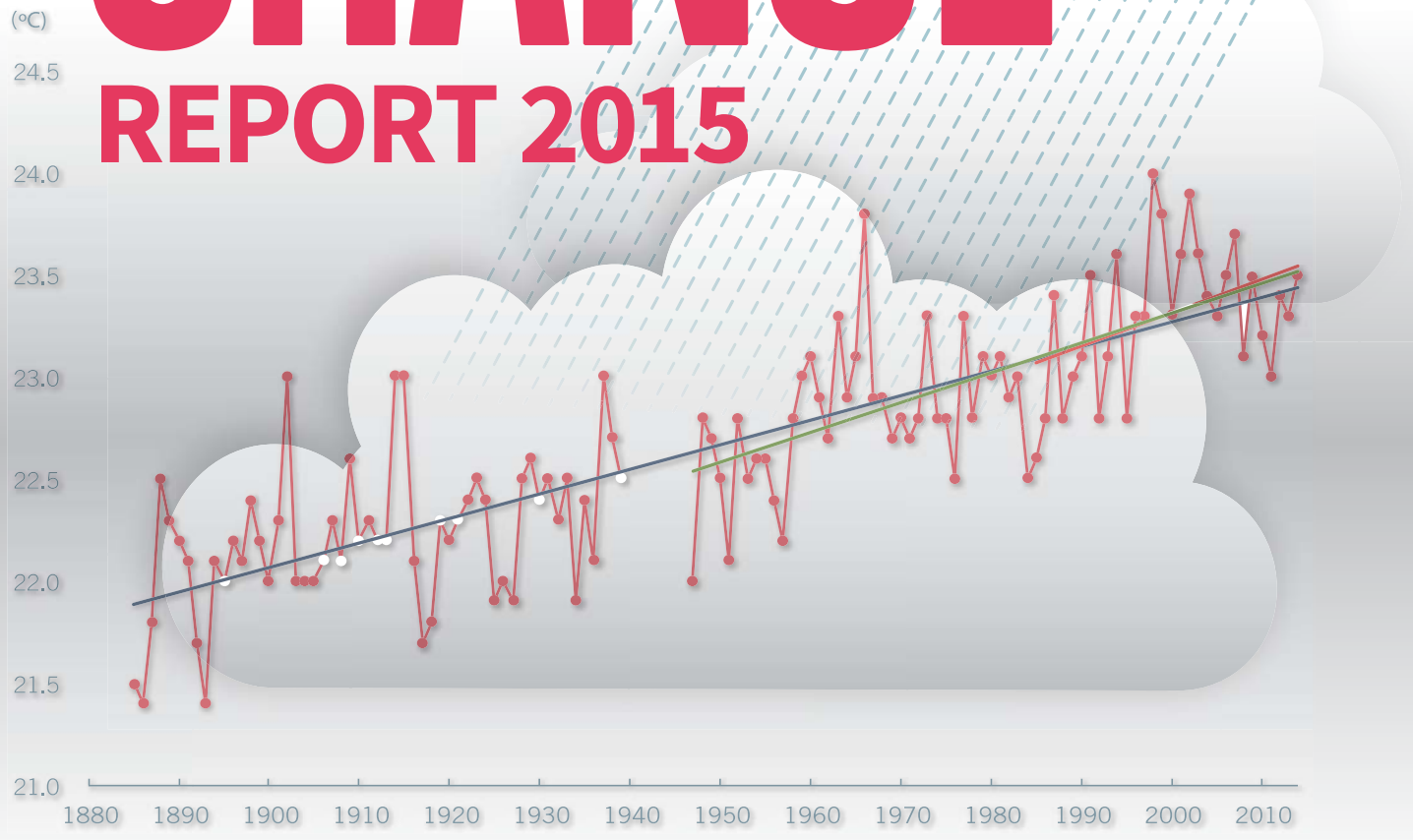
HONG KONG CLIMATE CHANGE REPORT 2015



Environment Bureau in collaboration with

Development Bureau | **Transport & Housing Bureau**
Commerce & Economic Development Bureau | **Food & Health Bureau** | **Security Bureau**

November 2015

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MESSAGE FROM THE CHIEF EXECUTIVE

I welcome the publication of the "Hong Kong Climate Change Report 2015" and commend the Environment Bureau for its work in putting together this timely and topical document.

Our world is at a climate crossroads. Extreme weather and higher temperatures, along with warming oceans and melting ice sheets, are clear evidence of accelerating climate change – the warming of our planet. The resulting socio-economic impact will be significant for the world and its communities, including ours.

The "Hong Kong Climate Change Report 2015" outlines the work, to date, of the Hong Kong SAR Government and the key private-sector stakeholders in responding to climate change. It also seeks to engage the efforts of the general public in combating climate change.

This is, of course, a complex and long-term challenge. The encouraging news is that we have a good grasp of the science of climate change. The reality, however, is that we still have much more to do, as does the rest of the world.

The report will be included in Hong Kong's formal presentation at the 2015 Paris Climate Conference, or COP21. The conference, 30 November to 11 December, hopes to achieve a multilateral agreement on climate, with the aim of keeping global warming below 2°C. China will have a major presence at COP21. The Hong Kong SAR Government's Secretary for the Environment will join the national delegation in Paris.

I look forward to a successful conclusion of COP21 and to making our city climate-ready and resilient, while improving Hong Kong's social and economic environment.

CY Leung
Chief Executive
Hong Kong Special Administrative Region

MESSAGES FROM PRINCIPAL OFFICIALS

"Climate change will affect infrastructure, transportation systems, energy, food, water supplies and public health. The consequences are felt by all strata of society but may be particularly serious for the poor and vulnerable. Government departments need to be well-ordinated to deal with climate change, and we must also collaborate with the community as a whole to face a variety of socio-economic challenges with a positive attitude."

Carrie Lam Chief Secretary for Administration

"Changing weather patterns will impact on the availability and price of many natural resources, which will in turn impact on the goods and services produced and the jobs and livelihood of those who depend on them. Hong Kong, too, will be affected in a significant way, and we must pay closer attention to climate change."

John C Tsang Financial Secretary

"Laws and regulations can play a critical role in combating climate change. Through international agreements and domestic legislation, we may regulate and set standards for a whole variety of products and services conducive to the protection of our environment. We will, as always, provide full support to the Environment Bureau and the community in taking forward necessary legislative initiatives for containing climate change."

Rimsky Yuen, SC Secretary for Justice

"My bureau is making ongoing efforts to make Hong Kong ready for climate change in areas ranging from land use planning and building infrastructure to preventing landslides and flooding, supplying and saving water, and greening the city. As we continue to develop and update our infrastructure and built environment, we should simultaneously adopt low-carbon and climate resilient approaches for the sustainable development of Hong Kong and to optimise socio-economic gains for our community as a whole."

Paul MP Chan Secretary for Development

"One of the things I am most proud of is the adoption of green building design and construction for public housing. The whole-life energy and water saving potentials from doing so are very high indeed. Moreover, we are collaborating with tenants to adopt green habits, which are found conducive to saving energy and water in existing buildings. I am also proud of Hong Kong's transport system, which is rightly giving priority to public transport, thereby less cars-dependent and helping to reduce road congestion and carbon emissions. We will do more still going forward."

Professor Anthony Cheung Secretary for Transport and Housing

"Not wasting natural resources, such as energy, water and food, should be an important part of public education. In fact, many people in our districts are keen to participate in evironmental activities. District administration can help our communities to be better prepared so as to minimise the loss of life and property from extreme weather events."

Lau Kong Wah Secretary for Home Affairs

"Climate change has spurred the financial services sector worldwide to consider how the industry plays a more active role in assisting the global low-carbon transformation. I am happy to see increasing interest and activity in Hong Kong too by the corporate sector, including the stock exchange, to take on these issues."

Professor KC Chan Secretary for Financial Services and the Treasury

MESSAGES FROM PRINCIPAL OFFICIALS

> Climate change is both a local, regional and national issue. Cross-boundary sharing of knowledge and solutions will help and I anticipate there will be more such dialogue going forward.

Raymond Tam Secretary for Constitutional and Mainland Affairs

Climate change has a direct bearing on Hong Kong's labour and welfare issues. In the process of improving our climate readiness, we can create more and different types of jobs for the people of Hong Kong. On the other hand, extreme weather occurring in other parts of the world can push up food prices in Hong Kong and in turn affect the people's livelihood, particularly the needy and vulnerable. We must therefore pay more attention to and raise public awareness of climate change.

Matthew Cheung Kin-chung Secretary for Labour and Welfare

Climate and weather play a role in people's health. Climate change affects the average weather conditions that we are used to. Hotter weather could increase the number of heat-related illnesses. Changes in temperature, rainfall patterns, and the increase extreme weather events could also enhance the spread of certain diseases. We need to stay vigilant of these changes from the healthcare perspectives.

Dr WM Ko Secretary for Food and Health

Our students have acquired a good understanding of climate change through school education, including project learning and life-wide learning activities. They are showing increasing awareness, interest and concerns over environmental issues, and learning to adopt a green lifestyle. Through active engagement with the community and parents, we will continue to equip our young people with suitable knowledge, skills, values and attitudes for becoming a new generation of climate change-aware citizens.

Eddie Ng Secretary for Education

> Extreme weather affects everyone. Bad weather affects tourism for one. I am glad to see that many companies are taking the low-carbon transition seriously and they are providing business solutions to climate challenges.

Gregory So Secretary for Commerce and Economic Development

We adopt a holistic approach in meeting the challenges brought about by climate change. Apart from enhancing our emergency responders' capacity in responding to extreme weather events through upgrading equipment and training, and supporting contingency planning with the use of more advanced technologies, our efforts extend to contributing to a multi-department Task Force on Emergency Preparedness led by the Development Bureau that drives, amongst other things, the implementation of preventive and mitigating measures in infrastructure design and construction.

TK Lai Secretary for Security

Although a variety of initiatives have been rolled out to prepare Hong Kong for emerging challenges posed by climate change, we cannot be complacent and should strengthen the relevant training for civil servants to elevate their awareness, enrich their knowledge and enhance their capability on this global menace.

Clement Cheung Secretary for the Civil Service

FOREWORD

We are only too conscious of the carbon emissions cuts science tells us the world needs to achieve in order to maintain the 2°C warming scenario within this century. We also know that to have a chance of success, the world has to work very hard over the course of the next few decades to reduce carbon emissions by a very substantial margin even as population rises and development continues rapidly in emerging economies. Indeed, the carbon mitigation challenge requires a total transformation of the global energy sector to decarbonise and save energy.

Hong Kong has followed the fraught international negotiations for a successor treaty to the Kyoto Protocol; but we are hopeful that a new agreement could be achieved at COP21 in Paris for the world to have a chance to achieve the 2°C warming scenario.

Hong Kong wishes to contribute actively to the national and global effort. The Government has already taken various important actions, and that some in the private sector have also taken significant steps.

While climate change is a very major challenge, it also offers us a chance to pursue our livability by embarking on a low-carbon path. This opportunity is very real for a high density city like Hong Kong, as we have considerable possibilities to enhance our natural assets and physical infrastructure, create jobs, as well as strengthen social collaboration.

The purpose of this document is to provide an account of Hong Kong's climate actions prior to COP21. We include what key non-government stakeholders are doing so that the public can have a more complete picture of Hong Kong's contribution, as we all look forward to a global agreement at COP21.

I am especially conscious of the role for governments in meeting the climate transformation – transitions are smoother and more durable when they are policy-led and policy-enabled. There is much work to do after COP21. We will have more dialogue with stakeholders and the community so that we can galvanise ourselves for the long-term to face the challenge of climate change. We hope you will play an active part in Hong Kong's low carbon transformation.

KS Wong
Secretary for the Environment
November 2015

EXECUTIVE SUMMARY

I: Global challenge and local social transformation

Climate change is a challenge faced by everyone, everywhere. For humanity to meet the challenge, local, regional, national and international collaboration on a long-term basis is needed since carbon emissions emitted anywhere contribute to the warming of the atmosphere.

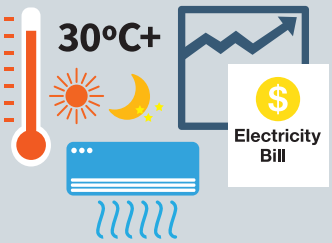
While climate change is a multiplier of risks, it offers communities around the world a chance to embark on a low-carbon path, which brings many societal benefits. This opportunity is important for a high density city like Hong Kong with considerable possibilities to enhance our natural assets and physical infrastructure, as well as strengthen social collaboration.

NEGATIVE IMPACTS

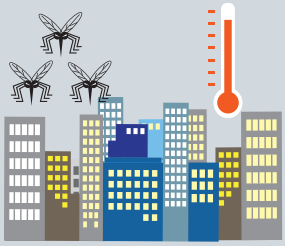
degraded environment and loss/damage

human and economic loss/ damage

extreme weather affects everyone, especially outdoor workers and those living in vulnerable areas



rising cost of living that put most pressure on low income families



greater health impacts on those living in crowded conditions and risk of infectious diseases

POSITIVE IMPACTS

new jobs to spur low carbon growth

saving money

better sharing of resources

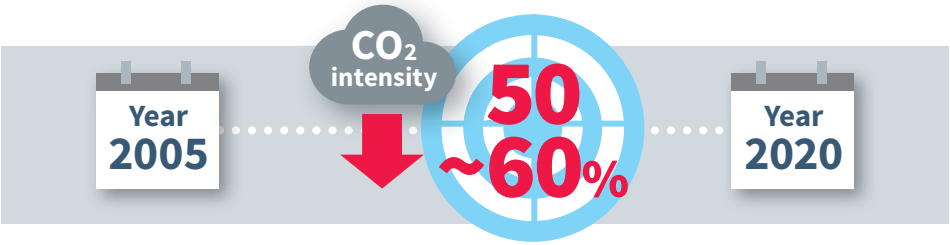
smarter, greener and healthier buildings, greener and more beautiful city, shorter commuting time

healthier biodiversity and ecosystems, better recreational opportunities

district and stakeholder collaboration leads to greater social cohesion

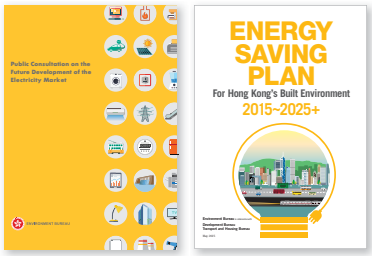
II: Energy saving becomes a core activity

We took into account China's national commitment to set Hong Kong's own local target. In 2009, China committed to lower its overall carbon intensity by 40-45% from the 2005 level by 2020. In 2010, Hong Kong put forward our own target to reduce the carbon intensity by 50-60% from the 2005 level by 2020. Since 2010, Hong Kong has developed a range of measures to meet our stated target. As of 2012, Hong Kong's carbon intensity had dropped 19% using 2005 as the base, and we expect to reach a reduction of about 50% by 2020.



Local mitigation potentials

The greatest potentials to reduce sizable quantities of carbon emissions in Hong Kong are through reducing coal usage for local electricity generation and maximizing energy efficiency, especially in buildings. Our related proposals and plans are articulated in the *Public Consultation on the Future Development of the Electricity Market* (March 2015) and *Energy Saving Plan for Hong Kong's Built Environment 2015-2025+* (May 2015). Our plans will bring various societal benefits too, including better air quality, cost savings from reducing energy consumption, better health and introduce a variety of local green jobs in the economy.



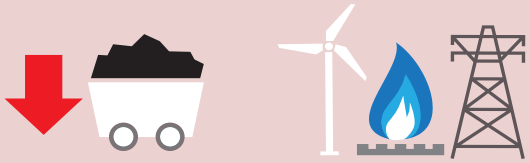
Our decision to revamp the fuel mix for local electricity generation by increasing natural gas and reducing coal by 2020, and our extensive energy saving measures will contribute the most to help meet Hong Kong carbon intensity reduction target, while other mitigation measures relating to transportation and waste-to-energy are also relevant.

Mitigation commitment by 2030

China announced on 30 June 2015 a new commitment to lower the nation's overall carbon intensity by 60-65% from the 2005 level by 2030. Hong Kong will use this as our reference to continue to shape our mitigation plans.

MAJOR MITIGATION MEASURES

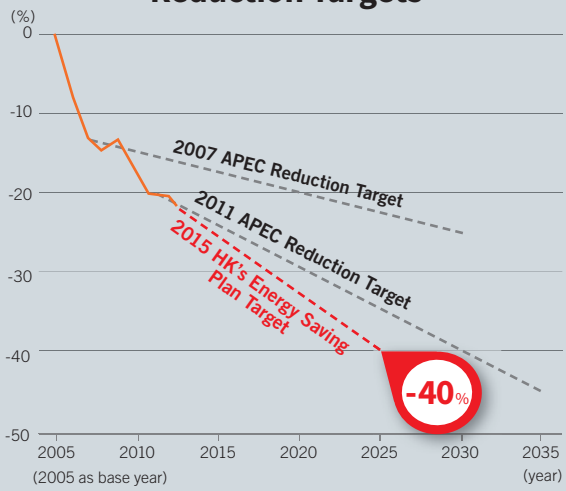
Revamping Electricity Fuel Mix



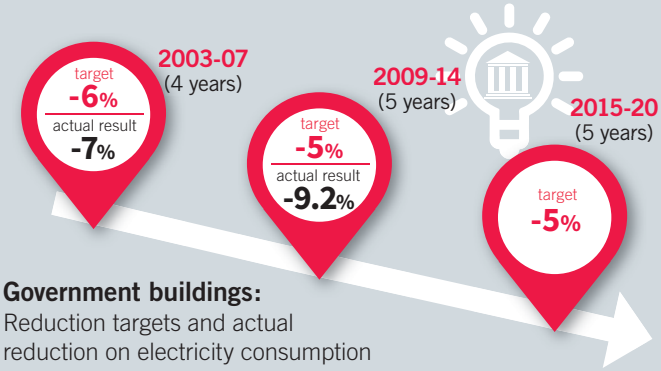
Reduce coal usage

Use cleaner fuels (e.g. natural gas) develop RE and distributed power

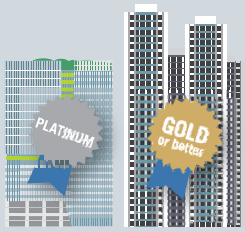
Setting Energy Intensity Reduction Targets



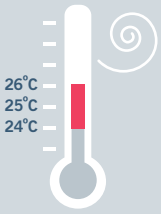
Practicing Energy Saving in Buildings



Government buildings:
Reduction targets and actual reduction on electricity consumption



Green building standards, design and construction



Better air conditioning performance

More energy efficient electrical appliances

Improve building management

Extend life span of buildings

Greening the City

Better landscape networks

Enhance biodiversity and native planting / urban agriculture

Explore blue-green infrastructures to improve external environmental qualities

Greening Transportation

promote electric and energy efficient vehicles and cleaner fuel

Extend rail and prioritise public transport

Energy saving across transport sector

Promote energy efficient vehicles and cleaner fuels

Improve pedestrian experience

Turning Waste-to-Resources

Implement waste reduction, reuse and recycling plans

Recover energy from waste treatment, including organic waste

Maximise use of landfill gases

Capture energy from waste water treatment

III: Optimise low-carbon living opportunities

There are many opportunities to create low-carbon living in Hong Kong, including creating a variety of new green jobs:

- **NDAs and other long-term strategic growth areas (SGAs)** – There are significant opportunities with the development of New Development Areas (NDAs) and other long-term SGAs to be explored under Hong Kong 2030 to integrate low-carbon ideas at the early planning stage, such as suitable urban design and greening to improve air ventilation and reduce heat island effect, bringing jobs closer to homes and promoting mixed uses to reduce commuting, concentrating population and economic activities within walkable catchments of public transport stations and nodes to reduce private car use, as well as exploring the feasibility of green infrastructure networks including distributed power, water efficiency, green building, convenient waste and recyclables collection, and pleasant walking and cycling environments.

- **Brownfield sites** – Brownfield sites in the New Territories are occupied by various haphazard industrial operations incompatible with the surroundings. Measures are being considered to optimise land utilisation and improve the environment through better land use planning and more efficient resource management.

- **New buildings** – New developments also offer low-carbon opportunities in how they are designed and built, so that people can improve health and livability albeit in a high-density environment. By observing green building principles, the inhabitants can benefit from significant energy and water saving. Public housing is a leader in this field in Hong Kong from which private developers can draw inspiration.

- **Building retrofit and use conversion** – Buildings have natural retrofit lifecycles, which present major opportunities for energy saving and low carbon improvement. Existing buildings can also be converted and refurbished for new uses, such as Hong Kong's industrial buildings, government buildings and also commercial buildings.

- **City greening** – Our efforts to enhance landscape diversity in the city has helped promote enjoyment and livability for residents. Apart from climate change related benefits, there are opportunities to explore and develop a series of green infrastructure networks to improve general micro-climate values. All of this help contribute to an enriched sense of place for our communities.

Hong Kong's adaptation efforts

Our work in climate science gives us a good understanding of the climate risks that are relevant to Hong Kong. The Government has been proactive in strengthening physical infrastructure – which also gave us opportunities to create many societal benefits – and enhancing various mechanisms and capacities to defend against such risks – which brought about greater social cohesion. Some of the risks, such as flooding and landslides, have already been very greatly reduced over the years through planning and infrastructure investments though the efforts need to be sustained; while the risks related to temperature rise, infectious diseases and drought require on-going attention.

More low-carbon opportunities

By taking full advantage of the large range of works projects, Hong Kong can create exceptional low-carbon outcomes that also improve the city's livability. For example, the Kai Tak District Cooling System saves energy for a large number of buildings. Works related to adaptation projects, such as in flood control, can also incorporate low-carbon aspects that also create a more pleasant living environment and improve ecosystems, such as with the Yuen Long Bypass Floodway.

Long-term sea level rise presents a unique global challenge, which requires us to pay close attention to the latest climate science and make appropriate plans.

IV: Increasing societal resilience

Every society needs to enhance its climate resilience so as to increase its economic, energy, ecological and food security, in addition to protecting life and property.

While we have kept up with climate change science and risks, we must continue to stay abreast of the latest knowledge, and also to fill gaps in understanding our local conditions. This requires government departments to share knowledge and work together, and also to use the knowledge base within our universities and among professionals to strengthen Hong Kong's overall capacity and capability to be more climate-ready.

We have effective, longstanding weather-related emergency plans, which are updated as necessary. We are continuing to improve communication and coordination with non-government stakeholders so as to ensure those who provide essential services have their own climate plans. These efforts bring about more community collaboration and social cohesion.

The more that we are aware of climate risks, the better our people can contribute to mitigation and adaptation, which would increase the city's overall ability to deal with climate change, improve our city for our people, as well as respond and recover from climate change related emergencies.

Challenge and Opportunities

In 2010, the Government stated that climate change posed an unprecedented, global challenge for everyone; and committed Hong Kong to contribute to the solution by taking community-wide action to reduce greenhouse gases (GHG) emissions. In meeting the challenge, we also see there are many opportunities to capture a large range of societal gains, such as a cleaner power sector, improved air quality, better buildings, better health for our people, cost savings for all, less pollution and waste, less damage as a result of extreme weather events, more greening in the city, a more pleasant living environment, improved public transport, and more jobs that are tied to improving the livability of our city.

A brief history of the climate change process

Negotiations on what became the UN Framework Convention on Climate Change (UNFCCC) were launched in December 1990 by the United Nations (UN) General Assembly. The Convention was adopted in 1992 and entered into force in 1994. Soon thereafter, the original emission reductions provisions in the Convention were felt to be no longer adequate. Negotiations began on how to strengthen the global response to limit average global temperature increases and cope with impacts, which resulted in the Kyoto Protocol. This multilateral treaty was adopted in 1997, although it only went into force in 2002, when a sufficient number of countries ratified it. The Protocol, based on the principle of 'common but differentiated responsibilities', had legally binding emissions reduction targets for developed countries on the basis that they are historically responsible for the then current levels of GHG in the atmosphere. The targets added up to an average 5% emissions reduction compared to 1990 levels; and they were to be achieved over the Protocol's first commitment period of five years from 2008 to 2012. The global target was not achieved.

The negotiations over what should be the arrangements post-2012 had been difficult. Developed countries wanted developing countries to do more, especially those that were becoming major emitters. Developing countries wanted arrangements that allowed them to industrialise. The Copenhagen Accord of 2009 and Cancun Agreement of 2010 helped to chart a path for continuing negotiations to create a multilateral climate structure. For the first time, there was an agreement that global temperature increase was to be kept below 2°C, and that both developed and developing countries would contribute to achieving this objective, within the limits of common but differentiated responsibilities, and by nationally appropriate actions. The Durban Platform on Enhanced Action, agreed in 2011, committed all countries to reduce carbon emissions and provided a roadmap to guide countries towards a binding agreement in 2015 that would take effect in 2020. Negotiations have been on-going to focus on arriving at a global agreement at the next UNFCCC gathering in Paris, at the Conference of the Parties (COP), which will be the 21st such gatherings since 1995. Hence, the Paris meeting is referred to as COP21.

We have laid the ground for near-term work over the past five years. Dealing with climate change requires sustained efforts for every administration. Nevertheless, no administration can make all the decisions in one go. There is also a national and global context to take into account, as GHG emitted anywhere in the world affect global warming; and multilateral negotiations for international efforts to deal with climate change have been underway since the mid-1990s.

This document updates the actions the Government has taken so far in order to set the stage for considering further actions in the future.

Global consensus on long-term goals

There is global consensus on what can be done to meet the challenge of climate change through mitigation and adaptation, as well as building community resilience to take and sustain action. At the same time, we can deliver socio-economic gains and livability improvements in Hong Kong as we deal with climate change.

Mitigation

Climate change mitigation refers to efforts to reduce or prevent emission of GHG. The global consensus is that at present levels of warming (about 0.8°C above pre-industrial levels), the impacts of climate change are already being felt in many parts of the world, such as through heat waves and droughts, extreme storms, pressure on water resources and crop yields, damage to corals, sea level rise etc. Further impacts are likely unavoidable because the Earth's atmospheric system is already locked into warming of about 1.5°C above pre-industrial levels by mid-century. International negotiations on climate change is focussing on holding warming below 2°C by 2100 with early adoption of aggressive mitigation actions and development along a low-carbon, cleaner-energy trajectory. What this means is that the international community will have to cut GHG to net zero before 2100.

Adaptation

Since the impacts of climate change is already evident, and even with much more aggressive mitigation action, there will be changes to ecosystems and damage to infrastructure brought about by extreme weather events. There is a need to anticipate the adverse effects of climate change and take appropriate actions to prevent or minimise the damage they may cause, or take advantage of opportunities that may arise. The term 'infrastructure' includes energy, water, buildings, coastal structures, transport, emergency services, health, food, finance and communication. Moreover, these are linked in networks, which need to be robust. Adaptation measures that are well-planned early on will save lives and money later.

Resilience

The concept of climate resilience involves both mitigation and adaptation. There is a need to strengthen and empower a community's capacity and capability to reduce carbon emissions, as well as cope and absorb climate change related stresses and maintain the functional operation of public services, and economic and social activities. The key focus of climate resilience efforts is to address the vulnerabilities that Hong Kong faces as a community with regards to the consequences of climate change. We may regard climate adaptation as dealing with reducing the risk of damage to our physical infrastructure, whereas strengthening resilience as developing processes that can help to transform our planning, infrastructure and way of life in the face of climate change – and in this sense, greater resilience helps us to extend our ability to reduce carbon emissions.

Climate change and the national context

China is a Party to the UNFCCC and Kyoto Protocol. Under the Kyoto Protocol, as a developing country, China is not required to meet mandatory GHG emissions limits or reduction targets but is required to submit reports to the UN on its national emissions inventory and information about impacts of climate change, mitigation and adaptation measures and other information. The UNFCCC and Kyoto Protocol were extended by the Central People's Government to Hong Kong in May 2003.

The Mainland's 11th and 12th Five Year Plans (2006-10 and 2011-15) devoted considerable attention to energy and climate change. There were new policies to support clean energy production, as well as a gradual green industrial transformation. In the 11th Five Year Plan, the Mainland government set a 20% target to decrease energy intensity (i.e. energy consumption per unit of GDP), as well as mobilised a national campaign to promote energy efficiency. The 12th Five Year Plan set a new energy intensity target by an additional 16% by 2015, an 11.4% target to increase non-fossil energy of total energy use; and a 17% target to reduce in carbon intensity (i.e. carbon emissions per unit of GDP). During these ten years, many old, inefficient and polluting power plants and industrial facilities have been closed. In 2009, the Mainland also pledged a 40-45% reduction in carbon intensity from 2005 levels by 2020.

During the Asia-Pacific Economic Cooperation (APEC) meeting in Beijing in December 2014, China and the United States (US) both made important pledges in climate mitigation. China announced targets to peak carbon emissions around 2030 and increase China's share of non-fossil fuel energy to around 20% by the same year. The US announced it would cut GHG by between 26-28% below 2005 level by 2025. As the two largest GHG emitters in the world, their announcements just ahead of the UNFCCC meetings at COP20 in Lima were well-received around the world.

Furthermore, on 30 June 2015, China published "its Enhanced Actions on Climate Change as its Nationally Determined Contributions" in order to contribute to the success of COP21.[1] The enhanced actions included China's pledge to peak carbon emissions around 2030; to lower carbon emissions per unit of Gross Domestic Product (GDP) by 60-65% by 2030 from the 2005 level; as well as an array of mitigation and adaptation measures.

Hong Kong's local context

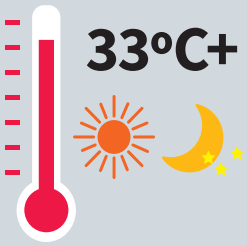
The UNFCCC and Kyoto Protocol were extended to Hong Kong in May 2003 as a part of the People's Republic of China. Hong Kong is obliged to play a part to fulfill the obligations imposed upon China.

The Hong Kong Special Administrative Region Government's climate change science authority is the Hong Kong Observatory (HKO), which is well-respected nationally and internationally. HKO works with local scientists and collaborates with Mainland counterparts on climate change science, and actively participates in international climate change science

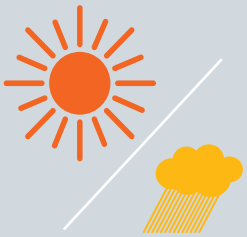
expert meetings, including at the Intergovernmental Panel on Climate Change (IPCC) under the United Nations. HKO has published a variety of reports on climate change science relating to Hong Kong. A summary of its latest assessment is available in the Appendix to this report.

Environment Bureau puts together Hong Kong's GHG emissions inventory in accordance with UN guidelines. **Chapter 2** discusses the intricacies of GHG emissions measurements. Environment Bureau also leads the Government's Inter-departmental Working Group on Climate Change (IWGCC) that coordinates the Government's obligations under UNFCCC, mitigation and adaptation efforts by departments, public awareness promotion, and keeps pace with climate-related international development.

HONG KONG'S CLIMATE IN THE 21ST CENTURY

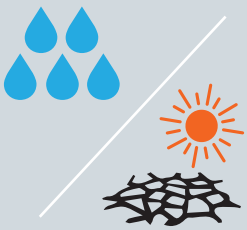


More very hot days and hot nights

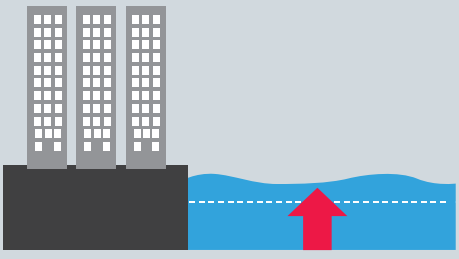


Fewer rain days but average rainfall intensity will increase

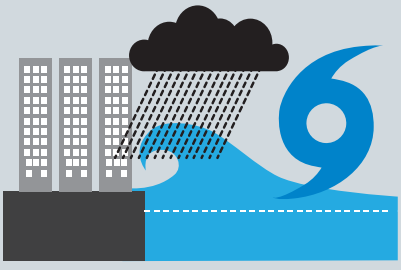
More extreme rainfall events



More extremely wet years but risk of extremely dry years will remain



Global sea level rise will lead to coastal changes all over the world, including Hong Kong



Threat of storm surges associated with tropical cyclones will rise

Hong Kong's current targets are to reduce carbon intensity from the 2005 level by 50-60% by 2020; and to reduce the city's energy intensity from the 2005 level by 40% by 2025. **Chapter 3** discusses background to these targets and mitigation in general.

Our adaptation measures are based upon our assessment of the climate change risks and vulnerabilities Hong Kong is likely to face in the coming decades. In considering how to expand the city's resilience – which is reasonably robust – we are collaborating with major public and private sector stakeholders to ensure efforts are well-coordinated and our residents will be better prepared in the future. Security Bureau (SB) coordinates Hong Kong's Contingency Plan for Natural Disasters, which is relevant for all extreme weather events that the community is used to encounter. **Chapter 4** reviews the Government's efforts on adaptation relating to public infrastructure and **Chapter 5** deals with strengthening the city's overall climate resilience, which includes coordination with the private sector and local communities on mitigation opportunities and adaptation needs.

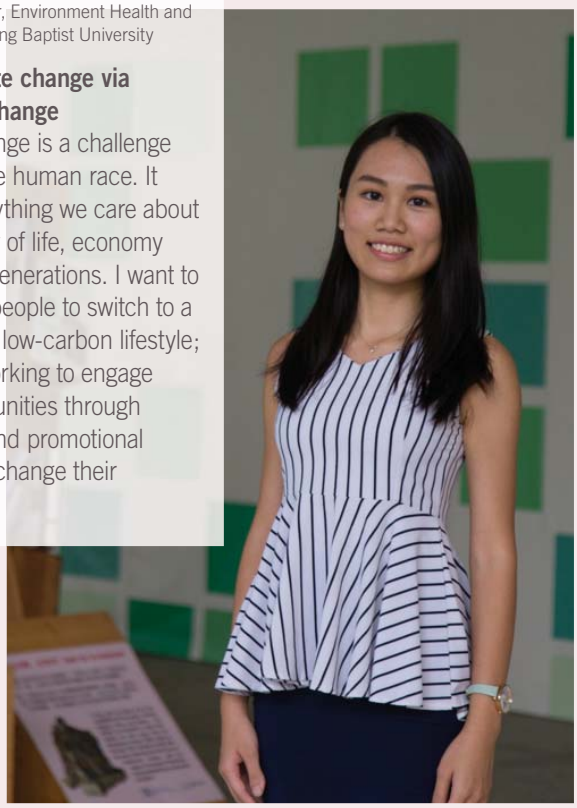
Chapter 6 summarises Hong Kong's many climate change-relevant efforts to date, setting the stage for further community reflection on the magnitude of efforts needed to go forward towards 2030 and beyond.

We hope this document provides the Hong Kong public with a full picture of local efforts ahead of COP21, when international attention will focus on global efforts to deal with the climate change challenge.

THEIR VOICES ON CLIMATE CHANGE

Alice Lam

Born in 1990's
Assistant Officer, Environment Health and Safety, Hong Kong Baptist University



Fight climate change via behaviour change

Climate change is a challenge for the whole human race. It affects everything we care about – our quality of life, economy and future generations. I want to encourage people to switch to a sustainable, low-carbon lifestyle; and I am working to engage local communities through education and promotional activities to change their behaviour.

