

Health Impacts and Spatial Pattern of Extreme Hot Weather in Hong Kong

香港極端酷熱天氣對健康的影響及其空間分佈

Dr. Kevin Ka-Lun LAU
Institute of Future Cities,
The Chinese University of Hong Kong



香港中文大學
The Chinese University of Hong Kong

Dr. Chao REN
Faculty of Architecture,
The University of Hong Kong



香港大學
THE UNIVERSITY OF HONG KONG

Increasing the resilience to the health impacts of extreme weather on elderly people under future climate change

在未來的氣候變化下，增強極端天氣對老年人健康影響的應變能力

- Three major aspects 研究的三大範疇
 - Future climate data to take into account urbanization effect
 - 考慮城市化影響的未來氣候數據
 - Mitigation through urban planning and design
 - 透過城市規劃及設計制定減緩措施
 - Adaptation to extreme hot weather by social services
 - 提供社會服務及支援以適應極端酷熱天氣



政府間氣候變化專門委員會（**IPCC**）在2012年的極端事件特別報告中指出：

21世紀大多數地區，**熱浪的長度，頻率和/或強度**均可能會**增加**。

The length, frequency and/or intensity of heatwaves would likely increase over most land areas in the 21 century.



Climate countdown
Climate change

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About this content

Oliver Milman in New York

@olliemilman

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4,851

Rising temperatures will cause more deaths than all infectious diseases - study

Poorer, hotter parts of the world will struggle to adapt to unbearable conditions, research finds



▲ A woman drinks as children cool off in a public fountain in Milan, Italy, on 31 July. 2020 is set to be hottest or second hottest on record, in line with the longer-term trend of rising temperatures. Photograph: Luca Bruno/AP

The growing but largely unrecognized death toll from rising global temperatures will come close to eclipsing the current number of deaths from all the infectious diseases combined if planet-heating emissions are not constrained, a major new study has found.

