

Policy Implication of Health Impacts of Climate Change in Hong Kong

Policy Brief

October 2016

Emily YY CHAN, Heidi HUNG, Gabriel NC LAU, Edward YY NG

Collaborating Centre for Oxford University and CUHK for Disaster and Medical Humanitarian Response (CCOUC), The Chinese University of Hong Kong

Institute of Environment, Energy and Sustainability (IEES),
The Chinese University of Hong Kong



Collaborating Centre for Oxford University and CUHK
for Disaster and Medical Humanitarian Response
CCOUC 災害與人道救援研究所



香港中文大學
The Chinese University of Hong Kong



香港中文大學醫學院
Faculty of Medicine
The Chinese University of Hong Kong



Supported by:



香港賽馬會災難防護應變教研中心
Hong Kong Jockey Club
Disaster Preparedness and Response Institute
architecture for humanitarian crisis and disaster management

Funded by:



香港賽馬會慈善信託基金
The Hong Kong Jockey Club Charities Trust
同心 同步 同進 RIDING HIGH TOGETHER

For more information:

Collaborating Centre for Oxford University and CUHK for Disaster and Medical Humanitarian Response

Address: 3/F, School of Public Health, Prince of Wales Hospital, Shatin, New Territories, Hong Kong

Email: ccouc@cuhk.edu.hk

Website: www.ccouc.org

Authors' Information:

1. Emily YY CHAN, Director, Collaborating Centre for Oxford University and CUHK for Disaster and Medical Humanitarian Response (CCOUC), and Professor, School of Public Health and Primary Care (SPHPC), Faculty of Medicine, The Chinese University of Hong Kong, Hong Kong.
2. Heidi HUNG, Research Assistant, Collaborating Centre for Oxford University and CUHK for Disaster and Medical Humanitarian Response (CCOUC).
3. Gabriel NC LAU, Director, Institute of Environment, Energy and Sustainability (IEES), and AXA Professor of Geography and Resource Management, The Chinese University of Hong Kong, Hong Kong.
4. Edward YY NG, Team Leader of Urban Sustainability and Public Health in the Institute of Environment, Energy and Sustainability (IEES), and Yao Ling Sun Professor of Architecture, The Chinese University of Hong Kong, Hong Kong.

Acknowledgement:

Gloria CHAN, Zhe HUANG, Carman MARK

Introduction

Climate change is one of the main Global Environmental Changes (GEC) which global communities are experiencing in the 21st century. Among its various adverse impacts, urban communities are vulnerable to climate impact for its high density based living arrangements and its residences' reliance on life-line infrastructure for basic survival (food, water and electricity, etc.). This paper examines and discusses the human health impacts of climate change in Hong Kong. It also presents key recommendations to support resilience building for the health challenges posed by climate change for the decades to come.

Key Messages

- Globally, climate change and health is a key emergency public health issue for the years to come.
- Health threats brought about by extreme weather / climate disasters are expected to increase in frequency and intensity. Local researches found significant relationships between temperatures patterns and higher mortality and morbidity rates, as well as the harmful effects of worsening air quality in temperature ranges on respiratory and cardiovascular health following climate change.
- Hong Kong must implement effective public health protection measures and conduct an overall technical review of the climate readiness of its health system, without losing sight of the non-health measures, in particular those related to building and urban design.

Climate-related Natural Disasters and Human Health

Climate change refers to “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods” (1). An increase of greenhouse gases (GHG) in the atmosphere has been regarded as of the main cause of global warming. The impact of climate change leads to not only a rise in the average temperature, but also extreme temperatures which are associated with weather / climate-related natural disasters. Examples of extreme weather / climate events include heat waves, cold air outbreaks, tropical cyclones, heavy rainstorms and wind storms, prolonged droughts and ocean storm surges. Changing of climate leads to alteration of frequencies, intensity, spatial extent, duration, and timing of extreme weather and climate, e.g. heavy precipitation will become more likely, increasing the frequency of flooding; average tropical cyclone maximum wind speed will increase, leading to more intense storms; droughts will intensify in some seasons and areas due to increased evapotranspiration (2). While extreme events may not take place often, any occurrence could cause tremendous damage and disruptions, and will lead to surge capacity needs of health systems and increase the burden on urban infrastructures.

