the melting of the Greenland ice sheet lowers sea level near Greenland and increases it far away, including adding 1.0 to 2.0 mm/year to the sea level around Hong Kong.

FIGURE 2-4

HIGHER REGIONAL SEA LEVEL AFFECTING EAST ASIA

Source: IPCC (in the presentation by Xuebin ZHANG at CARe2018)



Melt model: green 2: Greenland (incl MG&IC) – variable "Sealevel" fingerprint (cf tide gauges)

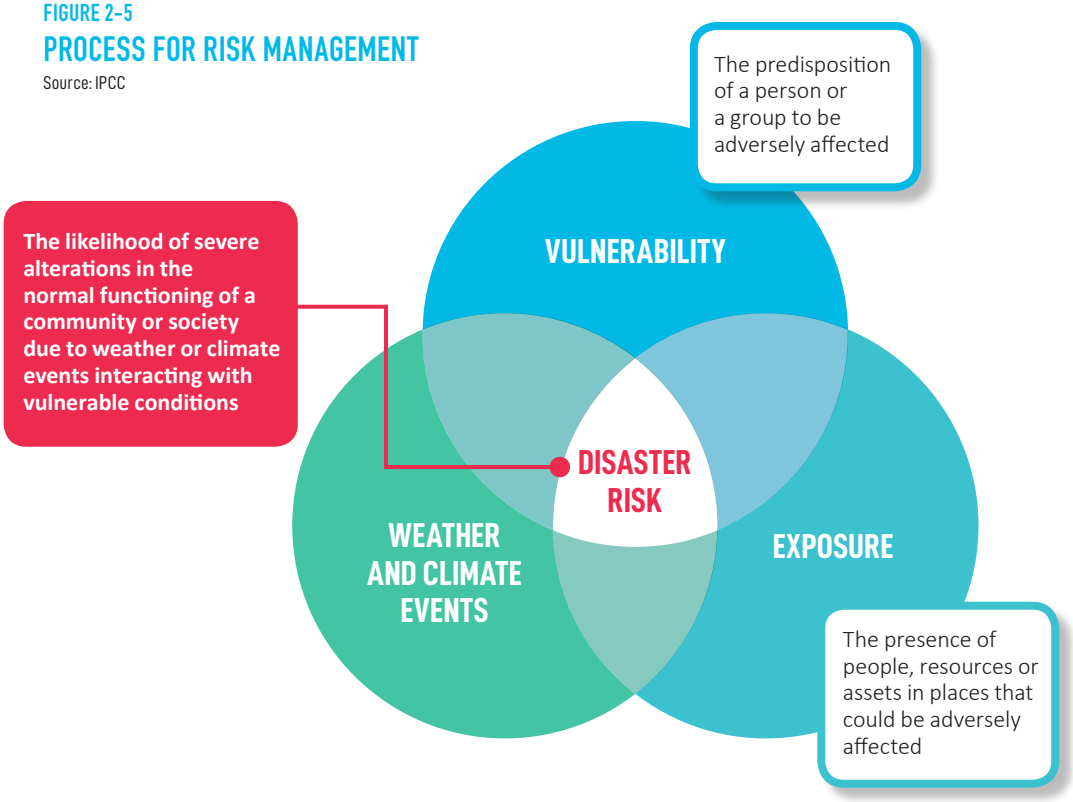
In other words, with typhoons that are more intense, coupled with an accelerating rise in sea level, which is more prominent in the surrounding ocean, the combined risks of storm surge and flooding is already greater than in the past for Hong Kong and will intensify as sea level continues to rise. Typhoon Mangkhut in 2018 offers a glimpse into the ever-increasing risk. Storm surge led the sea level in Victoria Harbour to rise by 3.9 metres, which was considerable. It could have been 4.7 metres had the typhoon taken a slightly different path. Moreover, had it been high tide, the storm surge would have been very much higher still, thereby threatening public infrastructure and property.

1. Committee on Climate Change, Managing the Coast in a Changing Climate, October 2018, www.theccc.org.uk/publication/managing-the-coast-in-a-changing-climate/.
2. Glacial isostatic adjustment refers to land levels gradually adjusting for the removal of the last ice-age's ice-sheets, which exacerbates risk of flooding.

RISK VS. DAMAGE

The degree of damage from sea level rise and storm surge is a function of the physical threat (severe climate events), exposure to the threat (the presence of people, resources and assets in places that could be adversely affected) and vulnerability (propensity to be adversely affected). Threats are increasing due to climate change and exposures are more difficult to contain due to the high density of people and assets in the whole of the Greater Bay Area. The vulnerability of people and assets to storm surge and long-term sea level rise must therefore be substantially reduced to minimise the risk of damage. Hong Kong and the Greater Bay Area experienced two super-typhoons in the recent two years. Typhoon Hato caused substantial damage and loss of life in 2017. However, the even stronger Typhoon Mangkhut in 2018 caused less damage; thanks in large part to increased public awareness and government preparedness, which significantly reduced the vulnerability of the region.

FIGURE 2-5
PROCESS FOR RISK MANAGEMENT
Source: IPCC



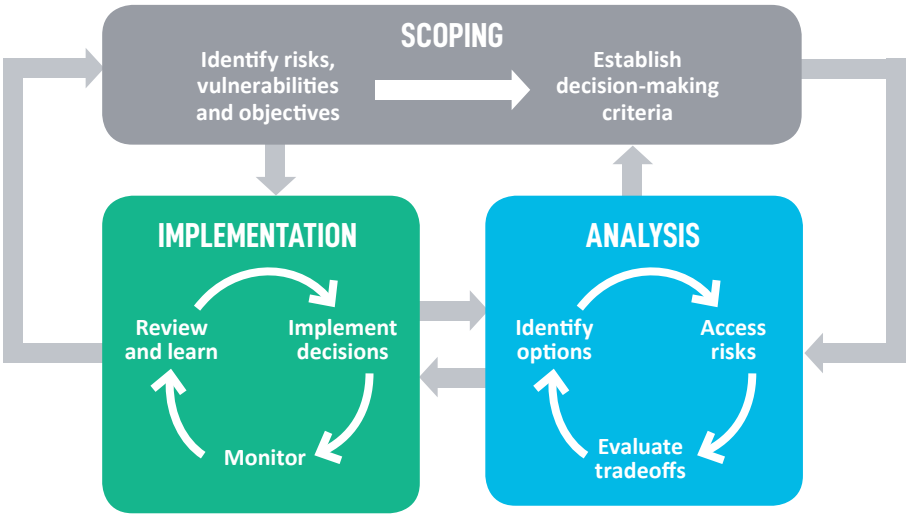
ENHANCE MONITORING, RAPID ANALYSIS AND LEARNING

Climate impacts are highly non-linear and locally specific (e.g. underground parking lots are a priority for flood prevention in Hong Kong and Macao but may be less of a hazard in the region). Lessons learnt from Typhoon Hato helped to substantially reduce the damage during Typhoon Mangkhut. Government departments are learning from each event. The Steering Committee may wish to ensure this continuous learning is institutionalised to reduce systematic vulnerability. This includes establishing an early warning system with enhanced monitoring and rapid analysis capability to identify small failures, and correct/prepare for them so that they would not lead to catastrophic failures during future extreme weather event.

FIGURE 2-6

ASSESSING DISASTER RISK

Source: IPCC (in the presentation by Alexis LAU at CARe2018)



STUDIES AND EVENTUAL DECISIONS

Hong Kong should invest in understanding sea level rise locally and regionally to be better prepared for long-term challenges. This might be best done through Hong Kong supporting its own research, and as a Greater Bay Area initiative, to understand the extent to which sea level rise would:

1. Exacerbate inundation and flooding of low-lying coastal areas;
2. Increase coastal erosion, such as beaches;
3. Impact coastal ecosystems, such as mangroves and coral reefs;
4. Lead to salt water intrusion into estuaries;
5. Change sediment deposition along river channels; and
6. Result in impacts on human society arising from the above changes.