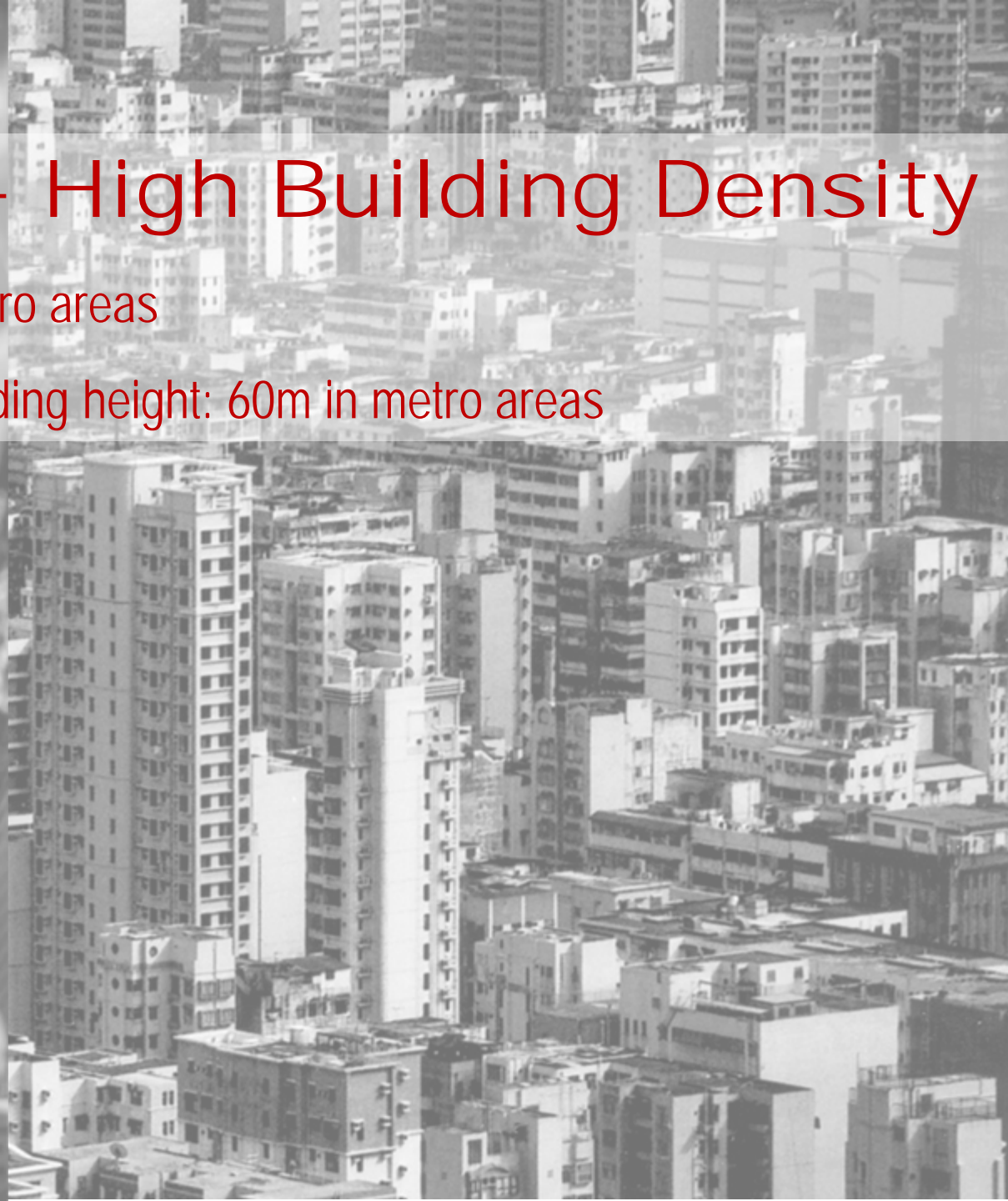
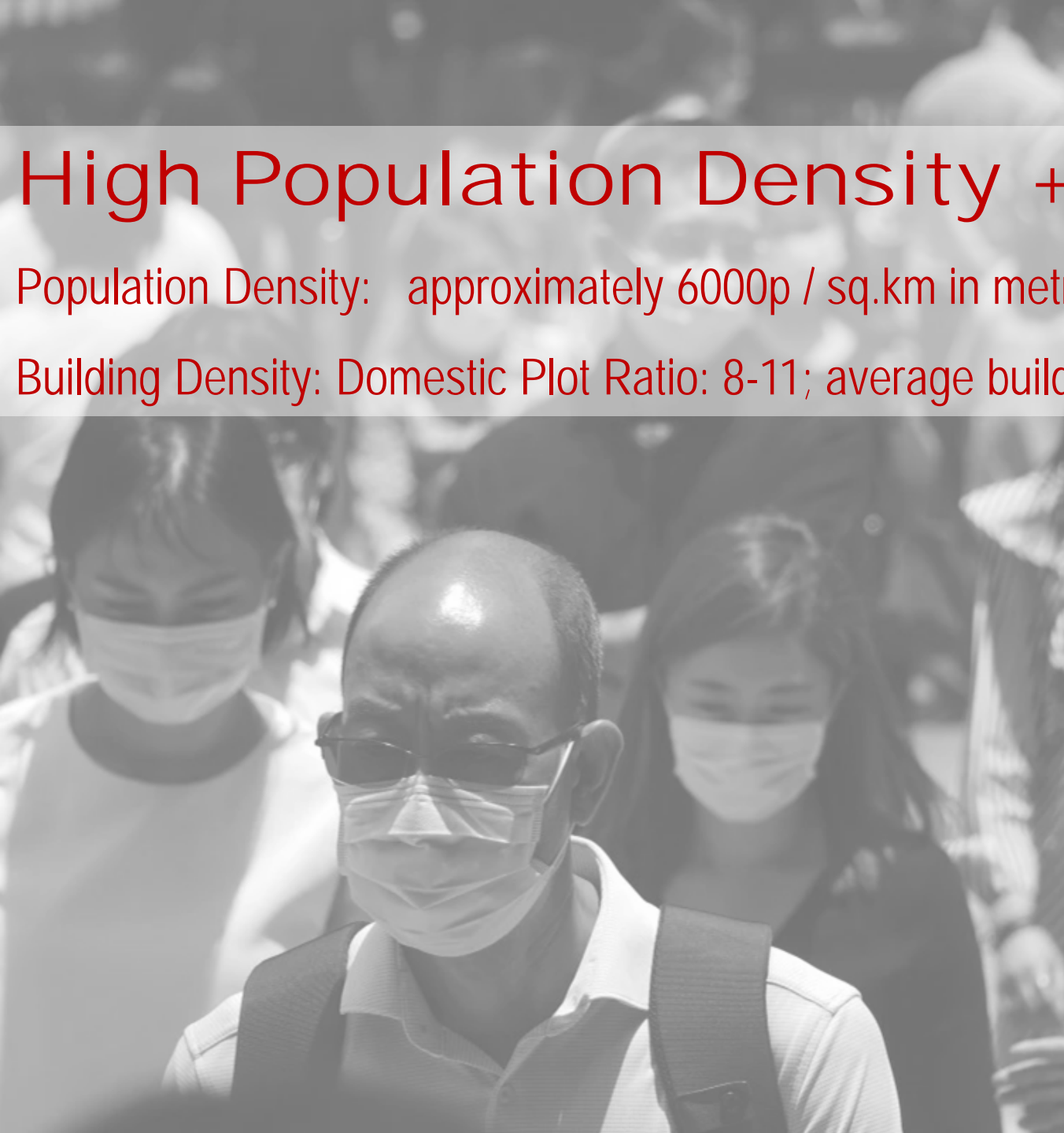
Rising temperatures are set to cause particular devastation in poorer, hotter parts of the world that will struggle to adapt to unbearable conditions that will kill increasing numbers of people, the research has found.

We need to understand the risk and invest to mitigate that risk, before we really start to notice the impacts.