Climate changes are expected to continue in the next few decades and these changes pose major health and emergency threats to global population. The World Health Organization (WHO) estimates that climate change will lead to an additional 250,000 potential deaths per year between 2030 and 2050, and calls **climate change “the defining issue for health systems in the 21st century”** (3). In 2015, international experts from multidisciplinary background reached the conclusion that the effects of climate change “represent an **unacceptably high and potentially catastrophic risk to human health**” (4).

Climate-related Health Threats for Hong Kong Population

Latest global research findings have indicated the adverse health impacts of climate change and global health policies (**Box 1**) have regarded **climate change as one of the core public health threats to human security and public health well-being for the 21st century**.

Box 1. International Treaties and Bodies Related to Climate Change and Health

UNFCCC: The United Nations Framework Convention on Climate Change (UNFCCC) is the single most important international treaty to combat climate change. Specifically, *Article 7* commits all parties to employ appropriate methods to minimize effects of climate change on public health.

Sendai Framework for Disaster Risk Reduction 2015 – 2030: Climate change has played an increasing role in inducing and exacerbating disasters, e.g. drought, storms, hurricanes. “Climate change” thus is considered as one of the drivers of disaster risk in the Sendai Framework, and global communities are urged to include various climate change scenarios in their disaster risk assessments and their related policies / programmes planning.

Sustainable Development Goals (2015-2030): Among the 17 Sustainable Development Goals (SDGs) advocated by United Nations Development Programs (UNDP) and its partners, climate change has been regarded a major global challenge and the agenda has referenced across most of its development commitments till 2030. *Goal 13* commits all countries to take urgent action to combat climate change and its impacts. *Goal 3* calls for the strengthening of national capacity for early warning, risk reduction and management of national and global health risks; and the number of deaths and illnesses from air, water and soil pollution be substantially reduced by 2030.

IPCC: The Inter-governmental Panel on Climate Change (IPCC) publishes regular assessment reports relevant to the understanding of climate change regularly, involving thousands of scientists from all over the world. IPCC predicts that climate change will exacerbate existing health problems, increase the number of ill-health in many regions, especially in developing countries, and by 2100, even common human activities will be compromised, including growing of food and working outdoors (34).

WHO: WHO has since 2009 developed a global Work Plan to support member states in climate change and health protection. The four objectives of the latest Work Plan on Climate Change and Health 2014-2019 are to (a) advocate and raise awareness; (b) strengthen partnerships; (c) enhance scientific evidence; and (d) strengthen health system.

Local studies (**Table 1**) reported that Hong Kong, a major global metropolis, has already been experiencing climate change related impacts such as ambient temperatures abnormalities, frequency increases in extreme climate events (tropical cyclones and rainstorm surges), and the mounting pressure to intensify vector borne disease control with the changes of weather patterns. As a densely-populated coastal city with sub-tropical climate, Hong Kong will need to gather more evidence and review in current policies and plans in order to protect its community from the challenges associated with the local specific climate change impacts in health.

Table 1. Summary of Major Health Impact Associated with Climate Change in Hong Kong

<i>Climate Changes in Hong Kong in the 21st Century (5)</i>	<i>Threats/ Pathways</i>	<i>Health Impacts</i>
Temperatures: <ul style="list-style-type: none"> • Annual mean temperature to rise by 3 to 6 °C • Extreme temperature events (cold spell / heat wave) 	<ul style="list-style-type: none"> • Very hot days, heat waves • Cold spell • Flooding • Landslides • Drain backflow • Storm surge • Cyclones • Exacerbation of effects of air pollution • Altered survival patterns of vectors • More active pathogens • Potential implication of the stability of life-line infrastructure in urban settlements • Disruption of access to regular health services. 	(a) Temperature-related illnesses: e.g. heat cramps, heat exhaustion, heatstroke, hyperthermia, hypothermia (b) Non-communicable diseases: e.g. cardiovascular disease, respiratory disease, skin cancer (c) Communicable diseases: e.g. vector-borne diseases (dengue fever, Japanese encephalitis, malaria), food / water-borne diseases (cholera, <i>Salmonella</i> poisoning), diarrheal diseases, skin related diseases
Precipitation: <ul style="list-style-type: none"> • Annual rainfall to rise by about 180mm • Extremely wet years to increase from 3 to 12 		
Sea level: <ul style="list-style-type: none"> • Annual mean sea level to rise by 0.63 to 1.07m 		(d) Physical injuries in extreme events: e.g. trauma, crush injury of fallen debris, drowning
Extreme weather events: <ul style="list-style-type: none"> • Storm surges brought by tropical cyclones will increase • Urban flooding as a result of inadequate drainage 		(e) Mental health impact associated with extreme events: e.g. stress, anxiety, depression, post-traumatic stress disorder