In addition to research by scientists, the HKSAR Government must identify low-lying areas in Hong Kong that requires special attention to reduce asset exposure. This might be through limits to further development in some areas and relocation of certain assets in the longer-term. The study must also consider what kind of defensive infrastructure could be constructed; areas of rich biodiversity that need protection etc. As these are very major decisions that affects many people, their livelihood and investments, consideration should also be given by the Steering Committee as to how the HKSAR Government might work with society to have relevant discussions over the course of time from one administration to the next. This is particularly important because the on-going long-term nature of climate change means answers will need to be updated. The issue today is how the current administrations intends to improve planning for such eventualities. ■

SHORTER HORIZON

The HKSAR Government already has to consider what could be done in Heng Fa Chuen and Tseung Kwan O in light of recent storms and the storm surges that caused considerable damage.

3 EXCESS WATER CHALLENGES IN HONG KONG

Landslides, flooding and multi-hazards

The threats of severe and extreme rainfall events pose to Hong Kong is very high because of its hilly condition, and high and dense population. The expected increasing trend of total rainfall and decreasing trend of rainy days (i.e. likelihood of extreme downpours) as a result of climate change highlights the importance of better understanding the non-stationarity and non-linearity of the occurrences of flooding and landslide events due to excess water, which can lead to cascading hazards.

CARe2018 observed that Hong Kong needs to consider its existing infrastructure, as well as how to design new infrastructure to deal with excess water challenges.

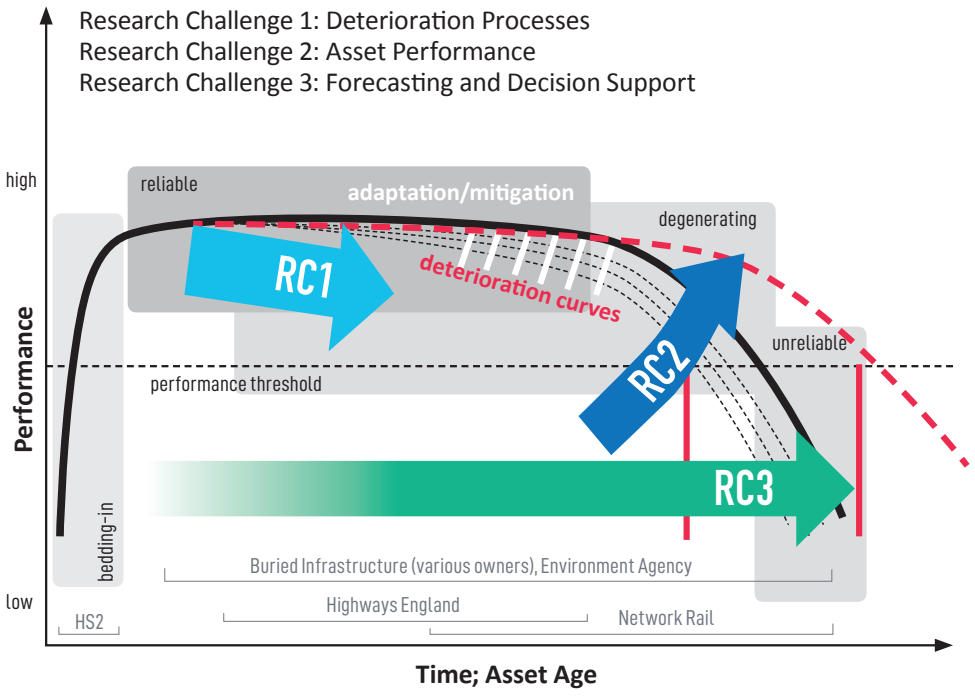
I: MATERIAL DETERIORATION

A major challenge to be addressed is that materials and systems deteriorate with time, while environmental loading has been and continues to get heavier. Increased utilisation and development increase both the likelihood and consequence of systems failure. Understanding where and when failures might occur is very challenging.

FIGURE 3-1

WHOLE-LIFE CYCLE MATERIAL DETERIORATION OF CIVIL INFRASTRUCTURE

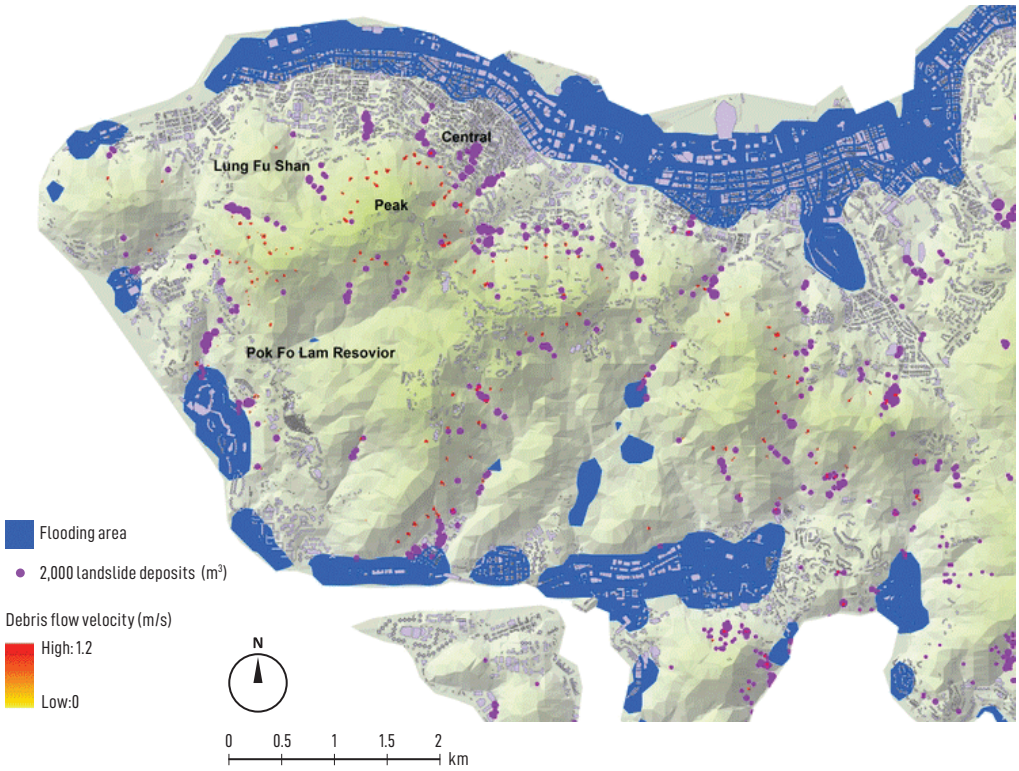
Source: in the presentation by Stephanie GLENDINNING at CARe2018



II: CASCADING HAZARDS

Advancement in addressing excess water concerns can only result from an improved understanding of the relevant climate drivers. Government departments, such as HKO, GEO/CEDD and DSD, are conducting studies that can fill gaps in understanding, and much more research and experimentation need to be done.

FIGURE 3-2
UNDERSTANDING CASCADING HAZARDS
Source: in the presentation by Limin ZHANG at CARe2018



In dealing with hazards arising from excess water, CARe2018 noted that thorny problems to be solved include developing a monitoring and an early warning system for possible slope failure through better understanding of the initiation and failure mechanisms of slopes under extreme rainstorms. Joint efforts between the government and universities, such as GEO/CEDD-HKUST's development of landslide barrier systems, enable cross-disciplinary collaboration that is vital for continuous advancement. In light of the high risk of slope failure in Hong Kong, another area of possible collaboration is to develop data-driven landslide forecasting using artificial intelligence and machine learning, in addition to physical and numerical models.