High Population Density + High Building Density

Population Density: approximately 6000p / sq.km in metro areas

Building Density: Domestic Plot Ratio: 8-11; average building height: 60m in metro areas



Built Environment vs Environmental Problems

Low urban air volume
High surface temperature

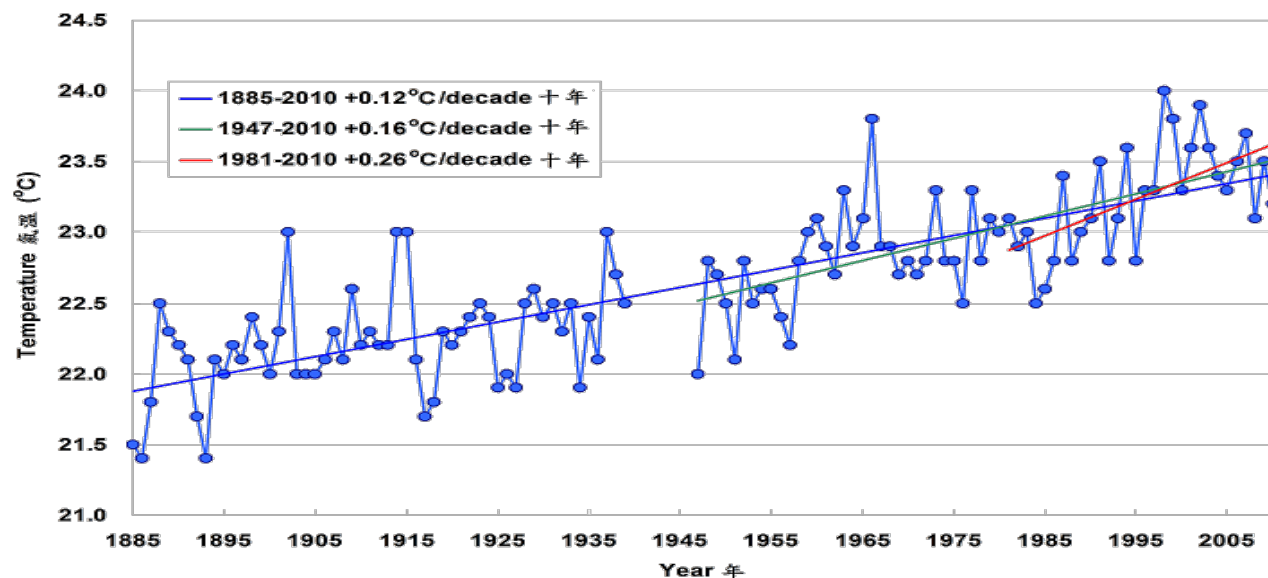
Low sky view

No shading

No greenery

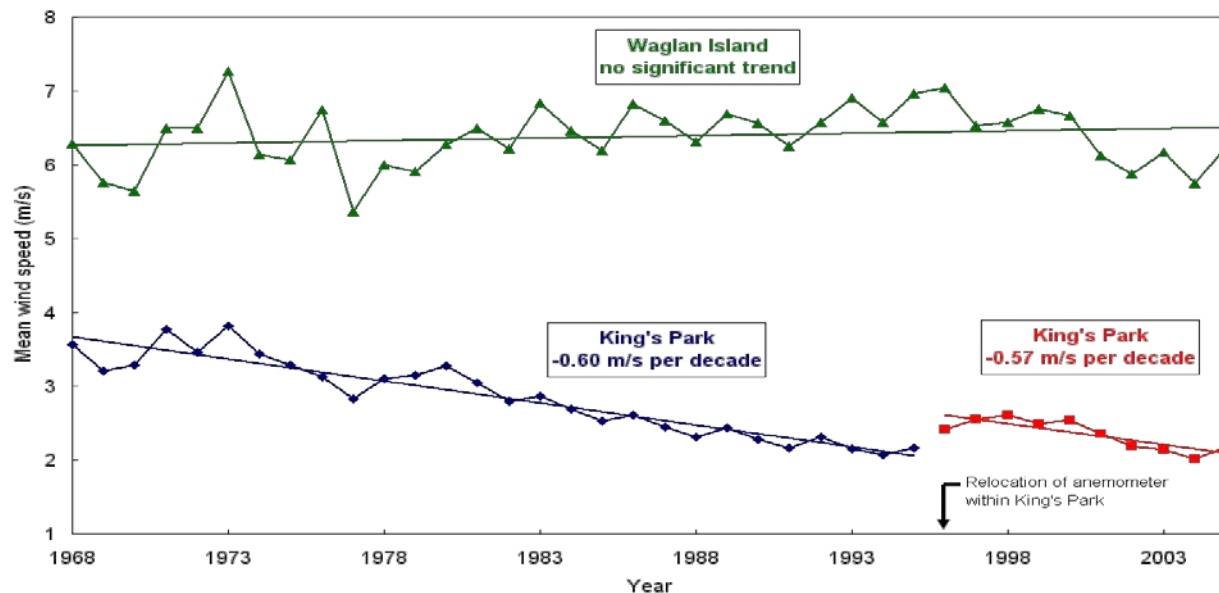
poor Air Ventilation
hotter urban environment
heat stress
hot air cannot escape
heat cannot radiate out
direct sunlight
hotter urban environment
reduced evapotranspiration
hotter urban environment

Hot, but ~~Less~~ No Wind



Accelerating Increase in Urban Temperatures

- 1947 to 2010: $\uparrow 0.16^{\circ}\text{C}$ per decade
- 1981 to 2010: $\uparrow 0.26^{\circ}\text{C}$ per decade