(a) Temperature-related Discomfort, Mortality and Morbidity

Based on data from 1979 to 2010, notable increase in the frequency, number of heat waves days, duration and severity of heat waves, and average daily maximum temperature in periods before and after the onset of rainy season over Indochina Peninsula were found (6), and a marked increase in the severity (up by 1°C), duration (prolonged by a factor of 2-3), frequency (by a factor of almost 3) and number of heat waves days per year (to rise steeply by a factor of 3-4) has been projected in East Asia during the 21st century (7).

Box 2. Some Facts on the Scale and Urgency of Climate-related Health Burden Faced by Hong Kong

- Hong Kong has one of the world's highest average increase of urban ambient temperature during the past century (8).
- 2015 has seen the highest annual mean temperature in Hong Kong since 1885 (32), and the Hong Kong Observatory (OHK) predicts that annual mean temperature will rise by 3 to 6 °C in the 21st century (5).
- A study conducted by CUHK found that an average 1°C increase in daily mean temperature above 28.2°C was associated with an estimated 1.8% increase in mortality (8).
- The monthly mean temperatures from June to September in the past two years (2014 and 2015) are all above 28.2 °C (33).

Elevated temperatures and more frequent and prolonged hot days may induce health complications, e.g. heatstroke, heat exhaustion, worsened chronic conditions etc. For Hong Kong, a significant correlation between higher temperatures and the number of deaths has been identified: ***an average 1°C increase in daily mean temperature above 28.2°C was associated with an estimated 1.8% increase in mortality***, and cardiovascular and respiratory infection-related deaths were more sensitive to high temperature effects (8). Urban heat island is apparent in Hong Kong: ***a 1°C rise above 29°C was associated with a 4.1% increase in natural mortality in areas with high urban heat island index (UHII) but only 0.7% increase in low UHII areas***, exuberated by wind speed (9). Hospital admissions were found to increase during extreme temperatures, with elevated temperature affecting morbidity to a greater extent than cold: ***hospital admission rate rose by 4.5% for every increase of 1°C above 29°C, and 1.4% for every decrease of 1°C within the 8.2-26.9°C range, with children and elderly being especially vulnerable*** (10).

(b) Non-communicable Diseases: Impact of Air Quality on Respiratory and Cardiovascular Health

Weather conditions significantly affect air quality, in particular, warmer temperatures increase atmospheric concentrations of ground-level ozone and particulate matter (PM) (11), exposing the community to higher risk of cardiovascular and respiratory illnesses. More stagnant air also means worsening of air quality due to lower dispersion effect. A study on the Pearl River Delta region predicts that when stable condition occurs, air stagnation is going to be more extreme in future, leading to more severe air pollution (12).

Local research indicated that **higher daily ozone levels were strongly associated with higher short-term mortality in Hong Kong, especially for respiratory and cardiovascular mortality** (13), and heart disease hospitalization in Hong Kong rose by 1.1% with a 10ppb increase in nitrogen dioxide (NO₂) level (14). Study on the lung functions of local children found that **lung functions of primary-school-age boys in high pollution district were significantly lower than those in low pollution district**, e.g. 8.4% lower as measured by forced expiratory flow at 75% of forced vital capacity; and PM₁₀ was the primary pollutant responsible for the lung function deficit (15). Further research has confirmed certain adverse health effects on local children's respiratory system from long-term exposure to ambient air pollution, in particular **significantly higher risk for coughing at night and phlegm without cold for girls**, marginal significance for elevated risk for asthma, wheezing and phlegm without cold for boys (16). Beside respiratory health, it was found that the **cardiorespiratory fitness of children in high pollution district was significantly poorer than those in low pollution district, with the situation slightly more serious for girls** (17).