Johnson Leung

Born in 1990's
Musician, MEng in Civil, Structural and Environmental Engineering, University of Cambridge

Let music play a role

Vivaldi's "Four Seasons" is one of my favourite pieces. As a conductor, I really cannot imagine directing it if there is no more "Winter" due to global warming! Nature, like Music, is a gift from God that should be appreciated, cherished and preserved. So often elements of Nature – the climate, creatures and sceneries are themes of great music. To hasten people's awareness about climate change, I have a vision of promoting music that depicts the beauty of Nature to nurture my audience's love for Nature. Someone who loves Nature would surely refrain from destroying it.

Ray Chair

Born in 1980's
Creative Officer, Green Monday

Change by every bite we take

Climate change is not just the problem of any one country. To me, it is a global security issue that affects everyone. Extreme weather will be more frequent in the future and it will affect the survival of many people in the world. One thing we can all do is to adopt a vegetarian diet, which can slow down global warming. So, let's change the world with 'every bite we take'.

Xiao-xin Shi

Born in 1980's
Chinese University of Hong Kong graduate, now Project Attorney, Institute of Energy and the Environment, Pennsylvania State University

Plan for more extreme weather events

A central issue is how we should plan for more frequent, extreme weather events as a result of climate change. Our generation needs to find pragmatic solutions to adapt to climate change. I am working on the nexus between climate change and the management of potential conflicts brought about by the increasingly uneven distribution of natural resources. I want to make solutions-oriented contributions to the world.

2 GHG EMISSIONS IN HONG KONG

National accounting of GHG emissions

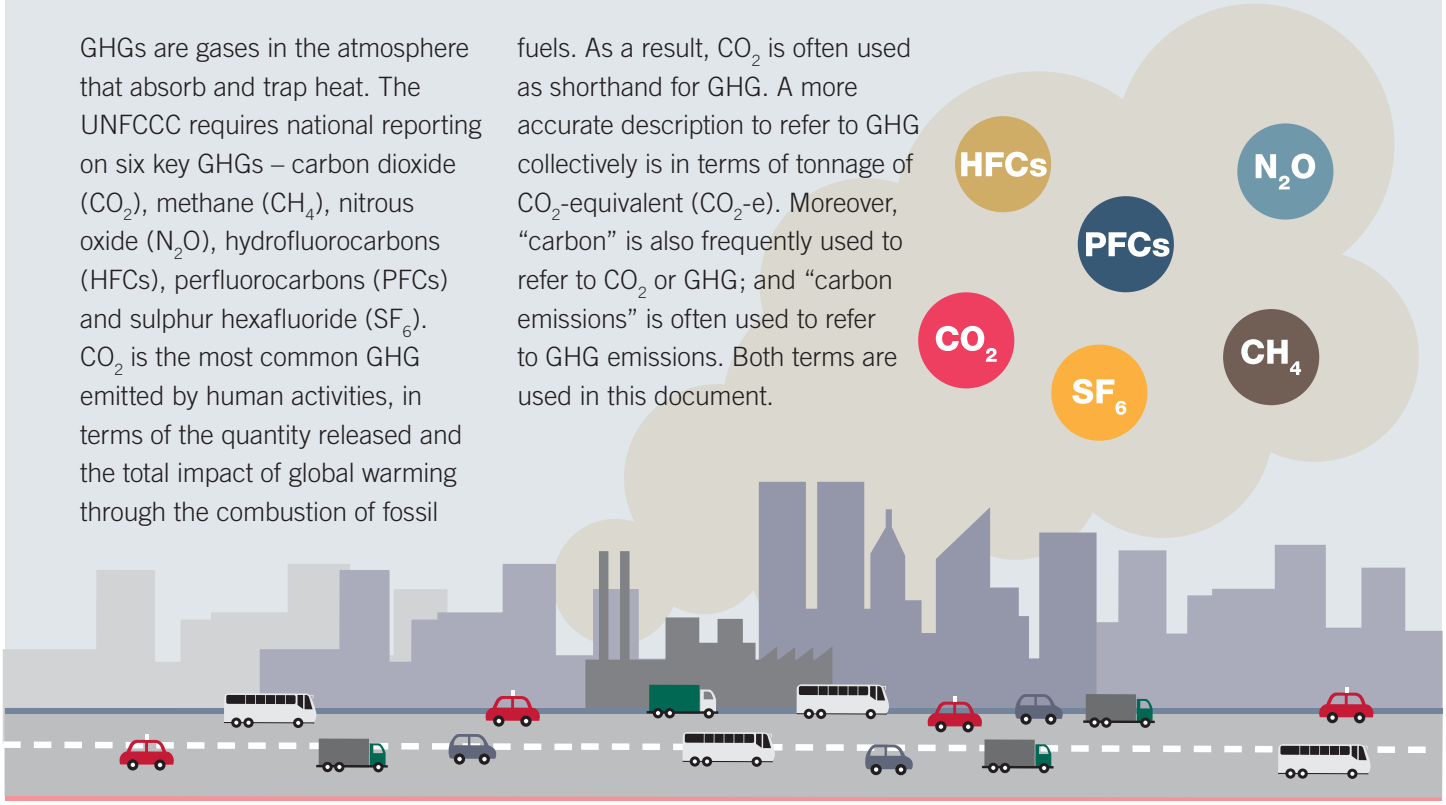
The signatory countries to the UNFCCC must submit national inventories of GHG emissions from 1990 by sources as part of their reporting obligations. To ensure consistency, the IPCC has a set of guidelines for calculating GHG emissions, which countries use to report their emissions. These guidelines provide countries with a consistent set of accounting rules.

As a signatory country, the People's Republic of China provides this information to the UNFCCC. Hong Kong and Macao, as sub-national Special Administrative Regions (SARs) within China, calculate their local GHG emissions using the IPCC method and report them to the Central People's Government so that an overall national emission inventory could be put together for submission to the UNFCCC.

The local SARs' sub-national inventories include emissions from energy, industrial processes, waste, agriculture, forestry and other land uses but exclude emissions from aviation and international marine transportation, as these are reported at the national level to avoid double-counting.

More about GHG emissions

GHGs are gases in the atmosphere that absorb and trap heat. The UNFCCC requires national reporting on six key GHGs – carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). CO_2 is the most common GHG emitted by human activities, in terms of the quantity released and the total impact of global warming through the combustion of fossil fuels. As a result, CO_2 is often used as shorthand for GHG. A more accurate description to refer to GHG collectively is in terms of tonnage of CO_2-equivalent (CO_2-e). Moreover, "carbon" is also frequently used to refer to CO_2 or GHG; and "carbon emissions" is often used to refer to GHG emissions. Both terms are used in this document.

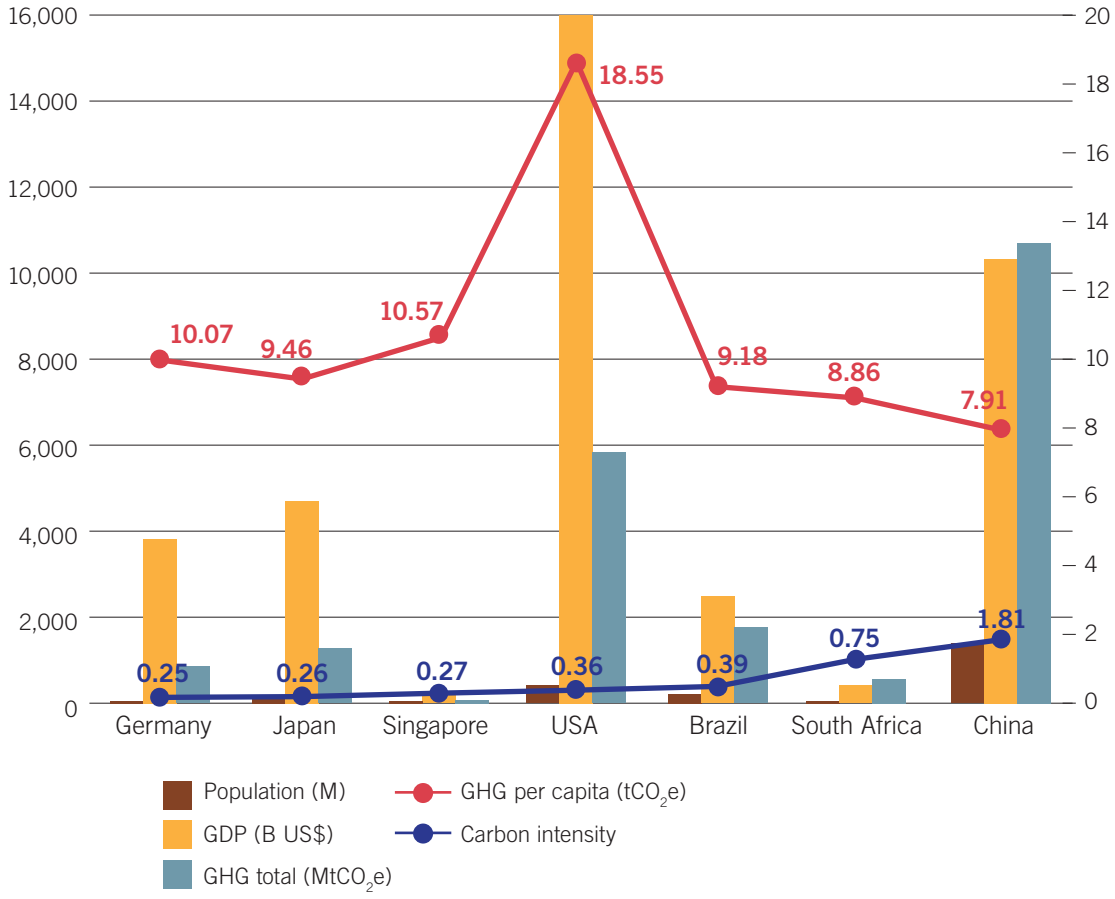


International comparisons

The global GHG emissions in 2011 were about 43 billion tonnes.[2] UNFCCC reporting provides country-by-country breakdowns of their GHG emissions.

GHG emissions may also be seen from a per capita basis, as well as on a carbon intensity basis. The per capita calculation is done by dividing a country's total GHG emissions with its population. By looking at GHG emissions on a CO_2-e per dollar of GDP basis, the carbon intensity of an economy can be calculated. Carbon intensity is a measure of how efficiently energy resources are used. Calculations on a per capita and carbon intensity bases can also be converted to world averages. Thus, the world average on a per capita basis is about 6.1 tonnes;[3] and the world average is 0.45 on a carbon intensity basis.[4] While each method of comparison provides insight, they also mask many differences.

Figure 1 **Data comparisons of selected countries (2011)[5]**

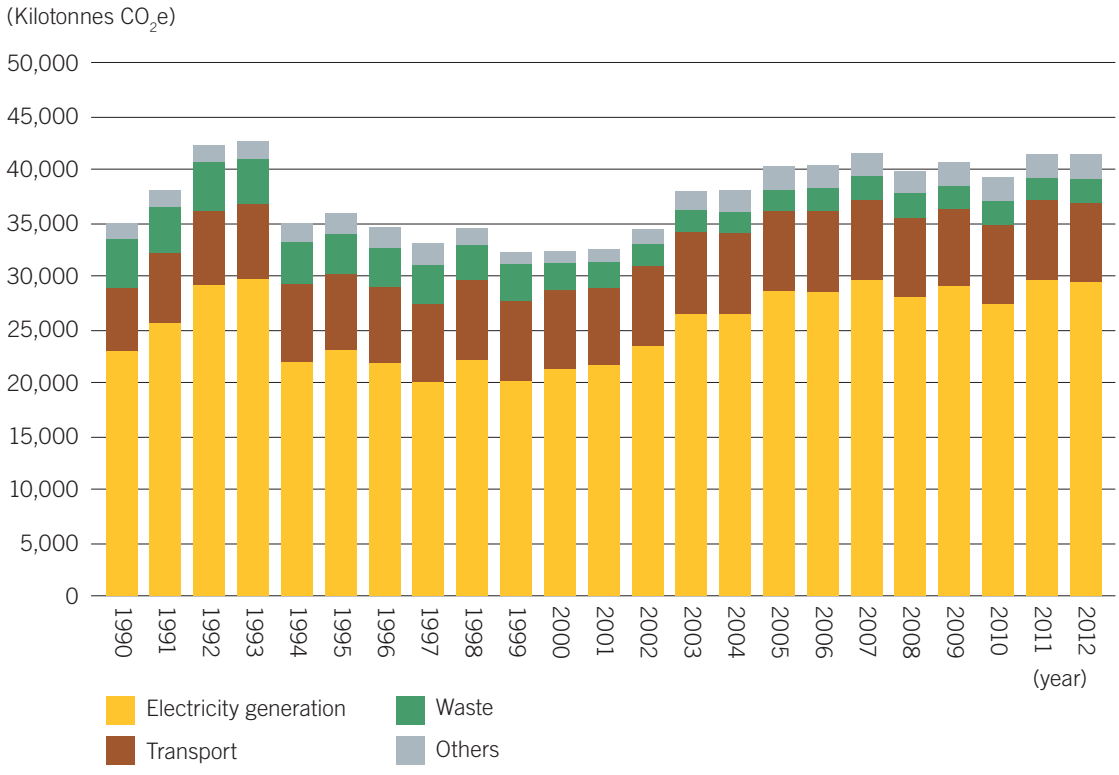


Hong Kong's GHG emissions inventory

In using the IPCC method of calculation, Hong Kong's annual GHG emissions ranged from 33.3 to 43.1 million tonnes of CO_2-e over the period of two decades from 1990 to 2012. In 2012, our total GHG level was 43.1 million tonnes of CO_2-e. The slight rise in carbon emissions in 2012 was due to an increase in local cement production, which was likely a result of the demand for cement for many infrastructure projects.

Figure 2 also shows Hong Kong's key local emission sources – electricity generation (including town gas production), local transport, waste and others – and their trends. Electricity generation makes up the largest single source of local GHG emissions, followed by emissions from local transportation, and to a much smaller extent, emissions from waste treatment. On the basis of these emissions, Hong Kong's contribution to the world's total is 0.1% (Hong Kong's population is 0.1% of the world).

Figure 2 **GHG emission trends for Hong Kong 1990-2012**



During that period, Hong Kong's GHG emissions on a per capita basis ranged between 5 to 7.4 tonnes CO_2-e, and is currently at about 6 tonnes CO_2-e. Comparing our per capita emissions with those of other countries is not directly appropriate because Hong Kong's GHG emissions are calculated on a sub-national basis and some of our emissions are counted at the national level. Hong Kong's carbon intensity ranged from 0.021 to 0.044 during the same period, with 2011 and 2012 being at the lowest levels.

Cities and climate change

The world's population is projected to grow from about 7.3 billion to about 8.8 billion by 2040 with the majority of the people living in cities.[6] Cities are major contributors to climate change. Although they cover less than 2% cent of the Earth's surface, cities consume nearly 80% of the world's energy and produce more than 60% of all CO_2 and significant amounts of other GHG emissions.[7]

Beyond the huge number of people cities house and the energy cities consume, their massive scale across the globe has the potential to make cities effective places in which to address climate change issues. City-scale efforts are therefore important to reduce global GHG emissions. City authorities from around the world have begun to collaborate, such as with the formation of C40 Cities Climate Leadership Group (C40) in 2006,[8] to share information, ideas and best practices on dealing with climate change. Hong Kong is a member of C40. By collecting and publishing the large number of climate action commitments from cities, C40 had demonstrated that the attention and efforts of cities in the global climate agenda is critical.[9]

Measuring GHG emissions and reduction targets of cities

It has not been easy to design a common method for quantifying GHG emissions attributable to cities that complements the IPCC's national reporting guidelines. Various inventory methods had been proposed and used by some cities in the past but they varied significantly.[10]

Collaboration among a number of global institutions with C40 has recently put forward a new accounting and reporting standard for city-wide (i.e. sub-national) GHG emissions, the intention of which is to help city leaders to consider their climate change efforts. Apart from standardising how cities' inventories are reported, the new method also seeks to measure the contribution of city mitigation actions.[11] In time, when cities have used this method to prepare their inventories, there will be new insights to help city authorities to better target their climate change efforts.

Looking at Hong Kong's GHG emissions

With current data, we can draw some broad conclusions about Hong Kong GHG emissions:

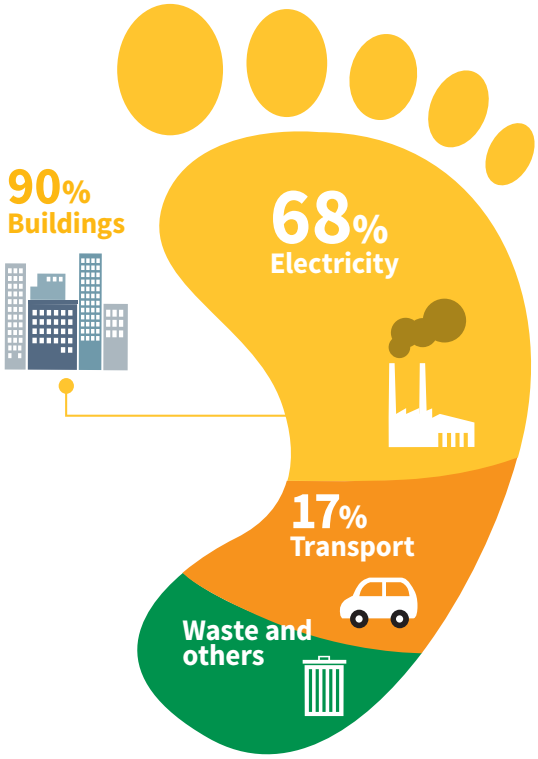
1. Electricity generation is the largest source of local GHG emissions (mainly in the form of CO_2), accounting for about 68% of the total in 2012.

2. About 90% of Hong Kong's electricity consumption is related to our 42,000 buildings, which means the electricity used in buildings contribute about 61% of Hong Kong GHG emissions.

3. Transportation is the second largest source, representing about 17% of our total GHG emissions, mainly arising from fuel usage for vehicles.

4. Other emission sources include waste treatment (5%), industrial processes (4%) and agriculture, forestry and other land use (0.1%).

5. The proportion of GHG emissions sources may change over time as a result of changes in our activities. For example, Hong Kong's GHG emissions dropped substantially in 1994 as we started to import nuclear electricity from the Mainland.



Measuring and continuously reducing energy-carbon footprint

Every organisation, whether institutional or commercial, can conduct energy audits and also review the sum of all the carbon emissions induced by their activities by conducting carbon audits. It is necessary to understand one's energy use profile to conduct a carbon audit since the two aspects are intimately linked. Professional audits should also provide information and advice on how to save energy and reduce carbon emission. The Environment Protection Department (EPD) has been promoting carbon auditing through its Carbon Reduction Charter programme since 2008; and the Electrical and Mechanical Services Department (EMSD) has been promoting energy auditing. They have worked together to assist government departments in conducting energy-cum-carbon audits. Beyond audits, there are various tools that can help an organisation to make continuous improvements, such as adopting international energy management standards. The public sector is a leader in better energy management. For individuals, there are also many versions of easy-to-use on-line 'calculators' created for individuals to estimate their carbon footprint.

Example 1: Government energy-cum-carbon audits

The Government rolled out a three-year programme to conduct energy-cum-carbon audits for 120 government buildings and public facilities in September 2012 and we completed all the audits in mid-2015, as scheduled. We will study the results and identify ways for the Government to improve our energy-cum-carbon management.

Example 2: Hong Kong Housing Authority (HKHA)

HKHA, which develops and manages public rental housing, provides a good example of an institutional body using various tools to actively and continuously manages the energy consumption and carbon footprints of public housing developments:

a) Since 2011, HKHA has implemented carbon emission estimation (CEE) model to estimate the life cycle carbon emissions of domestic blocks of public housing developments at the early design stage. It provides an effective design verification tool to gauge the overall performance of public housing developments in terms of carbon emission throughout the life cycle of the buildings.[12]

b) Soon after the ISO50001 Energy Management System was launched in 2011, HKHA applied for certification on its residential building design and became the first certified in Hong Kong for residential buildings in June 2012.[13] The System has since been extended to cover all existing public rental housing blocks of HKHA, for which the ISO50001 certification was received in March 2015; and

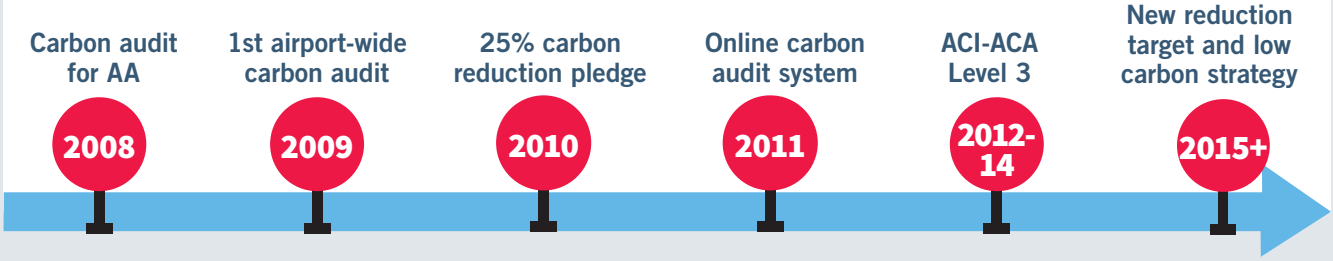
c) HKHA requires all its piling and new works building contractors to attain ISO50001 certification by December 2015 so as to enhance the management of energy use at construction sites.

Example 3: Airport Authority of Hong Kong (AA)

In 2008, AA completed its first carbon audit of its own buildings and facilities and was EPD's first Carbon Reduction Charter signatory. This was followed by an airport-wide audit in conjunction with business partners in 2009; and AA developed a proprietary on-line carbon audit system to calculate and monitor carbon emissions for both AA and its business partners. While AA accounts for about 40% of the airport-wide carbon emissions, the remaining 60% come from its business partners. In 2010, AA and its business partners pledged to reduce carbon emissions by 25% per work load unit[14] by 2015 compared to 2008 emission levels. AA is on track to achieve this target. Good progress has been possible because of the strong commitment of senior management, the establishment of a strong business case to invest in key infrastructure (such as replacement of 100,000 lights with LEDs), and active engagement with 46 business partners to work together to reduce their carbon footprint. It is currently developing new carbon reduction targets (5 and 20-year targets) and the associated implementation strategies.

In December 2012, the Hong Kong International Airport (HKIA) achieved "Optimisation" level under the Airports Council International's Airport Carbon Accreditation programme. This is the second-highest level of accreditation, and HKIA is the first airport in the Asia Pacific region to achieve this standard. The accreditation was renewed in 2013 and 2014.

Carbon reduction roadmap for Hong Kong International Airport



Example 4: Modern Terminals Limited (MTL)

MTL is one of the container terminal operators in Hong Kong and it manages several container terminals at Kwai Tsing. It handled 5.4 million 20-foot equivalent units (TEUs) in Hong Kong in 2014. In 2006, it measured its carbon emissions per container (14.25kg/TEU) and set a CO_2 reduction target of 30% by 2015, which translates into a target of around 10kg/TEU. Substantial investments were made to reduce emissions, including the conversion of its rubber-tyred gantry cranes (RTGs) to hybrid and electric cranes. Today, more than 90% of all its RTGs are fully electric, making it the largest electric RTG fleet in Hong Kong. The CO_2 emissions from these cranes are 60% less than the traditional diesel-powered cranes. MTL's efforts were recognised in 2011 by the Environmental Campaign Committee's (ECC) Hong Kong Award for Environmental Excellence. The CO_2 reduction target was almost reached over the first half of 2013 (10.88kg/TEU) but port congestion experienced in Hong Kong since then had increased the waiting and idling of barges and trucks, which also led to a reduction of business, and adversely impacting CO_2 performance on a per TEU basis (11.75kg/TEU in 2014). While environmental performance can be affected by external business conditions, nevertheless, it was crucial to have collected emissions data, set a reduction target and made the appropriate investments to achieve the target.

THEIR VOICES ON CLIMATE CHANGE

Leo Chan
Born in 1980's
Senior Environmental Consultant,
Hyder Consulting Limited

Building green matters

I see climate change as part of our daily life. We are being impacted by climate change and we are causing climate change by our activities every day. The impact of climate change such as the rising of temperature, flooding, etc. have become a norm in the news nowadays. However, all of us can do something about it, from turning the tap off when brushing your teeth, separating cans and water bottles at home, to switching the lights and air-conditioning off when not needed. All these may not seem much but when it comes to tackling climate change, every little bit counts. As a built environment professional, I work hard to promote green building in Hong Kong.

Benson Poon
Born in 1980's
Town Planner, Masterplan Limited

Plan Hong Kong for walking

Climate change is a sign that our cities are over-heating, over-consuming, and unhealthy. To remedy this, I believe our city, Hong Kong, needs to become more walkable, with roads designed for people to walk, socialise, and rejuvenate in a breathable and healthier city environment. There are too many cars taking up all the space, spewing toxic fumes and heat. As a town planner, I am advocating better and efficient design of roads for people to walk and as public spaces.

Leung Po Shan
Born in 1980's
Engineer, CLP Power Hong Kong Limited

Take responsibility

The rate and severity of climate change is shaped by the aggregation of choices made by individuals, I believe that I have the responsibility as an individual and as an engineer to have a more holistic view of the impacts of my actions on the environment and hence to make the right choices. In my personal life, on a daily basis, I am committed to a low carbon lifestyle by taking public transport, using energy efficient appliances and consuming local produce.

Brandon Ng
Born in 1980's
Co-founder; QFE at Hong Kong Science Park

Democratising energy storage for people and businesses

As a Chemical Engineer by training and coming from a country economically built on the energy industry, Brunei, I have always felt at the forefront of the energy challenge. That is: how do we provide more energy, more reliably, more cheaply, to more people and how do we do so sustainably. At QFE – the startup I co-founded – we aim to address this challenge for people and businesses in emerging markets with the products we are currently developing. The importance of this challenge is very much alive at the Hong Kong Science Park, which has been one of our instrumental backers from our earliest days as a company.

THEIR VOICES ON CLIMATE CHANGE

Samantha So

Born in 1980's
Sustainability Officer, Towngas

Lower your carbon footprint

Human activities are a major cause of climate change and the impacts are already obvious. Further rise in global temperatures will have devastating effects that we probably can't quite fully grasp yet. Limiting the use of fossil fuels and developing RE is critical for the world. We can be smart about what we do, such as using the landfill gas produced as a renewable source of energy. I have been attuning myself to live greener and lower my carbon footprint. Buy less, waste less, eat less meat and be a 'flexitarian'.

Andy Leung

Born in 1980's
Business Development Manager,
Green Common

Eat vegetarian at least once a week

Climate change is getting more serious in recent years. Storms, high temperatures and droughts are happening in many parts of the world, which have threatened food productions and water resources. Plant-based eating style can reduce GHG emissions and save water. Working at the Green Common, plant-based mini-supermarket allows me to promote green and sustainable living, and encourage the public to start eating vegetarian at least once a week. Once you get used to it, you can eat vegetarian more often!

Diana Chan

Born in 1990's
Blogger

Eat with true health in mind

Man, animals and the Earth are united as ONE. If we truly appreciate this connection, we would care about all of them. We take care of ourselves when we are ill, so we shall take care of our feverish Mother Earth. I am a raw foodie. This means eating mainly living, uncooked plant-based food. The consumption of meat and dairy products generates a lot of GHG emission. Food preparation on an industrial scale also involves a lot of chemicals. A poor diet and lifestyle can lead to over use of cosmetic products and medicine to maintain shallow "health". This raw vegan lifestyle allows me to live a low-carb and eco-LOVEly lifestyle, at the same time a happier and beautiful life.

Carol Liu

Born in 1980's
Environmental educator,
Eco-education and Resources Centre

We can all change

The Earth getting hotter and hotter has to do with how we live – what we eat, how things are produced, how people and goods are transported, the waste we generate, etc. So, everyone can contribute to slowing down climate change by changing our lifestyle. Every bit helps. I was teaching kids how to upcycle the "trash" generated in their daily life by making fun things, and this has become my career now. I want to work with the next generation to treasure the Earth's limited resources.

3 MITIGATING CLIMATE CHANGE

For the first time in 40 years, the International Energy Agency (IEA) noted that in 2014, annual global CO_2 emissions did not rise even though the global economy grew about 3%. The IEA concluded that it was mostly because of the shifts in energy use in the world's three largest emitters – China, the US and the European Union (EU). For example, China has imposed energy efficiency standards on industry, reduced its coal usage and increased its use of renewable energy (RE). RE includes a wide range of energy sources, such as hydropower, wind power, solar power, waste-to-energy, geothermal power, co and tri-generation etc. There has been a shift to using cleaner shale gas in the US, and both the US and the EU are promoting low-carbon technologies, improving energy saving and using more RE.[15]

In other words, reducing CO_2 emissions, the largest portion of GHG emissions, through changing fossil fuels usage is effective in mitigating climate change. This will require large-scale changes in energy systems all around the world. Reducing and eliminating coal usage where possible is critical and to replace coal with low-carbon and zero-carbon alternatives. Notably, on 8 June 2015, The Group of 7 Industrial Countries (G7) acknowledged that deep cuts in global GHG were required with de-carbonisation of the global economy over the course of this century; and they pledged to cut GHG by 40-70% by 2050 from 2010 level.[16] In the national enhanced actions on climate change announced on 30 June 2015, China's pledge included accelerating the transformation of energy production and consumption through reducing coal and increasing RE and nuclear power in the nation's energy mix and improving energy efficiency. China's pledge includes achieving the peaking of carbon emissions by around 2030 and making best effort to peak early, and to lower carbon intensity by 60-65% by 2030 using 2005 as the base.[17]

Reducing Hong Kong's GHG emissions

Electricity generation – supply side

The China national target announced in 2009 is to reduce carbon intensity by 40% to 45% by 2020 as compared with the level in 2005. Hong Kong's climate change target, first proposed in 2010, is to reduce carbon intensity by 50% to 60% by 2020 as compared with the level in

2005. Whether we can achieve the upper or lower-bound of the range in Hong Kong depends greatly on the extent to which we can reduce the proportion of coal used in our fuel mix for electricity generation and find suitable lower carbon replacements.

We have stated in the *Public Consultation on Future Development of the Electricity Market of Hong Kong* that natural gas usage would increase from 21% to around 50%, and for nuclear import from the Mainland to be around 25% by about 2020. Subject to public views on the tariff implications, we would consider developing more RE. We will also enhance our efforts to promote energy saving in the community and adopt more demand side management (DSM) measures to reduce overall consumption. The remaining demand for electricity will be met by coal-fired generation.[18] The challenge of achieving this fuel mix revamp should not be underestimated. The current Scheme of Control Agreements (SCAs) with the two power companies will expire in 2018 and new contractual arrangements will need to be negotiated. New natural gas electricity generating plants will also be required over the next few years. Our goal is to arrive at arrangements that represent an appropriate balancing of the policy objectives of safety, reliability, affordability and environmental protection. Changing the fuel mix of electricity generation as noted above will help Hong Kong to create a cleaner power sector, reach the lower-bound of our carbon intensity target by around 2020, as well as improve air quality and public health arising from lower pollutant emissions.

As for what options Hong Kong may have to meet the new national goal of lowering carbon intensity by 60-65% using 2005 as the base by 2030, we will have to consider how to replace the electricity from local coal-fired generation by then, as Hong Kong's coal plants are retired.

Improving power plant and transmission energy efficiency

The issue of power plant efficiency can also be improved since power generation is the largest source of carbon emissions. Currently, the power plant efficiency in Hong Kong ranges from about 37% to 45%. We will continue to explore with the two power companies how to achieve higher plant efficiency. Furthermore, since the plant efficiency of natural gas-fired

combined cycle generating units is in general higher than that of traditional coal-fired generating units, with the proposed increasing use of natural gas for power generation in the future, the power plant efficiency of the two companies will improve. There may also be efficiency gains from the transmission and distribution networks through better design combined with the latest technology.

Co-generation and tri-generation

Supply side efficiency could be further improved through co-generation and tri-generation. Co-generation generates power and makes use of the heat that is produced during the process. Tri-generation takes this a step further by also producing cooling (using an absorption chiller) as part of the process. Co-generation and tri-generation can use a variety of fuels, including coal, natural gas and biogas from waste. By using the heat output from electricity production for heating, co-generation can convert up to 80% of the fuel source into useful energy (i.e. electricity and heat) and produce around 60% less carbon emissions. The main challenge is to include these technologies as a part of planning our new towns, districts or buildings, so that we could use the residual heat of the power generation to support space air-conditioning, dehumidification and/or hot water.

Future Development of the Electricity Market of Hong Kong
March to June 2015

Energy Saving Plan for Hong Kong's Built Environment 2015-2025+
May 2015

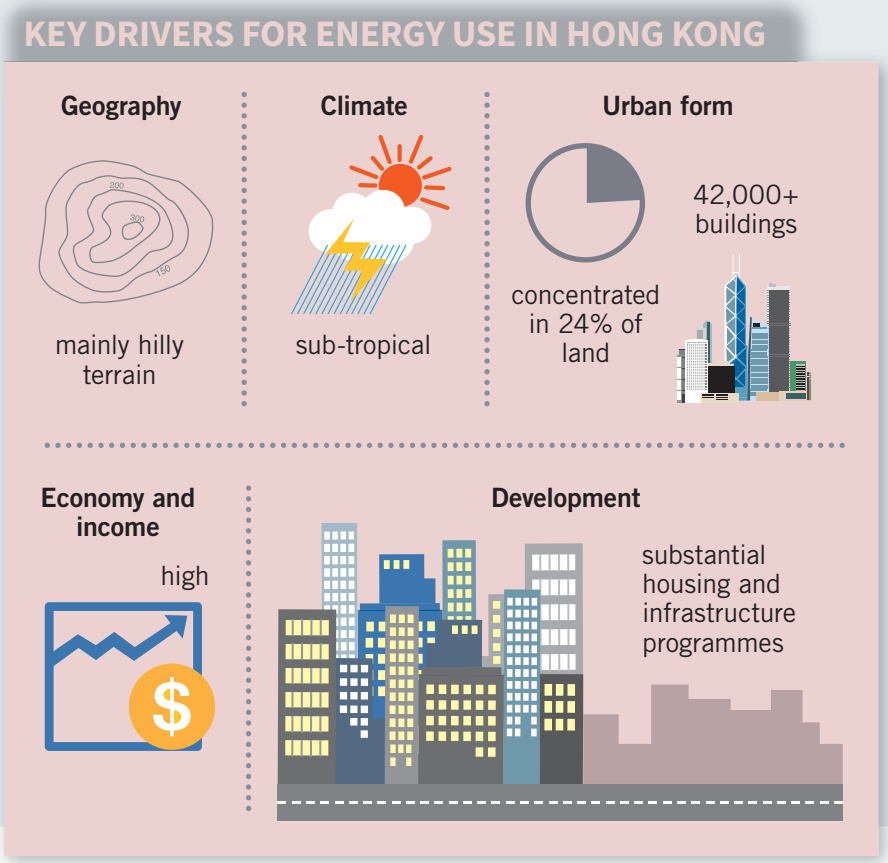
Energy saving – demand side

At the same time, we have also published our plan to save energy in the *Energy Saving Plan for Hong Kong's Built Environment 2015-2025+*, where we pledged to achieve a reduction target of 40% in energy intensity by 2025 using 2005 as the base year.[19] This is an ambitious target because population and energy usage are still projected to continue to rise albeit quite moderately. Achieving the energy saving target is equivalent to reducing about 3.36 million tonnes of CO_2 per annum.

Drivers of energy usage and energy saving potentials

There are a number of drivers of energy usage in all cities, including Hong Kong, including population, geography, climatic conditions, city layout, level of economic development and income levels. Obviously, larger and growing populations drive greater consumption at any given level of economic development; and as income levels improve, people and businesses tend to use more energy.