Deteriorating Urban Wind

- Waglan Island: No significant trend
- King's Park: $\downarrow 0.60\text{m/s}$ per decade

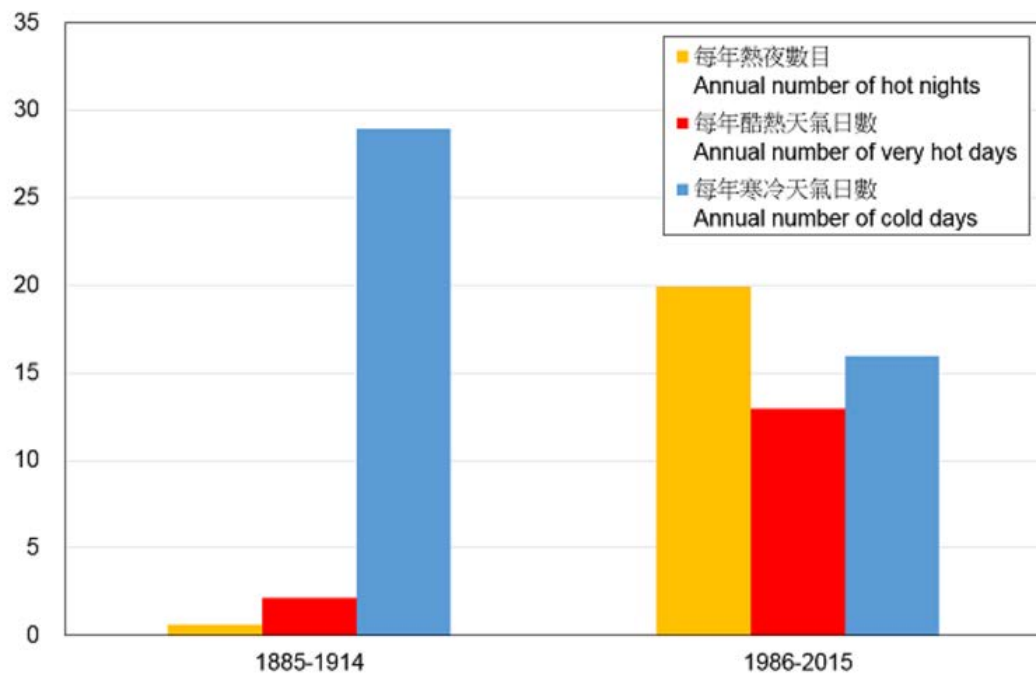
Extreme Hot Weather in Hong Kong

香港急速的城市化和氣候變化導致更頻密的極端酷熱天氣，例如**酷熱日**及**熱夜數目**。

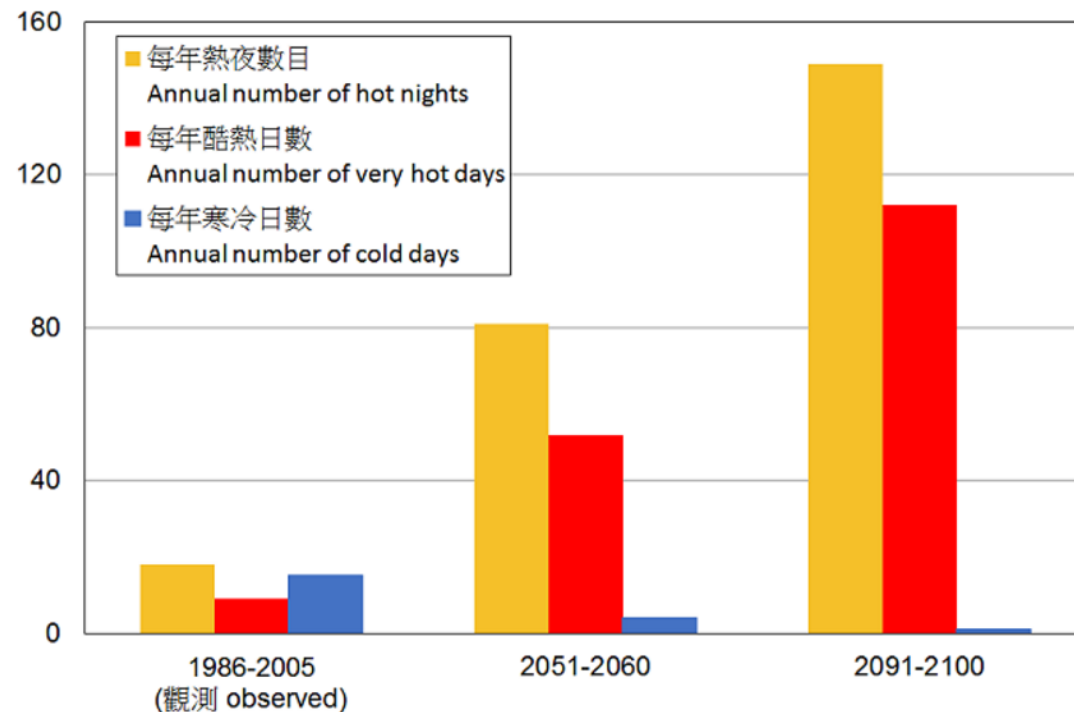
Rapid urbanization in Hong Kong and climate change have led to more frequent extreme weather events such as very hot days and hot nights.