FIGURE 3-3

NEW LANDSLIDE BARRIER SYSTEM BY GEO/CEDD-HKUST

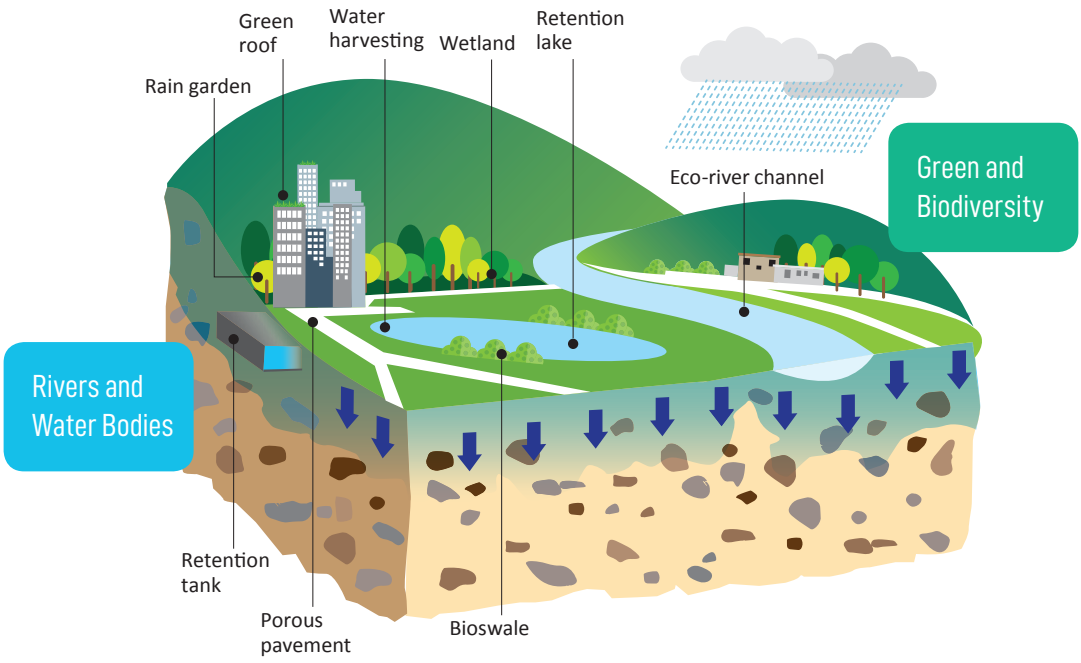
Source: HKUST

In addition, thinking has also advanced in designing adaptive infrastructure, such as the "blue-green" infrastructure approach that uses nature and natural processes for greater resilience. While traditional engineering aims to defend assets by stopping, repelling or controlling natural forces, the new approach requires infrastructure that can both defend and repel excess water treats at the same time. DSD's sponge city concept is an important example of this new approach.

FIGURE 3-4

SPONGE CITY CONCEPT

Source: DSD



III: MORE COLLABORATION TO MEET CHALLENGES

While Hong Kong has excellent engineers and systems in place for slopes and flood management, CARe2018 noted that cross-disciplinary effort and greater collaboration that synergises the input from engineers, policy-makers and stakeholders is essential to meet the higher challenges posed by climate change. Involving government officials, universities and professionals in the development of adaptative measures is crucial for the effective transfer of the latest thinking and technologies to help Hong Kong design and build more resilient and sustainable civil infrastructure. Moreover, there is a strong case to educate the general public using MOOC via the latest augmented reality and virtual reality technologies about slope safety so as to empower communities to improve their disaster preparedness.

In summary, the Steering Committee should:

- Recognize increased development increases both the likelihood and consequence of systems failure; and excess water risks can lead to multiple, concurrent failures in high risk Hong Kong.
- Support cross-disciplinary research and experimentation to lower excess water threats is essential to make Hong Kong more climate-ready.
- Support Hong Kong to develop a science-based, data-driven landslide forecasting system that is based on better understanding of where and under what circumstances failures might occur; as well as the interaction between resisting barrier, excess water, soil and vegetation.
- Empower communities to improve their disaster preparedness through well-designed public education using new tools, such as MOOC aimed at unlimited participation and open access with appropriate visualisation and interactive components. ■

4 SEAS AND OCEANS

Greater understanding needed

The Earth's seas and oceans are major heat and carbon sinks and thus are inextricably linked to climate change, including long-term shifts in ocean currents. The subject is large and complex and deserves much greater study and policy attention than it has had to date.

POLICY ATTENTION JUSTIFIED

The Steering Committee may consider asking HKO, ENB/EPD and AFCD to work together with local and national universities to increase Hong Kong's knowledge in order to contribute meaningfully to what is a vital, although so far neglected, subject.
The justification for the HKSAR Government to step-up and play a better coordinated role is obvious: Hong Kong has more sea area than land area (1,650 km^2 vs. 1,104 km^2), is a major port city, and has a long coastline. Hong Kong has significant fisheries-related activities (fishing, trading, aquaculture – with a policy to increase the quantity and quality of local aquaculture – and seafood consumption), and a large maritime sector. Moreover, the national authorities are now paying significant attention to the study of oceans and to make policy; and Guangdong has put forward the concept of an "ocean economy", which Hong Kong should play a role in shaping.

CLIMATE CHANGE TRIPLE WHAMMIES

Seas and oceans face the triple whammies of higher temperatures, acidification and eutrophication for marine life and ecosystems. Global warming (i) raises water temperatures – a 1˚C increase leads to a 2% reduction in oxygen; (ii) the water absorb more carbon and becomes more acidic; and (iii) run-off from land (mainly sewage and fertilisers) create 'dead zones', such as the 2,200 km^2 off the coast of the Pearl River.

The occasional intense red tides in Hong Kong is a negative signal of ecosystem imbalance, as well as for local aquaculture.

OCEAN CURRENTS

Over the coming decades, East Asia, including China, will see temperatures rise because the Kuroshio Current will transport more heat and shift northward. The heat will not only make storms more likely in the region but will also lead to less nutrients entering the South China Sea, thereby fish catch is expected to decrease.

UNANSWERED QUESTIONS

Studies are needed to understand the relative quantities and mix of water pollution contributions between Hong Kong and the Pearl River Delta, and why red tides incidents are more prevalent on the eastern rather than the western side of Hong Kong.

CARe2018 could only touch on a few issues for early attention. Obvious entry points for consideration at this stage are:

1. Doing more to reduce water pollution from Hong Kong sources. This will mean providing adequate funds for sewage treatment projects in new towns and New Territories villages. The policy to allow the use of sceptic tanks in villages should be reassessed.
2. Managing Hong Kong's marine environment at an ecosystems level, which requires government departments (AFCD, ENB/EPD) to collaborate.
3. Ensuring cross-boundary collaboration in water pollution control across the Greater Bay Area that can eventually lead to adopting an ecosystems approach.
4. Improving understanding of the mechanisms that determine acidification, eutrophication and hypoxia through government departments and universities cooperating to define and conduct the right research projects.
5. Improved water and pollution monitoring, including funding an additional research vessel and buoys. ■

5 CLIMATE CHANGE AND HANDLING WATER

Improve integration for multiple benefits

In thinking about water and climate change, Hong Kong's challenge going forward is heavy downpours, though there may be the occasional prolonged dry spells.

Arising from CARe2018, policy-makers may wish to take the following observations into consideration:

Dealing with excess water challenges
This is the responsibility of DSD, which deals with drainage and wastewater treatment. DSD has done an admirable job over the years to put in place effective wastewater and flood treatment plans.

Reducing water usage and dealing with dry spells
Water supply is the responsibility of WSD. Dealing with times of less rainfall requires society to get used to consuming less water, which can be through different means – lowering per capita consumption; increasing the use of reclaimed and recycled water; reducing wastage through leakage; and Hong Kong's existing plan calls for using desalination to produce 5% to 10% of its fresh water. These are all aspects of WSD's existing Total Water Management Strategy (TWMS 2008) to varying degree of success.

Saving water is saving energy and money, and reducing carbon footprint
Pumping water, which is the responsibility of WSD, and pumping away wastewater and sewage, which is done by DSD, require energy. Minimising pumping saves energy. Desalination will also require significant energy consumption. Using less water will lower the energy required for both pumping and desalination, thereby reducing costs for society and helping Hong Kong to decarbonise.

Closer collaboration between WSD and DSD
To maximise outcomes, WSD and DSD need to work hand-in-glove. In most other jurisdictions, the functions they perform are done by one department. Having two entities creates inefficiencies. Short of institutional reform to combine WSD and DSD in one department, the Steering Committee should nevertheless examine how they can improve outcomes.

Contributing to water basin sustainability
For Hong Kong's long-term water sustainability, the whole of the Pearl River Basin of which the Dongjiang is a tributary, must be well-managed. The mainland is improving its approach to water management, and Hong Kong's local efforts should contribute to regional sustainability efforts.

FIGURE 5-1

SUMMING UP: REVISING HONG KONG'S TOTAL WATER MANAGEMENT STRATEGY

6 CHANGING RISKS AND PUBLIC HEALTH

Integrate health system and city planning

When taken together, climate change is altering many types of risks associated with weather conditions. There are serious public health and safety issues for the HKSAR Government to consider that the Centre for Health Protection, an agency under the Department of Health, has acknowledged. Local experts have also recommended what should be reviewed.