The extreme high density and compactness of Hong Kong means our energy usage is concentrated in about a quarter of the land area, in high-rise buildings, and to provide mobility to people to move around the city.



Extending the lifespan of existing buildings

Improving the energy efficiency of buildings and adopting green construction methods can contribute to reducing carbon emissions. Our *Energy Saving Plan for Hong Kong's Built Environment 2015-2025+* discusses green building and energy saving in buildings extensively so this document will not repeat the details.

One aspect should be added however. A useful approach is to extend the life span of buildings. Building use conversion saves a lot of materials and energy that in turn reduces carbon emissions that go into the production of building materials and use of energy to demolish a building and then construct a new building. Building conversion and retrofit require a lot less materials and are thus lower-carbon approached.

Revitalise industrial buildings

The Government first announced in 2009 revitalisation measures to facilitate the redevelopment and conversion of old industrial buildings. We made clear that in granting applications for modification of or exemptions from various building regulations we would encourage green building designs and practices. Refinements to the scheme have been made and owners may apply up until March 2016. So far, about 120 applications have been received and about 100 approved. Integration of green building design and energy saving practices are encouraged.

Public sector buildings

The Government is also converting its former central offices and some public buildings for adaptive reuse, as well as selling a number of older office buildings for conversion:

- **EMSD Headquarters**
  The EMSD Headquarters building in Kowloon Bay was formerly the air cargo terminal until 1998. The building was converted in 2005 to become the new headquarters of the EMSD. It has been designed to retain most of the concrete structures of the old building to save construction waste. It has also been installed with environmental friendly and energy efficient features; and there is an education path for public education tours.
- **Murray Building**
  The 27-storey Murray Building in Central was completed in 1969. The building has high architectural merit and is energy efficient. The building was vacated in 2012 and subsequently sold for conversion into a hotel.
- **Central Government Offices**
  After moving to new offices at Tamar, the Central Government Offices at Lower Albert Road, built in the mid-1950s, were vacated in 2012. They are being converted and refurbished for use by the Department of Justice and law-related non-government organisations. Energy saving and many green features are being incorporated.
- **Revenue Tower, Wanchai Tower and Immigration Tower**
  The Government is planning the relocation of 29 departments and 10,000 staff from the three government buildings in Wanchai so that the buildings could be sold to create 'Grade A' office space in a prime location. The buildings are not to be torn down but refurbished instead.
- **Chai Wan Factory Estate**
  HKHA is converting the Chai Wan Factory Estate, built in 1959 to meet the demand for low-cost factory spaces into public housing. Over 70% of the existing building structured has been retained and many sustainability features have been incorporated. The project will be completed in early 2016.

Private sector retrofit

- **China Resources Building**
  The China Resources Building, built in 1983, is a large commercial office tower in Wanchai. The major retrofitting and refurbishment project retained over 97% of the structural frame and improved the building's energy efficiency. The project was carried out when the building remained occupied, which required minimum disturbance to tenants.

Mandatory Building Inspection Scheme

- Buildings aged 30 years old or more may be served with a statutory notice, requiring the building to be inspected by a registered inspector, and carry out repair where necessary. The scheme aims to foster a building care culture by owners and contributes to a sustainable living environment through extending the lives of existing buildings.

Carbon labelling for construction products

The Construction Industry Council (CIC) launched a Carbon Labelling Scheme for Construction Products in January 2014. The scheme arose from research on the verification of information on the carbon footprint of construction products, which can be easily used by designers, contractors and end-users in their selection of low-carbon materials. A second phase of research started in March 2014 to look into additional construction products, including concrete, precast concrete products, stainless steel, asphalt etc. The Government makes reference to the labelling scheme for public sector projects, while the scheme is gaining traction in Hong Kong with the private sector.

Lower carbon living in public housing

Buildings in Hong Kong consume about 90% of total electricity generated, and residential buildings consume about 27% of that. There are currently about 784,100 public rental housing units in Hong Kong, which totally consume about 28% of the total electricity used in residential buildings. The Government announced its Long Term Housing Strategy in December 2014 and adopted a housing supply target of 480,000 units for the ten-year period from 2015-16 to 2024-25, with a public-private split of 60:40. Accordingly, the public housing supply target is 290,000 units, comprising 200,000 public rental housing units and 90,000 subsidised sale flats.

HKHA, which manages the great majority of public rental housing in Hong Kong (i.e. other than those units provided by the Hong Kong Housing Society), has an important role in carbon reduction and in helping tenants to achieve lower carbon living, as approximately, 30% of Hong Kong's population live in such public rental housing. Since 2000, HKHA has been implementing a range of energy saving measures that contribute to carbon reduction. Taking a new 40-storey block with about 800 flats as illustration, the communal energy consumption has been reduced by about 48% in 2014-15 as compared with 2000's level. In future, HKHA has also planned to adopt LED bulkheads in the communal areas of domestic blocks in new public housing developments when there is adequate supply of quality certified products in the market, with a view to further reducing the communal energy consumption.

Upper Ngau Tau Kok Estate

Enabling 'smart' technology

Like most cities, Hong Kong has hardly begun to truly optimise the opportunities to save energy and at the same time deliver much better performance in light of digital technology that is now available to increasingly connect people, hardware infrastructure, processes and data to drive efficiency, cost and performance.

For example, operators and managers of the businesses of our key stakeholders in the power, transport, port, airport and logistics sectors can achieve significant energy saving through exploiting network communication, smart sensors, as well as analytic and prediction technologies, such as weather-driven energy demand forecasts. 'Smart' power would be delivered by power companies via the Smart Grid. Utilities globally are making their grids 'smarter' by using advanced information and communications technologies (ICT), such as smart meters and grid sensors, to help residential, business and institutional customers make more informed choices about their energy usage so they can save energy and save money. The Smart Grid supports the adoption and integration of electric transportation and RE to lower emissions whilst enabling power companies to further improve supply reliability, safety, and operational efficiency. 'Smart' airport and port require airport and port managers to be linked to customs and also to the operators of airlines, highways, bridges, tunnels, barges, trucking etc. It is the ability of digital technology to enable data to be supplied from multiple converging points that allows people, data and processes to connect real-time that can result in higher performance. 'Smart' transportation leveraging on advanced ICT and Internet of Things (IoT) do predictive maintenance, ease traffic congestion, and enable greener, speedier and more convenient travelling modes. For example, smart traffic management systems driven by big data would automatically monitor and adjust traffic flows, including dynamically changing traffic signal timings to best suit real-time traffic conditions. In time, smart traffic systems will proactively communicate with connected cars and buses for greener and more efficient movements, thereby reducing congestion, improving roadside emissions and minimising the need for additional investment in road capacity.

Property developers, built environment professionals and building owners and managers also have important roles to play to be more energy efficient, and also to enable inhabitants of buildings to have the digital tools to save energy. With the increasing maturity and popularity of IoT and big data analytics technologies, finer granularity and better analysis of energy end-use data will become available for the power companies to make more optimal system planning and to better respond to energy demand irregularities due to extreme weather events. In other words, 'Smart' buildings and indeed 'Smart' districts are possible when buildings and infrastructure in a district can have the appropriate digital overlay to enable smarter use of the infrastructure for higher performance.

In Hong Kong, our efforts at Energising Kowloon East (EKE) include developing a 'Smart City' pilot. As the EKE project includes the transformation of a former industrial area into a core business district, it must necessarily make use of digital technology to improve the performance of the whole area that can enable smart buildings and mobility with a low-carbon outcome. Our NDAs also present opportunities for examining new information system platforms.

We know the digital revolution that is taking place has the potential to help save energy and we are open on its wider application. Hong Kong needs more opportunities for stakeholders, including the Government to exchange knowledge and ideas on how best to exploit the technology (see Chapter 5).

Afforestation and city greening

Hong Kong's original vegetation no longer exists as a result of centuries of deforestation and fire. Today, over 70% of the total land area is vegetated, including secondary forests, shrubland and grassland. About 40% of Hong Kong's total land area is protected as country parks and special areas. Over two-third of our forests lie within these protected areas. Thus, Hong Kong has significant capacity for carbon storage.

Trees and plants help to reduce the amount of carbon in the atmosphere as vegetation can sequester and store carbon. Trees and plants use photosynthesis to convert CO_2 into sugar, cellulose and other carbon-containing carbohydrates that they use for growth. Trees and plants can lock-up large carbon in their wood and continue to absorb carbon as they grow. Although trees and plants release some CO_2 from natural processes, such as through respiration and decay, they typically lock-up carbon at a greater rate than they releases it.

Afforestation and protecting forests

Afforestation has been carried out in Hong Kong as early as the 1870s. The major purposes for this have shifted from erosion control, improving water supplies and creating an attractive environment to biodiversity enhancement and ecological restoration. Today, about 22% of Hong Kong's total land area is covered in forests. Although there is relatively limited room to carry out large-scale afforestation today, the Government takes all opportunities to restore degraded habitat with native species. Our country parks are managed by the Agriculture, Fisheries and Conservation Department (AFCD).

Landscaping and general greening

Development Bureau (DevB) implements the Government's general policy to carry out landscaping and active planting. The goal is to bring about noticeable improvements throughout Hong Kong, including to take opportunities presented by public works projects. Thus, many departments are involved in the planning and execution of a large range of greening works in urban and rural areas. The Greening, Landscape and Tree Management Section within DevB coordinates the overall greening effort in non-country park areas.[20]

Landscape rehabilitation is an integral part of the Government's greening works. It covers planting and associated maintenance works on sites with heavy soil erosion or disturbed areas (such as borrow areas, quarries, degraded slopes, vegetated areas damaged by hill fires), which are mainly located at urban fringe or in the rural areas. The planting works of landscape rehabilitation focus mainly on

Landscape rehabilitation at Shek O Quarry

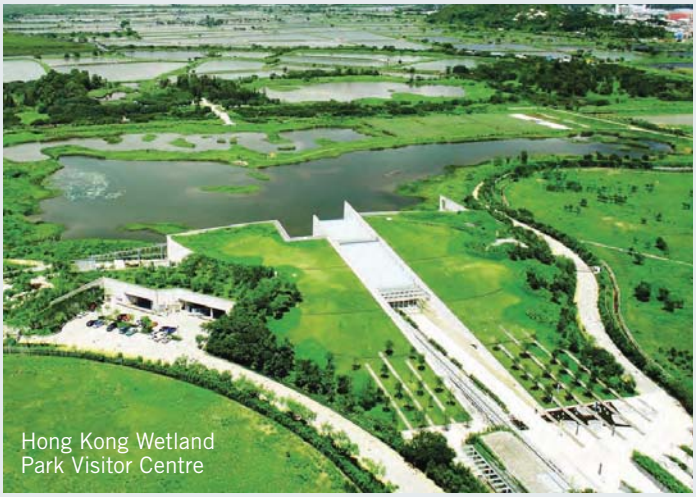
Afforestation and city greening (cont.)

stabilising the physical condition of eroded or degraded land; mitigating the visual impact of badlands or scars; and re-establishing vegetation cover with ecologically sustainable habitat and biodiversity.

Hong Kong's extensive greening and planting programmes since 2010 include vegetating man-made slopes, incorporating planting elements into public works projects, increasing planting along roadside areas, developing and implementing Greening Master Plans on a district basis, promoting and implementing green infrastructure projects (such as green roofing, vertical planting on buildings, pervious pavements, rain harvesting etc) and skyrise greenery etc. Some of these projects are described elsewhere in this document.

Skyrise greenery is a good example of having multiple benefits that helps to reduce climate impacts and promote built-in low-carbon living. By creating greenery on buildings, it helps to ameliorate heat island effect by reducing temperature of heat-absorbing surfaces, and the plants release oxygen and absorb CO_2. It can also help to control water runoff, absorb noise transmission and create attractive areas for inhabitants.


18 Kowloon East


Hong Kong Wetland Park Visitor Centre


Kwun Tong Promenade

Near-term mitigation measures

The main potentials for Hong Kong to mitigate GHG emissions, as noted above (besides afforestation and greening), rest mainly in using less coal in our local electricity generation, reducing electricity usage in buildings, making transport more energy efficient, and recovering (renewable) energy from waste. The table below shows the various means by which Hong Kong is mitigating GHG emissions.

Major mitigation measures

Electricity Supply	Buildings	Transport	Waste
Reduce coal usage in fuel mix through using more natural gas, nuclear electricity and RE	Drive energy saving through various means: • New buildings – better design and construction; • Existing buildings – re-commissioning; auditing and better management; and retrofitting; • Change property management's and inhabitants' behaviour based on energy demand monitoring and forecast ; • Influence inhabitants to buy energy efficient electrical products	• Make public transport primary choice for mobility • Expand rail options and services • Improve rail operation energy efficiency • Improve vehicle fuel efficiency • Testing low-carbon and zero emissions franchised bus technologies	• Recover and use landfill gas • Recover energy from sludge treatment • Develop waste-to-energy treatment for organic and yard waste and municipal solid waste

Other mitigation measures

Electricity Supply	Buildings	Transport	Waste
• Promote use of RE, such as solar power • Improve power plant energy efficiency • Promote co-and-tri-generation	• Extend lifespan of existing buildings with low carbon adaptive reuse • Research, label and use low carbon construction materials and products	• Promote private electric vehicles and expand charging facilities • Improve driving habits to save fuel • Promote biofuels use in government vehicles and non-road mobile machinery	• Capture and use gas from wastewater treatment • Recover waste cooking oils for biodiesel production • Extend lifespan of existing buildings where appropriate to reduce construction waste

Actions beyond 2025

We believe it is important for our community to understand the magnitude of the effort required by all of us to achieve the targets noted above. To exceed them requires greater effort still; and if we were to continue to set new targets in the future, this requires sustained effort from the whole society. This is why our *Public Consultation on Future Development of the Electricity Market of Hong Kong* sets a lower carbon fuel mix for implementation by 2020, and invited public views on how the power companies could be required to help promote DSM and RE under the future contractual arrangements; and our *Energy Saving Plan for Hong Kong's Built Environment 2015-2025+* provides for the setting-up of a dialogue platform, led by the Secretary for the Environment, to collaborate with key stakeholders, to make energy saving a key objective in society and especially for buildings.

Expanding the magnitude of efforts needed

The IPCC has made it clear that international efforts should aim at limiting global warming to less than 2°C by 2100 relative to the pre-industrial levels (global temperature has already risen 0.8°C since then).[21] The IPCC also emphasised that there will need to be substantial emissions reduction of 80% over the next few decades (i.e. decades before mid-century) and to achieve net zero emissions of CO_2 and other GHG by 2100.

The IPCC fully recognises that implementing such reductions for any place poses substantial technological, economic, social and institutional challenges. Obviously, every jurisdiction has to consider what mitigation options are available in its major economic sectors, and what may be the more cost-effective approaches. It is also obvious that by taking an integrated approach that combines measures to reduce energy use and the carbon intensity of end-use sectors with decarbonising energy supply and reduce net emissions would maximize mitigation outcomes. Yet, this is no small feat and Hong Kong, like other places, has to work with stakeholders and the public to co-learn about the possible mitigation options for Hong Kong and agree on implementation pathways over the course of several decades.

Achieving current targets

Our current target on fuel switching to reduce coal usage by around 2020 will help to reduce Hong Kong carbon intensity by about 50% using 2005 as the base. Furthermore, our success in achieving the energy intensity reduction target of 40% by 2025 using 2005 as the base would mean that Hong Kong is able to achieve an additional saving of about 17,300 TJ (or equivalent to 4.8 billion kWh) when compared to the 'business-as-usual' (BAU) case based on our projections.

National actions by 2030

Hong Kong needs to consider our mitigation actions in light of China's nationally enhanced actions pledged to the UNFCCC on 30 June 2015. One of the actions pledged by China is to lower carbon intensity by 60-65% by 2030 using 2005 as the base. Indeed, we would need to continue to reduce our carbon intensity beyond 2020.

Beyond 2030

As noted above, our supply side and demand side targets will help Hong Kong to reduce about 3.36 million tonnes of CO_2 per annum by 2025. While our effort today is making a start, it will take enormous on-going effort of the whole community to reduce Hong Kong's carbon emission by 80% by 2050 if we were to use the IPCC's global reduction marker for reference. Hong Kong's 2005 base year carbon emission is about 41 million tonnes of CO_2 per annum (similar to 2010). An 80% reduction equates to 32.8 million tonnes of CO_2 per annum. It must also be recognised that while Hong Kong is already quite a well-developed city, we still have an enormous housing and infrastructure development programme to achieve in the coming two decades; and our population is also estimated to rise moderately.

Better land use planning beyond 2030

Cities and especially the buildings within them are the major sources of carbon emissions and consumers of natural resources. Various levels of town planning can help address the problems of climate change.

In 2007, the Government's *Hong Kong 2030* set the direction for the city's spatial development to meet the challenge of the future that advocated the principle of to "do more with less". *Hong Kong 2030* promoted concepts such as transit-oriented development and smart use of space. DevB and Planning Department (PlanD) are now updating Hong Kong's development strategy, known as *Hong Kong 2030+: Towards a Planning Vision and Strategy Transcending 2030*, the aspiration of which is to make Hong Kong a smart, green and resilient city to tackle climate change and to enhance the convenience, environmentally friendliness and efficiency of urban living. Measures for promoting a sustainable and livable urban form, and more integrated green and blue spaces will be explored. Technical assessments for reducing commuting demand and optimising the use of transport infrastructure, and strategic environmental assessment for evaluating the cumulative environmental impacts of development options are being done to facilitate us in planning for a more sustainable Hong Kong.

Energy saving and Hong Kong

The cheapest and cleanest energy is ideally what we don't need to use. There are also other benefits to energy saving, such as lowering our energy bills and contributing to cleaner air. However, energy saving cannot replace the very large quantities of energy Hong Kong needs to power the city. Thus, reducing the carbon intensity of our fuel mix for power generation remains critical.

The many innovative DSM and technologies for energy saving combined with RE-distributed power is changing the business model of power companies worldwide. Our *Public Consultation on Future Development of the Electricity of Hong Kong* and *Energy Saving Plan for Hong Kong's Built Environment 2015-2025+* discusses how the contractual arrangements with the power companies may begin this transformation in Hong Kong. However, to make significant advances, energy saving will need to become a core activity for everyone. We look forward to the dialogue platform, led by the Secretary for the Environment, to help point the way to achieve larger energy saving especially from existing buildings.

Hong Kong Green Building Week 2015 Launching Ceremony

Reducing carbon emissions from transportation

Our *Energy Saving Plan for Hong Kong's Built Environment 2015-2025+* discusses energy saving and transportation so this document will not repeat the details except to emphasize that Hong Kong's has a low-carbon transportation system that is focused on providing public transport for the vast majority of personal trips.

Carbon emissions from transportation sources account for approximately 17% of total GHG emissions. The majority of the emissions come from fossil fuel usage in commercial diesel vehicles and petrol private cars. While the number of commercial diesel vehicles has remained quite stable over the past 10 years, the number of licensed private cars has increased dramatically from 345,000 in 2004 to about 495,000 in 2014, which led to an overall rise in the total number of vehicles. As we intensify the promotion of the use of electric vehicles (EVs) in Hong Kong, we have seen a progressive rise in numbers as more models are introduced into the local market and as charging facilities are built out.

There are FOUR interrelated ways to mitigate carbon emissions from transportation in the context of Hong Kong:

1. Ensure public transport remains the preferred choice

With an average of over 12 million passenger journeys made on public transport every day (accounting for about 90% of all passenger trips), Hong Kong is highly efficient in providing mobility to a large number of people. Mobility in Hong Kong is already low-carbon by comparison to many other developed cities. Going forward, we must continue to encourage the use of our multi-modal public transport service which are convenient, accessible, affordable and of good service quality. This requires continuous investment in both public transport infrastructure and service improvements, especially rail and further improving its interface with franchised buses and public light buses (PLB) as appropriate, as Hong Kong continues to develop more housing and new towns in the New Territories to cope with population increase and rising aspiration for better accommodation. Indeed, the development of rail, franchised bus and PLB services, and also park-and-ride facilities, need to be considered together to ensure people will continue to choose public transport as their preferred mobility option.

Planning to reduce commuting time and car usage

Over 80% of the new population at the Kwu Tung North NDA will reside within 500m of the railway station. At the Hung Shui Kiu NDA, we have proposed a Green Transit Corridor encompassing a rail-based or road-based environmentally-friendly transport services, pedestrian walkways and cycle tracks connecting the residential clusters with employment nodes, railway stations and key community facilities. All new population and employment will be within 200m to 300m of a public transport node.

Rail extensions

Hong Kong is building and planning an extensive rail system. Four more under-construction rail projects are expected to be completed during the period to 2021. Seven more new projects, as recommended in the Railway Development Strategy 2014, are expected to be implemented in the planning horizon up to 2031. When these projects are completed, our railway's share in the public transport patronage is expected to rise from around 40% at present to between 45% and 50% by 2031. By then, 75% of Hong Kong's population will have convenient access to rail as a means of daily transport.

While more electricity will be needed to power all these new rail-lines, it is still the lowest carbon way to provide mass mobility.

Franchised bus services

Currently, the proportion of daily trips made on franchised buses is about 31%. With more rail lines in the future, there will be changes in travelling demand and pattern of bus passenger usage, which will require adjustments to road-based public transport services (including franchised bus and PLB services) to achieve better complementarity amongst different transport modes. In light of the above and with on-going efficiency initiatives to enhance bus routings, it is expected that the increase in the number of franchised buses from 2020 onwards will be limited. The franchised bus fleet currently has a total of about 5,800 buses.

Cleaner and zero-emissions bus technologies

There are no pre-EURO and EURO I franchised buses in the fleet. According to the latest bus replacement programme, the estimated retirement year of all EURO II and III franchised buses, amounting to about 60% of the franchised bus fleet, will be around 2019 and 2026 respectively. Since 2013, in renewing bus franchises, operators are required to acquire the most environmentally-friendly buses in terms of exhaust emissions (with the ultimate objective of switching to zero emission buses) that are technologically proven and commercially available.[22] The current legislative requirement is for new buses to be of at least EURO V standard; and the next progression is for the adoption of EURO VI as the standard.

In pushing towards adopting zero emission franchised buses, the Government has funded and collaborated with the operators to trial new technologies, including 6 double-deck hybrid diesel-electric buses (EURO VI) that are being trialed currently, and 36 single-deck electric buses that will arrive in Hong Kong by batches for trials from the second half of 2015.[23] These trials enable the operators to collect valuable data via employing the technologies under the real operating conditions in Hong Kong, as well as the costs for operating and maintaining them. Double-deck electric buses are not yet available in the commercial market for Hong Kong's context.

In the planning of strategic growth areas, we will promote more mixed uses and bring jobs closer to homes, so as to reduce commuting needs on the one hand; and we will plan to cluster population, key economic activities and major community facilities within walking distance of mass transit and public transport nodes on the other hand so as to reduce the use of private cars.

2. Improve system and operational efficiencies

For Hong Kong, this means continuing to aggressively prioritise public transport for the vast majority of trips made; encouraging people to buy vehicles that are more energy efficient where fossil fuel has to be used, and to buy zero emissions vehicles where available. Other complementary policies include instituting good traffic management and urban planning. Also, we agree in principle with and plan to take forward in phases the recommendations made by the Transport Advisory Committee (TAC) on reducing road traffic congestion. When finalising the details of these measures, we will take into account various factors, including public sentiments and stakeholders' views, the availability of resources, and the latest technology and overseas experience, etc.

3. Promote low and zero-carbon choices

There are a number of measures to help people make various zero-carbon choices, such as improving walkability through pedestrian bridges and elevators/escalators so people can navigate the city more easily on foot. We also want to promote walking especially for shorter distances. Plans for the harbour-front enable people to walk quite a distance. Moreover, we have also built cycling paths in the New Territories and in new town areas so it can also become a preferred choice for residents. Our First Registration Tax scheme favours zero emissions vehicles; and we have been promoting the use of biodiesel in government vehicles.

4. Promote better driving techniques

By improving driving techniques, all drivers can be more fuel efficient. This is especially important for commercial drivers who are on the road every day. We will continue to promote eco-driving techniques from time to time and will collaborate with stakeholders, such as the Automobile Association and the relevant bodies associated with the commercial driving trades.

Promotion of clean vehicles

The Consultancy Study of Climate Change completed in 2010 by EPD suggested that by 2020, it might be possible to have wider use of cleaner vehicles in Hong Kong (such as hybrid and electric technologies) with the following percentages – 15% buses (including franchised buses); 15% heavy goods vehicles; 15% light goods vehicles and 30% private cars.[24] As of this time, these assumptions appear optimistic because the technologies are not yet ready for commercialisation for some of these types of vehicles, not just in Hong Kong but also elsewhere in the world.

As of end-April 2015, there are about 13,400 franchised and non-franchised buses in Hong Kong, out of which only 15 are hybrid or electric. As noted above, the franchised bus companies are trying out various technologies and it is premature for full adoption of these technologies before the completion of the trials, having regard to, amongst other things, operational and financial viability in actual services deployment. The franchised bus companies' experience is relevant for other bus service operators in their readiness to adopt these new technologies.

There are currently about 5,300 licenced heavy goods vehicles in Hong Kong and they are all powered by diesel, as there are as yet no hybrid or electric technologies for such vehicles. There are about 108,000 licensed light and medium goods vehicles of which only about 110 are hybrid or electric. More than half of these hybrid or electric vehicles are on trial with subsidies from the Pilot Green Transport Fund, which is designed to promote commercial and non-profit making organisations to try out new technology vehicles.[25] As more models are coming on to the market in Hong Kong, and as users become more confident to use such vehicles, we expect their uptake to increase in the coming years. Currently, hybrid and electric light and medium goods vehicles are still 30% to 50% more expensive.

The picture is better for private cars. As of end September 2015, there are about 500,000 licenced private cars, out of which about 14,000 are hybrid and about 2,890 are electric. The rise in the number of private cars was due to vehicle manufacturers supplying more hybrid and EVs models to the local market and the roll-out of additional charging facilities. There are now more than 1,100 EV chargers for public use, including over 160 medium chargers, covering all 18 districts in various types of buildings. In addition, there are 46 quick chargers set up at various districts. We believe our exemption of First Registration Tax for EVs is very attractive for potential buyers to opt for EVs.

We do see the number of new technologies vehicles of all types rising by 2020. Our policy would continue to favour subsidising the trials of public transport and commercial vehicles so that we and the operators can be clearer on the commercialisation timeline and costs. Meanwhile, we will continue to opt for zero-emission vehicles for the government fleet whenever possible.

Energising Kowloon East (EKE) to be 'smart' and pleasant

The Energising Kowloon East project

The EKE project, initiated in 2012, includes the promotion of low-carbon solutions to improve livability. The project prioritises "walkability" to enhance connectivity and the pedestrian experience of Kowloon East. By integrating urban planning and low-carbon mobility, EKE will create pleasant spaces for walking and more vibrant neighbourhoods. The tools for such transformation include facilitating the provision of elevated walkways, improving connectivity between subway stations and the waterfront, and transforming back-alley areas to become a part of the pedestrian network. At the same time, the project will apply digital technology to enhance pedestrian and vehicular accessibility, to manage district facilities, and provide public information.

Waste management and carbon emissions

While local waste treatment only accounts for about 5% of Hong Kong's carbon emissions, it is important to note that our new approach to turning waste-to-resources is becoming an importance source of RE. Moreover, how we consume can make a major difference to global carbon emissions since many raw materials and products are imported. The manufacturing and transporting of all kinds of products, including food, and the dealing with the resulting waste all require energy.

Thus, resource conservation and reuse helps to lower overall carbon emissions. Our *Hong Kong: Blueprint for Sustainable Use of Resources 2013-2022*, and *Food Waste and Yard Waste Plan for Hong Kong 2014-2022*, published in 2013 and 2014 respectively lay out a clear path for Hong Kong. There are multiple measures and infrastructure investments to reduce waste at source, to reuse where possible, to recycle and to use waste to generate energy so that we are confident of achieving a 40% reduction in per-capita MSW disposal rate (per day) by 2020. In support of the Yard Waste Plan, "Guidelines on Yard Waste Reduction and Treatment" were promulgated in 2014.

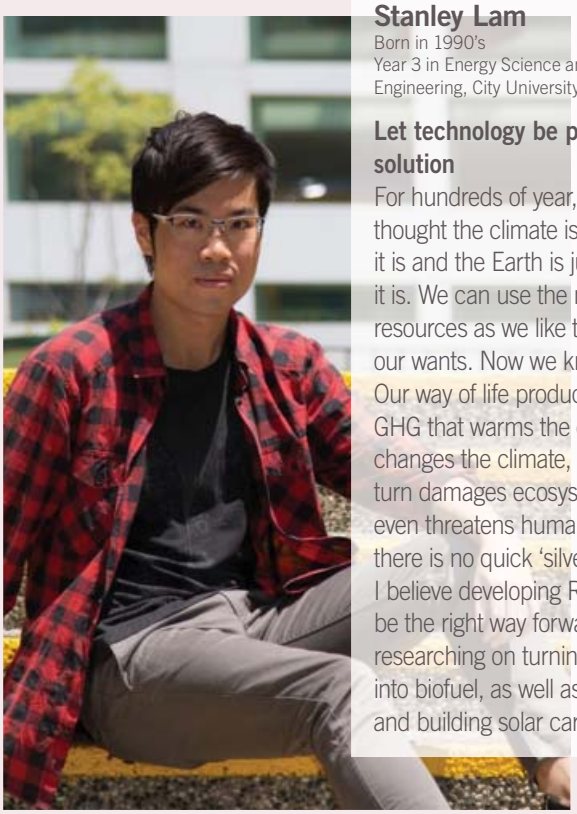
THEIR VOICES ON CLIMATE CHANGE

Samantha Kong Wing Man

Born in 1990's
Hong Kong Top 10 Outstanding Youth 2014,
Graduate Environmental Engineer, SMEC Asia Limited

Promote positive change in the world

Climate change is the toughest and most important environmental issue that requires at least two generations to get it under control. Upon graduation, I worked at the United Nations Headquarters where I observed the negotiation process of the UN Sustainable Development Goals. I realised slowing global warming is imperative for achieving a world free from suffering. On climate change, there is no overriding consensus as it is a substantial issue threatening both people and society. I will be participating at COP21 in Paris and I hope to pursue further studies to promote positive change in the world.



Stanley Lam

Born in 1990's
Year 3 in Energy Science and Engineering, City University of Hong Kong

Let technology be part of the solution

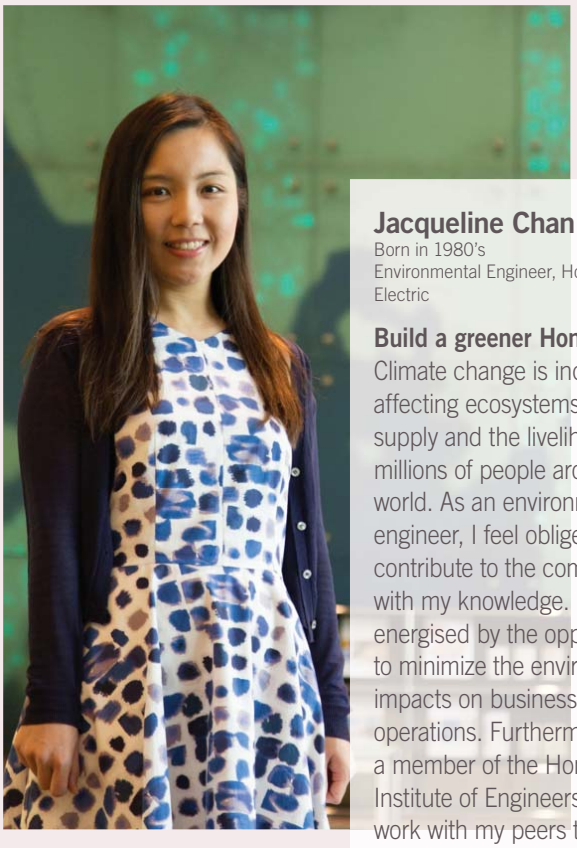
For hundreds of year, people thought the climate is just what it is and the Earth is just what it is. We can use the natural resources as we like to satisfy our wants. Now we know better. Our way of life produces a lot of GHG that warms the earth and changes the climate, which in turn damages ecosystems and even threatens human life. While there is no quick 'silver bullet', I believe developing RE must be the right way forward. I am researching on turning waste-oil into biofuel, as well as designing and building solar cars.

Eric Cheng

Born in 1980's
Project Manager, The Hong Kong Research Institute of Textiles and Apparel

Science and technology provide many solutions

Sea level rise, global warming and extreme weather – these are the vital signs that the Earth systems are definitely in 'Red Alert'. As a researcher, I do innovative technology research to minimise adverse human impacts on the Earth. We can save water by developing waterless dyeing and finishing technology. We can also reduce energy usage in the entire manufacturing process. We have even developed a fibre from food waste. I want to do more in the future.



Jacqueline Chan

Born in 1980's
Environmental Engineer, Hong Kong Electric

Build a greener Hong Kong

Climate change is increasingly affecting ecosystems, food supply and the livelihood of millions of people around the world. As an environmental engineer, I feel obliged to contribute to the community with my knowledge. I am energised by the opportunities to minimize the environmental impacts on business operations. Furthermore, as a member of the Hong Kong Institute of Engineers, I can also work with my peers to promote awareness on climate change and resilience. I want to help build a greener Hong Kong.

4 ADAPTING TO CLIMATE CHANGE

Climate change risks assessment

Climate change is likely to significantly affect the operational performance of the infrastructure of any city and region, including Hong Kong, as it is a multiplier of risks. The term 'infrastructure' may be used to cover both large fixed assets, as well as soft networks that keep our economy and society functioning. Thus, 'infrastructure' includes the hardware for energy supply (e.g. power plants, pipelines, grids), water (reservoirs, pipelines, wastewater facilities), buildings (e.g. public sector, commercial and residential), coastal infrastructure, transport (e.g. roads, rail, port, airport), ICT networks (e.g. data cables), as well as the soft infrastructure of public communication and emergency services, health services, food and financial services. Clearly, there are inter-dependencies among these various sectors of infrastructure. Failure in one area can cascade into another area.

This chapter deals with adapting to climate change through defensive measures, which focuses upon strengthening the publicly-owned physical infrastructure (i.e. reducing risk to them), while the next chapter discusses strengthening resilience of the soft infrastructure to absorb stresses and maintain function in the face of external stresses imposed upon it by climate change, which includes coordination with the private sector that operates many important essential facilities and networks, such as power and transport facilities and services, all of whom also need to have their own defensive measures for their physical assets. Obviously, there are

opportunities for improving our city's hardware that can bring about many societal benefits, such as a better living environment; and there are also gains for society as a whole in working with stakeholders and residents to improve the city's software infrastructure.

Hong Kong's approach to adaptation tallies with the national approach to proactively adapt to climate change by enhancing mechanisms and capacities to effectively defend against climate change risks in key areas.[26]

Understanding Hong Kong vulnerabilities

The Government has assessed Hong Kong's climate change vulnerability and our thinking on adaptation and resilience planning takes this assessment as our starting point, including taking worst-case scenarios into account. Vulnerability comprises the people in their environment and their exposure to climate change related risks. There are two main components for vulnerability assessment. The first deals with the geographical and physical aspects of Hong Kong, such as demographics, and the city's infrastructure and facilities. The second deals with social and economic aspects, such as Hong Kong's capacity to cope with occurrence of extreme events. We used the available assessments and projections from the IPCC's latest Fifth Assessment Report 2014 (AR5)[27] and HKO's advice as the basis for our risk assessment.