(c) Communicable Diseases: Vector-borne and Food / Water-borne Diseases

Vector-borne Diseases

Disease vectors are sensitive to climate conditions, and in general, higher temperature and heavier rainfall create favorable conditions for the vector to survive and transmit diseases. Hong Kong population is susceptible to vector-borne diseases (VBDs) such as dengue fever, Japanese encephalitis, malaria, scrub typhus and spotted fever (18). Although there is currently no research data available to understand the impact of weather changes towards the various aspects of vector borne diseases in Hong Kong, published research results in Mainland China which based on 670 locations evenly distributed across the country indicated that environmental variables suitable for malaria transmission had shifted northwards, whereas transmission intensity in the central part of the country had increased due to prolonged suitable periods (19) (20).

In Hong Kong, it has been projected that **there would be less rainfall from February to May and more rainfall from June to November, and there would be higher possibility in extremely low rainfall (below 100mm) and extreme high rainfall (above 800mm)** (21). Such changes in rainfall pattern, together with projected rise in temperatures, are bound to push up the number of vector-borne infection cases in Hong Kong. In fact, the number of dengue fever cases in Hong Kong has been on a rise in the last five years, from 30 cases in 2011 to 114 cases in 2015 (280% increase) (22).

Food / Water-borne Diseases

Foodborne disease may cause by ingestion of foodstuffs contaminated with microorganisms (e.g. *Salmonella*) or chemicals (e.g. pesticides), and is mostly associated with gastrointestinal symptoms (e.g. diarrhea) (23). Similarly, waterborne disease is caused by ingestion of water

contaminated pathogens, or through other fecal-oral routes (e.g. cholera) (20). Environmental effects of climate change may affect the level of pathogens and chemicals in food and water, e.g. warm weather encourages growth of *Salmonella* in food and planktonic organisms in water, heavy rainfall leads to contamination of drinking water system (24). The most important mechanisms to prevent them are to have the relevant and appropriate surveillance and response system in place. Currently, there are limited scientific reports on the impact of how climate change might have affected food / water-borne disease patterns in Hong Kong. Urgent review of data and evidence will be needed to examine how current health protection measures and programmes in Hong Kong (such as the Prevention and Control of Disease Ordinance (Cap 599), the *Salmonella* Surveillance Programme of the Department of Health, the Food Surveillance Programme of the Centre for Food Safety) should be enhanced to support preparedness and emergency response for the potential but imminent health threats in the decades to come.

(d) Physical Injuries

Physical injuries are often resulted and associated with climate-related disasters or extreme weather events, e.g. drowning, injuries sustained from walking or driving through flood water, injured by collapsed or damaged building, crushed, cut or struck during storm, traffic accidents resulted for poor road conditions and landslides. In urban cities such as Hong Kong, major incidents with multiple casualties are likely to occur when extreme events were to happen to the high-density based human habitat (e.g. if landslide may occur in residents who reside near to slopes) as well as the population vulnerability to the secondary impacts of climate change (flooding post rainfall or fire post heat wave in its underground life-line infrastructures (water and sewage, gas-pipes, electricity telecommunication lines etc.). To protect the community from the expected increases of extreme weather events in the coming decades, better understanding of injuries patterns, estimation of health and service need estimations, relevant contingency plans, increase of health response surge capacity and community resilience building towards emergency health impact would be necessary to minimized physical harm that are caused by climate change.

(e) Mental Health Impact

Extreme weather conditions and weather-related disasters, e.g. flooding and storms, may induce extra stress on those who are suffering for underlying mental illness and associated disaster and emerging incidents that may also bring about new cases of anxiety, disaster-related psychiatric trauma, depression, aggression, which have both short-term and long-term impact (20 p. 732). In order to better supporting Hong Kong's ability to address mental health needs associated with climate change related incidents, urgent research evidence will be needed to understand how various climate change aspects might direct and indirectly affect mental well-being.

Recommendations

From recent research evidence, climate change has posed major impacts and health threats to population in Hong Kong. Effective public health protection measures and an **overall technical review of the climate readiness of the health system in Hong Kong are called for, based on the WHO's "six building blocks" Health Systems Framework (Box 3)** (25) (26). It should be emphasized that health measures alone are not able to address all climate-related health impacts and it takes multidisciplinary collaboration and actions to address climate and environmental challenges in urban settings, a key aspect of a comprehensive response is related to **building and urban design** should be considered.