The Steering Committee should call upon ministers to collaborate, as adaptation in the long-term requires them to bring together government officials in several Bureaux and Departments to make cross-and-transdisciplinary policy together, including ENB, DEVB, FHB, LWB, HAB and SB and the relevant departments. They should also work with non-government experts and professionals.

In particular, the following actions are recommended:[1]

Review health services

The government should review the health system's climate readiness and surge capacities, the result of which can help to reorganise and implement relevant public health, medical, education and social services at the community level to ensure services are relevant, appropriate, equitable and cost effective.

- Data on temperature-related mortality, morbidity/hospital admissions and extreme weather events should be thoroughly examined to ensure Hong Kong's health system can cope with increasingly frequent and intense extreme weather events of prolonged heat, occasional cold spells, and rainstorms that can cause casualties and increase risk of waterborne diseases.

Raise awareness of health workforce

The government should work with the Hospital Authority, medical schools and medical and nursing professions, as well as social welfare professionals to raise awareness and training about the health impacts of climate change.

- Training should cover core concepts to enable common terminology, technical skills to quantify population health risks and capacity building for health and climate change programme development.

1. Emily YY Chan, Heidi Hung, Gabriel NV Lau, Edward YY Ng, Policy implication of health impacts of climate change in Hong Kong, Policy Brief, October 2016, http://ccouc.org/_asset/file/policybrief-climatechangeandhumanhealthinhk-161020.pdf.

Upgrade and target health information system

Consider whether the current weather warning system may be further upgraded to include more targeted information to facilitate self-help and care behaviour in the community during extreme weather days.

Integrate built environment knowledge

Hong Kong already has policies to create more urban space and improve urban ventilation, as well as implement urban forestry, which all have public health benefits. The government should consider how these policies can be better integrated through working with property developers and owners, built environment professionals and districts, taking a specific focus on climate readiness (see also Chapter 7). ■

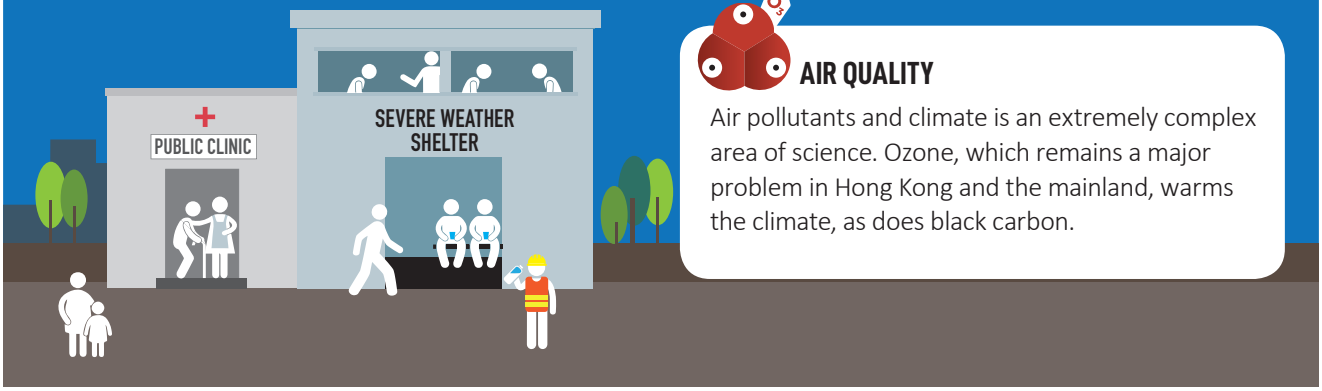
DEALING WITH HEAT AND COLD

As temperatures climb, there will be longer periods of high temperatures in the summer. Heatwaves will become more frequent and severe in future. They will tend to start earlier in the year and still occur later. The duration of individual can also become longer.

In Hong Kong, heat is exacerbated by dense, high-rise urban conditions. Extreme heat can overpower the human body and cause dehydration, heatstroke or even organ failure.

The populations most at risk include children, the elderly and people who live in sub-standard conditions with poor ventilation. So far, Hong Kong's general response to high temperatures is air-conditioning, and for those who do not have it at home, government community centres are open to people who do not wish to remain at home

Hong Kong has also experienced very cold spells in recent winters. Local research shows extreme cold can be deadly. As buildings and homes generally do not have heating, low temperatures can lead to hypothermia, especially among older populations. Local research shows the effect of cold last longer and greater than that of heat on people. Those over 75 are the most vulnerable group to cold temperatures, while those between 65-74 are most vulnerable to heat.[2]



AIR QUALITY

Air pollutants and climate is an extremely complex area of science. Ozone, which remains a major problem in Hong Kong and the mainland, warms the climate, as does black carbon.

2. Wen Yi and Albert PC Chan, *Effects of temperatures on mortality in Hong Kong, a time series analysis, International Journal of Biometeorology* 59(7):937-937, July 2015.

7 BUILT ENVIRONMENT, CLIMATE ADAPTATION AND RESILIENCE

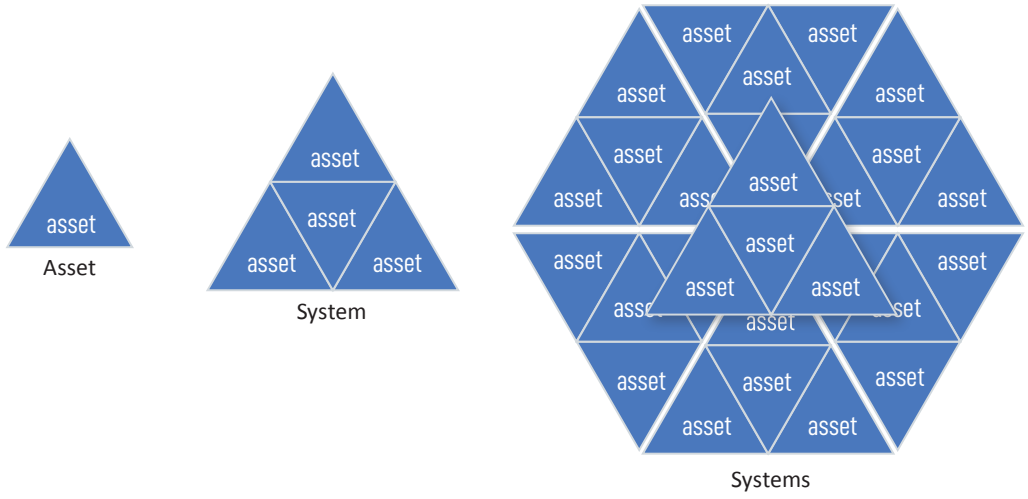
CRITICAL INFRASTRUCTURE

Extreme weather can severely disrupt and damage the infrastructure services of a complex modern city like Hong Kong. CARe2018's key conclusion in this area is that climate change impacts so many aspects of how a city functions that integrated policy-making and coordination is vital to climate-readiness.

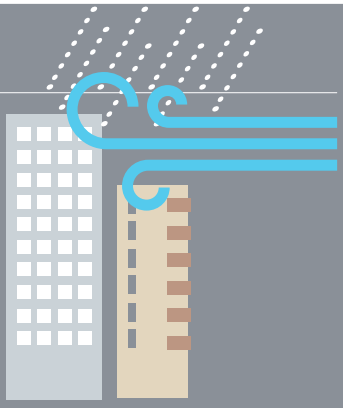
Each year, the public and private sectors in Hong Kong spend billions of dollars on infrastructure. Every opportunity needs to be taken to ensure these investments are designed to be climate-ready. Designs should not be based only on historical experiences of climate, but should take into account the needs of a warmer, wetter, and more extreme weather.

Major public works, and critical privately-owned assets (i.e. no substitute for them), such as power plants and railways, are designed to last for several decades. During that time, the climate will continue to change, and extremes will become more prominent and severe. Thus, in designing and constructing infrastructure, there must be an adaptive element that allows for upgrades, retrofits and alterations, and, wherever possible, to adapt to the changing climate. Moreover, increased interdependence between systems magnifies the risks and consequence of failure, such as between electricity supply and information and communication technology (ICT) systems. For example, do power plants, power networks and interconnection capacities need to be strengthened?