We had identified 8 key sectors as having 'high' vulnerability to climate change impacts in relation to Hong Kong. This chapter deals with built environment and infrastructure, energy as well as water resources, as these are areas where the Government's direct or regulatory role is crucial; while Chapter 5 deals with the other sectors, as they require significant private sector and community actions. The tables below summarise the impacts as they may affect Hong Kong directly and impacts that may arise elsewhere that impact on Hong Kong. The sectors are listed in alphabetical order.

Possible major impacts directly in Hong Kong

Biodiversity

Greater stress to montane and freshwater ecosystems due to increase in surface temperatures and extreme weather; loss of inter-tidal habitats, such as coral reefs or mangroves due to sea-level rise; harsher growing environments; increased erosion and landscape degradation and change in species distribution and migration patterns

Built environment and physical infrastructure

Damage to building foundations; damage to utilities cables, pipes and assets; increase risk of rain penetration, flooding and landslides due to strong winds, storm surges, tree failures and extreme weather

Business and industry

Higher maintenance and insurance costs due to extreme weather related damage; staff training to deal with extreme weather events

Energy supply

Damage to power lines and other assets under extreme weather; higher energy demand due to increase in temperature and extreme weather; supply interruptions and power spikes

Financial services

Direct and indirect risk related to telecommunications and computer system failure; changes in risk profile of individual business and investment; insurance sector exposed to higher extreme weather risks

Food resources

Lower availability of local/ regional food output as a result of extreme weather

Human health

Aggravate chronic health condition; higher risk of thermal stress, exacerbation of asthma and heat stroke; more accidents and emergency situations; changes in transmission patterns of infectious diseases

Water resources

Change in rainfall pattern and rise of demand under higher temperature may affect local water resources

Possible impacts arising elsewhere that may impact Hong Kong

Business and industry

Exposure to impacts beyond Hong Kong that may lead to higher costs of imports of essential goods

Energy supply

Price of fuel sources may rise due to extreme weather disruptions elsewhere

Food supply

Damage to cultivated areas leading to loss of production and lower availability of imported food products leading to higher prices as a result of extreme weather disruptions elsewhere

Water supply

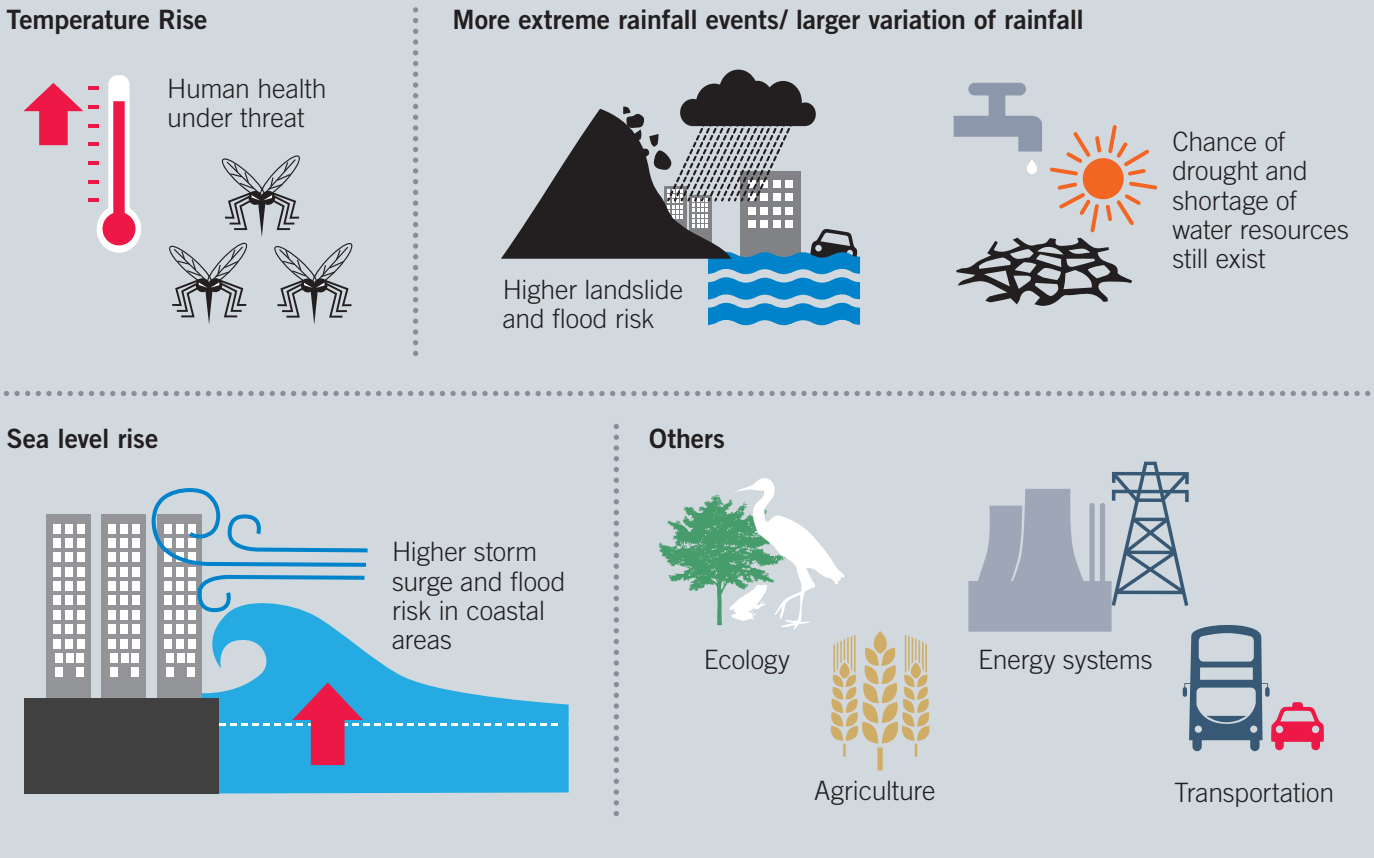
Change of rainfall patterns and possible drought in South China may affect the regional supply availability of water

Expected climatic changes

The latest science enables us to project the probable climatic changes that will affect Hong Kong. The impacts are broad and will affect many sectors of activities. The Government has done studies on the projected changes of temperature, rainfall and sea level rise. Projections necessarily involve assumptions of GHG concentration scenarios and therefore are subject to scenario uncertainty in addition to model uncertainties.

Nevertheless, the projections represent the best available consensus to date on the probable impacts. Needless to say, there must be continuous updates for new information to be fed into the policy assessment and decision-making process so that each succeeding administration may adjust plans.

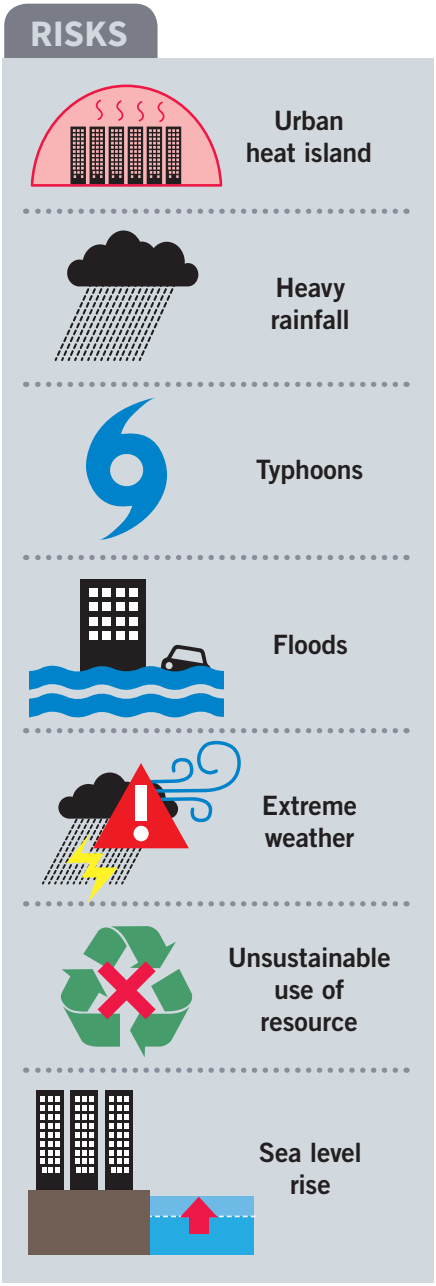
CLIMATE CHANGE AND ITS IMPACT IN HONG KONG



Summary of climate change and Hong Kong

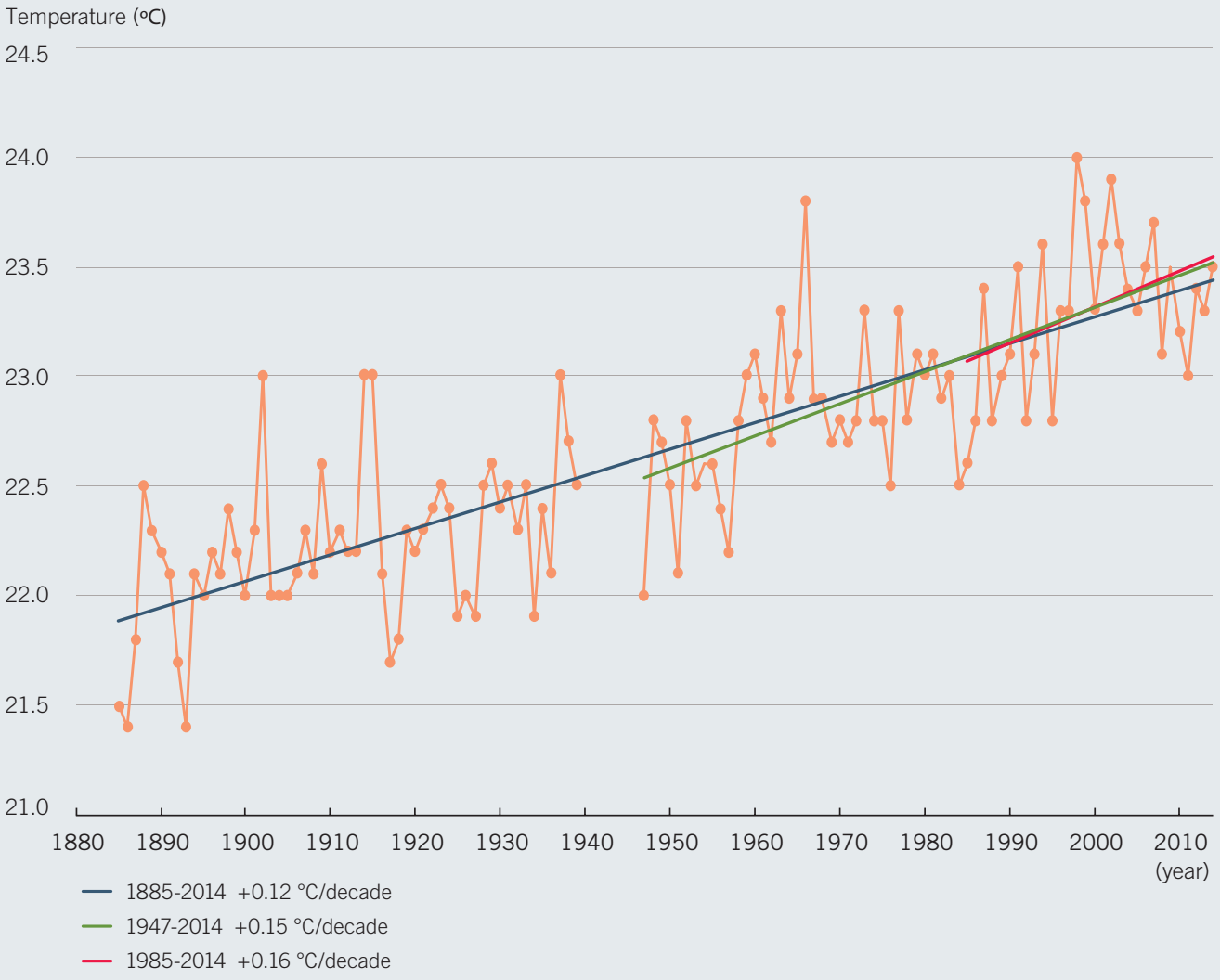
The effects of climate change have already emerged with Hong Kong experiencing raised temperatures, more frequent extreme rainfall and rising sea-level. The changes in Hong Kong's climate in the 21st century may be summarised as follows:

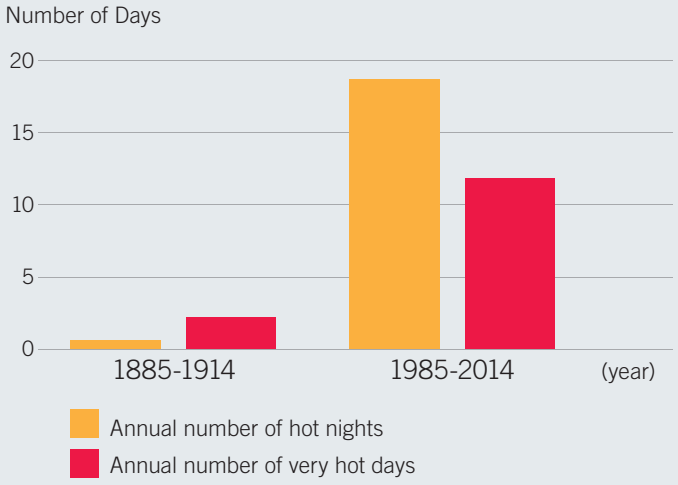
- The number of very hot days and hot nights is projected to increase;
- The number of rain days is projected to decrease while the average rainfall intensity will increase;
- The frequency of extreme rainfall events is projected to increase;
- There will be more extremely wet years but the risk of extremely dry years will remain;
- Global sea level rise will lead to coastal changes all over the world, including in Hong Kong; and
- The threat of storm surges associated with tropical cyclones will increase.

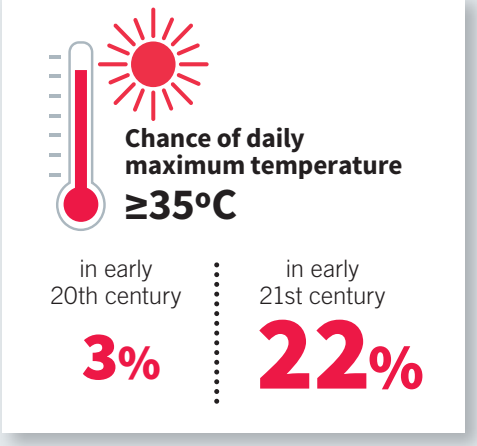


TEMPERATURE RISE

Hong Kong will be hotter







TEMPERATURE RISE

Hong Kong will be hotter (cont.)

Under the IPCC's latest 'high' global GHG concentration scenario, Hong Kong's temperature is expected to rise by 1.5-3°C in the mid-21st century (2051-2060) and 3-6°C in late 21st century (2091-2100), when compared to the 1986-2005 average of 23.3°C. Under the 'medium-low' global GHG concentration scenario, Hong Kong's temperature is expected to rise by 1-2°C in the mid-21st century and by 1.5-3°C in the late 21st century, when compared to the 1986-2005 average.

The annual number of hot nights (days with a minimum temperature of 28°C or above) and very hot days (days with a maximum temperature of 33°C or above) are expected to increase significantly in the 21st century. On the other hand, the annual number of cold days (days with a minimum temperature of 12°C or below) will continue to drop.

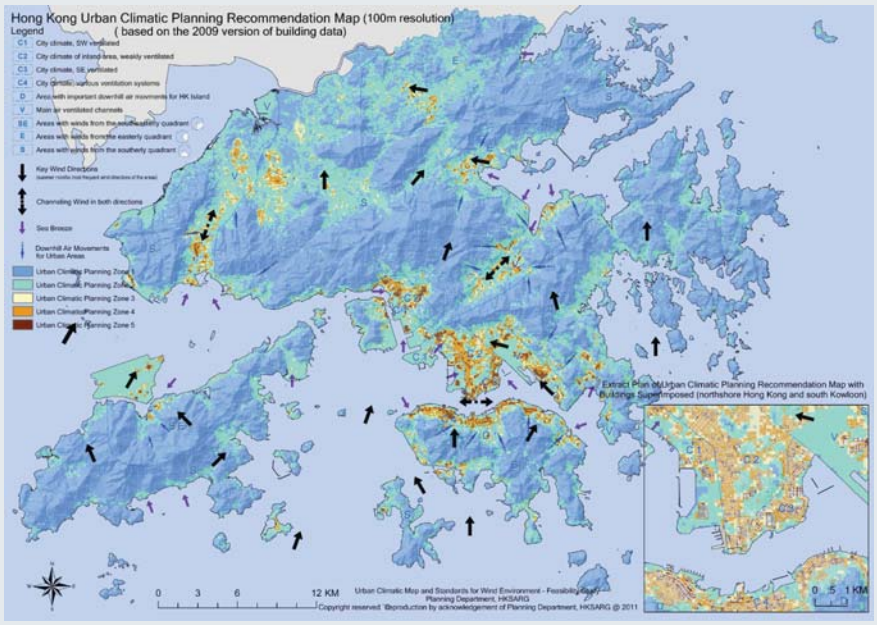
Like many other cities in the world with high development densities, Hong Kong suffers from the 'urban heat island' effect, where the temperatures are intensified at the dense urban areas because air ventilation is poor and heat is trapped by buildings. The Government has implemented a range of counter measures over the past decade. Examples include:

- **Hong Kong Planning Standards and Guidelines (HKPSG)** – Practising good urban design at the local level can contribute to a livable high-density environment. HKPSG provides design guidelines on aspects such as massing, height profile, street orientation, breezeways, etc. to promote better urban air ventilation, and thereby help tackle Urban Heat Island effect and improve the micro-climate of urban environment. The Government follows these qualitative guidelines on urban design and air ventilation that are promulgated in the HKPSG in the planning of NDAs. For existing built-up areas, project proponents are encouraged to take on board these design principles in planning and designing their development/ redevelopment projects so as to pursue incremental improvement of the urban wind environment.
- **Air ventilation assessment** – Since 2006, the Government requires air ventilation assessments to be done for all major government projects so that the result can improve the design to facilitate wind penetration to their surrounding area[28] and the private sector is encouraged to follow this practice. In new strategic planning studies, such as the Investigation of North East New Territories New Development Areas Planning and Engineering Study and the Feasibility Study of Planning and Engineering Study on the Remaining Development in Tung Chung, air ventilation considerations are reflected in the conscious planning decision to create breezeways and air ventilation corridors.

Wind Corridor of Kwu Tung North NDA

TEMPERATURE RISE
Hong Kong will be hotter (cont.)

- **Urban Climatic Planning Recommendation Map** – PlanD formulated an Urban Climatic Planning Recommendation Map in a consultancy study completed in 2012, which provides a scientific basis for assessing urban climatic and air ventilation impacts of major developments, and helps tackle the heat island challenge.[29]



- **Greening Master Plans (GMPs)** – The Government, led by the Civil Engineering and Development Department (CEDD), has developed districted-based Greening Master Plans to define comprehensively the greening framework of an area by studying its characteristics and particular needs, as well as providing a guide to the planning, design and implementation of works. The plans identified planting locations, established greening 'themes' and proposed appropriate planting species. GMPs for the urban areas were completed between 2007 and 2011, and further plans are being implemented in the remaining districts (also see Chapter 5).

- **Sustainable Building Design Guidelines** – Since 2011, the Government promulgated a set of Sustainable Building Design Guidelines on building separation, building set back and site coverage of landscape through the Building Department's (BD) Gross Floor Area concession policy, as well as including these guidelines in lease conditions of new land sale sites or lease modifications/ land exchanges of 1,000 square metre or more so as to achieve better air ventilation, provide more greenery and mitigate the heat island effect.

- **BEAM Plus** – BEAM Plus is a comprehensive environmental assessment scheme for buildings in Hong Kong. It is a standard for green buildings to emphasize the in-door health and environmental quality and amenities as key performance indicators, with proper consideration of the local, regional and global environment impacts.

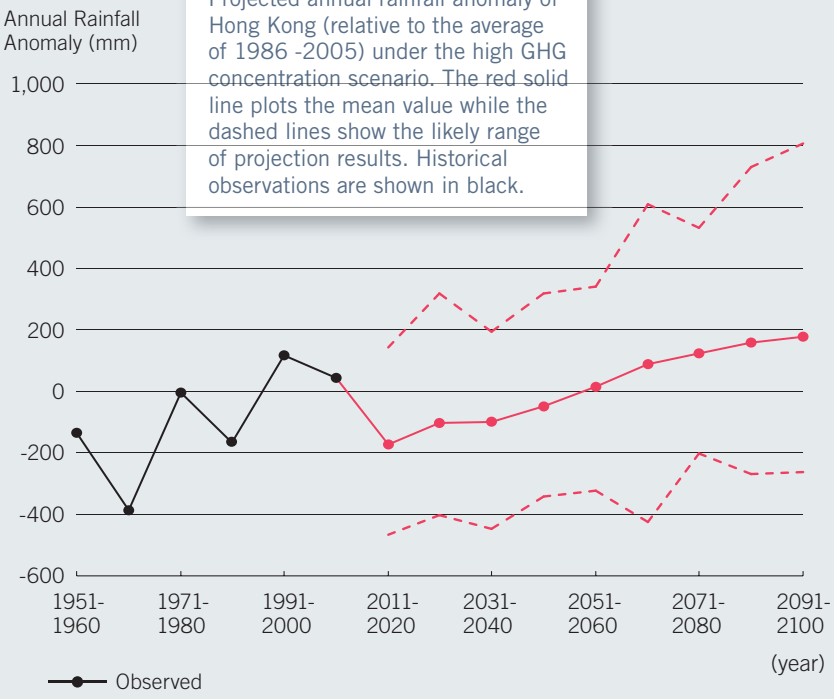
Tai Yip Lane, Kowloon Bay

RAINFALL

Hong Kong will be wetter with more extreme rainfall

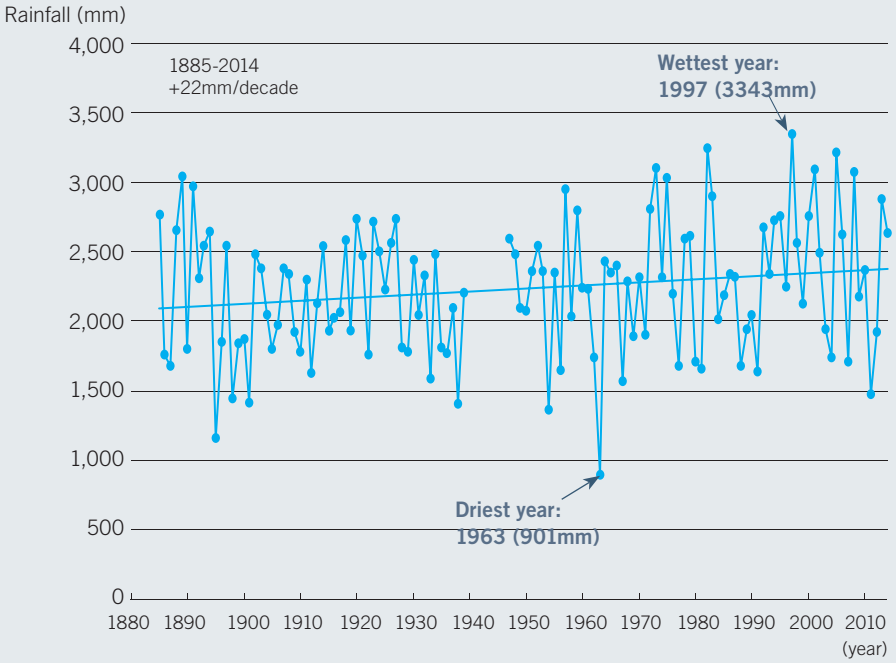
Under the IPCC's latest 'high' global GHG emissions scenario, the number of extremely wet years is expected to increase from 3 in 1885-2005 to about 12 in 2006-2100. Besides, the annual rainfall in late 21st century is expected to rise by about 180 mm when compared to the 1986-2005 average. Extreme rainfall events will also become more frequent this century.

Extreme rainfall events becoming more frequent



Projected annual rainfall anomaly of Hong Kong (relative to the average of 1986 -2005) under the high GHG concentration scenario. The red solid line plots the mean value while the dashed lines show the likely range of projection results. Historical observations are shown in black.

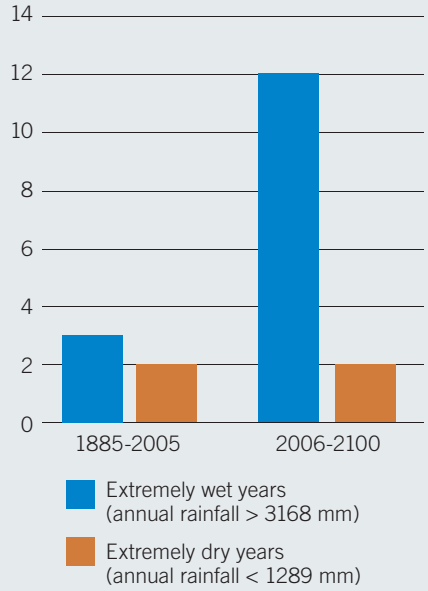
Annual rainfall at the Hong Kong Observatory Headquarters (1885-2014)



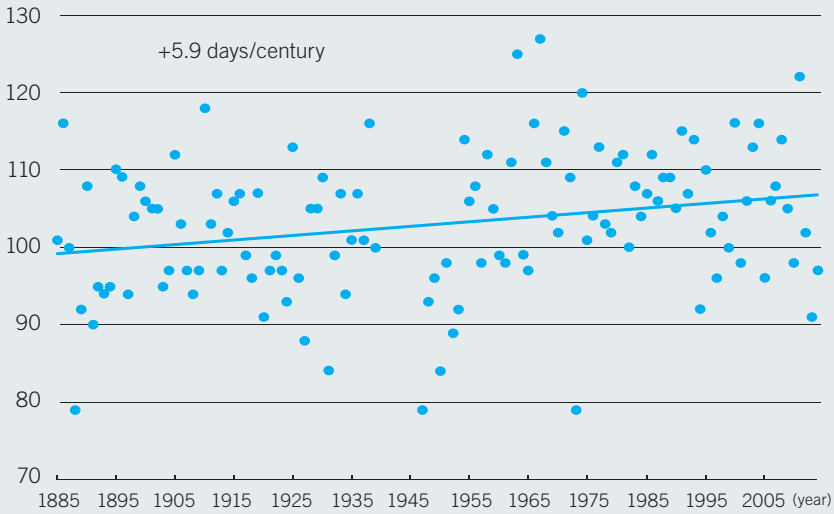
RAINFALL

Hong Kong will be wetter with more extreme rainfall (cont.)

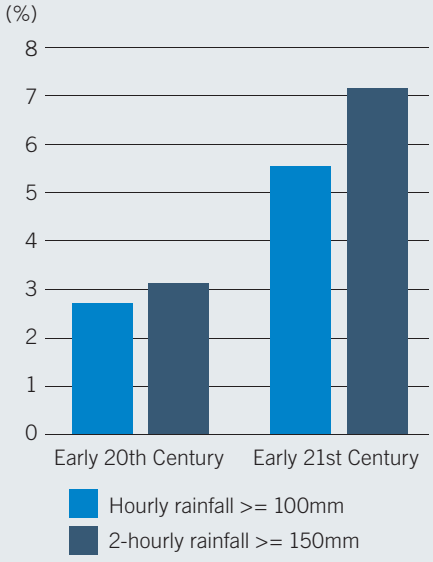
Future changes in extremely wet and extremely dry years under the high greenhouse gas concentration scenario



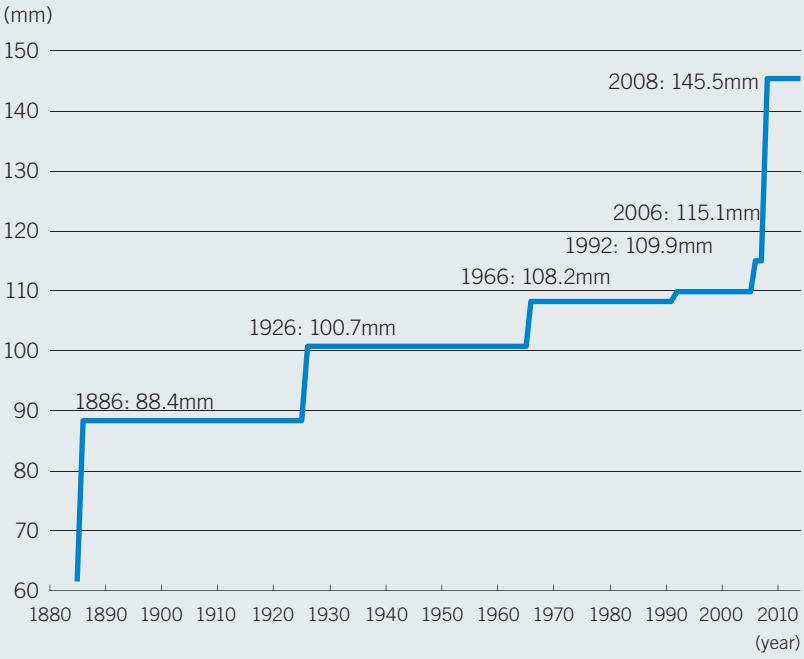
Number of days without significant rain in April - September (1885 - 2014)



Probability of annual extreme rainfall events



Hourly rainfall records at the Hong Kong Observatory Headquarters (1885 - 2014)



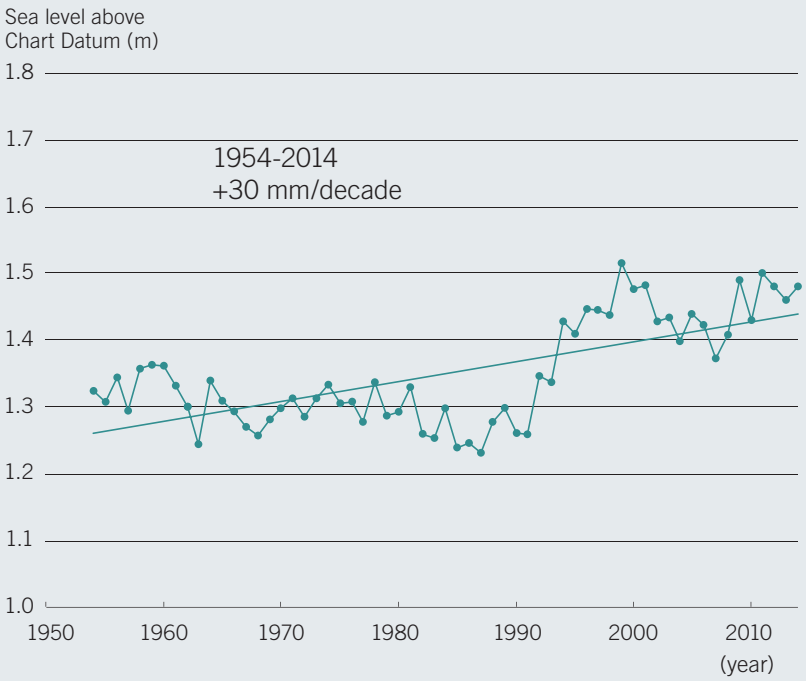
SEA LEVEL IS RISING

On average, the annual mean sea level in Victoria Harbour rose at a rate of 30 mm per decade during 1954-2014.

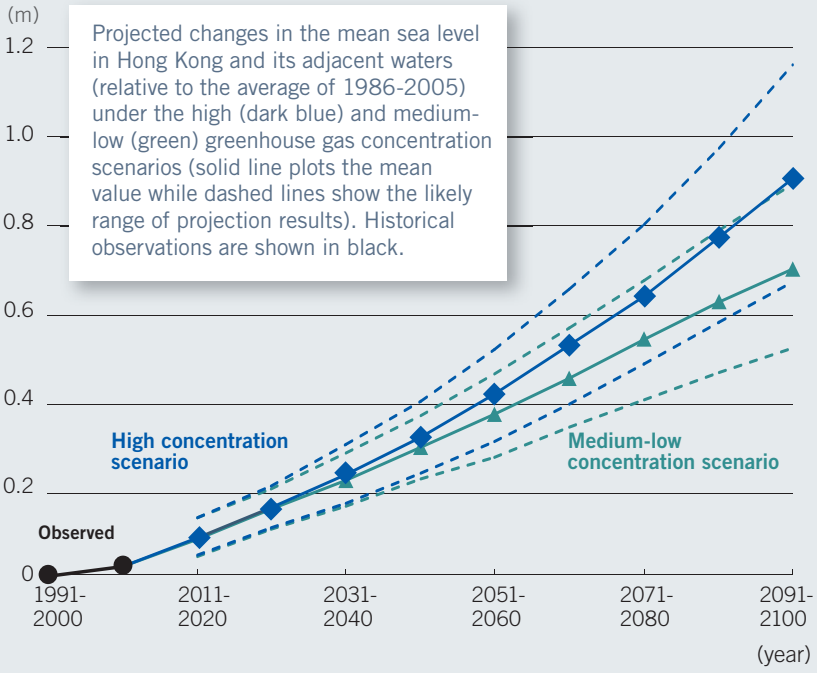
Under the high GHG concentration scenario, the annual mean sea level in Hong Kong and its adjacent waters is expected to rise by 0.32-0.53m and 0.63-1.07m relative to the average of 1986-2005 by mid-21st century (2046-65) and late century (2081-2100) respectively.

A major impact is an increase in sea flooding associated with storm surges caused by tropical cyclones. The extreme sea level brought by storm surges of the same typhoon will be higher when the mean sea level is raised. A sea level of 3.5 mCD[30] that can cause serious flooding in certain low-lying areas in Hong Kong, such as the one brought by Typhoon Hagupit in 2008, is a 1-in-50 year event today. It would however become a 1-in-5 year to 1-in-10 year event by 2021-40 regardless of the GHG concentration scenario, and a recurrent event every year by the end of the 21st century under the high GHG concentration

Annual mean sea level at Victoria Harbour (1954-2014)



Annual mean sea level change



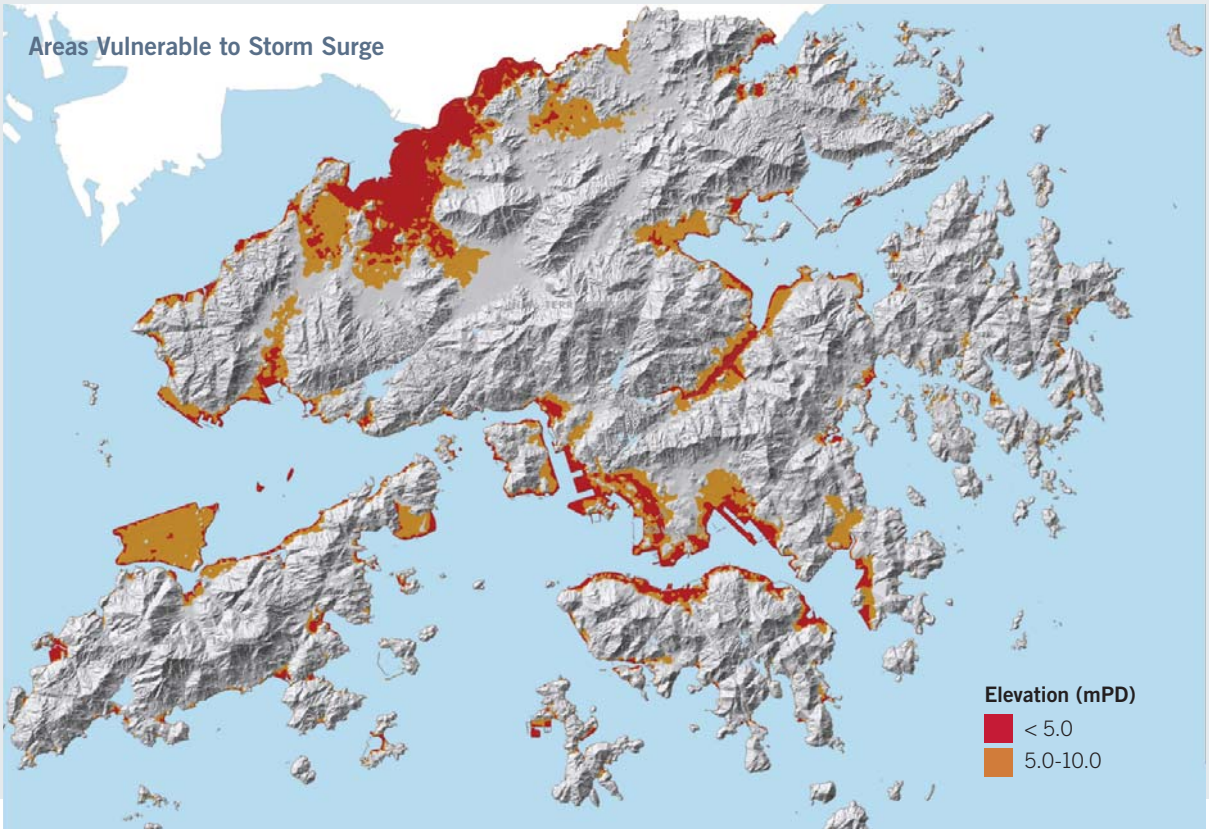
Projected changes in the mean sea level in Hong Kong and its adjacent waters (relative to the average of 1986-2005) under the high (dark blue) and medium-low (green) greenhouse gas concentration scenarios (solid line plots the mean value while dashed lines show the likely range of projection results). Historical observations are shown in black.