預計未來出現**極端酷熱天氣**的日子將會更加**頻繁**。

Extreme hot weather are also expected to substantially increase in the future.

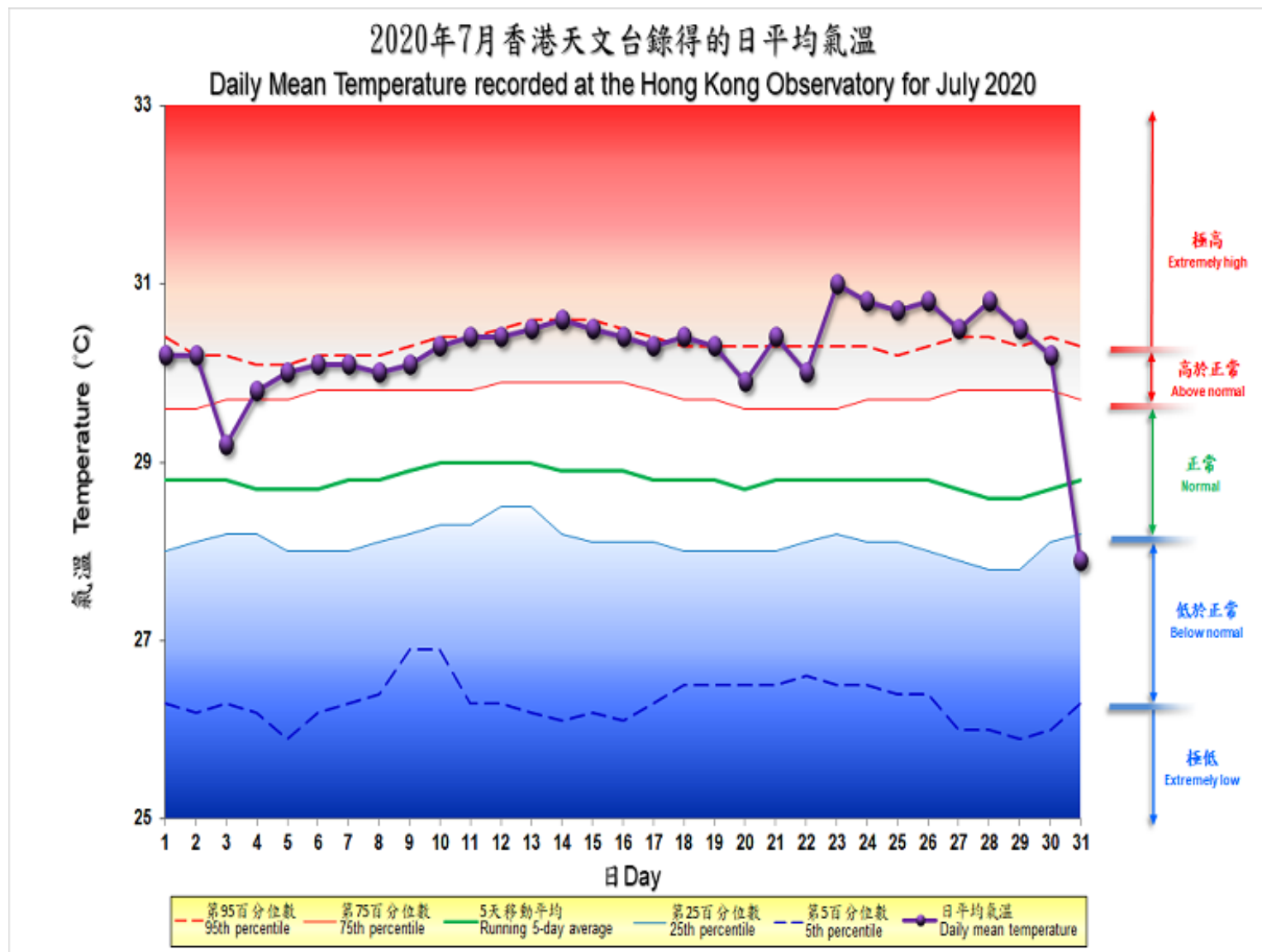


Changes in the annual number of hot nights, very hot days and cold days in Hong Kong



Projected annual number of hot nights, very hot days and cold days in Hong Kong under the high greenhouse gas concentration scenario

Extreme Hot Weather in July 2020



Source: The Weather of July 2020. <https://www.hko.gov.hk/tc/wxinfo/pastwx/mws2020/mws202007.htm>



來源: 香港天文台Facebook專頁

Risk Assessment for the Prevention of Heat Stroke at Work



Occupational Safety and Health Branch
Labour Department



衛生防護中心
Centre for Health Protection

Non-Communicable Diseases Watch

Volume 4 Number 6 June 2011

Health Tips

To stay healthy in the heat, we should take heed of the hot weather warning issued by the Hong Kong Observatory, take appropriate precautionary measures and follow the heat avoidance advice as given by the health authorities, and recognize the symptoms of heat illnesses.