In particular, the following actions are recommended –

- ***Building Block 1: Health Services: Make use of exiting scientific literature related to climate change impact on the health of population in Hong Kong to support policy development.*** Identifying local specific temperature thresholds (in both hot and cold weather) that might significant increased mortality and morbidity. This policy related research findings might allow the HKSARG to make evidence-based decision on how to reorganize and implement relevant public health, medical, education and social services at the community level ensure services are relevance, appropriate, equitable and cost-effectiveness. New service modalities such as outreach services and home visits for elderly, especially those who live alone or with chronic medical conditions, public venues should be utilized to open cooling centres.
- ***Building Block 1: Health Services: Review and upgrade contingency plans of hospitals and clinics and build up their surge capacities to cope with climate-related health threats.*** Data on

Box 3. WHO's Health Systems Framework

Building Block 1: Health services

Health services should be effective, safe, quality personal and non-personal health interventions, and be provided to those that need them, when and where needed, with minimum waste of resources.

Building Block 2: Health workforce

A well-performing health workforce is one that is responsive, fair and efficient to achieve the best health outcomes possible.

Building Block 3: Health information system

A well-functioning health information system is one that ensures the production, analysis, dissemination and use of reliable and timely information on health determinants, health system performance and health status.

Building Block 4: Medical products, vaccines and technologies

There should be equitable access to essential medical products, vaccines and technologies of assured quality, safety, efficacy and cost-effectiveness.

Building Block 5: Financing system

A good health financing system raises adequate funds for health, in ways that ensure people can use needed services, and are protected from financial catastrophe or impoverishment associated with having to pay for them.

Building Block 6: Leadership and governance

Leadership and governance involves ensuring strategic policy frameworks exist and are combined with effective oversight, coalition-building, regulation, attention to system-design and accountability.

temperature-related mortality, morbidity/ hospital admission rates, extreme weather events identified above should be taken into account, so as to ensure the overall resilience of the health system in the face of increasingly frequent and intense extreme weather events, e.g. heatwave of over 40°C lasting for several days, intense and prolonged rainstorm causing casualties and waterborne diseases.

- **Building Block 2: Health Workforce: *Train and sensitize our health workforce and non-health professionals the health impacts of climate change.*** The relevant training should cover core concepts to enable common terminology, technical skills to quantified population health risks and capacity building for health and climate change programme development. Monitoring of implementation of health related programme and regular evaluation of climate change programme impact on health are important to ensure knowledge transfer across multi-dimensional stakeholders.
- **Building Block 3: Health Information System: *Develop targeted weather warning system to facilitate self-help and care behavior in the community during extreme temperature / weather days.*** The current “very hot weather warning” of Hong Kong in general population should be upgraded to a comprehensive early heat health warning system, with special attention given the mode of communications, specific health risk content in warning efforts to media strategies that might be relevant to the specific target groups. Referenced might be made to similar systems adopted in other parts of the world, and to the heat-health warning system guidelines jointly published by WHO and World Meteorological Organization (WMO) (27). Research is also urgently needed to understand the current behavioral pattern related to how Hong Kong community perceives their health risks, their emergency responses and adaptation behaviors (28) (29).
- **Building Block 4: Technologies: *Introduce tighter regulations and guidelines on urban greening, urban spaces and naturally ventilated buildings.*** Regulations and guidelines on (a) intensifying urban greening and tree planting, and better micro-climatic design of urban spaces; (b) greener, more energy-efficient and naturally ventilated building should be introduced to promote well-being of population. For Hong Kong, ground level tree planting is recommended as the main green strategy and the greening coverage must be over 30% for the air temperature at pedestrian level to be lowered by 1°C (30). Local researchers have developed the frontal area density map and urban wind permeability map of Hong Kong for city planners to assess air ventilation situation at an early stage of their design (31).
- **Building Block 5: Financing System: *Integrate the public health measures against climate-related health threats into existing health care system*** and have them supported by public funds. Government central funding should be considered to support contracting out of certain service provisions (e.g. outreach service for elderly) and to allow financial incentives to encourage application of certain health protecting technologies in private sector (e.g. building designs).
- **Building Block 6: Leadership and governance: *Support cross-discipline researches on climate change and health with practical implications for Hong Kong.*** Concerted efforts across different government departments and civil society are necessary to address the health effects of climate change and the Hong Kong government should provide the necessary leadership and support. To facilitate knowledge transfer of the latest scientific findings and their better incorporation into government policies and actions, an on-going and cross-bureaus “government-academic” dialogue at the Chief Secretary level of the Hong Kong government should be established.