SEA LEVEL IS RISING (cont.)

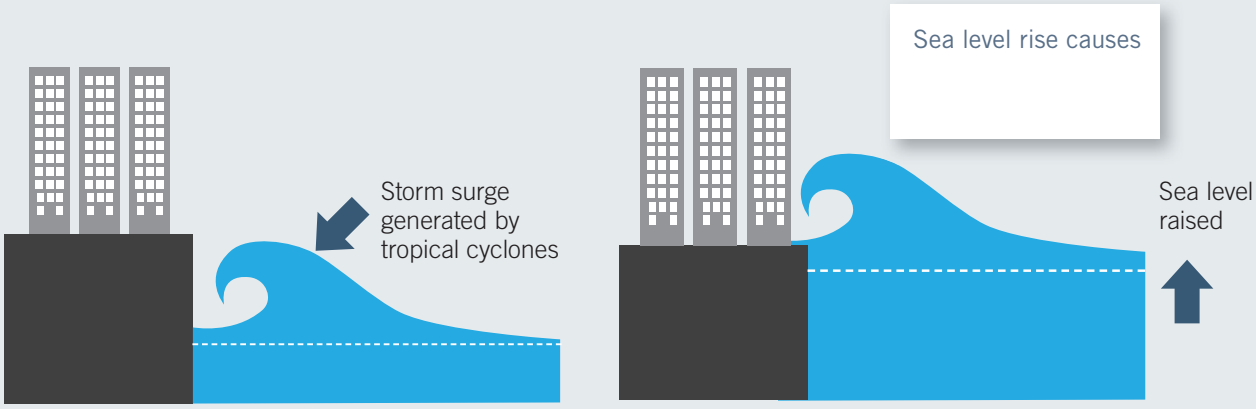
scenario, even if overall tropical cyclone activities in the region remain by and large the same.

Unlike storms and rain, which last a relatively short time, sea level rise will move the coastline incrementally although gradually. It will affect whatever is in its way, such as property and communities. The projected time scale of sea level rise is critical to our response – the difference between decades and millennia is enormous. There is currently insufficient evidence to evaluate the probability of the specific levels and range noted above, as it relates to whether and how fast the Antarctic ice sheet may melt, which is an area of uncertainty acknowledged by the IPCC.[31] Recent studies showed that the melting glaciers in the Amundsen Sea sector of West Antarctica had passed the point of no return.[32] Although the timescale of the total collapse of the glaciers is uncertain, the global mean sea level rise at the end of this century is likely to lean towards the high side of IPCC's projection. Every government with a coastline and every coastal city will need to pay attention to this subject. What is much more certain is that extreme events can lead to collapse of seawalls and cause extensive flooding, as well as change the coastline suddenly and dramatically.

We are therefore investing in the understanding of climate science – particularly the uncertainty in projecting global sea level rise – land stability and subsidence, and better protection of our coastal areas with a history of flooding, so that we can be better prepared in land use planning and adaptation efforts.



SEA LEVEL IS RISING (cont.)



Return period (year)	Extreme sea level above Chart Datum (m)				Historical Typhoons bringing significant storm surges to Hong Kong (Maximum sea level above Chart Datum at Victoria Harbou)
	Current	Sea level rise reaching 0.26m in 2021-2040	Sea level rise reaching 0.53m in 2046-2065	Sea level rise reaching 1.07m in 2081-2100	
1	2.7	3.0	3.2	**3.8**	**T. Hagupit in 2008 (3.53m)**
2	2.9	3.2	**3.4**	4.0	
5	3.1	**3.4**	**3.6**	4.2	**T. Wanda in 1962 (3.96m)**
10	3.3	**3.6**	**3.8**	4.4	**Typhoon in 1937 (4.05m)**
20	**3.4**	3.7	3.9	4.5	
50	3.5	3.8	4.0	4.6	

Projected changes in return values of extreme sea level events in 2021-2040, 2046-2065 and 2081-2100 under the high GHG concentration scenario

Shatin was the most affected area, with 150 people killed, 100 injured and 100 missing during the passage of Wanda in 1962. Streets and houses were flooded and destroyed. Boats were used to ferry families and their possessions

A typhoon struck in September 1937, causing the loss of more than 10,000 lives. The Kowloon-Canton Railway track at Shatin was damaged by storm surge brought by the Typhoon.

The situation could be even worse as the global mean tropical cyclone intensity is likely to increase in the 21st century

Damages to ships and piers at Central, Hong Kong Island, brought by severe storm surge during the great typhoon of 1874 (The maximum sea level above Chart Datum might reach 5.2m as estimated by model simulation)

(Photo courtesy: Mr Shun Chi-ming)

Example of coastal flood risk – Typhoon Hagupit 2008

Typhoon Hagupit affected Hong Kong between 22 and 24 September 2008, when tropical cyclone warning signals No. 1, 3 and 8 had to be issued. Its impacts included strong winds, very heavy rain and storm surges despite its relatively large distance (~200 km) away from Hong Kong. The Amber Rainstorm Warning Signal was issued on 24 September between 11.05 a.m. and 4.20 p.m. and more than 100mm of rainfall were recorded over Hong Kong Island, New Territories West and Lantau Island on that day. The combined effect of the storm surges of Hagupit and high tides resulted in a maximum sea level of about 3.53mCD at Quarry Bay. At Tai Po Kau, the maximum sea level was about 3.77mCD.

There were 16 reports of flooding, 7 of collapsed scaffolding, 46 of fallen trees and 58 people injured. Around 4,500 trees were damaged with around 1,000 of them severely damaged. In Hung Hom, 50 windows of a residential building were blown out. Storm surges combined with high tides led to flooding and damages in coastal areas. Huge waves damaged an embankment in front of a row of houses in Cheung Chau, forcing the evacuation of more than 100 residents. The waves also caused damage to the wooden seaside walkway in Discovery Bay and vehicles near Ocean Park. Flooding due to back-flow of sea water affected low-lying areas in many parts of Hong Kong, including Tai O, Sham Tseng, Sai Kung Nam Wai, and Lei Yue Mun. The flooding in Tai O cut off electricity supply and affected more than 200 households there. At least 10 vessels sank or were damaged near Peng Chau. On the Tsim Sha Tsui East promenade, three barges smashed into the seawall after breaking free from their anchors at Yau Tong. Three beaches on Lantau Island were severely damaged as waves brought tons of rubbish to the shore or washed away tons of sand. At the Hong Kong International Airport, over 400 flights were either cancelled or delayed, and strong winds rotated a parked Boeing Classic 747-200 cargo plane. Seven fishermen were rescued from a sinking boat.

Threats to infrastructure

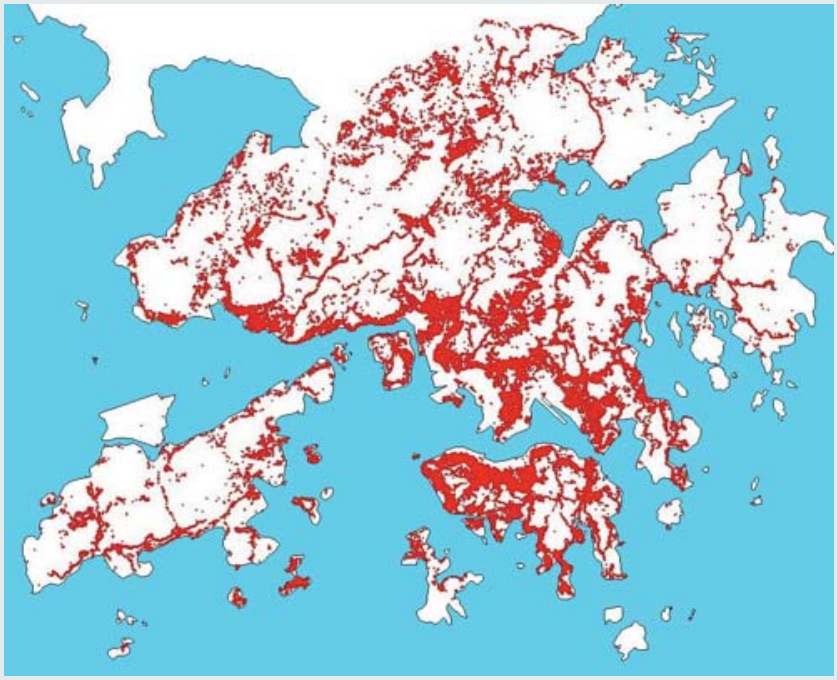
The main climate change threat to hardware infrastructure is damage and even destruction caused by extreme weather events, such as landslides, erosion, landscape degradation, loss of habitats, tree failures, flooding and storm surges. In particular, storm surges may cause inundation to underground utilities, like the flooding of the New York City Subway System during the passage of Hurricane Sandy in 2012. Hong Kong has made significant investment in the past two decades to cope with extreme weather events but further investment will be necessary in the coming decades. As we consider what is needed, there are also opportunities to ensure the outcomes can provide multiple societal benefits. Hong Kong will need to take into account where infrastructure is built and how it should be designed and operated in light of exacerbated climate change threats. These could include additional works, as well as retro-fitting existing infrastructure. The Government and the operators of the city's key services will all need to consider what they need to do to adapt to climate change. Changes to patterns of fresh water availability in the longer-term also impact on water security and require forward planning and investment for adapting measures.

LANDSLIDES
Slope safety greatly strengthened

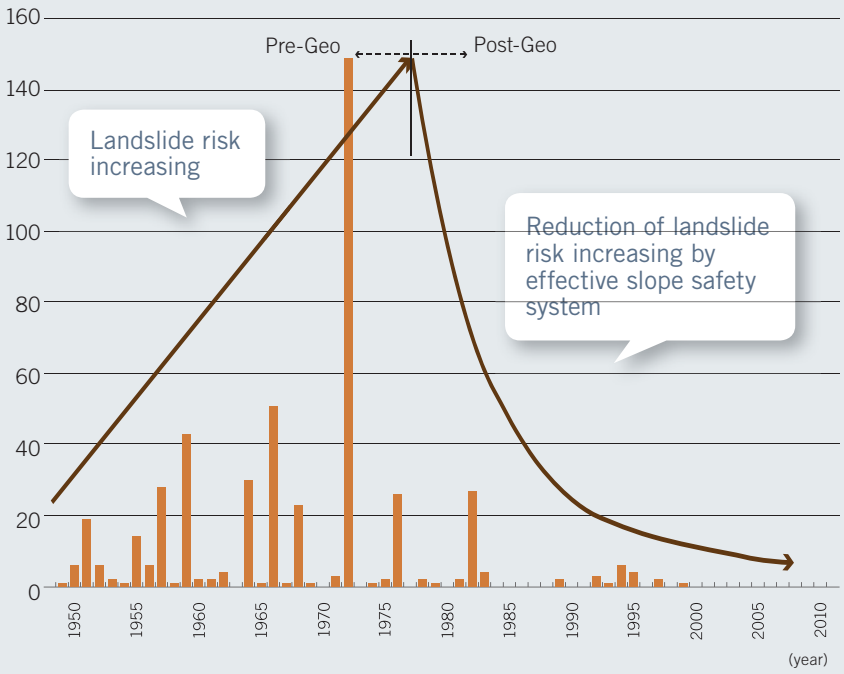
More than 60% of Hong Kong's land area is hilly terrain. Many urban developments are located on or near man-made slopes and hillside. The monsoon season and tropical cyclones can bring intense and prolonged rainfall, especially in spring and summer. Among the various impacts brought about by heavy rain, Hong Kong is prone to landslide hazards for its steep hilly terrain, tropically weathered soil mantle, manmade slopes and dense housing near hillside.

While most of the landslides are relatively small scale causing no or minor disruptions to the city, some landslide events in the past were highly destructive. Various catastrophes in the 1970s led to the creation of the Geotechnical Engineering Office (GEO) under CEDD to improve slope safety.[33] Since then, Hong Kong has invested substantially in slope identification, categorisation, risk assessment and protection, and is now a leader in the world in this area. The GEO has already improved more than 11,000 higher risk slopes and is now focussing on what may need to be done to another 17,000 slopes that are close to roads. Although landslides still occur, their scale and severity have been decreasing as indicated by the significant reduction in fatalities. Slopes on private land should be managed by the landowners.

Slopes in GEO's slope registry



Hong Kong landslide fatalities

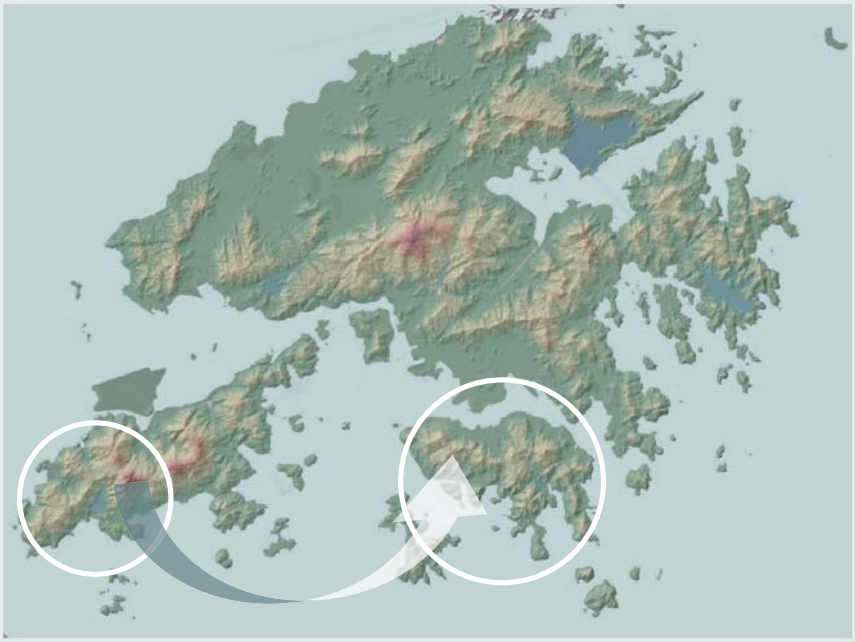


LANDSLIDES
Slope safety greatly strengthened (cont.)

Risk assessment requires us to consider worst-case scenarios. The GEO has considered two extreme rainfall scenarios – Scenario 1 assumed the extreme rainfall associated with the 7 June 2008 rainstorm would strike Hong Kong Island; and Scenario 2 assumed a rarer and even more severe rainfall event (assuming the extreme rainfall associated with Typhoon Morakot that hit Taiwan in 2009) would strike Hong Kong Island. Thus, Scenario 2 is still within the realm of possibility in light of the increasing scale, frequency and severity of extreme rainfalls brought about by climate change. The results of the assessment indicated that for Scenario 1, about 2,000 landslides could occur, some 200 to 300 of which would impact on buildings or roads. For Scenario 2, the assessment indicated that about 50,000 landslides could occur, some 4,000 to 9,000 of which could impact on buildings or roads.

If the extreme rainfall associated with the 7 June 2008 rainstorm were to strike Hong Kong Island, the existing landslide emergency system would be stretched to the limit. If a more extreme rainstorm, such as Scenario 2, were to hit Hong Kong Island, the very large number of landslides would completely overwhelm the capacity of the system. The solution lies with formulating an entirely different strategy, which will be discussed in Chapter 5.

Scenario 1: Near-miss event
(Transposing June 2008 rainstorm to strike Hong Kong Island)
1 in 1,000 years



Scenario 2: More extreme events
Transposing 2009 Typhoon Morakot rainstorm to strike Hong Kong Island with climate change effect projection to end of 2000's

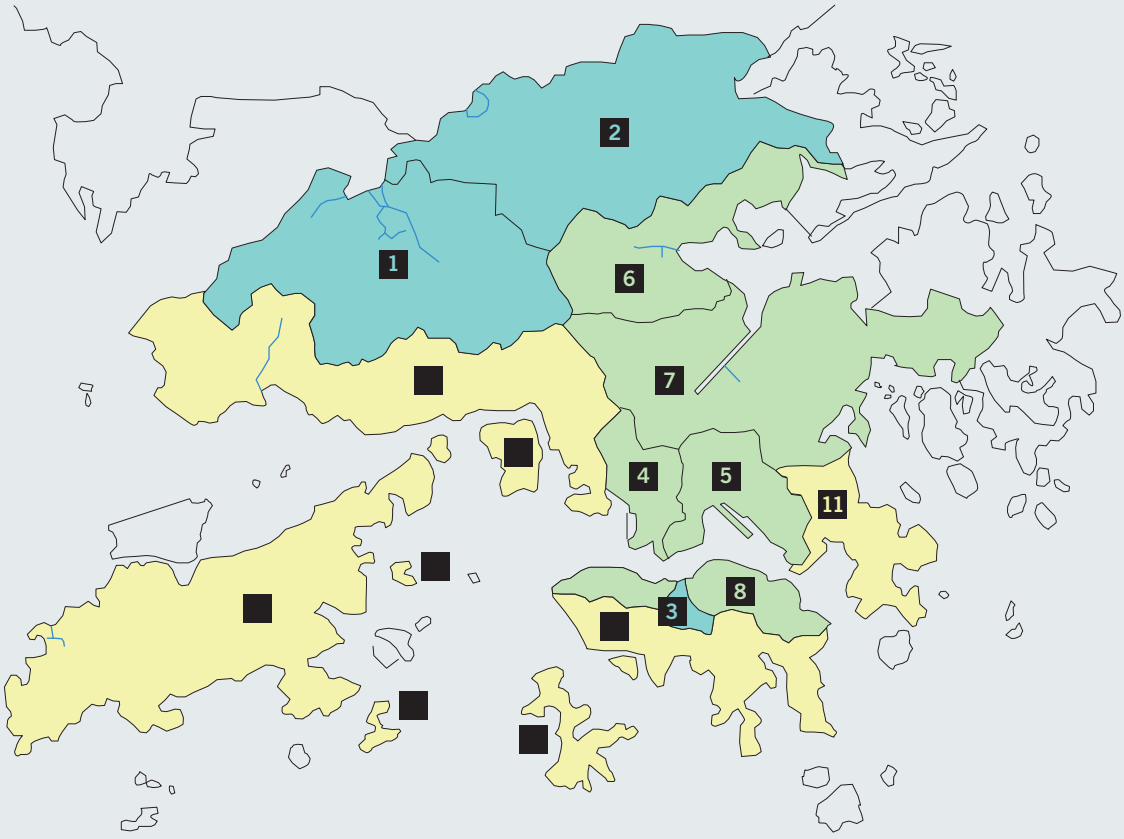
FLOOD PREVENTION

Substantial investments will continue to be made

Heavy downpour might overload the capacity of the stormwater drainage system and even cause landslides and landslip debris that can lead to blockage of the stormwater drainage system as a result. Over the past two decades, Drainage Services Department (DSD) had progressively completed the drainage master plan studies covering all the flood-prone areas in the whole territory, and the completed drainage improvement works have made substantial improvements to the drainage system. Since 2008, drainage master plan review studies have been started to identify further improvements to the drainage system with a view not just to enhancing the capacity of the system but also making the system more resilient in looming climate change. Up to now, drainage master plan review studies for 3 districts have been completed, 5 are on-going and the remaining 4 are under planning.

Since 1995, DSD has removed 121 flood prone black spots, thereby reducing the total number to 10 in 2015. Flooding in both urban and rural areas has not been particularly serious during rainstorms in recent years. Improvement works for the remaining flooding blackspots are being commissioned or planned.

Drainage Master Plan Review Studies
(On-going, since 2008)



Study areas:

Completed
1 Yuen Long
2 North District
3 Happy Valley

On-going
4 West Kowloon
5 East Kowloon
6 Tai Po
7 Shatin & Sai Kung
8 Northern Hong Kong Island

Planning
9 Lautau Island & Islands
10 Tsuen Wan, Tuen Mun & Tsing Yi
11 Tseung Kwan O
12 Southern Hong Kong Island

FLOOD PREVENTION
Substantial investments will continue to be made (cont.)

Revitalising water bodies

In the early years of urbanisation, most of the under-capacity rivers in Hong Kong were mainly channellised (i.e. paved over) with concrete as a quick flood relief measure without paying much attention to their design in the overall land use planning, not to mention combating the adverse effect arising from climate change. With higher public aspiration for a better living environment and growing concern about climate change, the concept of revitalising water bodies has been adopted in some selected drainage improvement projects as an adaptation measure.

The Government adopted revitalising water bodies in large-scale drainage improvement works and planning drainage networks for New Development Areas in the 2015 Policy Address. This approach will be further reinforced in future new town developments and drainage projects in Hong Kong.

In recent years, DSD has taken the lead to actively investigate the increased use of blue-green infrastructure in revitalising water bodies to further improve flood resilience. Blue-green infrastructure includes flood retention lakes, river revitalisation and other sustainable drainage systems, such as green roofs, porous pavements, rainwater harvesting systems, etc.

Revitalising water bodies has clear mitigation and adaptation benefits, including:

- Integrating water bodies with urban landscapes to reduce heat island effect;
- Turning "otherwise wasted" rainwater into useful resources;
- Improving urban living environment, harmonising human activity and nature;
- Increasing resilience against the flooding brought about by climate change; and
- Integrating drainage infrastructure with other land uses to improve carbon efficiency and reducing footprint.

Examples of revitalising water bodies

One of the early examples of revitalising water bodies in drainage improvement works is the Yuen Long Bypass Floodway. The bypass was constructed to mitigate flooding in the highly populated Yuen Long Town by intercepting runoff upstream in the urbanised area and route it through Kam Tin River, a rural downstream area. The intercepted runoff is diverted downstream through the bypass for discharge into the Deep Bay.

Instead of constructing a traditional concrete channel, the bypass was constructed as a green river channel, which incorporated a series of environmental designs. Bends, shallow ponds and engineered wetland were purposely included

FLOOD PREVENTION

Substantial investments will continue to be made (cont.)

in the river to attenuate flow and attract ecology. The river bed and riverbank are covered with different species of herbaceous plants to improve aesthetic and ecological value. The project included the construction of a 7 hectares engineered wetland, 3 ponds within the downstream channel, and planting of 13,000 trees, 140,000 shrubs and 550,000 herbaceous plants.

The engineered wetland has already developed into a habitat for wildlife since its completion in 2006. Continuous monitoring has shown a diverse range of species, including over 130 plant species and many species of birds, frogs, dragonflies and bats.

With the successful experience gained from previous river revitalisation projects, design and construction are now underway for revitalisation of more concrete-lined river channels, such as Kai Tak River, Tsui Ping River and Yuen Long Main Nullah. Taking the on-going Kai Tak River improvement project as an example, it is a concrete-lined river channel in an urban area with little ecological value and visually unpleasant. With the Kai Tak redevelopment, opportunity arises for revitalising the river channel to integrate with the redevelopment landscape. In addition to improving its flood protection capacity through reconstruction, the river is being revitalised into a green corridor with more special features, such as fish shelters, river bed boulders and extensive planting on the river bank.

The revitalised green river corridor will provide a leisure and sustainable environment for public enjoyment, and contribute to mitigating the urban heat island effect. This project is expected to be completed in 2017.

Mangrove management and multi-disciplined collaboration

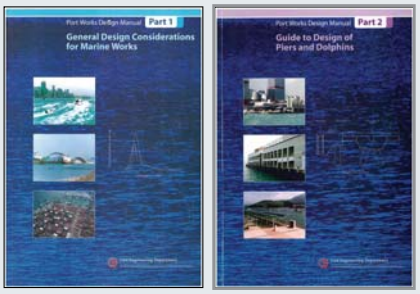
The Yuen Long and North District are mainly served by watercourses that include several rivers and the Tin Shui Wai Main Channel and together they serve the largest floodplain in the New Territories. Up until the recent past, significant expansion of mangrove habitat in Inner Deep Bay and the estuaries of inland rivers increased the flood risk of the area. Yet, the mangroves also represented a prominent feature of the Mai Po Ramsar Site with high ecological value and important to migrating birds. Thus, proper management of the mangrove habitat is also a priority. A mangrove management plan was developed to achieve the dual purposes of reducing flood risk and protecting habitat, which required multi-disciplinary collaboration between government departments (DSD, AFCD and EPD) and with non-government ecological experts.

COASTAL PROTECTION

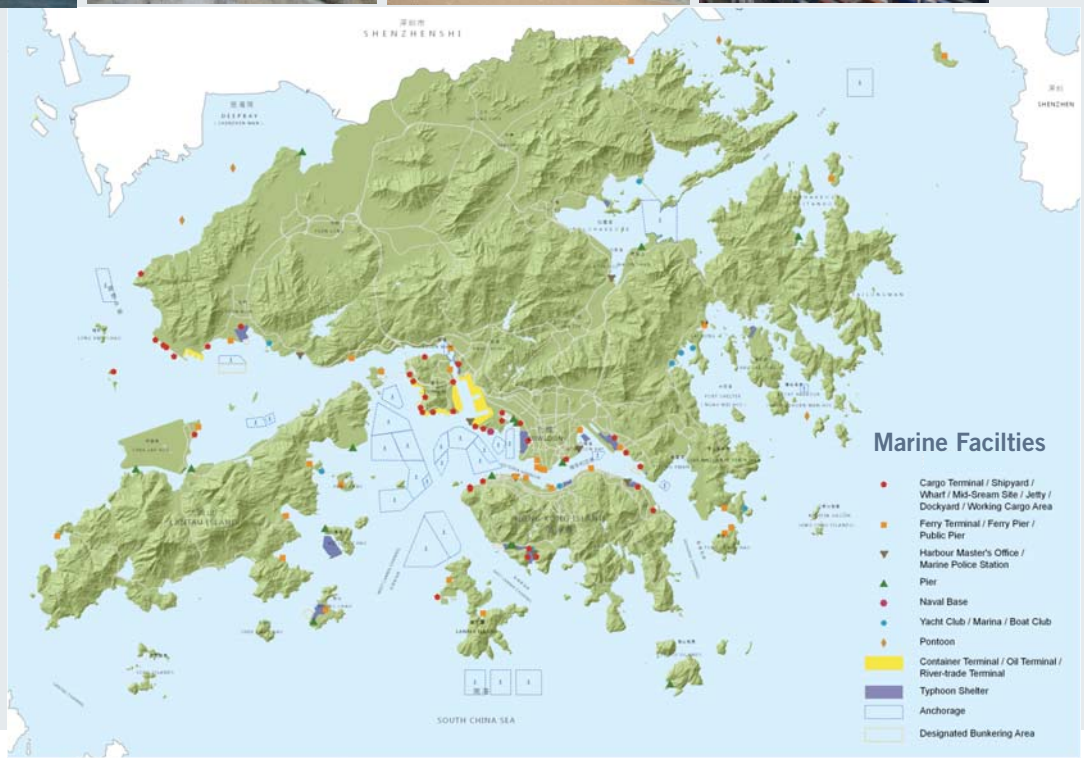
About 15% of Hong Kong's total land area is below mean sea level, and parts of these areas are pavements and densely populated. Coastal flooding may occur during rainstorms, storm surges and certain tidal conditions. Coastal flooding may also arise because of ground settlement and subsidence.[34]

Under the influence of climate change and rise in sea level, the frequency of occurrence of extreme sea level events and coastal flooding will likely increase. The wave height and wave loading experienced by coastal infrastructure may become more severe. In other words, Hong Kong can expect the risk of coastal flooding and also damage to coastal infrastructure to increase.

To understand the potential implications of climate change on coastal structures in Hong Kong and ascertain necessary updating of the current design standards, CEDD completed a study on Review of Studies on Climate Change and its Implications on the Design of Coastal Structures in June 2013 (based on IPCC AR4's assessments) for updating of the Port Works Design Manual. We are considering IPCC AR5's latest assessment and will update the Manual in due course.



As the adaptation approach is closely related to the on-going development of the issue on carbon reduction and other mitigation measures, we will remain vigilant on the latest prediction of sea level rise with reference to the Assessment Reports published by the IPCC at regular intervals and update the Port Works Design Manual as necessary.



WATER SECURITY

Hong Kong lacks fresh water resources. We have no natural lakes, rivers or substantial underground water sources. At the early stage of the city's development in the mid-20th century, the Government coped with the increasing water demand due to population and economic growth by constructing impounding reservoirs and designating about one-third of the land (300 km^2) as water gathering grounds. Today, Hong Kong has 17 impounding reservoirs with a total storage capacity of 586 million m^3 (mcm). Among them are the two reservoirs built in the sea – the Plover Cove and High Island reservoirs with a storage capacity of 230 mcm and 281 mcm respectively. In general, our reservoirs are maintained at a storage level equivalent to consumption of about 4 to 6 months.

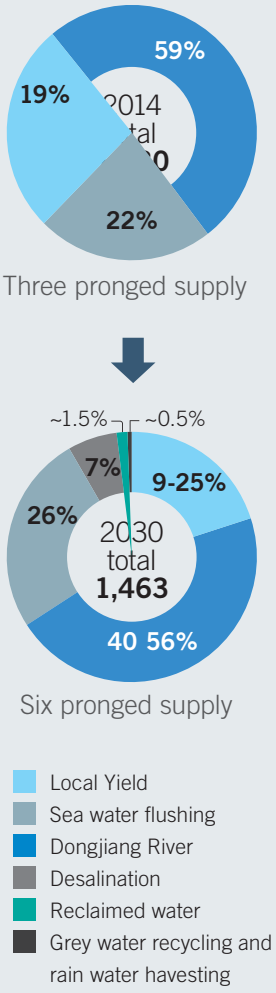
The local yield in Hong Kong varies significantly from 103 to 364 mcm in the past 20 years, which is far below our demand. We implemented an innovative scheme of using seawater for toilet flushing in the 1950s and required all buildings to be installed with a dual plumbing system. The seawater supply networks cover about 80% of the population in Hong Kong. It saves not only a huge amount of fresh water (about 280 mcm per year equivalent to about 30% of the annual total fresh water consumption of Hong Kong) but also saves electricity, as the seawater unit electricity consumption is about two-third of that for fresh water.

That aside, we have been importing raw water from the Dongjiang since 1965. Since 2006, our agreement with Guangdong Province adopts the "package deal lump sum" approach, which grants Hong Kong the right to import water up to a ceiling of 820 mcm per year. The actual quantity of imported water each year is dependent on Hong Kong's local yield and storage condition. This flexible approach enables us to secure a reliable supply of fresh water but avoid unnecessary wastage of water and pumping energy.

Thus, Hong Kong has three sources of water supply – local yield, seawater for flushing and imported water. In 2014, Hong Kong consumed a total of 1,230 mcm of water, of which 19% came from local water gathering grounds, 59% was imported and the remaining 22% was seawater for flushing.

We forecast that the current water supply arrangement is able to meet the long-term needs of Hong Kong beyond 2030. However, the risk of severe drought still exists and Hong Kong has to be prepared for the uncertainty. Moreover, drought events affecting Hong Kong will also affect the basin of the Dongjiang, which provides fresh water to Hong Kong as well as other major cities in the Pearl River Delta, including Guangzhou, Dongguan, and Shenzhen, serving altogether 40 million people.

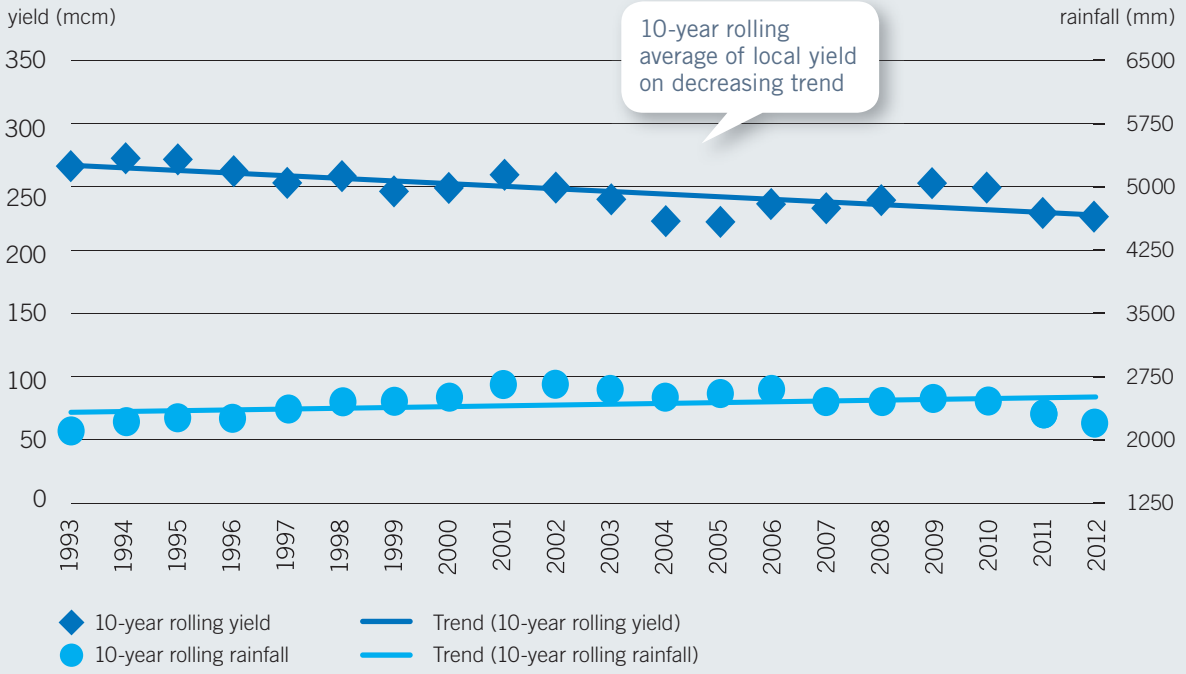
Water supply transformation from 2014 to 2030
(total consumption in mcm)



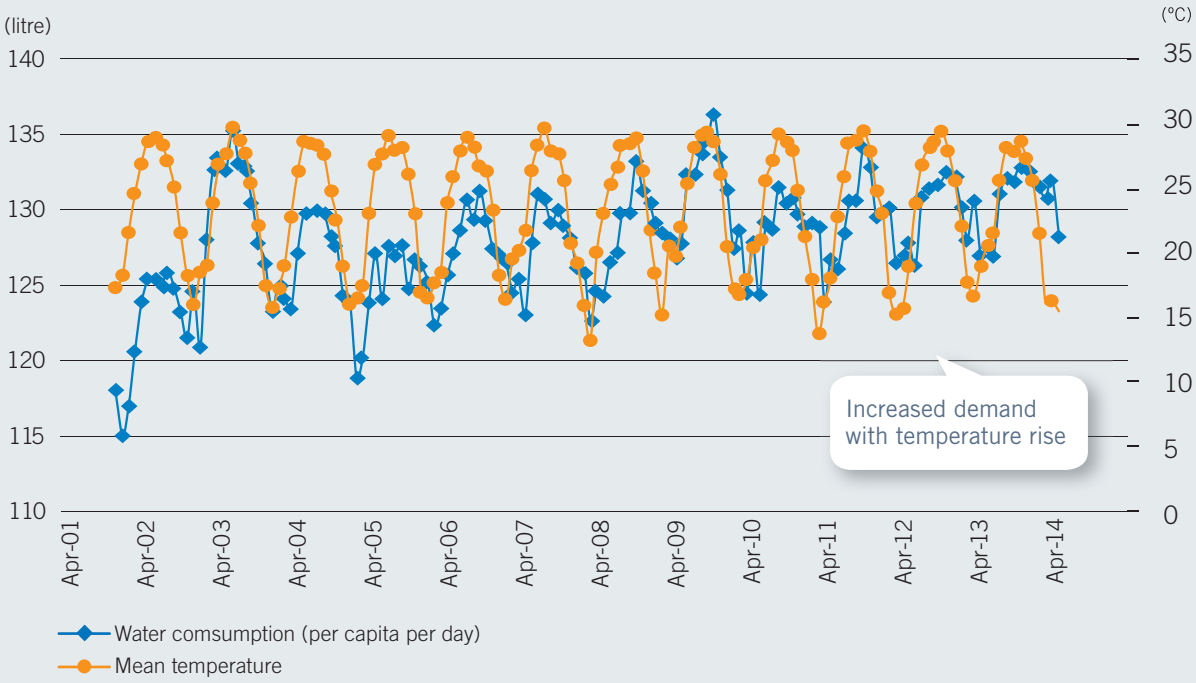
Since 2008, Hong Kong climate adaptation response has been embodied in the Total Water Management Strategy. Apart from campaigns to collaborate with many sectors of society to save water, the Water Supplies Department (WSD) is also exploring grey water recycling and reclaiming water for non-potable uses, seawater desalination for potable uses, and how to use local water resources more efficiently.