In this Issue

	Page
Be Aware of heat illnesses	1
News Bites	6
Data Brief	7

This publication is produced by the Surveillance and Epidemiology Branch, Centre for Health Protection of the Department of Health
18/F Wu Chung House
213 Queen's Road East
Wan Chai, Hong Kong
<http://www.chp.gov.hk>

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衛生署
Department of Health

Be Aware of Heat Illnesses

Heat illnesses (or heat-related illnesses) generally refer to the disorders caused by exposure to hot temperature. They include a spectrum of conditions that can go from milder forms of heat rash and heat cramps, to serious heat syncope, heat exhaustion and life-threatening heat stroke (Box 1). Because of climate change, heat illnesses have become a growing health problem in the world today. In Hong Kong, they are also a common concern, especially during the hot and humid summer months.

Vulnerable Population Groups

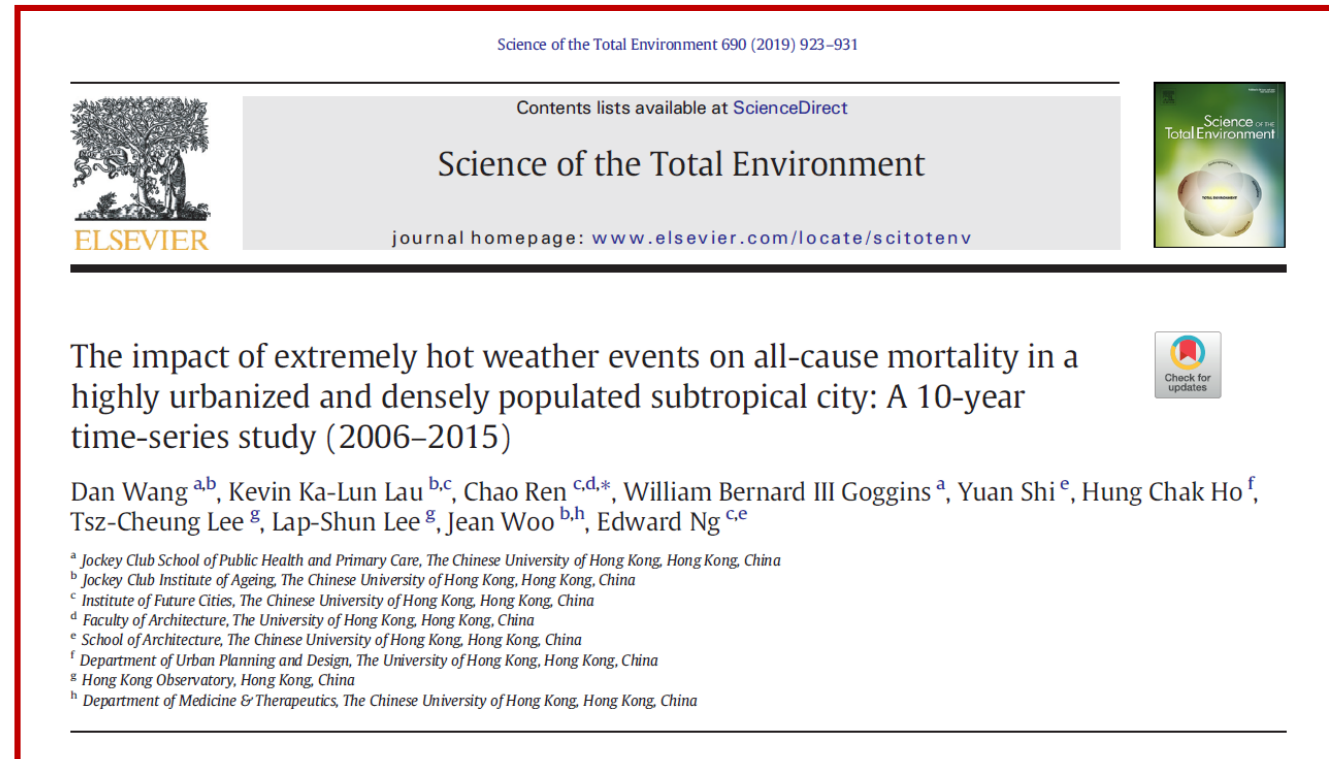
Normally, healthy individuals have effective heat regulatory mechanisms to maintain body temperature between 36°C and 38°C. When the body temperature rises above this range, the body responds by increasing blood flow to the skin and sweating to get rid of the excess heat. However, heat illnesses occur when the environment becomes so hot or when the body generates so much heat from physical activity that the body's regulatory responses are overwhelmed and cannot effectively cool down the body. While anyone at any time can suffer from heat illnesses when exposed in a hot environment, some people are at greater risk than others.