References

1. United Nations Framework Convention on Climate Change. Fact sheet: Climate change science - the status of climate change science today. 2011.
2. Field CB, editor. Managing the Risks of Extreme Events and Disasters to Advance Climate Change adaptation: Special Report of the Intergovernmental Panel on Climate Change. Cambridge University Press; 2012 May 28.
3. World Health Organization. Put Health at the Center of the Climate Agreement [Internet]. [cited 2016 July 26]. Available from: <http://www.who.int/globalchange/publications/didyouknow-health-ministers.pdf?ua=1>
4. Watts N, Adger WN, Agnolucci P, Blackstock J, Byass P, Cai W, Chaytor S, Colbourn T, Collins M, Cooper A, Cox PM. Health and climate change: policy responses to protect public health. *The Lancet*. 2015 Nov 7;386(10006):1861-914.
5. Hong Kong Observatory. Hong Kong in a warming world [Online]. 2015 [cited 2016 July 26]. Available from :https://www.google.com.hk/search?q=Hong+Kong+in+a+warming+world&gws_rd=ssl.
6. Luo M, Lau NC and Cheung CC. Synoptic characteristics of heat waves over the Indochina. Paper presented at American Geophysical Union Chapman Conference; 2015; Hong Kong SAR, China.
7. Lau, Ngar-cheung. In: Chang Chih-Pei, editor. Heat waves over East Asia: Model Simulation of Synoptic Characteristics and Projections for the 21st Century. World Scientific, Forthcoming. (World Scientific Series on Asia-Pacific Weather and Climate).
8. Chan EYY, Goggins WB, Kim JJ, Griffiths SM. A study of intracity variation of temperature-related mortality and socioeconomic status among the Chinese population in Hong Kong. *Journal of Epidemiology and Community Health*. 2012 Apr;66(4):322–7. Available from: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3292716&tool=pmcentrez&rendertype=abstract>
9. Goggins WB, Chan EYY, Ng E, Ren C, Chen L. Effect modification of the association between short-term meteorological factors and mortality by urban heat islands in Hong Kong. *PLoS ONE*. 2012; 7(6): e38551. doi:10.1371/journal.pone.0038551
10. Chan EYY, Goggins WB, Yue SK, Lee PY. Hospital admissions as a function of temperature, other weather phenomena and pollution levels in an urban setting in China. *Bulletin of World Health Organization*. 2013 August 1; 91(8): 576–584. doi: 10.2471/BLT.12.113035
11. Crimmins A, Balbus J, Gamble JL, Beard CB, Bell JE, Dodgen D, Eisen RJ, Fann N, Hawkins MD, Herring SC. The impacts of climate change on human health in the United States: a scientific assessment. Washington, DC: US. Global Change Research Program. 2016.
12. Cheung CC and Yim SHL. Projecting the impacts of climate change on air quality using statistical downscaling of atmospheric stability indices: a case study in Pearl River Delta. Paper presented at 5th International Workshop on Climate Informatics; 2015 September 24-25; Boulder, United State.