WATER SECURITY (cont.)

10-year rolling average yield and rainfall



Seasonal Variations in Water Consumption



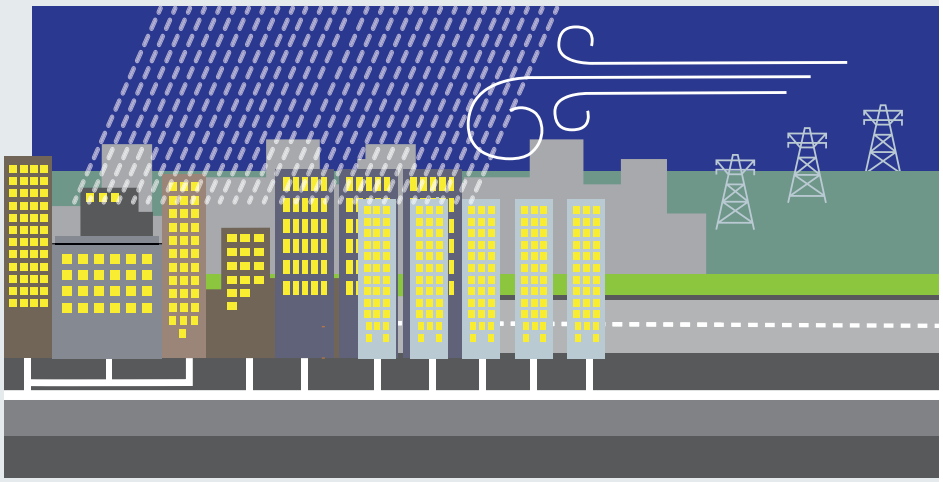
ROBUST ENERGY SYSTEMS

Losing power, even on a modest scale, in a city like Hong Kong can have serious consequences, and a large-scale power loss due to a weather event will lead to multiple failures. Thankfully, Hong Kong's electricity supply system is among the most resilient in the world. The two power companies and the town gas supplier conduct regular weather-related assessments and drills, particularly ahead of each year's typhoon season.

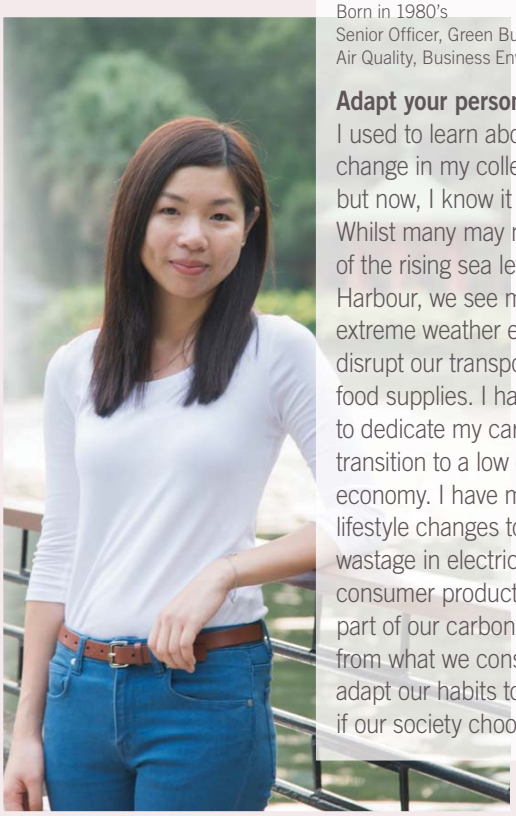
CLP Power Hong Kong (CLP) supplies electricity to residents in Kowloon and the New Territories, which is about 80% of Hong Kong's total population. The Hongkong Electric Company (HEC) provides electricity to Hong Kong Island and Lamma Island covering about 20% of the population. In CLP's case, more than 30% of its 400kV and 132kV network is carried through overhead lines while more than 700 transmission pylons form the backbone of its 400kV supply system. Since overhead lines are vulnerable to extreme weather events, the system design allows for an alternative pylon or supply circuit to maintain electricity supplies in the event of the failure of a pylon or a circuit. If a pylon is destroyed by strong winds or collapses because of a landslip, tower kits are available that can be assembled within a short time to bypass the damaged pylon. In HEC's case, it has been gradually phasing out overhead lines since 2012. Its transmission and distribution network now consists mainly of cable tunnels and underground power cables, which are unaffected by storms. Both companies have also deployed advanced cable diagnostic techniques to identify and replace weak components to reduce risk of failure.

Both CLP and HEC are concerned that climate change would increase the probability of local extreme temperatures, and escalate typhoon intensity that would affect sea levels. Both companies have reviewed the resilience of its generation, transmission and distribution systems against extreme weather phenomena. They have extreme weather proofing programmes, which include strengthening high risk building and pylon structures, installing smart switchgear, setting up flood prediction and prevention mechanisms, and enhancing equipment specification for higher operating temperatures. In addition, emergency procedures and a manpower mobilisation plan are in place, with regular drills to ensure adequate resources are available and prepared for such contingencies.

The Hong Kong and China Gas Company Limited (Towngas) has about 1.8 million households and businesses as its customers all over Hong Kong. In 2013, the company reviewed the robustness of its production plant to withstand the predicted higher frequency and intensity of severe storms and flooding. Various technical enhancements are being made; and weather-related emergency procedures have always been in place.



THEIR VOICES ON CLIMATE CHANGE

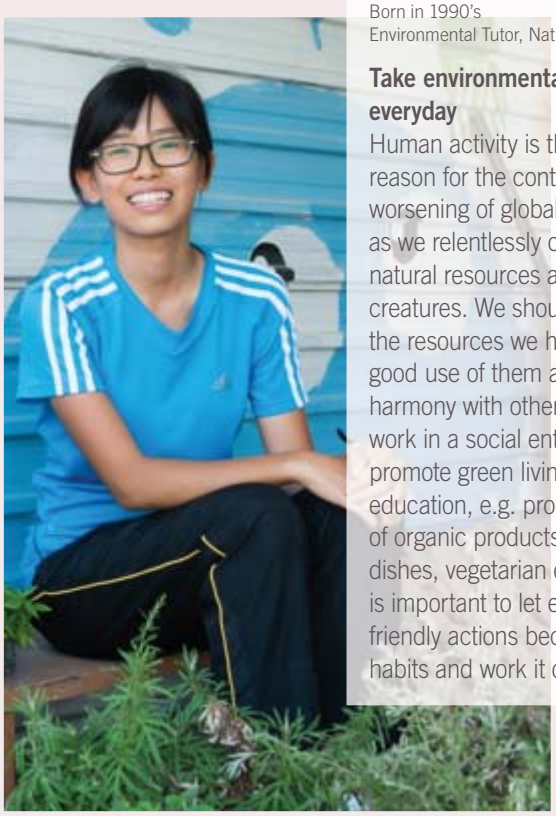


Danica Chan

Born in 1980's
Senior Officer, Green Building and Indoor Air Quality, Business Environment Council

Adapt your personal ways

I used to learn about climate change in my college textbooks, but now, I know it in daily life. Whilst many may not be aware of the rising sea level in Victoria Harbour, we see more and more extreme weather events which disrupt our transportation and food supplies. I have decided to dedicate my career to the transition to a low carbon economy. I have made personal lifestyle changes too, avoiding wastage in electricity and in consumer products, as a large part of our carbon emissions are from what we consume. We must adapt our habits to climate change if our society chooses to succeed.



Ann Yiu

Born in 1990's
Environmental Tutor, Natural Network

Take environmental actions everyday

Human activity is the vital reason for the continuous worsening of global warming, as we relentlessly consume natural resources among other creatures. We should treasure the resources we have, make good use of them and live in harmony with other animals. I work in a social enterprise to promote green living through education, e.g. promote the use of organic products for washing dishes, vegetarian eating etc. It is important to let environmental friendly actions become our habits and work it out everyday.

Johnny Lau

Born in 1980's
Researcher and activist, Hong Kong Agricultural Development Research Centre

Promote local agriculture; reduce food mileage and recycle food waste

Climate change is not only about the unbearable heat on streets, but also the droughts and floods that can devastate global food production. When many countries are concerned about possible food crisis as a result of climate change, Hong Kong should preserve our farmland, so we can reduce our carbon footprint from importing more and more food. I want to protect farmland by doing agricultural research and community projects. Local sustainable agriculture can reduce food mileage. We can also reduce and recycle food waste for a better world.

Apple Chui

Born in 1980's
PhD Candidate in Biology, Chinese University of Hong Kong

Protect ecosystems

Diving in Hong Kong is full of surprises, every time I dive, I might see something new. I made more than 800 dives in the last 7 years observing coral spawning, coral recruitment processes and changes in coral diversity around Hong Kong as part of my research. Although my experimental studies showed corals to be quite tolerant to environmental stresses, I cannot help but to think how much more they could tolerate with climate change. This drives me to study more about corals as nothing is going to get better unless we care and understand more about them.

THEIR VOICES ON CLIMATE CHANGE

Andy Lau

Born in 1980's
Assistant Vice President, Secretarial Services, Listing and Regulatory Affairs, Hong Kong Exchanges and Clearing Limited

Promote and develop a Low-Carbon Economy

Climate change is happening and its effects are not simply environmental but economic and social as well. The business community must share the common responsibility to tackle climate change. It is also vital for a company to take into account climate change risks and opportunities in its business strategy to pursue long-term sustainability. Companies should measure, monitor and report their GHG emission in order to understand and manage their climate resilience. Act now! Let's join hands and build a low-carbon economy for the next generation!

Shanice Kwan

Born in 1990's
Graduate Trainee, Securities and Futures Commission

Share and bond through green action

Climate change has started to create irreversible changes to the Earth, making lives more difficult for many people around the world. I believe we all have the responsibility and the ability to make an impact. I try to incorporate green practices in my daily life. I also participate in green events, such as tree planting and countryside and beach clean-ups. I learn more about the environment through these activities, and I can also enjoy them together with friends and family, which also strengthens our bond with each other.

Jayesh Peswani

Born in 1980's
Manager - Assurance, Financial Services Practice, Pricewaterhousecoopers

Invest in our common future

I believe everyone has to play their part in making society more sustainable. Being born, raised and working in Hong Kong, I can do something here; and also be a part of the change in Asia. To date, I have co-edited a recent trade association publication for real estate funds, which discussed the greater role of ESG analysis and reporting in the industry. Furthermore, I am interested in responsible investing, which I see as a growth industry worldwide.

Monica Leshan Woll

Born in 1980's
Associate, Hong Kong Exchanges and Clearing Limited

Live the talk

I grew up in Hong Kong. Climate change has been an important issue to me since my years as an undergraduate student at Princeton University, where I wrote my thesis on climate change with a particular focus on the impact that such issues can have on business. In my professional life, I have had the opportunity to build on this interest through my involvement in HKEx's ESG initiatives. By studying climate change in my studies and now my work, I have become more attuned to how my behaviour can impact the environment, so I strive to minimise my carbon footprint in any way I can – from taking public transportation, to reducing my water and electricity consumption.

5 STRENGTHENING CLIMATE RESILIENCE

The concept of resilience includes the capacity for communities and even individuals to cope and grow in the face of stresses and shocks through change when conditions require it.[35] Empowering people and institutions to act is important in building resilience capacity since it requires shared action and responsibility at multiple levels.

Obviously, resilient responses start with surviving and coping with extreme weather events. However, a more fulsome response includes adapting our hard infrastructure (which has been discussed in the previous chapter) and long-term transformation and empowerment in how we plan and design our systems, and even our way of life so that we can achieve low-carbon living. Thus, becoming climate resilient also helps a community to gain greater capacity and capability in climate mitigation, as well as build social cohesion. This chapter focusses on resilience-building as an on-going process that enables that transformation in Hong Kong to take place.

While Hong Kong already has good resilience to severe weather events, consideration and planning across the Government can be improved to deal with the likelihood of more frequent extreme weather events. The key is for the decision-making and review process to be better joined-up across departments, including cross-boundary collaboration with the authorities in the Pearl River Delta since strengthening the resilience of the entire geographical neighbourhood is in the interest of all.

Therefore, we can continue to evolve better coordination to identify and prioritise the risks and opportunities associated with extreme weather, implement measures to address them, carry out occasional drills on extreme weather preparedness, set-up monitoring arrangements, periodically assess the effectiveness of the measures, evaluate progress and readjust where necessary.

Contingency planning for natural disasters

As Hong Kong has a sub-tropical climate and is occasionally affected by tropical cyclones and heavy rain, we have longstanding and effective plans to deal with severe weather events that the community is used to facing. Hong Kong's Contingency Plan for Natural Disasters is coordinated

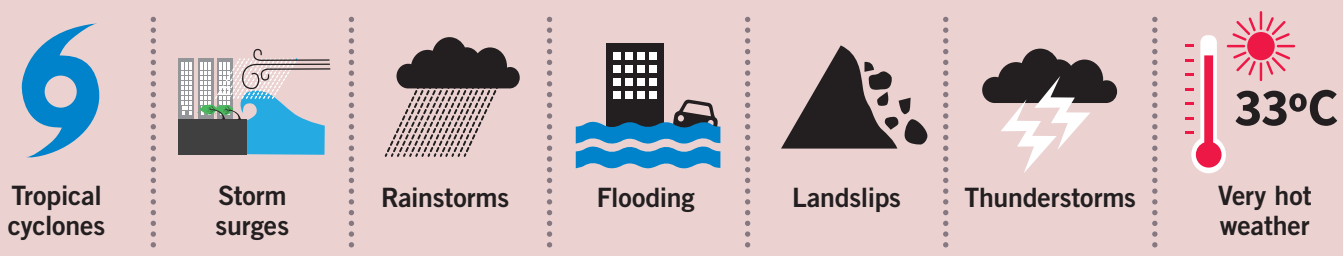
by SB's Emergency Support Unit. This is a detailed plan setting out the Government's various alert and warning systems and organisational framework for responding to extreme weather conditions and disruptions caused by extreme heat, rain, landslides and floods and other incidents giving rise to casualties and damage. Apart from internal coordination, the plan includes coordination with non-government stakeholders that provide a range of essential services to the public.

For the financial services sector, the financial regulators under the purview of the Financial Services and the Treasury Bureau have also put in place procedures, guidelines and continuity plans to cater for emergency circumstances including incidents caused by extreme weather events. For example, periodic practice drills are carried out; and HEC conducts drills with key institutions, such as Hong Kong Exchanges and Clearing Limited (HKEx).

Increasing Hong Kong's response capability in disasters and emergencies

Hong Kong's knowledge for handling a disaster and emergency benefits from the setting-up of the Hong Kong Jockey Club Disaster Preparedness and Response Institute in 2014. Led by the Hong Kong Academy of Medicine in collaboration with the medical schools of The University of Hong Kong and The Chinese University of Hong Kong, and supported by international experts, the institute trains healthcare professionals, teachers, community workers and the public with a view to establish the city as a regional hub for disaster preparedness and response training. It is the first of its kind in Asia.

WARNINGS AND ALERT SYSTEMS
to extreme weather connected to climate change impact



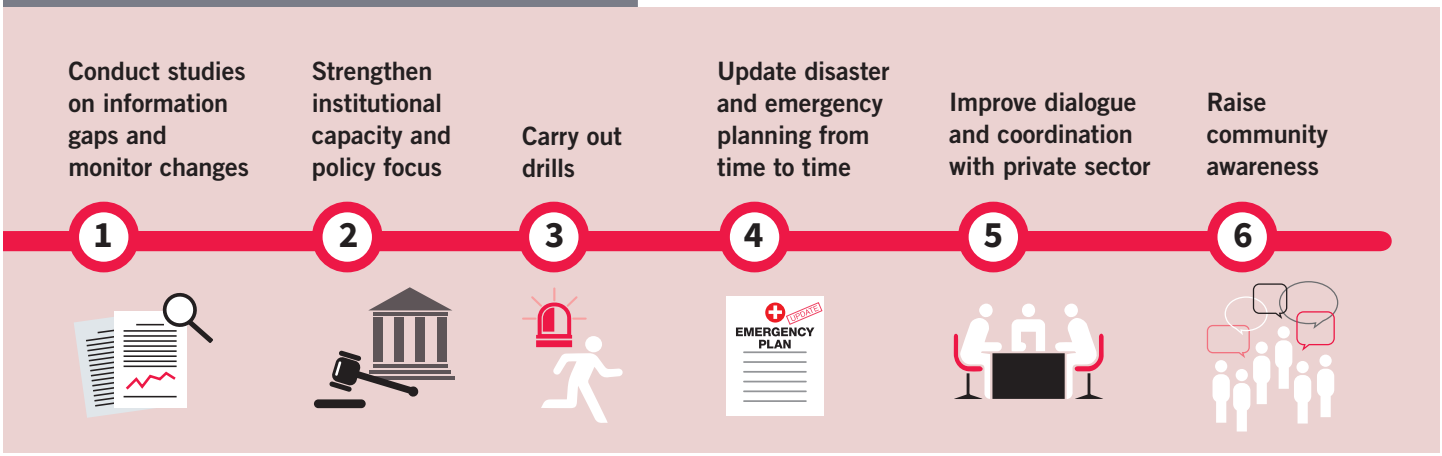
Government Departments
Multiple departments with responsibilities and coordination for:

- Information
- Recovery
- Rescue
- Restoration

Non-governmental Organisations
Multiple organisations are responsible for transmitting information and coordinating with government departments on essential services:

- Media
- Cross-boundary ferry operators
- Power suppliers
- Airport and airline operators
- Transport operators
- Schools
- Tunnels operators
- NGOs e.g. Red Cross, Oxfam
- Port and terminal operators

PATH TO STRENGTHEN RESILIENCE



Strengthening contingency planning

Various government departments already have plans for enhanced resilience in light of climate change. The following are the most relevant examples.

Climate-weather related communication

A key component of preparedness is to have a good communication system that can inform all sectors of society about the onslaught of an extreme weather event. Hong Kong has a longstanding and well-

respected public alert system of severe weather conditions provided by HKO. Currently, various government departments are responsible for their own public awareness raising campaigns. The Government may review its public communication strategy as a whole to inculcate a higher appreciation among residents of the various extreme weather risks, such as how to protect themselves from the danger of landslides, storm surges, swells and floods during stormy weather, as well as various health-related risks associated with high temperatures.

Landslide risk

As noted in the previous chapter, while Hong Kong's slope safety management system has been performing well in reducing landslide risk and in supporting the development of the city, there are new challenges in facing the extreme landslide hazards that may be brought about by climate change. It is neither practical nor cost-effective to rely solely on engineering solutions to manage the risk of extreme rainfall. 'Soft' measures involving enhanced emergency preparedness, response and

Impact of higher temperatures

Vulnerable groups

HKO has developed a Hong Kong Heat Index as a reference for assessing the severity of extreme heat by different user groups; and is also collaborating with various stakeholders, such as the Chinese University of Hong Kong and the Senior Citizen Home Safety Association, to study the effect of climate on public health and vulnerable groups, such as influenza activity in relation to weather conditions and the impact of extreme temperatures on the help-seeking behaviour of the elderly.

Outdoor workers

Heat stress may adversely affect the health of outdoor workers, and employers have the responsibility to adopt effective preventive measures to safeguard the safety and health of workers at work in light of the likelihood of Hong Kong facing higher temperatures. Indeed, some employers, who are also key stakeholders, such as CLP and MTR Corporation Limited, have highlighted the greater difficulty to recruit and keep workers who have to work outdoors and under difficult weather-related conditions. As an example, significant heat stress parameters have been established in CLP such that workers are equipped with the proper measures to avoid heat stress. These measures include increased water usage (based upon the heat parameters), increased shelters and enhanced cooling stations in power generation facilities.

Tenants in public housing and low-income accommodation

HKHA designs its public housing developments in compliance with the requirements of the Residential Thermal Transfer Values (RTTV) of building envelopes and natural ventilation, as well as promoting green roofing, vertical and

Impact of higher temperatures (cont.)

community greening in order to reduce urban heat island effect. HKHA, as the developer of public housing, has a policy to work towards 'BEAM Plus Ready' for all new public housing developments from 2015-16 with the potential to achieve the performance equivalent to at least BEAM Plus Gold.

Public rental housing in Hong Kong is well-maintained and relevant arrangements are in place to handle various emergencies, which is not necessarily the case for some private sector buildings with low-income accommodation. We recognise that tenants in these private buildings may be disproportionately affected under extreme weather conditions, ranging from very hot days to stormy days although it is beyond the ambit of this document to discuss building repairs and maintenance of private buildings. Indeed, Home Affairs Department (HAD) provides city-wide emergency relief services where necessary, such as temporary

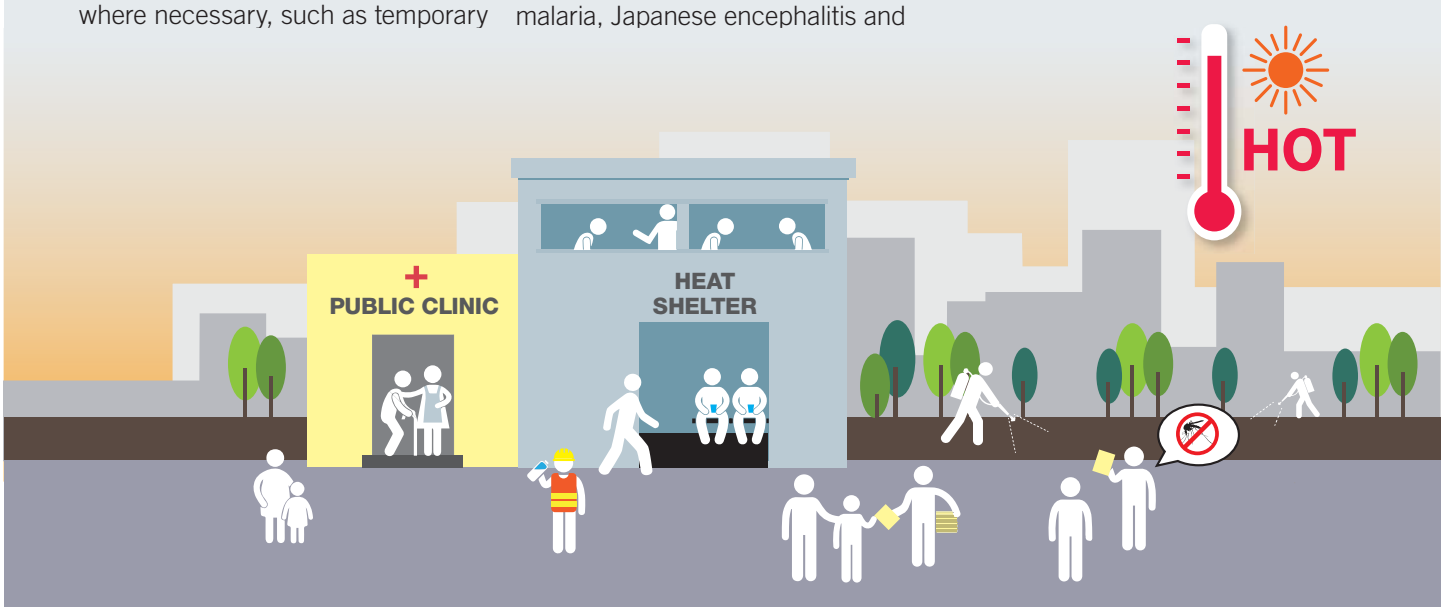
Risk of infectious disease

Warming and more extreme weather is having an impact on infectious diseases, their vectors and hosts. Climate change may affect the transmission and geographical range of various vector-borne diseases. Diseases carried by mosquitoes are particularly sensitive to meteorological conditions – warmer temperature shortens the life cycle, increases their biting activity, shortens the overwintering period and the rate at which pathogen mature within them.

There has been an average rise of 0.15°C per decade from 1947 to 2014. An example of the challenges Hong Kong faces is dengue fever. The Aedes mosquito vector of dengue is highly sensitive to climate conditions; and various parts of sub-tropical and even temperate East Asia is seeing a rise in dengue fever over the last few years. Other similar diseases that could affect Hong Kong as a result of warming include malaria, Japanese encephalitis and

While the Department of Health (DH) already has well-established public health information and surveillance systems, the Food and Environmental Hygiene Department (FEHD) is dealing with vector control (such as mosquito and rodents), and the Centre for Food Safety's surveys microbiological hazards at the import, wholesale and retail levels for food, specific focus will need to be given to the challenge of climate change with respect to public health and for efforts to be well-coordinated. The Food and Health Bureau (FHB) would consider improving where necessary:

- Surveillance and response capacity;
- Risks prediction through integrating surveillance into long-term terrestrial and marine monitoring programmes and raising capability in ecological epidemiology; and
- Clinical care and public health services.



recovery must be in place in addition to the engineering approach. Under extreme event Scenario 2 (see page 64), the current landslide emergency system will break down. Resilience to landslides under extreme rainfall conditions needs to be enhanced.

CEDD has been developing a new strategy for managing landslide emergency, in partnership with other government departments. Part of the strategy is to step up public education and communication to enhance community resilience against extreme landslide hazards. Measures will be taken to engage the public for community support, education and preparedness and to promote self-protection and neighbourhood support. Public messages are being formulated to inform the public about how the dangers of extreme weather can be avoided so that the community can recover more quickly afterwards.

Urban trees risk

As trees are living organisms, its health and structural conditions will change over time. A range of environmental factors also contribute to the health of trees. The government has been actively engaged in the effective management of our urban trees. The strategy includes a risk management approach to assess, maintain and monitor a key urban asset.

Storm and Flood Risk

Government alerts already attempt to inform the public to avoid going near the shore and beaches during stormy weather. Government advertisements remind the public to stay away from watercourse and stay indoors during rainstorm warning and typhoon signals. However, some members of the public use such occasions to swim and surf, which is highly risky. Emergency planning from relevant departments is required, including stationing of staff at high risk area, such as beaches, during adverse weather condition.

As for floods, DSD has already operated gauging stations at major rivers, channels and flood-prone low-lying areas to monitor water levels at all times and provided flood warning at four locations.

In September 2008, Tai O experienced significant flooding due to storm surges induced by Typhoon Hagupit. The contingency planning for Tai O was reassessed and improved. An early alerting system, emergency relief

Demountable flood barrier at Tai O

and services for serious flooding in Tai O was established in 2009 to alert residents and relevant departments to mobilize their resources for the evacuation and relief efforts. CEDD carried out flood proofing works; DSD improved drainage; PlanD designed the Tai O Revitalisation Plan; and HKO has an arrangement to release mobile text-message warnings about 5 hours in advance of potential flood specifically to relevant officials and rural representatives so that they can be prepared for evacuation. HAD also runs emergency evacuation practices once every two years with multiple departments so that they become familiar with what to do when facing a real event. The Social Welfare Department (SWD) has specifically identified the homes of the older members of the Tai O community to ensure they will get the assistance needed. The Police have maintained a database on the elderly residents in Tai O to facilitate police rescue actions during emergency relief and serious flooding in Tai O.

In addition, DSD, HKO and HAD have jointly established early storm surge alert systems for five low-lying areas prone to sea flooding. HKO will issue storm surge alert message to DSD, HAD and other relevant government departments when the sea levels are forecast to reach the trigger levels at respective locations. Upon receipt of the alert, DSD will arrange mitigation measures, if necessary, based on the local need to alleviate the impact of flooding to the local residents, and HAD will inform relevant representatives so that residents can take flood preventive measures.

In light of the Tai O experience, similar plans and collaboration among government departments and the local communities of the other flood-prone areas may be assessed with the aim of putting them in place in due course. This will lead to Hong Kong having a set of similar flood management plans for the vulnerable communities.

Drought risk

In addition to the measures put in place in the 1950s and 1960s as detailed on page 69 to enhance water security, the Government's Total Water Management Strategy, promulgated since 2008 and implemented by WSD, helps to deal with drought risk and enhance Hong Kong's resilience to climate change. The strategies aim at containing less growth

of water demand and developing new water resources not susceptible to climate change. The former is driven through various water conservation measures and expansion of seawater supply networks for flushing to increase its coverage from the current 80% to 85% of the population (infrastructure for extending supply network to Pokfulum and Northwest New Territories is already completed and these areas are being converted to seawater flushing) and a 15-year large-scale replacement and rehabilitation of aged water mains programme (anticipated to be largely completed by the end of 2015) to improve network performance and reduce the water mains leakage rate from over 25% in 2000 to 15% in 2015. WSD will also progressively establish the Water Intelligent Network by installation of sensors at the water supply networks for setting up District Metering Areas (DMAs) for continuous monitoring of their conditions.

As for the development of new water resources, WSD is collaborating with engineering experts to develop ways that are less susceptible to climate change, such as seawater desalination and water reclamation. The planning and investigation study for the construction of desalination plant in Tseung Kwan O has been largely completed and detailed design is about to begin. The desalination plant expected is to be commissioned in 2020 with an initial annual output of 50 mcm, which can be increased to 100 mcm when need arises.

With regard to water reclamation, WSD has completed technical studies, including water quality standard and pilot test for production of reclaimed water using the treated effluent of the Shek Wu Hui sewage treatment works for flushing and other non-potable uses in the north-eastern part of New Territories. WSD has also started the planning of infrastructure and it is studying the financial and legal aspects of supplying reclaimed water to the public. The target is to supply reclaimed water starting from 2022. The estimated amount of fresh water that can be saved by supplying reclaimed water to the north-eastern part of the New Territories is about 21 mcm per year.

As for grey water recycling and rainwater harvesting, WSD has established corresponding technical and water quality standards and provided detailed guidelines on the use of recycled grey water in government buildings. WSD is currently collaborating with other government departments on a plan to implement grey water recycling in a new residential area.

Water saving campaigns

Since 2009, WSD has launched a series of programmes targeting young people to promote water conservations. These include school water audits, roadshows and Water Conservation Ambassadors Selection Scheme in primary schools to help the schools establish effective water conservation practices, encourage students to help conserve water and relay the message to their peers and family members. In 2012, WSD set up a temporary Water Resources Education Centre to enhance the younger generation's knowledge about water conservation. WSD has commenced the planning and design of a permanent Water Resources Education Centre at Tin Shui Wai, which is expected to be opened in 2018.

Since 2013, WSD has extended its water saving campaign to the community by roving exhibitions and mobile showrooms at shopping malls and housing estates. In March 2014, WSD started the "Let's Save 10L Water" campaign to encourage the public to reduce daily water consumption by 10 litres per capita. Each participating household receives a pair of complimentary flow controllers for taps to help conserve water. Over 138,000 households have received flow controllers and the scheme is still open for application. Furthermore, in collaboration with the Housing Department and Housing Society, WSD commenced a pilot project in August 2014 to install flow controllers in 16 selected public rental housing estates with a target of about 25,000 households. Up to July 2015, WSD had installed flow controllers in 24,200 households under the pilot project, reaching 97% of the target.

For non-domestic users, WSD completed retrofitting works to replace about 51,500 plumbing appurtenances with water saving devices in about 630 government venues and schools. WSD has also commenced a plan to install about 100,000 flow controllers to existing taps and showers in other government facilities and schools. WSD has also been carrying out water efficiency audits and developing best water-using guidelines for selected government facilities and high water-consuming commercial trades, such as catering, hotels, laundries, etc.

To help water users to save water, WSD established the voluntary Water Efficiency Labelling Scheme (WELS) in 2009, which now covers bathing showers, water taps, washing machines, urinal equipment and flow controllers for showers and tap. WSD will conduct study to extend WELS to cover dual flush water cisterns as well. WELS helps consumers to consider the water efficiency of appliances and equipment when they make purchases. To take WELS a step forward in the near future, WSD plans to mandate the use of WELS products in all new developments and existing premises undergoing major renovation.

WSD is also planning a number of new water conservation initiatives, including the Water Conservation Integrated Education Programme (IEP) for primary schools and the Water Conservation Week. The IEP aimed to develop a tailor-made education kit for primary school studies and train the teachers of participating schools to use the kit to facilitate pupils' in-depth learning on water conservation. The Water Conservation Week would comprise a host of activities such as exhibition, conference, workshop, carnival, etc., in which WSD will join hands with stakeholders in different sectors to promote water conservation to different target groups and the community at large.

Left: Launching Ceremony of "Let's Save 10L Water" Campaign

Right: Students' Visit to Water Resources Education Centre

Inter-Reservoirs Transfer Scheme (IRTS) – dual purposes on flood control and water conservation

At present, rainfall in the upstream catchment of West Kowloon is intercepted and conveyed to the Kowloon Group of Reservoirs. When these reservoirs are full, excess rainwater will overflow to the sea through the existing drainage system in the downstream urban areas. Such overflow not only increases the flooding risk in the downstream areas but also waste precious water.

To alleviate the flooding risk and conserve water, DSD and WSD have proposed the IRTS. The scheme comprises the construction of a 2.8km long and 3m diameter water tunnel to convey surplus water from the Kowloon Group of Reservoirs to the Lower Shing Mun Reservoir from which water can be conveyed to the Sha Tin Water Treatment Works, thereby conserving about 2.5 mcm of water a year. Such an innovative scheme, with a holistic consideration of both flood control and water conservation improves the resilience of our urban built environment in the light of the looming climate change challenges.