FIGURE 7-1
CITIES ARE MADE UP OF SYSTEMS-WITHIN-SYSTEMS
Source: ARUP



DESIGN ASSUMPTIONS FOR INFRASTRUCTURE



Infrastructure designers use certain planning and design assumptions for a particular piece of infrastructure. Assumptions for public works are set by government through Codes of Practice, such as maximum wave impacts for coastal defence, maximum precipitation for dam safety, maximum wind speed for highways and bridges etc. Greater climate extreme risks mean these assumptions may have to be strengthened.

SWAYING BUILDINGS AND BLOWN-OUT WINDOWS

During Typhoon Mangkhut, people in high-rises felt their buildings "moving". This is a design feature of buildings in Hong Kong, as required by the government's Code of Practice on Wind Effects, so that they can sway and withstand very strong winds.

Also during the typhoon, a relatively small number of commercial and residential buildings had their windows blown-out. This may not be a sign that the relevant code of practice is inadequate, as the windows in adjacent buildings were unaffected. It may have to do with the materials used and/or the quality of construction or building maintenance. Nevertheless, the government may consider whether the relevant code should stipulate a certain quality or standard for hardware (in this case in ironmongery).

DESIGN PARAMETERS OF BUILDINGS

The government may also consider whether there is a need to strengthen the design parameters of buildings for more robust climate-readiness, such as:

- Increase the fresh water tanks capacity;
- Increase the capacity of the standby power of all buildings;
- Require the main electrical switchboards to be installed at sufficient height e.g. on higher floor to avoid backout of the whole building when the main switch room is flooded; and
- Raise the standard of windows design and construction to withstand positive and negative pressure.

Despite the costly disruptions that could arise from buildings or infrastructure being damaged by extreme weather, it is not always clear who is responsible for what. This can lead to failures to create and maintain buildings and infrastructure to a standard required to withstand extreme weather.

The Steering Committee needs to clarify who is responsible for what within the government bureaucracy; and strengthen Hong Kong-wide capabilities to improve climate-readiness. This must be an on-going, long-term effort, with much co-learning within government, as well as with the private sector. A fit-for-purpose institutional framework will be needed.

CARe2018 proposes that the Steering Committee considers the following:

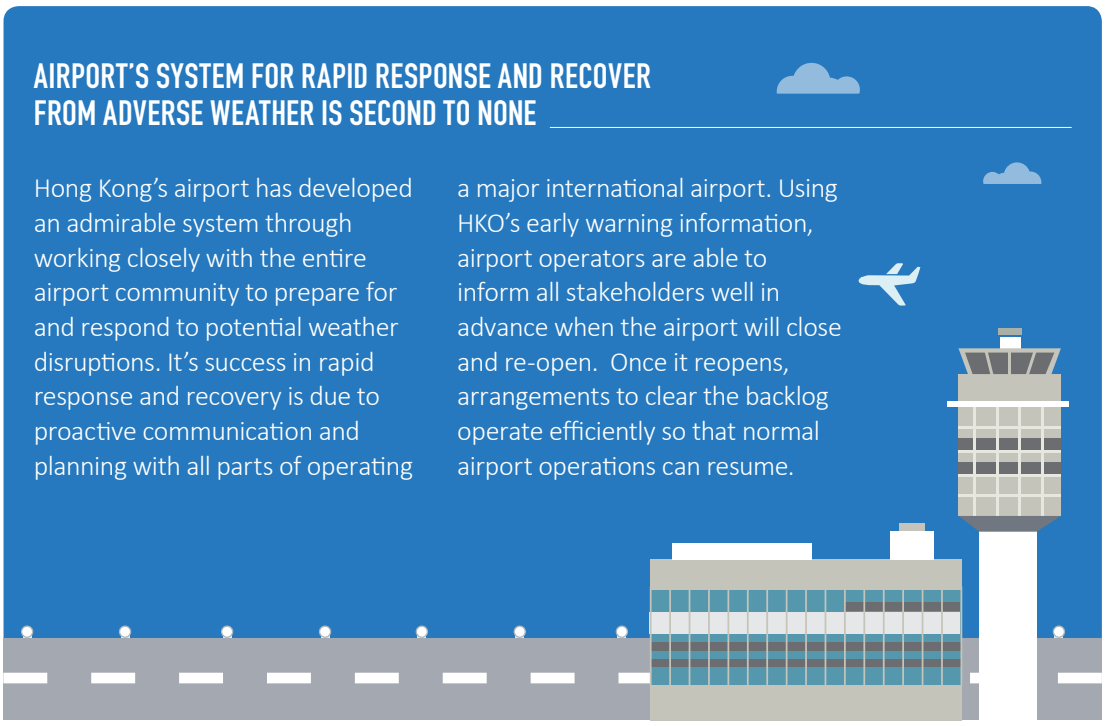
1. **Critical infrastructure identification and risk assessment**
The HKSAR Government should have a clear idea of the climate-readiness of the critical infrastructure it operates (buildings and infrastructure, such as offices, hospitals, fire stations, police stations, highways and roads, bridges, tunnels, breakwater, piers, water and sewage works etc). There are also government-owned but contractor-operated infrastructure (such as landfills, waste treatment facilities etc), which should likewise be assessed for their climate-readiness.

   Many critical assets are owned and operated by the private sector in Hong Kong – the most prominent of which are electricity generating plants, substations and transmission/ distribution systems, Towngas operations, fuel storage facilities, ports, the airport, the rail system and other transport facilities, banks and the stock exchange. Most of the private sector owners and operators are aware of the higher risks of failure due to climate change, but public information is not available as to their assessment of the risks and what investments are needed to keep them climate-ready for the long-term. This information is essential for Hong Kong to have a full picture of the city's climate-readiness.

2. **Fit-for-purpose dialogue**
CARe2018 showed that the private sector stakeholders were keen to have an institutionalised dialogue with the HKSAR Government and other key stakeholders because they realised that their assets and their businesses were inextricably connected in a modern city and that their efforts and that of the government can only be optimised with a truly cross-and-transdisciplinary approach. The question was who should play this facilitated engagement role.

AIRPORT'S SYSTEM FOR RAPID RESPONSE AND RECOVER FROM ADVERSE WEATHER IS SECOND TO NONE

Hong Kong's airport has developed an admirable system through working closely with the entire airport community to prepare for and respond to potential weather disruptions. It's success in rapid response and recovery is due to proactive communication and planning with all parts of operating a major international airport. Using HKO's early warning information, airport operators are able to inform all stakeholders well in advance when the airport will close and re-open. Once it reopens, arrangements to clear the backlog operate efficiently so that normal airport operations can resume.



3. District-based infrastructure

While the abovementioned types of infrastructure are critical for the city or a large section of the city, there are infrastructure that is vital for specific localities (clinics, community centres, schools, access roads etc). HAB already has much of the information and it could examine district-based infrastructure using the risk, exposure and vulnerability frame to fine-tune district communication and emergency plans. Indeed, district-based command centres may be useful. Well-coordinated involvement of district representatives and non-government organisations (NGOs) would be important. Particularly as, in and extreme weather event, multiple problems may occur simultaneously overwhelming the capacity of the regular emergency services.

DISTRICT-AND-NEIGHBOURHOOD-BASED INITIATIVES

District-based initiatives could be structured to develop neighbourhood climate-ready management plans. Decentralised neighbourhood networks could be more accessible and resilient to help affected communities. NGOs could have important roles to assist districts/neighbourhoods to prepare plans, organise drills, and consolidate/share resources during climate events. Neighbours should also be encouraged to help each other.

Examples of possible measures include:

a	Use SMS and social media means to communicate with people before, during and after emergencies.
b	Decentralise emergency call numbers by auto-forwarding incoming calls to district police stations when the 999/112 centre is overloaded.
c	Establish district-based resources centres to provide pooled emergency equipment, such as submersible pumps, electric saw, etc.
d	Identify and earmark venues (such as community centres, schools, sport centre, etc.) as temporary accommodation.
e	Establish mutual aid network at local level which can, with the support of the local resources centres, act as focal communication and coordination points, disseminate information and instructions, distribute necessary resources and supplies, provide transportation, etc.
f	Identify collection centres to collect and store debris and fell trees after the crisis and before the central handling system can gradually absorb such debris and fell trees.