Elders are most vulnerable to suffer from heat illnesses due to a reduction in thermoregulatory capacity associated with ageing.¹ **Babies, young children and disabled individuals** are also particularly sensitive to the effects of high temperatures because of their reliance on others to regulate their thermal environments and for hydration. **People with chronic diseases** are at higher risk of heat-related morbidity and mortality because of impaired thermoregulatory ability.¹ A meta-analysis of six studies involving 1 065 heat wave-related deaths showed that during heat waves, the risk of death for people who were confined to bed and unable to care for themselves is about 6 times and 3 times that of the control subjects respectively. Pre-existing psychiatric illness tripled the risk of death, followed by cardiovascular (2.5-fold) and pulmonary (1.6-fold) diseases.² **Overweight and obese persons** tend to have impaired ability in sensing and losing heat so that they are more likely to have heat-related health problems. Studies showed that heat illnesses occurred approximately 3 times more frequently in overweight and obese adults than in individuals with optimal body weight.^{1,3}

Objective of the Study

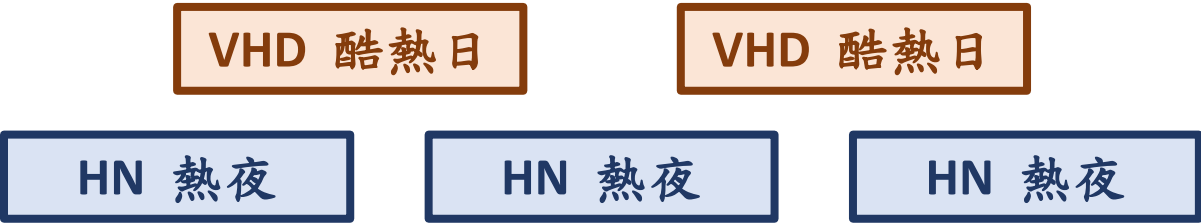
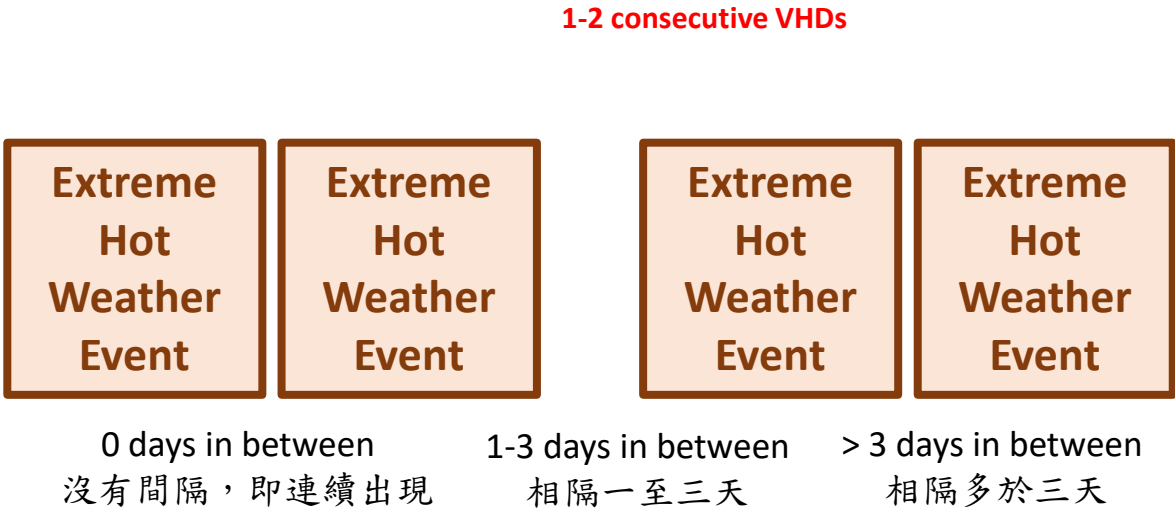
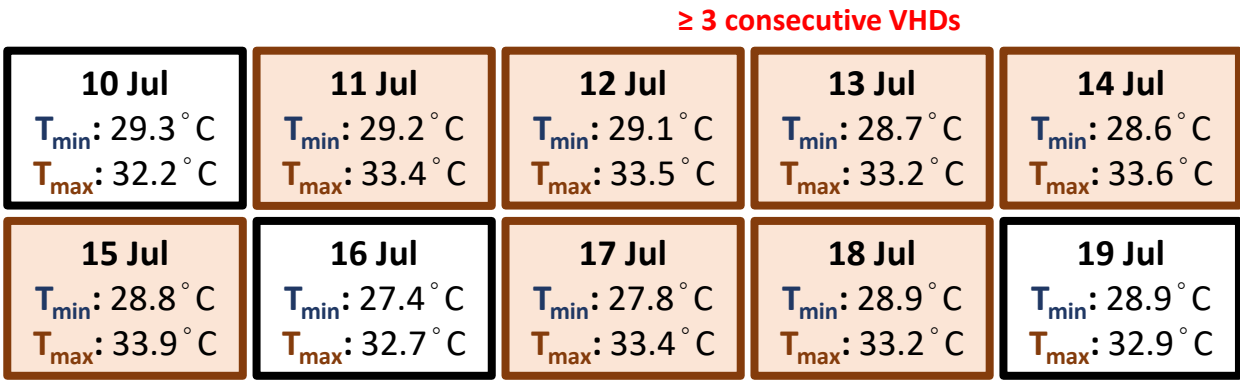
研究目的