Further efforts to strengthen overall resilience

Sea level rise

With continuous thermal expansion of the oceans due to global warming and the accelerating melting of glaciers, the global, as well as local sea level rise is likely to lean towards the high side of the current projections. This calls for the need to determine the type of coastal defensive infrastructure that will be necessary, whether and where the existing infrastructure will need to be retrofitted or relocated, and how to deal with the future planning of the coastal areas.

Biodiversity, nature conservation and general greening policies

Climate change is likely to become one of the most significant drivers of biodiversity loss worldwide by the end of the century. The rate and magnitude of climate change induced by a rapid rise in GHG emissions affect biodiversity either directly or in combination with other drivers of change. Climate change is already forcing biodiversity to adapt either through shifting habitat, changing life cycles, or the development of new physical traits. Conserving natural terrestrial, freshwater and marine ecosystems and restoring degraded ecosystems are goals of both the UNFCCC and the UN's Convention on Biological Diversity (CBD) because ecosystems play a key role in the global carbon cycle and in adapting to climate change, while also providing a wide range of ecosystem services

that are essential for human well-being. Biodiversity also supports efforts to reduce the negative effects of climate change. For example, conserved or restored habitats can remove CO_2 from the atmosphere.[36] The CBD promotes the implementation of approaches for adaptation, which includes the sustainable management, conservation and restoration of ecosystems, as part of an overall adaptation strategy.

Since the 1970s, Hong Kong has set aside large tracks of land for protection as country parks and special areas (about 40% of the total area). Today the total stands at 44,300 hectares. Under our overall greening policy as described in Chapter 3, we are also planting more native trees and seedlings in appropriate areas in the countryside and urban areas. Furthermore, in more recent years, marine parks and a marine reserve have also been created and protected by law. These efforts protect natural habitats that help to maintain ecosystem services and ecological linkage, hence strengthening the resilience of ecosystems to climate change.

Developing a city-level Biodiversity Strategy and Action Plan 2016-2021

Hong Kong is taking a comprehensive view of protecting biodiversity. China, as a contracting party to the CBD, extended it to Hong Kong on 9 May 2011. In our role as a city of China, it is our duty to assist the Central People's Government in fulfilling her obligation under the Convention. At the same time, we wish to contribute to China's national Biodiversity Strategy and Action Plan (BSAP) by formulating the first locally-relevant, city-based BSAP for implementation from 2016-21.

We established a BSAP Steering Committee in 2013, consisting of government and non-government members, to advise the Government on Hong Kong's first BSAP. As part of the process, existing knowledge on the vulnerability of local habitats and wildlife to climate change has been reviewed to identify vulnerable areas. Some categories of habitats, such as coastal habitats, forests and streams, are deemed to be sensitive to climate change but there are many information gaps about their vulnerability. It was agreed that the priority is to substantiate our knowledge through conducting surveys and studies, with a view to supporting decision-making and prioritisation of biodiversity management and planning.

Sustainable agriculture development

The FHB is considering a more proactive policy towards the modernisation and sustainable development of local agriculture, and recognises that it could help to diversify our local food supply, enhance its productivity, meet the market demand for domestically grown produce, create job opportunities, as well as help to reduce Hong Kong carbon footprint in the food supply chain.

Financial services

While the subject of financial services and climate change is a major topic and beyond the ambit of this document, we wish to highlight why it is important and the Government's efforts to date.

The climate change challenge to the financial services sector may be seen from three perspectives:

- The first relates to emergency preparedness, such as the closure of banking business when there is a weather-related emergency (e.g. Typhoon Signal Number 8 is hoisted); and also how banking and financial services institutions may need to protect their assets in light of weather-related risks;

- The second relates to the changing business environment, as the world prepares to meet the climate challenge through investing in mitigation, particularly in clean energy infrastructure, environmental clean-ups and sustainable development; and

- The third relates to insurance since it is an important risk management business that can facilitate adaptation to climate change and shore up sustainable development.

Carbon Footprint Repository for Hong Kong Listed Companies Launching Ceremony

The subject of climate change is relatively new to the financial services sector. We note the important effort of the HKEx since 2012 to promote Environment, Social and Governance (ESG) Reporting.[37] We collaborated with the Business Environment Council (BEC) in March 2013 to organise a climate change adaptation workshop for the business sector, where financial services and insurance were included. In 2014, we collaborated with HKEx to launch our Carbon Footprint Repository for Listed Companies in Hong Kong, which enables listed companies to disclose their carbon footprints as a result of their business operations and share successful stories on carbon management and practices.[38] As the subject of the role of financial services in meeting the challenge of climate change and sustainable development has become

an increasingly important topic of discussion worldwide, the Government's Financial Services Development Council (FSDC) formed a Working Group on Green Finance in April 2015 to examine the issues relevant to Hong Kong and consider measures that can be pursued by the local financial industry to help manage the risks and repercussions of climate change.

Multi-sector dialogue

We have described many of the efforts of government departments in climate-related work, including public education and stakeholder collaboration. Some of the key private sector stakeholders are already paying serious attention to meeting the challenge of climate change. We have already highlighted some of the key aspects of the thinking and action of some sectors in previous chapters. As resilience depends on stakeholders taking both anticipatory and reactive decisions and actions, good communication and coordination are vital. To build resilience, communication and coordination needs to take place within a sector, among several sectors and also across sectors, as well as on a district level in affected areas. This kind of dialogue and long-term collaboration helps to build social cohesion, which we very much value. We are grateful to those stakeholders who have contributed to this report.

Regional collaboration on climate change

In August 2011, Hong Kong and Guangdong Province agreed to set up the Hong Kong/Guangdong Joint Liaison Group on Combating Climate Change (JLGCCC) under the Hong Kong/Guangdong Co-operation Joint Conference (HKGDCJC), which is the primary cooperation platform between the two sides. The JLGCCC was set-up in May 2012 and is led jointly by Environment Bureau of the HKSARG and Development and Reform Commission of Guangdong Province.

Under the establishment of the JLGCCC, an Adaptation Working Group and a Mitigation Working Group have been set up and various seminars and workshops on climate change-related topics were jointly organised for government departments and the public. These included seminars on RE and EVs in 2012, a workshop on climate change adaptation for the financial services sector in 2013, and a seminar on energy saving in buildings.

The JLGCCC meets annually to review the collaboration of the two sides and to agree on a work plan for the next year. In 2015-16, Hong Kong and Guangdong will carry out further exchanges on climate projections, urban drainage system design and slope safety management. Workshops on measurement, reporting and verification (MRV) of carbon mitigation measures will be organised.

Hong Kong's participation in international dialogue on climate change

The Government participates in a variety of climate change-related dialogue at the internationally level. As Hong Kong is a part of the People's Republic of China, Hong Kong participates at the UNFCCC climate discussions as part of the Chinese delegation.

On climate change science, HKO participates in international gatherings, including at the IPCC, which is the UN's scientific intergovernmental body established by the UN's World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), and at the Intergovernmental Board on Climate Services (IBCS) established by the WMO. The IBCS is to support the implementation of the Global Framework for Climate Services (GFCS) to enable better management of the risks of climate variability and change and adaptation to climate change, through the development and incorporation of science-based climate information and prediction into planning, policy and practice on the global, regional and national scale.

Various government Bureaux and Departments also participate in international gathering on specific issues that are relevant to climate change, such as energy, energy efficiency, green building, urban planning, transportation, waste management, biodiversity and ecology, public health, water issues, flood control, coastal protection, slope protection, emergency preparedness, financial services etc. For example, DevB led a large delegation of government and non-government experts to attend the World Sustainable Built Environment Conference in Barcelona in 2014.

Hong Kong is also a member of C40 and a member of its Steering Committee. We have also joined four of the C40 networks to exchange experience on specific subjects. These networks are on Connecting Delta Cities, Private Building Efficiency, Low Emission Vehicles and Sustainable Solid Waste Systems.

Our universities, professional associations and other non-government bodies are also organising international climate change gatherings in Hong Kong. Two recent examples are the 3rd International Conference on Climate Change in November 2014 on *Urban Adaptation to Climate Change*; and the 4th Nobel Laureates Symposium on Global Sustainability in April 2015 on *Changing Climate, Changing Cities*, which resulted in the Nobel Laureates Hong Kong Memorandum.[39] In both cases, the Government was a supporting organisation.

The World Green Building Congress was held in Hong Kong in October 2015, and the next triennial World Sustainable Built Environment Conference (WSBEC) will be held in Hong Kong in June 2017.

Signing of the Memorandum of the Nobel Laureates in Hong Kong, 25 April 2015

Back row: James Mirrlees (1996 Economics), George Smoot (2006 Physics), Peter Doherty (1996 Medicine), William Esco Moerner (2014 Chemistry), Brian Schmidt (2011 Physics) and with Penny Sackett, Australian National University

Front row: Ronnie Chan (Asia Society) and Hans Joachum Schellnhuber, Potsdam Institute for Climate Impact Research

THEIR VOICES ON CLIMATE CHANGE

Preston Cheung

Born in 1990's
Year 2 in Politics and Public Administration, University of Hong Kong

Advocate for change

I know climate change is affecting the lives of many people on this planet. My studies are helping me understand the policy formulation process, as well as the international politics of climate change. I plan to join the battle against global warming using my knowledge as a weapon. I want to safeguard the environment with policy advocacy. This will be important for my generation and also my grandchildren's generation.

Karen Chiu

Born in 1990's
Year 3 in BBA, Hong Kong University of Science and Technology

Unite to create the change we want

Society is shaped by the collective behaviour of individuals. All of us have influence on and is responsible for the outcome. Hong Kong has many merits that Honkongers could be so proud of, yet we tend to overlook them ourselves; we may all be suffering from a culture that weakness is emphasized but virtue not appreciated. I am committed to bringing people a sustainable and fulfilling lifestyle. Bearing in mind our pride, love and responsibility for Hong Kong, let us minimize energy and resource usage, devote to green initiatives, and unite together to tackle climate change and other challenges ahead.

Xoni Ma

Born in 1980's
PhD Candidate in the Kardoorie Institute, University of Hong Kong

Lead as a city, and be the change personally

Everything is connected and the climate is a critical factor in regulating many ecosystem services like food production. Climate change is man-made and is happening now. Since we share the planet with other creatures, we must shoulder the responsibility to make things right. An advanced city like Hong Kong must take the lead in combating climate change.

I am dedicated in sustainable development education and have organised educational programmes for students to raise their climate literacy. Personally, I have adopted a sustainable lifestyle; I am a vegetarian and will take any means to reduce my carbon and ecological footprint.

Jia Lu

Born in 1970's
Chinese University of Hong Kong Graduate, Vice Chief Planner of Shenzhen Urban Planning & Land Resource Development Research Center

Plan for a low-carbon region

Climate change poses a considerable threat to all human beings. It has likely contributed to more extreme weather, e.g. prolonged droughts and devastating hurricanes, causing deaths and huge financial loss. Although scientists and government leaders agree that actions must be taken, it is hard to change the habits of individuals because the issue is too easy to ignore. As an urban planner, I initiate low-carbon ecological planning and other environmental-friendly planning researches. Cities are the main source of climate change. By proper layout of land-use, a lot of extra GHG emission can be reduced and mitigated. I hope the case of Shenzhen is a positive example in the PRD neighbourhood.

6 REPORT SUMMARY

Everyone has a responsibility to reduce their carbon emissions so that globally it would be possible to maintain the 2°C warming scenario within this century. At the same time, we also have to adapt locally to the greater climate-related risks that will affect our community, as well as build societal resilience to increase our capacities and capabilities to both mitigate carbon emissions and deal with severe weather events at a community level.

I: Hong Kong's climate policy

In meeting the challenge of climate change in Hong Kong, the Government has the primary responsibility to protect people and infrastructure by providing information, policy, appropriate legal frameworks and public sector investment where needed. Our climate change policy is aligned with the national and global consensus on mitigation, adaptation and resilience.

We will continue to:

- Stay abreast of the latest climate science so as to be able to reassess risks and vulnerabilities from time to time;
- Meet local targets for carbon intensity by 2020 and energy intensity by 2025, as well as consider longer-term measures so that succeeding administration may continue to adopt further mitigation efforts;
- Take preventive and adaptive actions to reduce exposure to risks and vulnerabilities;
- Take opportunities presented by the need for mitigation and adaptation to optimise broader societal benefits;
- Strengthen resilience with improved coordination with stakeholders and the community; and
- Participate and contribute to the on-going national and international dialogue on dealing with climate change.

Importance of strengthening resilience

Strengthening resilience should not be seen as an afterthought to mitigation and adaptation because multiple levels of capacities and capabilities are needed to mitigate and adapt effectively to climate change. The tools that can make us more resilient are the soft tools to increase knowledge, share experience, co-learn, co-plan and communicate them across disciplines, stakeholders and communities. The Government has an important role in strengthening Hong Kong's overall climate resilience but each organisation should do likewise.

Government's continuing path to strengthen resilience

- Conduct studies on information gaps and monitor changes
- Strengthen institutional capacity and policy focus
- Update disaster and emergency planning from time to time
- Improve dialogue and coordination with private sector
- Raise community awareness

Beyond the Government's efforts, the private sector must also take action, as must individuals. We will continue to work with key stakeholders to help promote the practice that companies, organisations and individual should calculate their own energy consumption and carbon emissions so that they can seek ways to use energy and other resources much more sustainably. Only through the efforts of everyone would the global community be able to maintain the 2°C warming scenario within this century.

II: Making energy saving a core activity in Hong Kong

Our negotiations with the two power companies on the new contractual arrangements for the next regulatory period are still on-going. We have made it clear in the *Public Consultation on Future Development of the Electricity Market of Hong Kong* that energy saving and promotion of RE are important aspects from the Government's perspective. The two power companies are essential stakeholders if Hong Kong is to transform the energy sector into one that makes energy saving and low-carbon a core activity.

At the same time, we believe we have made a reasonable start in our *Energy Saving Plan for Hong Kong's Built Environment 2015-2025+* to provide a comprehensive view of energy use and energy saving opportunities in Hong Kong. We recognise that our near-term efforts would

only reduce about 3.36 million tonnes of CO_2 per annum. While this is no small feat viewed from where we are today, we know Hong Kong would need to make greater strides in the years to come through both the supply and demand side of energy.

We proposed in the *Energy Saving Plan for Hong Kong's Built Environment 2015-2025+* that we would create a platform for dialogue, led by the Secretary for the Environment, with the power companies and built environment sector for cross-sector deliberation on how Hong Kong can push further and faster to save energy.

This platform is taking shape and will continue through 2016. An important outcome of this dialogue should lead to a heightened awareness among the built environment sector of the relationship between energy consumption, energy saving and carbon emissions reduction.

We will need long-term collaboration among government and key stakeholders, such as the power and gas companies, transport services providers, building developers and owners, residents' bodies, relevant professional bodies, trade associations (such as those supplying electrical and electronic products), educational institutions, and non-government organisations.

III: Deepening understanding of risks

To keep abreast of the latest climate change science and with the resultant risks to Hong Kong, HKO and other government departments will continue their effort to undertake relevant studies and to share the results with stakeholders and the community, so as to enhance knowledge and deepen understanding of the issues at stake. As such issues very often touch on a wide range of policies and strategies across the society and require support and action from various sectors of the community, a multi-disciplinary approach through stakeholder engagement and expert collaboration with universities and research institutes is considered essential.

Risk of heat waves

Heat waves in other parts of the world, such as in Europe in 2013 and India in 2015, have caused high fatalities. The elderly and people with cardiovascular illnesses are particularly vulnerable to high temperatures. In Hong Kong, we can learn from the community response approach developed after the Tai O floods in 2008 (as noted in Chapter 5) through which government departments are able to work in a coordinated fashion with local districts, building managers, healthcare workers and welfare organisations to implement the necessary measures for providing relief. Residents in local communities can also be mobilised to look out for each other and report to the relevant bodies when assistance is needed, and the opening of temporary shelters, such as those established in community centres, can offer facilities to reduce extreme heat discomfort.

However, in managing the risks arising from heat waves and a warmer climate, we should also be mindful of other consequential impacts, such as increasing energy demand in an air-conditioned city like Hong Kong, enhanced urban heat island effect, and the migration of infectious and insect-borne diseases, such as dengue fever from the tropical regions. In the absence of careful planning and coordinated actions, such impacts will only reinforce each other and multiply through a vicious feedback cycle that exacerbates the situation in a way that is environmentally, socially and economically costly.

Uncertain speed of sea level rise

While we can never be certain about the speed of sea level rise, we can be quite certain though that it will definitely rise as an unmistakable consequence of global warming. The time for coastal communities like Hong Kong to respond adequately with appropriate plans could well be shorter than currently estimated should the Antarctic ice sheets melt even faster. It is therefore in our interest today to plan ahead and deal with both the near-term risks associated with land instability and subsidence, as well as the long-term risks arising from climate change to ensure that our coastal infrastructure and assets with a history of flooding are adequately protected and resiliently constructed against such threats.

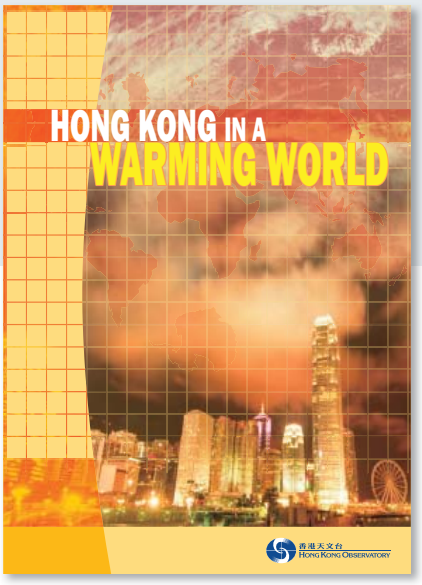
Risks for specific locations

While HKO will continue to take the lead in the overall assessment and projection of potential climate change impacts on Hong Kong as a whole, effective implementation of mitigation and adaptation plans for specific locations, especially in anticipation of more frequent extreme weather and other related hazards, such as enhanced storm surges brought by tropical cyclones, require detailed understanding of local knowledge and in-depth study of regional differences within Hong Kong. This can only be achieved through the active engagement of various stakeholders and the effective utilisation of research capacity in collaboration with universities and other academic institutes.

Evidence-based risks assessments and continuing public education

We will make use of the GFCS, established by the WMO and supported by HKO, to develop and incorporate science-based climate information and prediction into planning, policy and practice to reduce exposure to risks and vulnerabilities, and to strengthen resilience of Hong Kong to climate change effects. The global and regional projects, best practices and guidance material developed by WMO under the five priority areas of GFCS, viz. agriculture and food security, disaster risk reduction, energy, health and water, will provide useful resources and references for taking forward science-based climate change actions for the various sectors in Hong Kong. Coordination mechanisms that bring together various stakeholders to address issues related to the production and application of climate services can play a critical role in ensuring coordination, exchange of information and promotion of partnerships among the government, policy-makers, planners, managers, practitioners and the local communities.

HKO is making use of various channels to promote and strengthen climate change education, including website, mobile app "MyObservatory", videos, social media, school and public talks such as the annual Science in the Public Service lecture series and exhibitions and the publication of the booklet *Hong Kong in a Warming World*.[40]



IV: Communication for better preparedness

The Government's public communication strategy as a whole may be fine-tuned to inculcate an appreciation among residents of the various extreme weather risks, such as how to protect themselves on extremely hot days, to be aware of the danger of landslides, waves and floods during stormy weather, as well as various health-related risks beyond high temperatures. At present, different government departments are responsible for areas they are responsible for. If we are to study and act upon the specific risks arising from specific locations, then the Government would be able to put together targeted plans when weather-related emergencies strike, and have in place communication plans that are also location specific, as they have done in Tai O on flooding.

Combating climate change requires everyone's participation and actions, which include habitually supporting a low-carbon lifestyle.

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12. There are techniques to assess the carbon footprint associated with all the stages of a development's life from cradle to grave (i.e., from raw material extraction through materials processing, manufacture, distribution, use, operation and maintenance, and disposal). By understanding the carbon emissions in the life cycle of buildings, deisgn adjustments can be made to reduce the developments' carbon footprint.
13. The International Organization for Standardization (ISO) is an international standard-setting body and the ISO 50001 Energy Management Systems Standard, created in 2011, provides organisations with a framework to increase energy efficiency, reduce energy costs and improve energy performance. Certification proves that the energy management system meets the requirements of ISO 50001 and the certified organisation is saving energy. It also helps to ensure that the energy management system is working throughout the organisation. Another advantage of certification is its emphasis on continual improvement.
14. One workload unit (WLU) is equal to one passenger or 100kg cargo. This is a common measurement for commercial airport operations.
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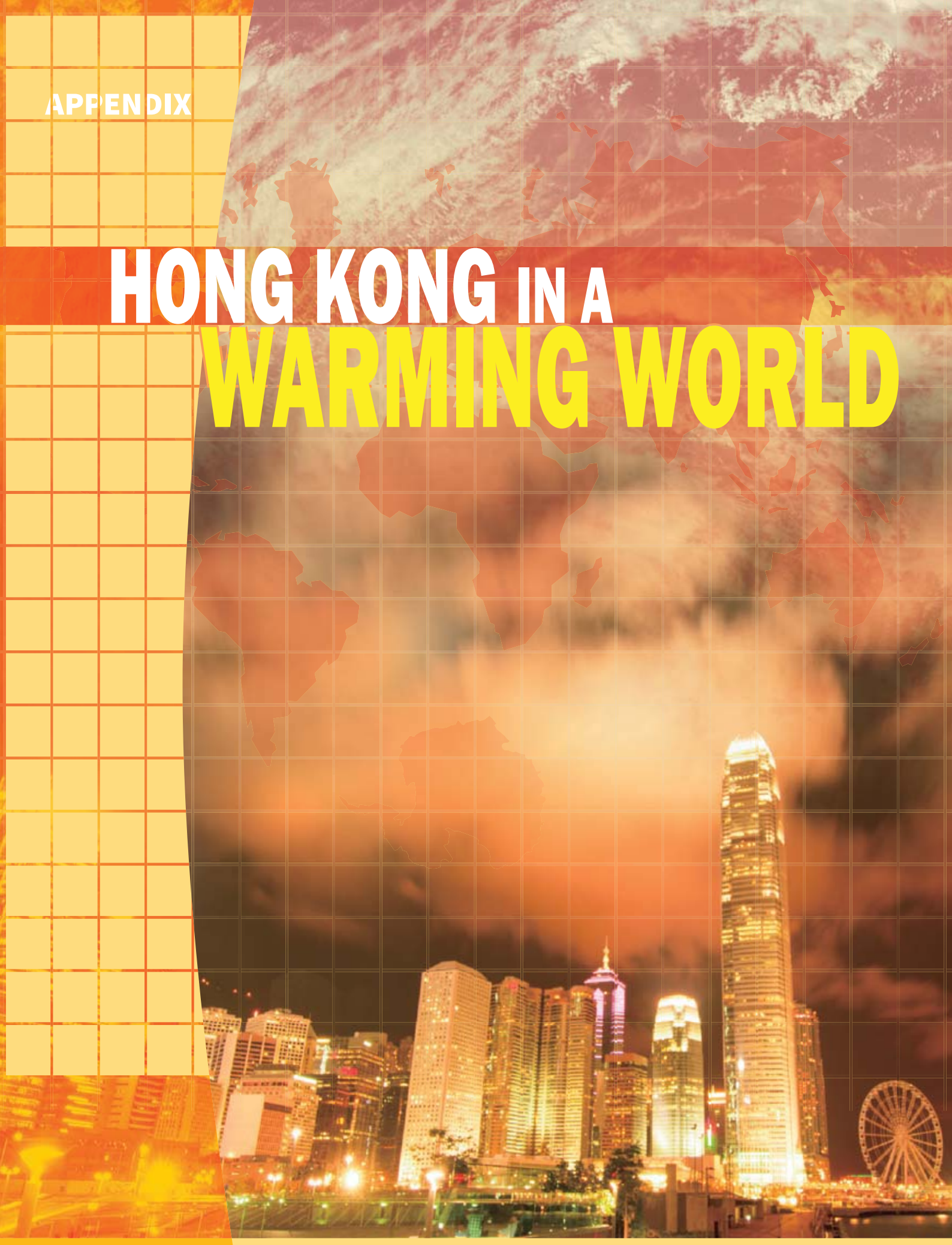
ABBREVIATIONS

AA	Hong Kong Airport Authority
AFCD	Agriculture, Fisheries and Conservation Department
APEC	Asia-Pacific Economic Cooperation
AR4	IPCC Fourth Assessment Report
AR5	IPCC Fifth Assessment Report:
BAU	Business as Usual
BD	Buildings Department
BEC	Business Environment Council
BSAP	Biodiversity Strategy and Action Plan
C40	C40 Cities Climate Leadership Group
CBD	Convention on Biological Diversity
CEDD	Civil Engineering and Development Department
CEE	Carbon Emission Estimation
CH_4	Methane
CIC	Construction Industry Council
CLP	China Light and Power Co., Ltd.
CO_2	Carbon Dioxide
CO_2-e	Carbon Dioxide Equivalent
COP	Conference of the Parties
DevB	Development Bureau
DH	Department of Health
DMAs	District Metering Areas
DSD	Drainage Services Department
DSM	Demand Side Management
ECC	Environmental Campaign Committee
EKE	Energising Kowloon East
EMSD	Electrical and Mechanical Services Department
EPD	Environmental Protection Department
ESG	Environment, Social and Governance
EU	European Union
EV	Electric Vehices
FEHD	Food and Environmental Hygiene Department
FHB	Food and Health Bureau
FSDC	Financial Services Development Council
G7	Group of Seven Industrialized Countries
GDP	Gross Domestic Product
GEO	Geotechnical Engineering Office
GFCS	Global Framework for Climate Services
GHG	Greenhouse Gases
GMPs	Greening Master Plans
HAD	Home Affairs Department
HEC	Hongkong Electric Company
HFCs	Hydrofluorocarbons
HKEx	Hong Kong Exchanges and Clearing Limited
HKGDCJC	Hong Kong/Guangdong Co-operation Joint Conference
HKHA	Hong Kong Housing Authority
HKIA	Hong Kong International Airport
HKO	Hong Kong Observatory
HKPSG	Hong Kong Planning Standards and Guidelines
IBCS	Intergovernmental Board on Climate Services
ICT	Information and communications technology
IEA	International Energy Agency
IEP	Integrated Education Programme
IPCC	Intergovernmental Panel on Climate Change
IRTS	Inter-Reserviors Transfer Scheme
IWGCC	Interdepartmental Working Group on Climate Change
JLGCCC	Hong Kong/Guangdong Joint Liaison Group on Combating Climate Change
IoT	Internet of Things
MCM	million cubic metres
MRV	Measurement, Reporting and Verification
MTL	Modern Terminals Limited
N_2O	Nitrous Oxide
NDAs	New Development Areas
PFCs	Perfluorocarbons
PlanD	Planning Department
PLB	Public Light Bus
RE	Renewable Energy
RTGs	Rubber-tyred Gantry Cranes
RTTV	Residential Thermal Transfer Value
SARs	Special Administrative Regions
SB	Security Bureau
SCAs	Scheme of Control Agreements
SF_6	Hexafluoride
SWD	Social Welfare Department
TAC	Transport Advisory Committee
TEUs	Twenty-foot Equivalent Units
Towngas	The Hong Kong and China Gas Company
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
WELS	Water Efficiency Labelling Scheme
WMO	World Meteorological Organization
WSBEC	World Sustainable Built Environment Conference
WSD	Water Supplies Department

APPENDIX

HONG KONG IN A WARMING WORLD



香港天文台
HONG KONG OBSERVATORY

*"**Warming of the climate system is unequivocal**, and since the 1950s, many of the observed changes are unprecedented over decades to millennia."*

*"It is **extremely likely that human influence has been the dominant cause of the observed warming** since the mid-20th century."*

The Fifth Assessment Report (AR5) of Working Group I of the Intergovernmental Panel on Climate Change (IPCC)

Contents

THE WORLD

HONG KONG

Unprecedented carbon dioxide concentration

The atmospheric concentration of carbon dioxide (CO_2), the most important greenhouse gas as well as the main driver of global climate change in the last century, has increased by **over 40 per cent** since pre-industrial times. The increase is primarily due to burning of fossil fuels and secondarily due to deforestation. Present-day concentration of CO_2 is the highest in the last **800,000 years**.

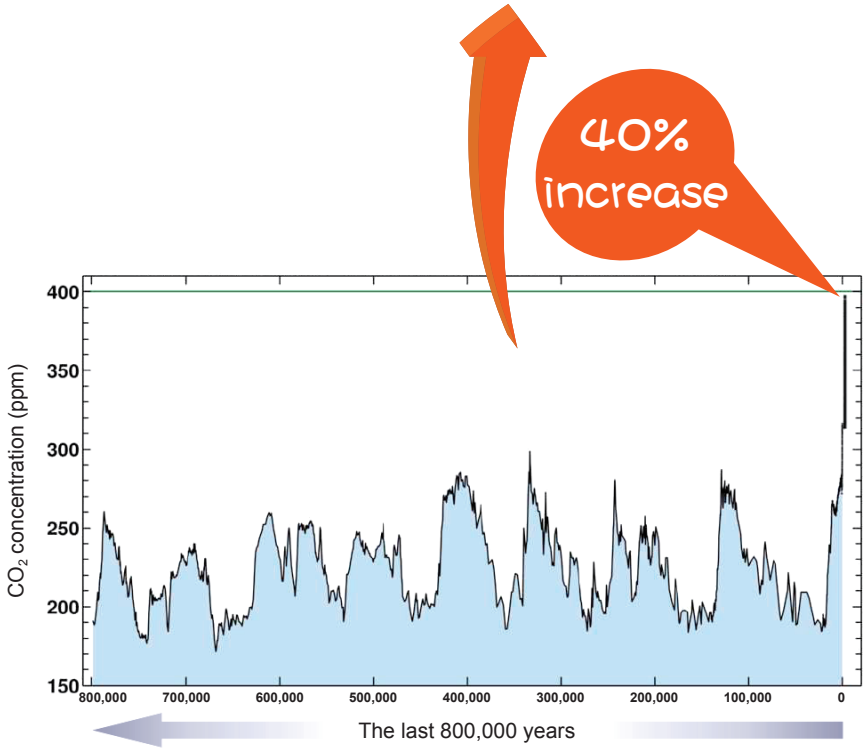


Figure 1 Atmospheric carbon dioxide concentration in the last 800,000 years.

Check the latest atmospheric CO_2 levels here:

Abrupt temperature rise

With heat trapped by the increasing presence of greenhouse gases, almost every corner of the globe has experienced a warming trend throughout the 20th century.

The first decade of the 21st century has been the warmest since 1850.

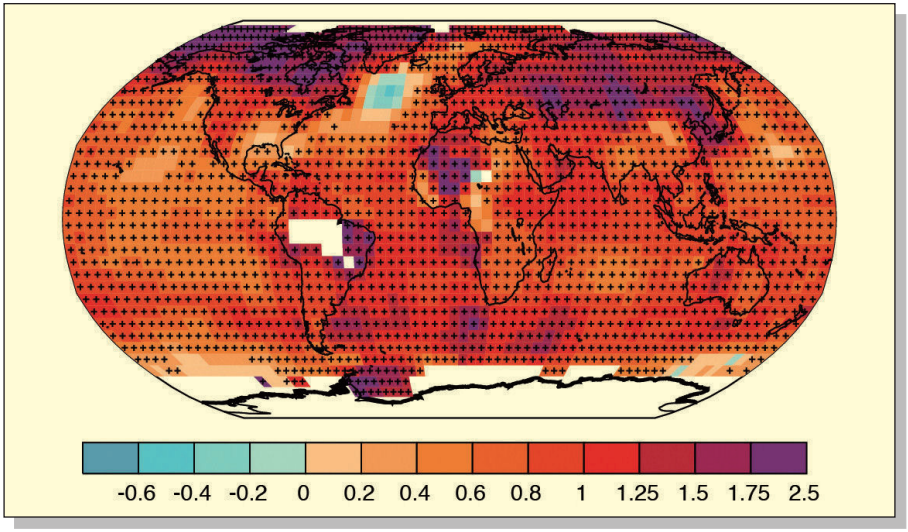


Figure 2 Warming trend during 1901-2012, unit in °C.

The recent warming is so abrupt that it has totally reversed the long-term cooling trend in the last 5,000 years.

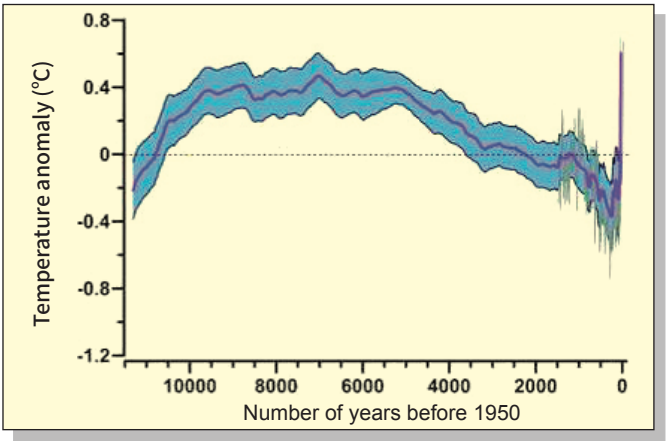


Figure 3 Global temperature anomalies with respect to the 1961-1990 average (purple line), with uncertainty in blue band.

Melting of ice and snow

The warming climate has contributed to **widespread melting of snow cover, ice caps, mountain glaciers and ice sheets over Greenland and West Antarctica**. Reduction of reflective surfaces of ice and snow will in turn mean more heat absorbed as the Earth's ability to disperse sunlight back to space is compromised. This is expected to accelerate the melting of ice and snow – a vicious cycle.

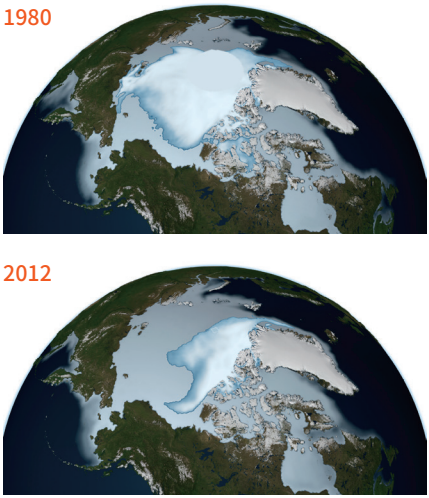


Figure 4 Arctic sea ice decrease from 1980 (upper) to 2012 (lower).

Figure 5 Melting of Muir Glacier, Alaska's Glacier Bay from 1941 (left) to 2004 (right).

Short video on the largest Greenland glacier calving ever filmed:

Mean sea level rise

Thermal expansion of sea water and melting of land-based ice and snow will lead to a global sea level rise. **The rate of sea level rise since the mid-19th century has apparently accelerated** when compared to the mean rate in the previous two millennia.