SECURITY BUREAU'S REVIEW

Post-Mangkhut, the Steering Committee has already asked SB to coordinate a review of how emergency preparedness could be improved. Besides critical infrastructure identification and taking a district-based approached, SB would no doubt reassess its coordination capacity during emergencies. It would need to consider the most extreme weather events and how to co-ordinate the efforts of the public and private sectors. During extreme climate events, the command centre would have to be able to give coordinated directives to the public in different districts and to manage different infrastructure stakeholders to mobilise resources or reserve certain limited infrastructural capacities for prioritised usages.

OLDER RESIDENTIAL BUILDINGS AND UNDER-PRIVILEGED POPULATIONS

The government estimates that there are now more than 5,000 private residential and composite buildings aged 50 or above in Hong Kong, many of which are in poor condition. This has been a growing problem, which led to the HK$2 billion Operation Building Bright scheme in 2009-10. The government provided small grants to owners of residential buildings over 20 years old, with less than 400 units, and in poor condition, to carry out basic repairs. In 2017, another HK$3 billion was injected over 5 years to help owners repair their buildings, and it is estimated that 2,500 older buildings could benefit from the extension of this scheme.

Such repairs will have some positive impact on these buildings from a climate change perspective. The Steering Committee may consider:

1. Whether and how climate-readiness can be made part of the mission of the Operation Building Bright scheme.
2. Whether further action is needed to reduce the risk of failures under extreme weather in older buildings, which may not be redeveloped for some years.
3. Whether the government should help prepare specific localities with neighbourhood support/refuge networks with open-sourced/coordinated initiatives provided by public/institutional premises during extreme climate events. ■

Typical examples of disrepair in Hong Kong's older residential buildings

HONG KONG'S VULNERABLE COMMUNITIES

From CARe2018, there appears to be no study done yet on the vulnerable communities in Hong Kong in light of climate change. The social welfare sector also does not appear to be paying much attention to climate change yet.

Vulnerable groups include low-income households, children in poverty, people living in cage homes, the working poor, and the homeless. The latest Hong Kong Poverty Situation Report released by the government on 20 November 2018 showed that, even after taking government's interventions into account, one in seven person in Hong Kong has to make ends meet with less than HK$5,000 each month.

Many of the underprivileged live in nano or sub-divided flats in old private residential buildings with poor ventilation, in rooftop dwelling structures built of sheet metal, wood, brick or plastics, or in public housing with bathroom and kitchen located outdoor on the balcony. As the climate continues to change, it may worsen their situation and thereby worsen pre-existent inequalities in Hong Kong. Understanding the profile of the living conditions of the underprivileged would help Hong Kong to focus on climate-ready social welfare policies.

! The Steering Committee should consider asking HAB, LWB, HFB and other relevant bureaux and departments to assess the climate risks, exposure and vulnerability of the underprivileged communities in Hong Kong.

INSIGHTS FROM TYPHOON MANGKHUT ON VEGETATION

Typhoon Mangkhut left a trail of destruction. Up until the end of October, the officially reported tree loss was over 46,000. This should not be a surprise, as the super typhoon had unprecedented sustained winds of up to 175 km/hour over approximately 10 hours, and at times wind speeds exceeded 200 km/hour.

Questions were raised as to whether Hong Kong's urban trees were properly planted and cared for, as well as whether the wood from fallen trees could have been used rather than dumped in landfills. Irrespective of how good Hong Kong's urban trees may be, it would be hard for them to withstand such sustained heavy wind loads. Among the urban trees lost, were many aging trees planted some years ago at a time when less attention was paid to how planting should be done. The planting of urban trees is an area where improvements can be made, including bearing in mind extreme events brought upon by climate change.

Going hand-in-hand with choosing the right type of trees for urban areas is soil volume and quality. Hong Kong's soils have a very high clay content and compacts easily.

However, there are good local opportunities to improve soils (without the need to import), such as recycling urban waste materials to blend into and improving the quality of local soils:

- Waste glass ground to 70-100 microns (sand) to rebalance the sand content and improve the porosity of soil;
- Yard waste chipped or mulched and blended into the soil;
- Recycled rubber at approximately 25 mm aggregate to improve the porosity of soil and as nutrient; and
- Possibly even remoulding of plastic to maximise 'holes' and porosity to capture water; nutrients; etc, which is also good for roots to go through and improve tree anchorage.

Hong Kong can innovate to improve soils and demonstrate proper holistic urban forestry practices. This includes the timely removal of trees, before tree death. Urban trees have Useful Life Expectancy (ULE) and should be replenished on a regular cycle. If the trees are not removed on such cycles, there will not be opportunities to replenish and rejuvenate the soil and the landscape to maintain resilience and relevance.

As Hong Kong has many plans to improve open spaces and walkability, various government departments can work together to consider how best to use green coverage to lower temperature,[1] to integrate good urban forestry practices to upgrade tree pits, soil quality, and tree types, as well as using sensing technologies so trees can thrive better in the pressures associated with urban environments. This will require an overall urban perspective to rethink, redesign, and reconstruct the urban landscape – in particular, Hong Kong's sidewalks.

As cities are made up of many different elements that are inextricably intertwined with each other, the onus is on the varying government departments to collaborate and maintain these synergies. Officials responsible for urban landscape and tree management policies and guideliens (GLTMS), landscape architecture and open space design (ArchSD), walkability (TD), as well as waste management (EPD) can work hand-in-glove with each other, and cooperate with private sector urban designers, landscape architects, engineers, and urban environmental designers to pull knowledge and thinking together to create better urban environments, which take climate change into account. Where Hong Kong does not have direct expertise, this could be sought internationally with a view of training local talent for the longer-term.

1. Ground level tree planting is important in Hong Kong as green coverage must be over 30% for the air temperature at pedestrian level to be lowered by 1˚C.

Fallen trees

With greater awareness and preparedness, Hong Kong can use fallen trees, not only large quantities from storms but also at normal times:

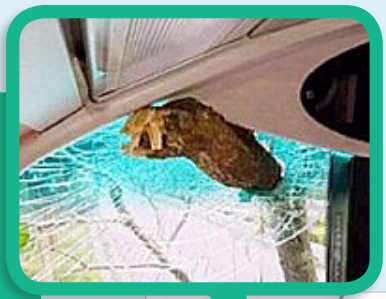
1	EPD to review land resumption schedule of the Tseung Kwan O (TKO) fill bank to allow the processing of yard waste; and in the longer term, the waste-to-energy-plant being built take yard waste.
2	AFCD to ensure urban yard waste cannot ever be disposed of in country parks.
3	AFCD to examine potential compost shipment to Shenzhen and nearby mainland projects.
4	CEDD to: • Undertake space planning of the TKO fill bank; • Coordinate departments with wood chippers, as well as hire additional industrial chippers when needed; • Procure arboriculture and horticulture contractors to assist in coordination; • Organise an expert 'Reference Group'[2] to provide technical advice, as well as help inform the public so there is high transparency; • Identify current and pipeline projects where the soil can be used; • Advertise to contractors for private projects / organic farmer / etc and invite them to go and help themselves; and • Set up a protocol for collection.
5	The Reference Group and arboriculture and horticulture contractors to agree on three basic types of soil options to blend the yard waste into the soil at the fill bank: i) for slope works and general infrastructure; ii) general soft landscape works; and iii) premium top soil.
6	Yard waste will need to be chipped then sprayed with broad-spectrum fungicide to disinfect diseased and contaminated stock (essential step for all yard waste) i.e.: i) chip; ii) fungicide; and iii) blend with soil.
7	Look into also blending rock aggregate to improve the aeration of the soil. This is a ready-made product currently used as road-base but can also be blended with other materials to replicate the technical and performance properties of soil in a practicable manner.

2. Experts could include (a) ecologists (b) soil experts; (c) landscape architects and urban designers with strong urban environmental design background (d) international representation from resilience aware cities such as Melbourne, Sydney, New York, San Francisco, London etc.

FAILURE IN BUS SERVICE AFTER TYPHOON MANGKHUT

It has already been observed and discussed immediately after Typhoon Mangkhut that there is a case for the government to consider staggering the resumption of office working hours after severe weather events, should it be necessary, to avoid overloading the public transportation system.