13. Goggins WB, Chan EYY, Yang CY, Chong M. Associations between mortality and meteorological and pollutant variables during the cool season in two Asian cities with sub-tropical climates: Hong Kong and Taipei. *Environmental Health*. 2013 Jan;12(1):59. doi:10.1186/1476-069X-12-59
14. Goggins WB, Chan EYY, Yang CY. Weather, pollution, and acute myocardial infarction in Hong Kong and Taiwan. *International Journal of Cardiology*. 2013 Sep 20;168(1):243–9. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/23041014>
15. Gao Y, Chan EY, Li LP, He QQ, Wong TW. Chronic effects of ambient air pollution on lung function among Chinese children. *Archives of disease in childhood*. 2013 Feb 1;98(2):128-35.
16. Gao Y, Chan EY, Li L, Lau PW, Wong TW. Chronic effects of ambient air pollution on respiratory morbidities among Chinese children: a cross-sectional study in Hong Kong. *BMC public health*. 2014 Feb 3;14(1):1.
17. Gao Y, Chan EY, Zhu Y, Wong TW. Adverse effect of outdoor air pollution on cardiorespiratory fitness in Chinese children. *Atmospheric environment*. 2013 Jan 31;64:10-7.
18. Centre for Health Protection, Department of Health. Vector-borne Diseases [Internet]. 2016. [cited 2016 August 3]. Available from: <http://www.chp.gov.hk/en/content/9/24/34622.html>.
19. Yang GJ, Tanner M, Utzinger J, Malone JB, Bergquist R, Chan EY, Gao Q, Zhou XN. Malaria surveillance-response strategies in different transmission zones of the People's Republic of China: preparing for climate change. *Malaria journal*. 2012 Dec 21;11(1):1.
20. Wong PP, Losada IJ, Gattuso JP, Hinkel J, Khattabi A, McInnes KL, Saito Y, Sallenger A. Climate change 2014: impacts, adaptation, and vulnerability. Part A: global and sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. United Kingdom and New York, NY, USA. 2014:361-409.
21. Cheung CC, Hart AM and Peart MR. Projection of future rainfall in Hong Kong using logistic regression and generalized linear model. Paper presented at 5th International Workshop on Climate Informatics; 2015 September 24-25; Boulder, United State.
22. Centre for Health Protection, Department of Health. Number of notifiable infectious diseases by month [Internet]. [cited 2016 August 5]. Available from: <http://www.chp.gov.hk/en/data/1/10/26/43/3829.html>
23. World Health Organization. Foodborne diseases [Internet]. [cited 2016 August 4]. Available from: http://www.who.int/topics/foodborne_diseases/en/
24. Vardoulakis S, Heaviside C. Health Effects of Climate Change in the UK 2012: Current evidence, recommendations and research gaps. Health Protection Agency. UK.
25. World Health Organization. Everybody business : strengthening health systems to improve health outcomes : WHO's framework for action [Internet]. 2007 [cited 2016 August 2]. Available from: http://www.who.int/healthsystems/strategy/everybodys_business.pdf

26. World Health Organization. Monitoring the building blocks of health systems: a handbook of indicators and their measurement strategies [Internet]. 2010 [cited 2016 August 2]. Available from: http://www.who.int/healthinfo/systems/WHO_MBHSS_2010_full_web.pdf
27. World Health Organization and World Meteorological Organization. Heatwaves and health: guidance on warning-system development [Internet]. 2015 [cited 2016 July 25]. Available from: http://www.who.int/globalchange/publications/WMO_WHO_Heat_Health_Guidance_2015.pdf?ua=1
28. Chan EYY, Goggins WB, Kim JJ, Griffiths SM, Ma TK. Help-seeking behavior during elevated temperature in Chinese population. *Journal of Urban Health*. 2011 Aug; 88(4):637–650. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21761264>
29. Chan EYY, Kim JH, Lee PYY, Lin CLY. 2011. Analysis of health risk perception and behavior changes during elevated temperatures for an urban Chinese population. *Prehosp Disaster Med*. 2011;26(Suppl.1):s26. doi:10.1017/S1049023X11000914
30. Ng E, Chen L, Wang Y, Yuan C. A study on the cooling effects of greening in a high-density city: an experience from Hong Kong. *Building and Environment*. 2012 Jan 31;47:256-71.
31. Ng E, Yuan C, Chen L, Ren C, Fung JC. Improving the wind environment in high-density cities by understanding urban morphology and surface roughness: a study in Hong Kong. *Landscape and Urban Planning*. 2011 May 15;101(1):59-74.
32. Hong Kong Observatory. Ranking of air temperature and rainfall in Hong Kong [Internet]. [cited 2016 July 25]. Available from: <http://www.hko.gov.hk/cis/statistic/erank13.htm>
33. Hong Kong Observatory. Daily extract of meteorological observations [Internet]. 2015 [cited 2016 July 25]. Available from: http://www.hko.gov.hk/cis/dailyExtract_e.htm?y=2016&m=07
34. Pachauri RK, Allen MR, Barros VR, Broome J, Cramer W, Christ R, Church JA, Clarke L, Dahe Q, Dasgupta P, Dubash NK. Climate change 2014: synthesis Report. Contribution of working groups I, II and III to the fifth assessment report of the intergovernmental panel on climate change. IPCC; 2014.