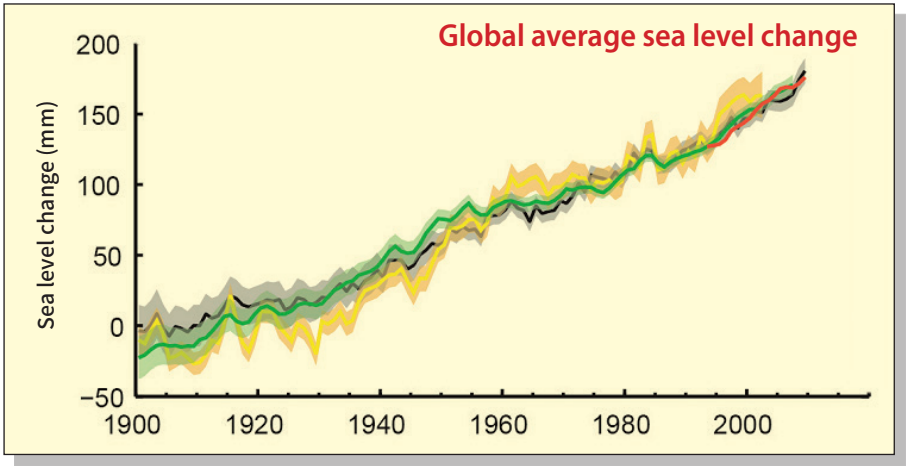


Figure 6 Global average sea level change relative to the 1900-1905 average. Different coloured lines represent different independent data sets.

Rising sea level will cause coastal flooding and accentuate the threat of storm surges brought by cyclones.

Figure 7 Storm surge caused by Hurricane Sandy along the east coast of the United States in 2012.

More extreme heat

A warming climate increases the chance of extreme heat. The number of cold days and nights has decreased and the number of warm days and nights has increased on the global scale. **The frequency of heat waves has increased in many parts of Europe, Asia and Australia.**

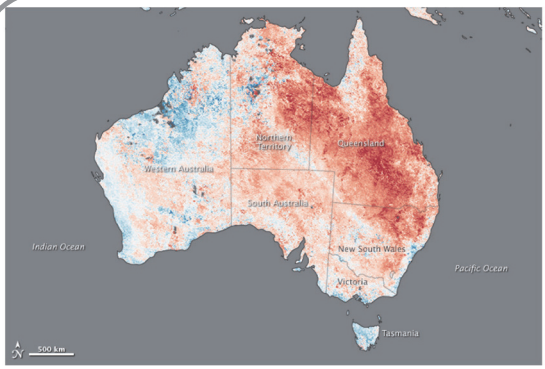


Figure 8 Land surface temperature anomaly (°C) over Australia during 27 December 2013 - 3 January 2014.

Enhanced water cycle

Ocean warming leads to more evaporation of sea water. A warmer atmosphere has the capacity to hold more water vapour, thereby increasing the chance of heavy rain. **More land areas have experienced an increase in heavy precipitation since the mid-20th century.**

Figure 9 Heavy rain in Shenzhen on 11 May 2014.

Projection of global climate for the 21st century

Temperature

Latest observations of CO_2 emission have a clear indication that the world is moving along the trajectory of a high greenhouse gas concentration scenario. Under this scenario, global mean temperature is expected to increase by four degrees by the end of the 21st century. It is virtually certain that **there will be more hot and fewer cold temperature extremes**. It is also very likely that **heat waves will occur with a higher frequency and duration** despite the occasional episodes of cold winter extremes.

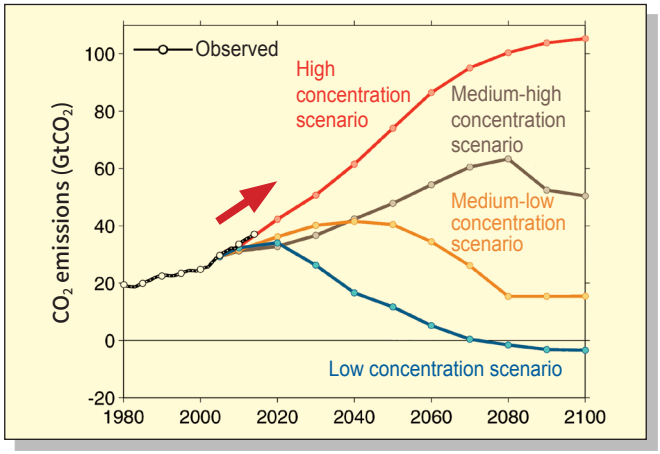


Figure 10 Carbon dioxide emissions associated with different greenhouse gas concentration scenarios shown in coloured lines. Historical observations are shown in black.

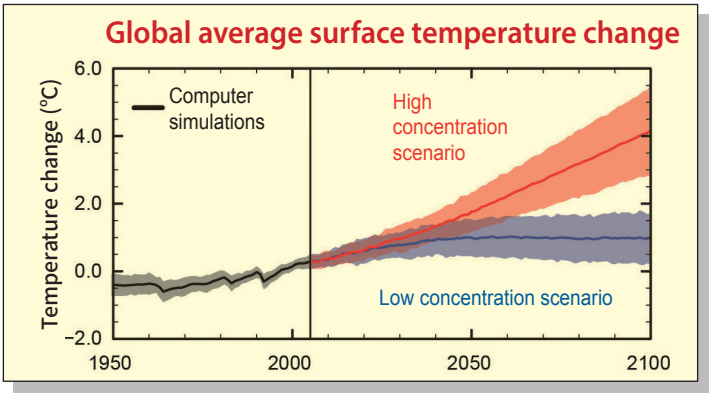


Figure 11 Projected global average surface temperature change (relative to the average of 1986-2005) under the high (red) and low (blue) greenhouse gas concentration scenarios.

Precipitation

In a warmer world, **extreme precipitation events will very likely become more intense and more frequent** over most of the mid-latitude land masses and over wet tropical regions by the end of this century. Meanwhile, **the risk of drought remains** in many parts of the world with substantial increases projected in the Mediterranean, Central and South Americas, southern Africa and Australia.

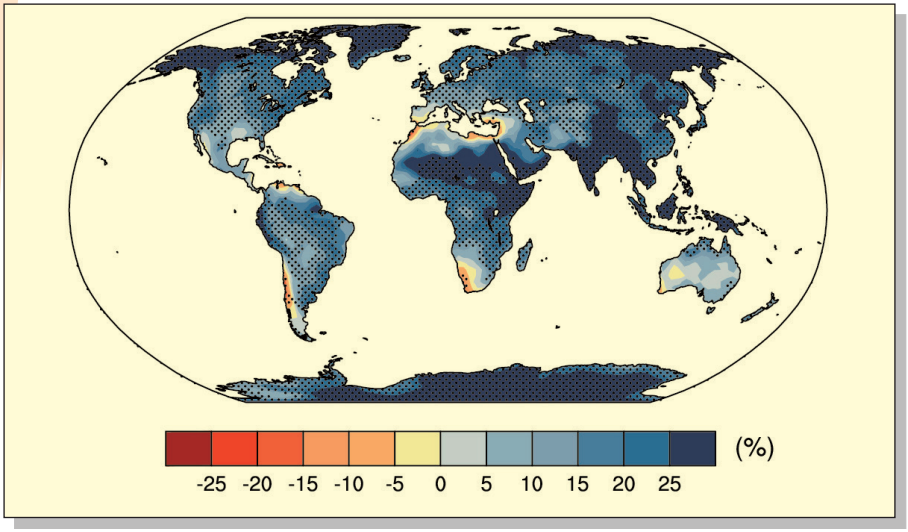


Figure 12 Projected percentage changes in annual maximum five-day precipitation in 2081-2100, relative to 1981-2000, under the high greenhouse gas concentration scenario.

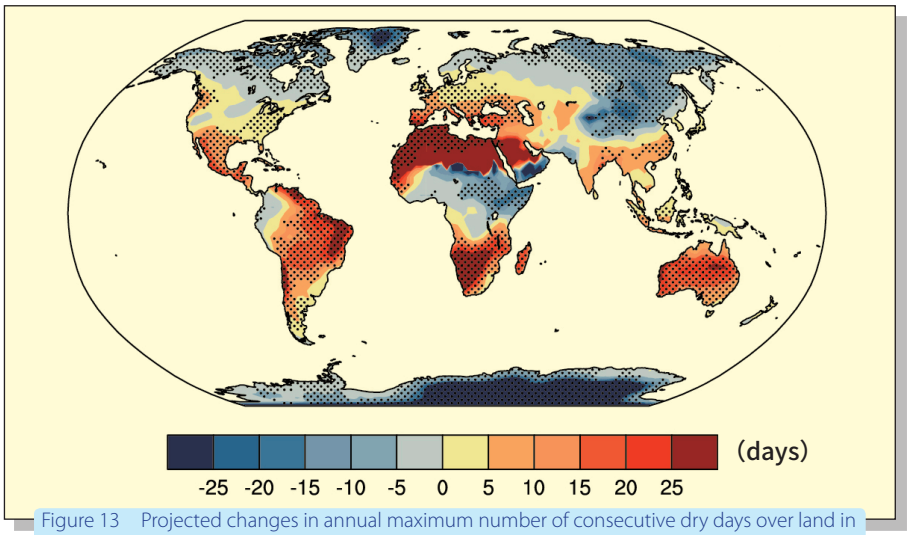


Figure 13 Projected changes in annual maximum number of consecutive dry days over land in 2081-2100, relative to 1981-2000, under the high greenhouse gas concentration scenario.

Sea level

Under the high greenhouse gas concentration scenario, **global mean sea level at the end of the 21st century (2081-2100) is likely to rise by 0.45 - 0.82 m** relative to the average of 1986-2005.

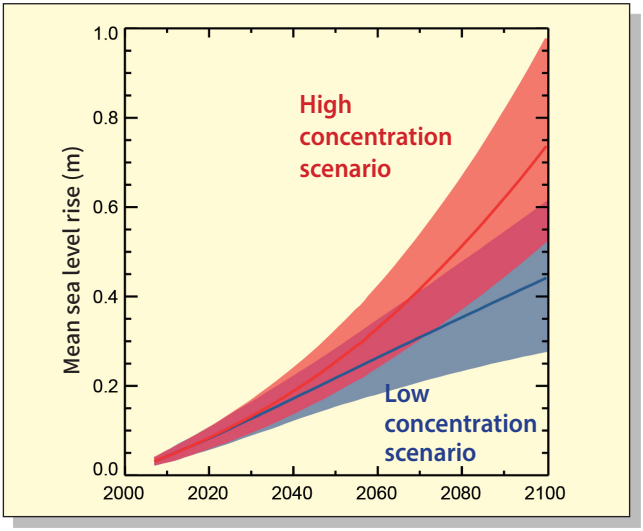


Figure 14 Projected global mean sea level rise relative to the average of 1986-2005 under the high (red) and low (blue) greenhouse gas concentration scenarios. Solid line and shaded area represent the median and likely range of the projection respectively.

Climate change in Hong Kong

Temperature

Since the late 19th century, Hong Kong has experienced a significant warming trend. Both global warming and effects of local urbanization contribute to the warming, with the latter estimated to contribute up to 50% of the warming.

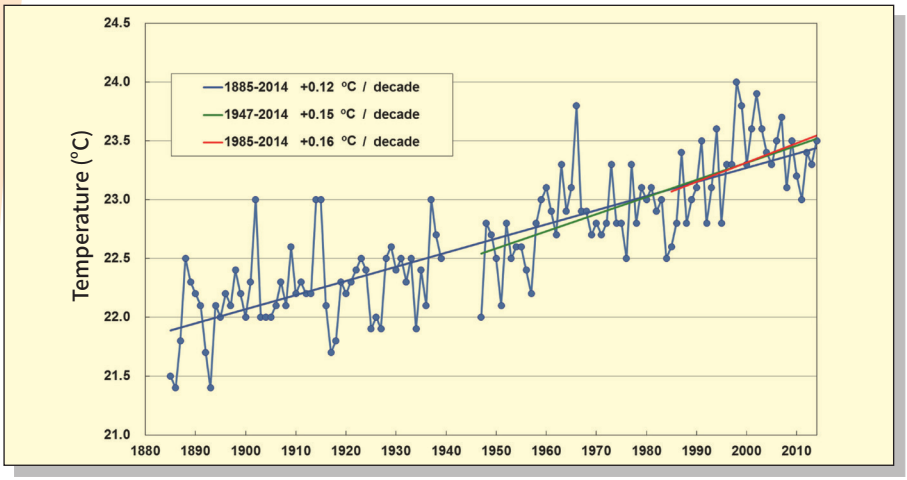


Figure 15 Annual mean temperature recorded at the Hong Kong Observatory headquarters (1885-2014). Data not available from 1940 to 1946.

Extremely hot days in Hong Kong have become more frequent while extremely cold days have become rarer.

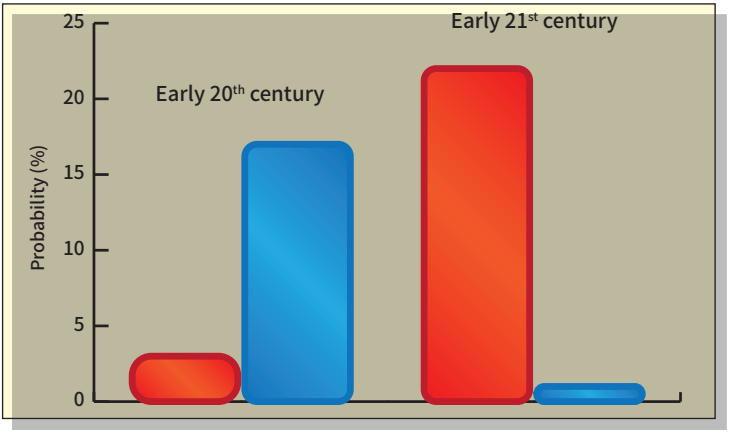


Figure 16 Probability of occurrence of daily maximum temperature ≥ 35°C (red bars) and daily minimum temperature ≤ 4°C (blue bars) in a year as measured at the Hong Kong Observatory headquarters.

Precipitation

Extreme precipitation events have become more frequent. The hourly rainfall record at the Hong Kong Observatory headquarters was broken several times in the last few decades, whereas it used to take several decades to break the record in the past.

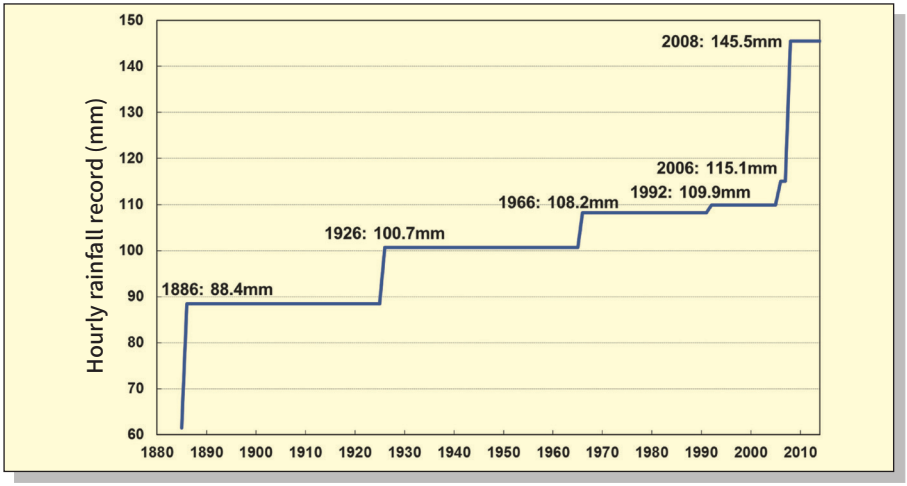


Figure 17 Hourly rainfall records at the Hong Kong Observatory headquarters (1885 – 2014).

Sea level

Tide gauge records in Victoria Harbour since 1954 show **an unambiguous rise of mean sea level**.

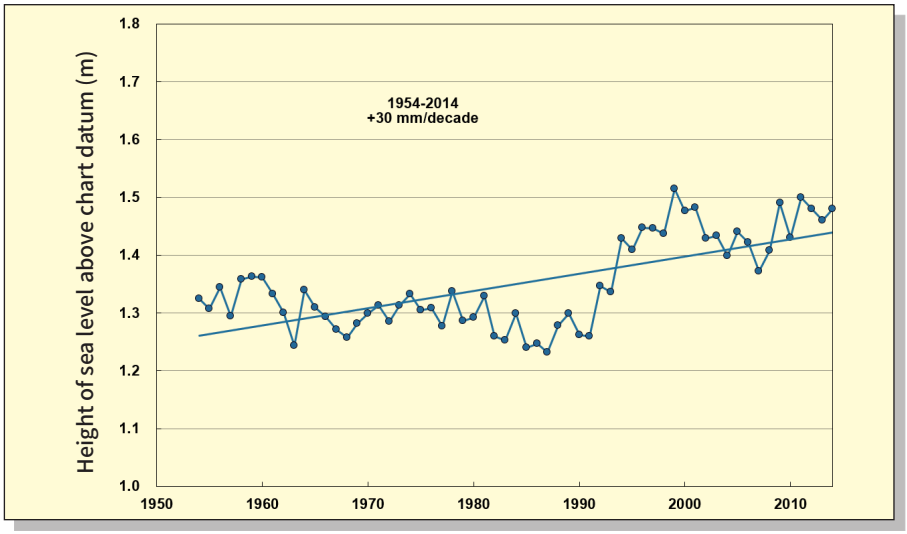


Figure 18 Annual mean sea level at Victoria Harbour (1954-2014).

Projection of Hong Kong climate for the 21st century

Temperature

Under the high greenhouse gas concentration scenario, the **annual mean temperature** in Hong Kong in the decade 2091-2100 is expected **to rise by 3 - 6 °C** relative to the average of 1986-2005.

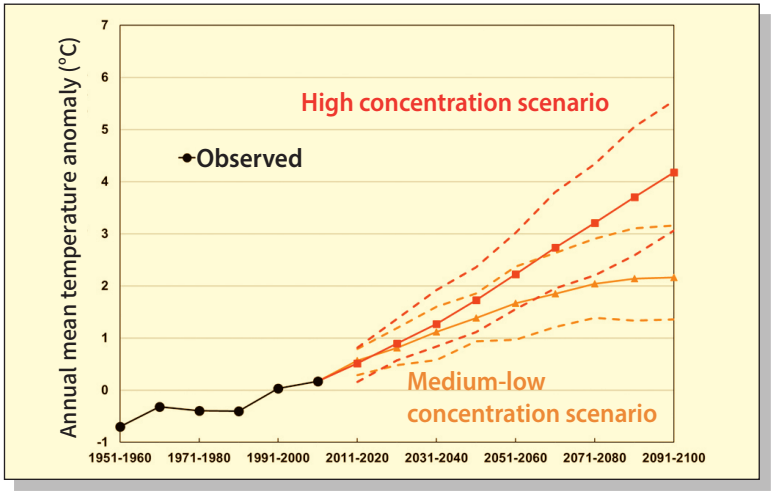


Figure 19 Projected changes in the annual temperature of Hong Kong relative to the average of 1986-2005 under the high (red) and medium-low (orange) greenhouse gas concentration scenarios (solid line plots the mean value while dashed lines show the likely range of projection results). Historical observations are shown in black.

Precipitation

The **annual rainfall** in the late 21st century is expected **to rise by about 180 mm** when compared to the average of 1986-2005 under the high greenhouse gas concentration scenario. Of even more interest is a **significant increase in extremely wet years** from three in 1885-2005 to about 12 in 2006-2100. On the other hand, the number of extremely dry years is expected to remain about the same.

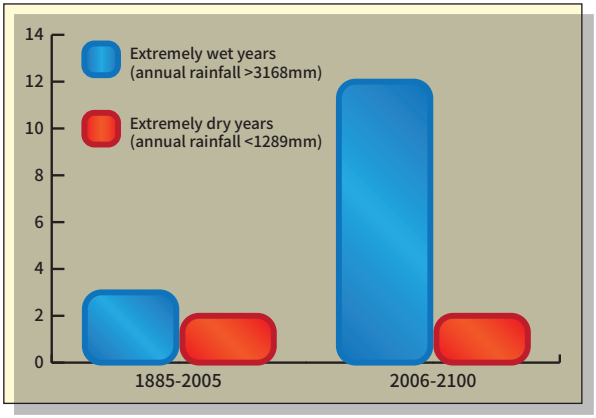


Figure 20 Future changes in extremely wet and extremely dry years under the high greenhouse gas concentration scenario.

Sea level

Under the high greenhouse gas concentration scenario, the **annual mean sea level** in Hong Kong and its adjacent waters in 2081-2100 is expected **to rise by 0.63 - 1.07 m** relative to the average of 1986-2005.

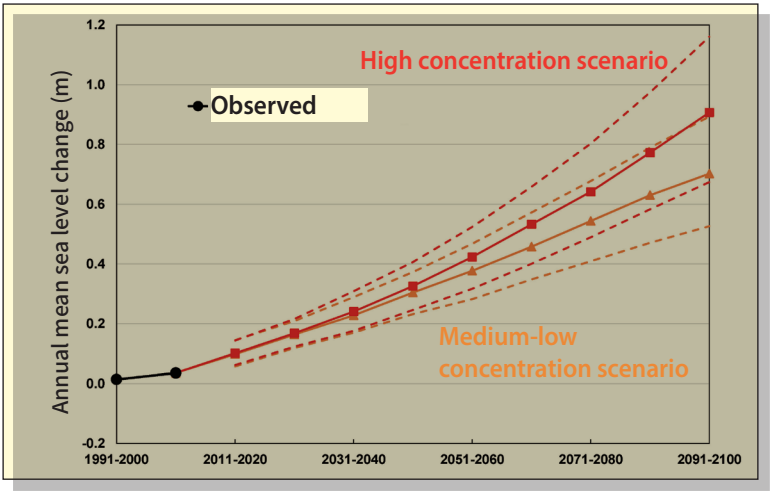


Figure 21 Projected changes in the mean sea level in Hong Kong and its adjacent waters relative to the average of 1986-2005 under the high (red) and medium-low (orange) greenhouse gas concentration scenarios (solid line plots the mean value while dashed lines show the likely range of projection results). Historical observations are shown in black.

Storm surge

Apart from high winds and heavy rain, storm surge is also a threat posed by approaching tropical cyclones. Over the last hundred years or so, several typhoons (e.g. in 1874, 1906, 1937 and 1962) had brought severe storm surges to Hong Kong, causing heavy casualties and damages.

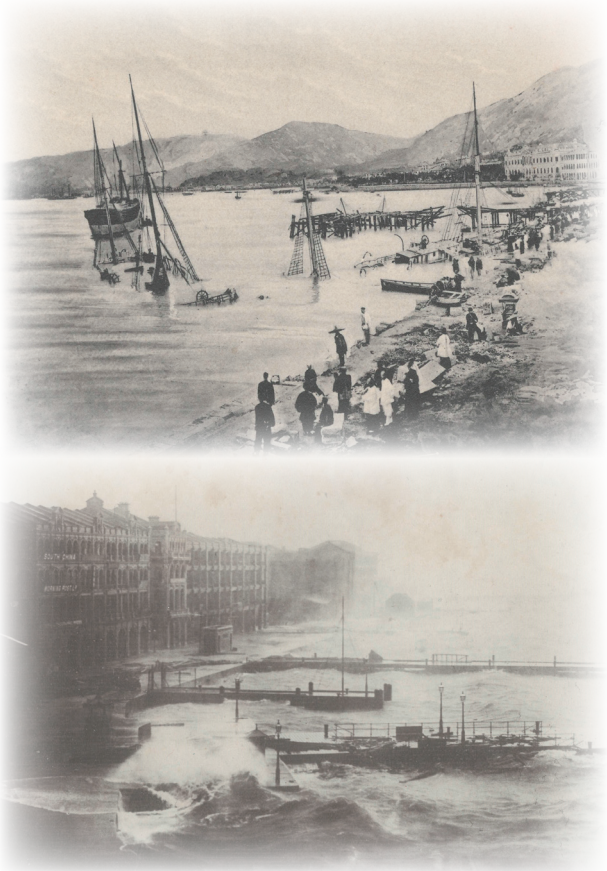
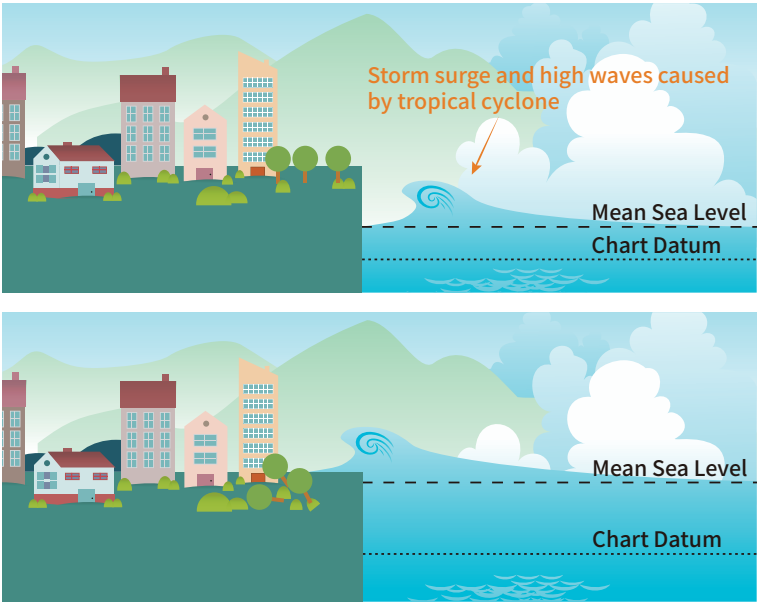


Figure 22 Upper: Damages to ships and piers at Central, Hong Kong Island, brought by severe storm surge during the great typhoon of 1874.
Lower: Sea waves bombarding the coast of Central, Hong Kong Island, during the great typhoon of 1906 which caused a death toll of more than 10,000.

Storm surge damages by Typhoon Wanda in 1962:



With an expected rise in mean sea level in Hong Kong and its adjacent waters by 1.07 m by the end of the 21st century under the high greenhouse gas concentration scenario, **the threat of storm surges brought by tropical cyclones will correspondingly increase**. A water height of 3.5 m that can cause serious flooding in low-lying areas in Hong Kong, such as the one brought by Typhoon Hagupit in 2008, may become a recurrent event every year by the end of this century. The situation could be even worse as the global mean tropical cyclone intensity is likely to increase.

Figure 23 Severe flooding in Tai O during the passage of Typhoon Hagupit in 2008.

Mitigating climate change - our duty

Just as mankind has played an undeniable role in bringing about climate change, we have an inescapable responsibility in mitigating the impact so caused. While some of the changes that are already taking place may not be reversible, the scenario-based projections as described in IPCC AR5 do provide some hope for steering the future course of events and hence mitigating the overall impact to a certain extent.

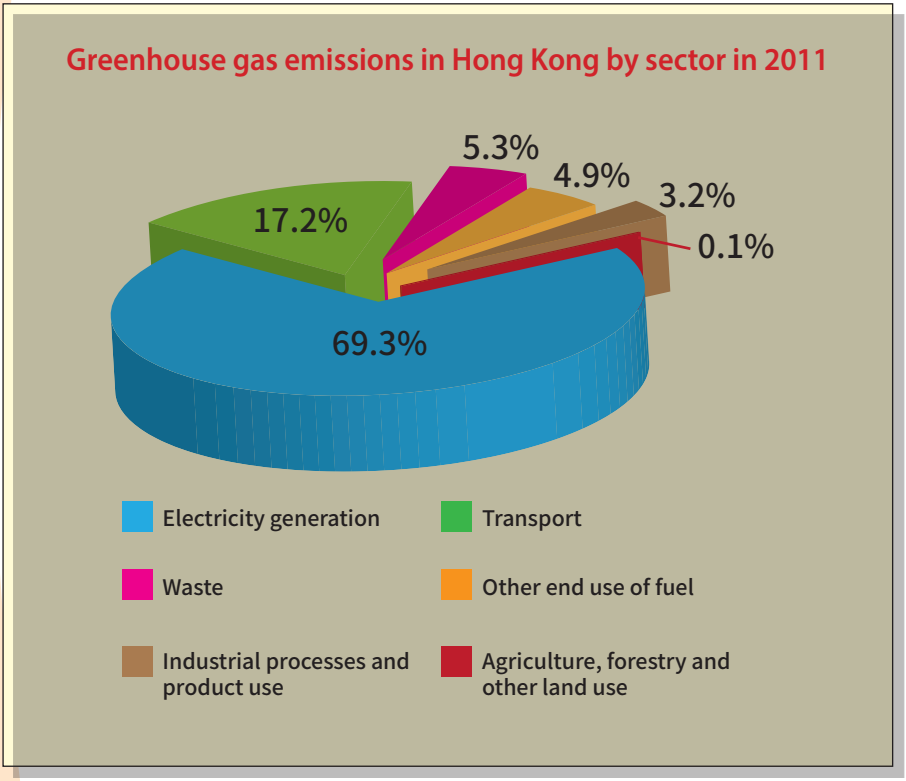
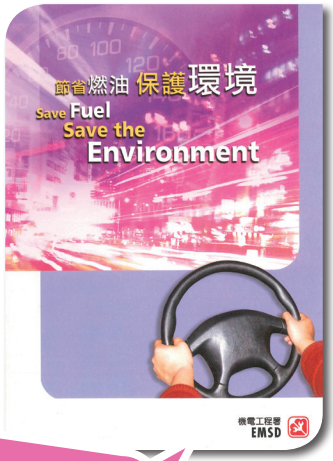


Figure 24 Hong Kong's total greenhouse gas emissions in 2011 amounted to 42.7 million tonnes carbon dioxide equivalent. Electricity generation is the major source of emissions.

As the governments around the world are still making an effort to formulate a concrete plan for global greenhouse gas reduction, we as citizens of the planet should also take matters into our own hands. We need to act conscientiously, collectively and with urgency. We should spread the word around, promote such awareness among the younger generations, and pursue societal progress in support of sustainable efforts in meeting the long-running challenges of climate change.

Adopt a low-carbon and pro-green lifestyle.

Save energy and water. Use energy-efficient products and switch them off when not needed.



Drive less and drive smart.

Reduce waste and recycle.

Collaborative effort in combating climate change

Hong Kong Observatory supports the Global Framework for Climate Services – an international initiative launched by the World Meteorological Organization (WMO) to enhance and extend the effective use of scientifically-based climate information to cope with climate change. Given the wide range of issues involved, the Observatory has been collaborating with partners and stakeholders in such efforts.

The Observatory partnering with government bureaux and departments to promote energy saving.

The Observatory partnering with the utility sector to encourage behavioural changes in mitigating climate change.

The Observatory partnering with Radio Television Hong Kong to spread the messages about climate change.

Production of YouTube videos by the Observatory to promote public awareness.

Useful links

- Hong Kong Observatory Climate Change Webpage
  www.weather.gov.hk/climate_change/climate_change_e.htm
- The Fifth Assessment Report of IPCC Working Group I
  www.ipcc.ch/report/ar5/wg1
- Environmental Protection Department Climate Change Webpage
  www.epd.gov.hk/epd/english/climate_change
- Council for Sustainable Development
  www.susdev.gov.hk/html/en/council
- Environmental Campaign Committee
  www.ecc.org.hk/english/index.html

Appendix

Projections of temperature and mean sea level

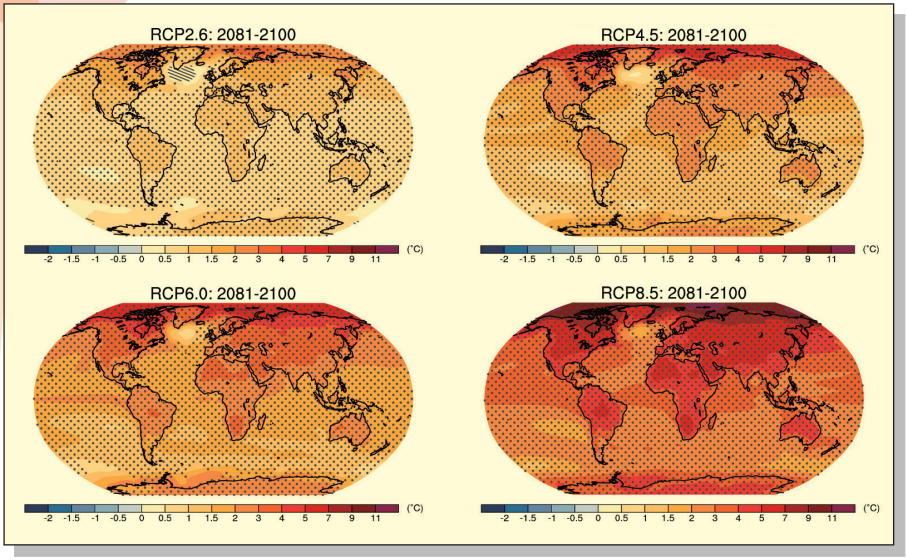


Figure 25 Projected annual mean surface temperature change from the period 1986-2005 to 2081-2100 under the low (upper left), medium-low (upper right), medium-high (lower left) and high (lower right) greenhouse gas concentration scenarios.

	Greenhouse gas concentration scenario	2046-2065		2081-2100	
		Mean	Likely range	Mean	Likely range
Global mean surface temperature change (°C)	Low	1.0	0.4 - 1.6	1.0	0.3 - 1.7
	Medium-low	1.4	0.9 - 2.0	1.8	1.1 - 2.6
	Medium-high	1.3	0.8 - 1.8	2.2	1.4 - 3.1
	High	2.0	1.4 - 2.6	3.7	2.6 - 4.8
	Greenhouse gas concentration scenario	Mean	Likely range	Mean	Likely range
Global mean sea level rise (m)	Low	0.24	0.17 - 0.32	0.40	0.26 - 0.55
	Medium-low	0.26	0.19 - 0.33	0.47	0.32 - 0.63
	Medium-high	0.25	0.18 - 0.32	0.48	0.33 - 0.63
	High	0.30	0.22 - 0.38	0.63	0.45 - 0.82

Table 1 Projected changes in global mean surface temperature and global mean sea level rise for the mid- and late 21st century relative to the reference period of 1986-2005 under different greenhouse gas concentration scenarios.

Source of figures and data

Figure 1:	World Meteorological Organization
Figures 2, 6, 11-14, 25 and Table 1:	Intergovernmental Panel on Climate Change
Figure 3:	A Reconstruction of Regional and Global Temperature for the Past 11,300 Years. Shaun A. Marcott et al. Science 339, 1198 (2013); DOI: 10.1126/science.1228026. Reprinted with permission from The American Association for the Advancement of Science. Readers may view, browse, and/or download material for temporary copying purposes only, provided these uses are for noncommercial personal purposes. Except as provided by law, this material may not be further reproduced, distributed, transmitted, modified, adapted, performed, displayed, published, or sold in whole or in part, without prior written permission from the publisher.
Figures 4 and 8:	US National Aeronautics and Space Administration
Figure 10:	Global Carbon Project
Figures 15-21:	Hong Kong Observatory
Figure 24:	Data from Environmental Protection Department

Photo credits

P.4	U. W. O. Field, B. F. Molnia, US National Snow and Ice Data Center (Melting of Muir Glacier, Alaska's Glacier Bay from 1941 to 2004)
P.5	Mark C. Olsen, US Air Force (Storm surge caused by Hurricane Sandy along the east coast of the United States in 2012)
P.6	weibo.com/szmb (Heavy rain in Shenzhen on 11 May 2014)
P.14	Mr Shun Chi-ming (Damages to ships and piers at Central, Hong Kong Island, brought by severe storm surge during the great typhoon of 1874. Sea waves bombarding the coast of Central, Hong Kong Island, during the great typhoon of 1906 which caused a death toll of more than 10,000.)
P.15	Television Broadcasts Limited (Severe flooding in Tai O during the passage of Typhoon Hagupit in 2008)
P.19	Radio Television Hong Kong (Poster of “Meteorology Series IV”)