Another problem arising from Typhoon Mangkhut had to do with franchise bus operations. While roads were cleared and the government informed the bus companies that services could resume, many double-deck buses ended-up being damaged by dangling branches (see photographs for examples). One operator had about 10% of its total bus fleet damaged through bus windows and windshields being cracked by protruding branches. At one stage, the operator was running out of replacement buses whilst bus maintenance staff were repairing the damage.

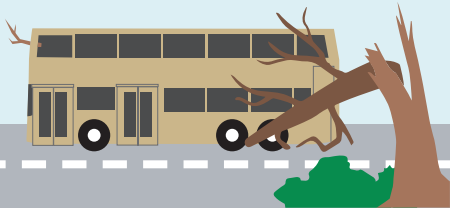


News report noted the following:

> “A KMB bus on Route 85 hit dangling tree branches near Shan Mei Street in Fo Tan at about 11am. On Route 93K to Po Lam in Tseung Kwan O, dangling branches broke the windshield of a KMB bus at about 9am. An hour earlier, another KMB bus on Route 1 hit a tree on Prince Edward Road West as it was making its way to Mong Kok. The windshield of the upper deck was cracked. A passenger notified the driver and the bus was driven to depot for repair. A falling branch punctured the top of a Citybus on Route 118 and dropped into its upper deck. A passenger saw a 1.5-meter branch on a seat of the upper deck at 8:30am. The top of the bus had a gaping hole. The driver took the bus back to the depot. On a New World First Bus 682 traveling along Chai Wan Road, a 20-year-old passenger was injured when the vehicle hit a tree at about 2:40pm. Branches fell on the top of the bus and windows on the upper deck were broken. Broken glass cut the man’s neck. The driver stopped the bus and called police. The passenger was sent to hospital. Elsewhere, three KMB buses and a Citybus were damaged by dangling branches. But no one was injured in those incidents.”

The majority of bus services could not in fact resume normal service immediately after the typhoon due to blockage of roads caused by widespread fallen trees and dangling branches. This had led to difficulties for people getting to work. Dangling branches can also be a problem even when there is no extreme weather event because many trees are planted near the roadside or grow from hillsides. This is an issue that can be addressed by more cooperation between relevant government departments and the franchised bus operators.

CARe2018 notes that the bus operators would welcome dialogue and cooperation with relevant government departments. They would welcome this topic being given priority within the bureaucracy since it has been an unaddressed, on-going challenge to operators.



8 CLIMATE CHANGE: FINANCE, INSURANCE AND PHILANTHROPY

A VARIETY OF INVESTMENT TYPES ARE REQUIRED FOR THE TRANSITION TO A LOW-CARBON, CLIMATE-RESILIENT ECONOMY

Public, private and philanthropic capital and insurance ("contingent capital") all have roles to play in funding the development of resilient infrastructure:

- "Catalytic capital" (foundations or family offices, venture capital or private equity) can jumpstart early stage development of projects, promote climate literacy and support climate leadership.
- Government can play an important role in facilitating the funding of innovative cross-border risk-sharing financial risk management instruments.
- As projects become established, and hence lower risk, their debt can be sold on to pension funds and other Long-Term Investors ("LTIs") who are seeking low risk investments, longer tenors and accept a lower rate of return.
- Additionally, insurance is needed to cover the increasing risk of loss and damage and consequential business interruption from extreme weather and natural catastrophes.

DEVELOPING HONG KONG AS A GREEN FINANCE AND INSURANCE HUB

It is already government policy to develop Hong Kong as a green finance hub. Practitioners at CARe2018 discussed what it would take for Hong Kong to be the leading Green Finance and Insurance Hub of Asia and, concurrently, fund the low carbon and climate resilient transition for both itself and the Greater Bay Area.

Hong Kong could:

- Provide **green finance** – include Disaster Risk Financing.
- Participate in the global work to establish **Green Bond Principles**, which allow funds to be raised more easily for low carbon, climate resilient projects. These principles include definitions around use of proceeds, eligibility criteria (waste/water treatment, clean transportation, energy, sustainable real estate), evaluation, management of proceeds and verification and reporting. As the green bond market matures, the government should consider tax and regulatory incentives to accelerate its growth from a niche activity to high-volume mainstream financing.
- Establish **Green Loan Principles**: green project finance, SME loans, Green Building and Energy Efficiency frameworks.

- Promote **Green Asset Management** including: mainstreaming ESG reporting, enforcing greater adherence by corporates, including insurance companies to TCFD[1]. In particular, make TCFD disclosure a condition precedent to insurers' participation in government-funded infrastructure.

The HKSAR Government's role is critical because it can engage effectively all relevant parties and use its multiple roles – as regulator, capital provider for infrastructure development and community leadership – to turn Hong Kong into the Green Finance and Insurance Hub. FSTB needs to lead and showcase the opportunities to other government departments, as well as get the public sector machinery to row in the same direction. For example, FSTB can:

- Rally the Hong Kong Monetary Authority, Securities and Futures Commission and the stock exchange to work in sync on Green Bond, Green Loan, ESG reporting and compliance, and setting tax or fiscal instruments to promote green finance. The government has the legal and political power to establish frameworks that incentivise the private sector, e.g. improving Hong Kong's energy efficiency legislation for real estate so that it can move closer to world leadership.[2]
- Find ways to fund green incubator or aggregator frameworks, for example, low-carbon buildings, renewable energy projects etc.

REASSERTING HONG KONG'S ROLE IN ARRANGING INSURANCE

The insurance industry can improve an economy's resilience by funding recovery from financial losses and property damage caused by extreme weather events. Currently, insurance coverage for these risks is inadequate in many Asian countries.

Singapore supplanted Hong Kong as the primary insurance centre of Asia nearly a decade ago with the establishment of the Lloyd's Singapore platform. The need for innovation in insurance of climate related risks provides Hong Kong with an opportunity to reassert its leadership in the insurance sector. Hong Kong can attract specialist insurers and "InsurTech" start-ups to drive insurance product innovation with academic/insurer collaboration in data, analytics and weather or climate change impact models.

A strong insurance regulatory framework is needed to support the incubation of innovative insurance solutions, such as:

- **Parametric natural catastrophe insurance** for corporates, local communities or specific to infrastructure. Trans-boundary or regional natural catastrophe "pooling" structures are particularly beneficial. – e.g. an Asia equivalent of the CCRIF;[3]

1. TCFD: The Task Force on Financial Disclosures guidelines are issued by the Financial Stability Board set up by the G20 www.fsb-tcfd.org/about.
2. In August 2018, the Urban Green Council, the New York affiliate of the US Green Building Council, released a plan for a 20% reduction in energy use across the city's largest buildings by 2030.
3. The CCRIF is the Caribbean Catastrophe Risk Insurance Facility supported by the World Bank. http://projects.worldbank.org/P108058/caribbean-catastrophe-risk-insurance-facility?lang=en.

- **Catastrophe Bonds** – using capital markets in tandem with traditional insurance and reinsurance capital;
- **Performance or "output" insurance** for solar, wind, battery storage and other projects which provide low carbon electricity;
- In the built environment, product development might include **green insurance coverage** that rebuilds damaged property at higher energy efficiency standards: or, Energy Savings Insurance to address the credit default and performance risk associated with Energy Efficiency retrofits; and
- Revenue stream and/or debt service **repayment obligation insurance** for when sustainable infrastructure is financed on a non or limited recourse basis.

CLIMATE PHILANTHROPY

Climate change requires an "all hands on deck" response. It also requires a different form of leadership for qualitative change in problem-solving. The philanthropic sector is uniquely positioned to facilitate this leadership. It can:

- **Develop climate literacy** by educating members of the public about climate change and what they could do;
- **Provide a climate-positive legacy** by creating a vision for a climate-positive, healthy and sustainable world for future generations;
- **Fund climate projects** that may fall outside the interests of private impact investors and public sector institutions but have a longer-term outlook on climate benefits;
- **De-risk climate politics and policy issues** that cannot be advanced due to political sentiment, inadvertent or otherwise; and
- **Cultivate climate leadership** by supporting values-based, forward-thinking leaders from diverse communities, who can articulate an inspiring vision of the changes needed to address climate change and move society toward that vision.

With these elements working together, philanthropy can make it easier for governments and business to take the action needed for the transition to a low carbon, climate resilient economy. The HKSAR Government could work more closely with those grants bodies that wish to fund climate change work. ■

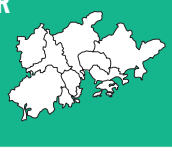
9 REGIONAL CLIMATE ADAPTATION AND RESILIENCE

Greater Bay Area collaboration

While Hong Kong is its own separate jurisdiction, it is a part of the larger geographical and climatic Pearl River Delta region, referred to as the Greater Bay Area. The region is closely connected not only through investment, commerce, transportation and ecosystems but also through social relations. Thus, enhancing the climate resilience of the Greater Bay Area is vital to maintaining the overall resilience of Hong Kong itself. National policy envisions the region would become a centre of international technological innovation and environmental cooperation, with a corridor connecting Hong Kong, Macao, Guangzhou and Shenzhen, with a comprehensive transport system to better connect Hong Kong and Macao with the mainland.

Greater connectedness demands regional awareness of common risks, exposure and vulnerabilities brought on by climate change. The need for the authorities to work together to ensure the region is climate ready should command high priority. Hong Kong's academic and professional experience in many fields should also be encouraged to collaborate with their counterparts in the Greater Bay Area and play a significant role in regional climate-readiness.

The preceding chapters noted areas of cooperation highlighted by CARe2018. The following is a summary of these areas that can be factored into the many existing cross-boundary mechanisms. Over the course of time, collaboration can be enhanced to solve practical problems, as well as to capture opportunities for greater resilience and safety of people and assets in the region:

1	**CLIMATE SCIENCE** 	Sharing data and conducting join studies will help regional and national authorities to deepen their knowledge of the region.
2	**SEA LEVEL RISE** 	Regional studies of sea level rise will help the authorities to plan land use for long-term planning.
3	**WATER POLLUTION SOURCES** 	Joint studies to better understand the contributions of water pollution from Hong Kong, Macao and Guangdong will help the authorities to improve control and enforcement.
4	**PEARL RIVER BASIN** 	Hong Kong should seek to play a role to contribute to the better management of the Pearl River water basin.

5	SLOPE MANAGEMENT 	Hong Kong can contribute to regional and even national effort in slope management, as Hong Kong has developed a good management system, the techniques of which can be shared.
6	WASTEWATER AND FLOOD MANAGEMENT 	This is an area in which Hong Kong has accumulated exceptional experience which it can share regionally and nationally.
7	GREEN FINANCE 	Together with Macao, Shenzhen and Guangdong, Hong Kong can use its highly experienced financial and professional services sector to raise funds for the many adaptation, mitigation and insurance needs for the region as a whole. This ought to be led by the private sector but working closely with the regional authorities since adaptation projects in particularly include many public sector projects.
8	PHILANTHROPY 	Private grants foundations can provide seed funding for climate change awareness building, especially in helping to build social resilience in climate-readiness.
9	ENERGY, WATER AND FOOD SECURITY 	As the region is closely knitted in energy sources, power supply, water supply and food supplies, it behoves them to consider the board picture of how to ensure security of supply.

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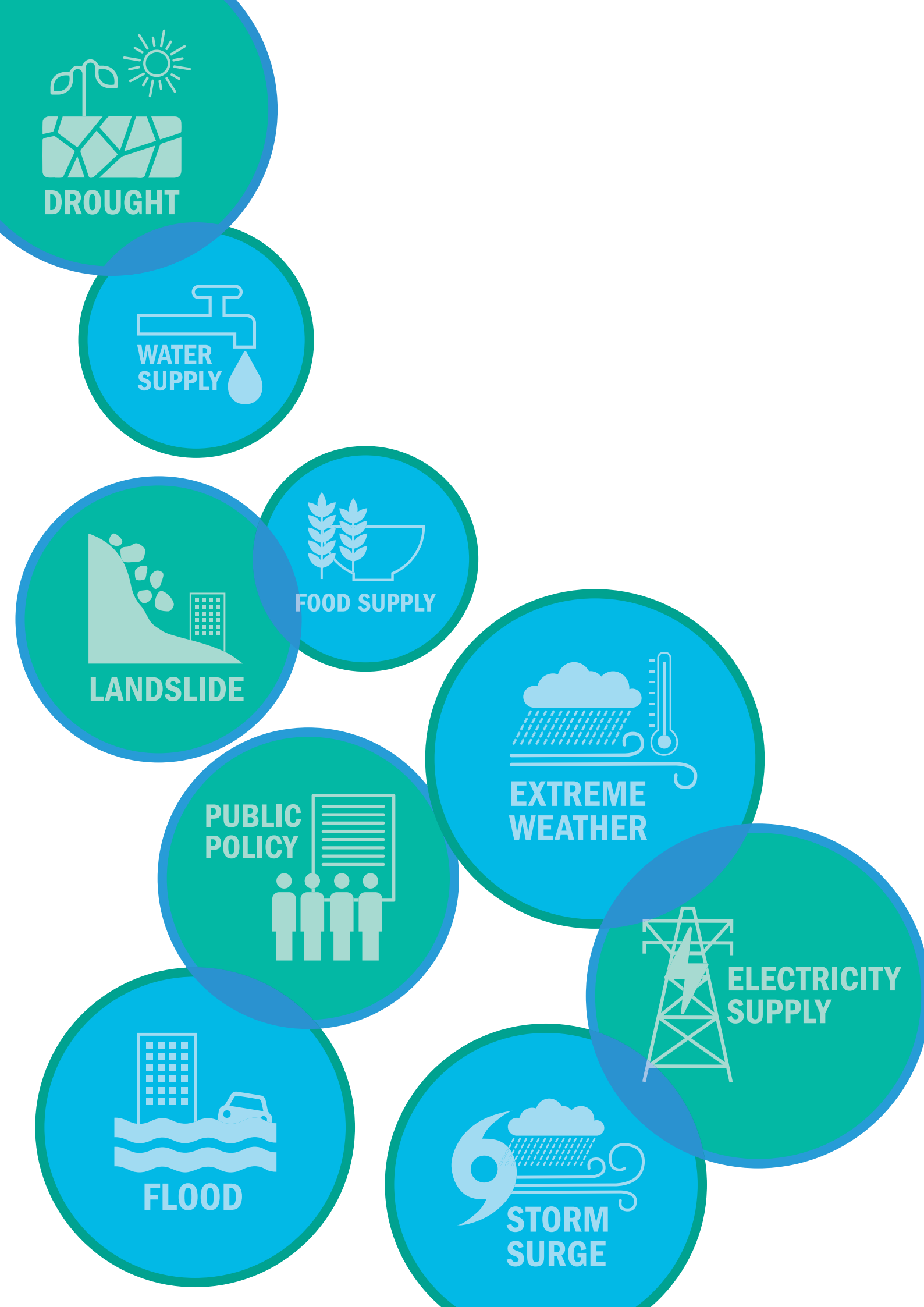
ACRONYMS AND ABBREVIATIONS

AFCD	Agriculture, Fisheries and Conservation Department
ArchSD	Architectural Services Department
CARe2018	Climate Adaptation and Resilience Conference 2018
CCAP 2030	Hong Kong's Climate Action Plan 2030+
CCRIF	Caribbean Catastrophe Risk Insurance Facility
CEDD	Civil Engineering and Development Department
DEVB	Development Bureau
DSD	Drainage Services Department
ENB	Environment Bureau
EPD	Environmental Protection Department
FHB	Food and Health Bureau
FSTB	Financial Services and the Treasury Bureau
GEO	Geotechnical Engineering Office
GLTMS	Greening, Landscape and Tree Management Section
HAB	Home Affairs Bureau
HKO	Hong Kong Observatory
ICT	Information and Communication Technology
IPCC	Intergovernmental Panel on Climate Change
LTIs	Long-Term Investors
LWB	Labour and Welfare Bureau
MD	Marine Department
MOOC	Massive Open On-line Courses
NGO	Non-governmental Organisations
SB	Security Bureau
SDC	Council for Sustainable Development
Steering Committee	Steering Committee on Climate Change
TCFD	Task Force on Climate-related Financial Disclosures
TD	Transport Department
TKO	Tseung Kwan O
TWMS	Total Water Management Strategy
ULE	Useful Life Expectancy
WSD	Water Supplies Department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