- To evaluate the impact of different types, lengths, and occurrence timing of extreme hot weather on all-cause mortality
 - 評估不同類型、長度、出現時間的極端酷熱天氣對死亡風險的影響
- To identify the difference and interactive effect of extremely hot weather conditions between daytime and nighttime
 - 判定日間和夜間出現的極端酷熱天氣對死亡風險的不同和交互效應
- To determine vulnerable population during an extreme hot weather event
 - 找出於極端酷熱天氣時較受影響的群組
- To suggest a typical heatwave definition in Hong Kong and estimate its lagged effect on all-cause mortality
 - 為香港作出典型熱浪的定義，與及估計對死亡風險之滯後效應



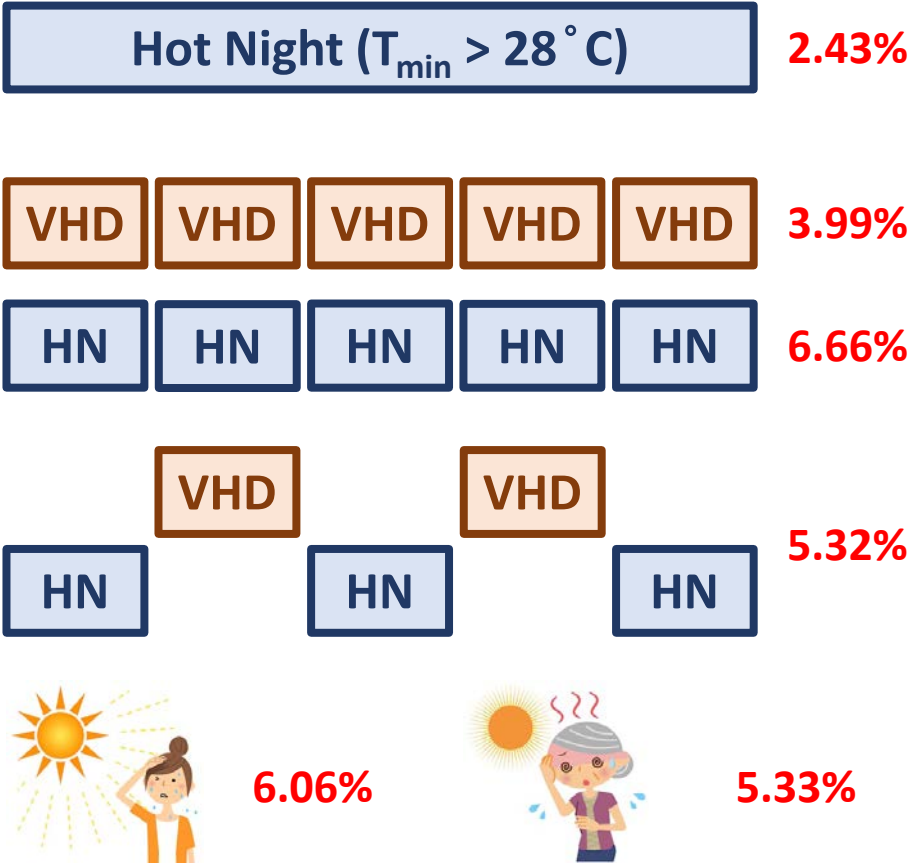
Methodology of the Study 研究方法

- Very Hot Day (VHD) 酷熱日
 - Daily $T_{max} \geq 33^{\circ}\text{C}$ 每天最高溫度攝氏33度或以上
- Hot Night (HN) 熱夜
 - Daily $T_{min} \geq 28^{\circ}\text{C}$ 每天最低溫度攝氏28度或以上
- Length 長度
 - 1-2 consecutive VHDs 連續一至兩天酷熱日
 - ≥ 3 consecutive VHDs 連續三天以上酷熱日
- Occurrence timing of a new “Extreme Hot Weather Event” 每次「極端酷熱天氣」出現時間
 - * Two consecutive VHDs as one EHWE 連續兩天酷熱日為一次極端酷熱天氣
 - 0 days in between 沒有間隔，即連續出現
 - 1-3 days in between 相隔一至三天
 - > 3 days in between 相隔多於三天
- Two consecutive VHDs with intermittent 0, 1, 2, 3 HNs 連續兩天酷熱日，而間歇出現 0, 1, 2, 3 天熱夜
 - 2D0N (30 times 次), 2D1N (37 times 次), 2D2N (44 times 次), 2D3N (47 times 次)



Findings of the Study 研究結果

- Increased mortality risk is relative to normal days.
酷熱天氣相對於一般日子所增加的死亡風險。
- Hot nights are associated with increased mortality risk (2.43%)
熱夜增加了2.43%的死亡風險。
- Prolonged heat events (≥ 5 days) are associated with higher mortality risk (3.99% for VHDs and 6.66% for HNs).
長時間的酷熱天氣與較高死亡風險有關，例如連續五天酷熱日增加了3.99%的死亡風險，而連續五天熱夜則增加了6.66%的死亡風險。
- A combination of consecutive very hot days and hot nights has a stronger effect on mortality risk.
連續日間和夜間的酷熱天氣對死亡風險有較顯著的影響。
- Female and elderly citizens are more affected by hot weather during night-time (5 consecutive hot nights).
女性及長者更容易受連續夜間酷熱天氣影響。



Conclusions of the Study 研究結論

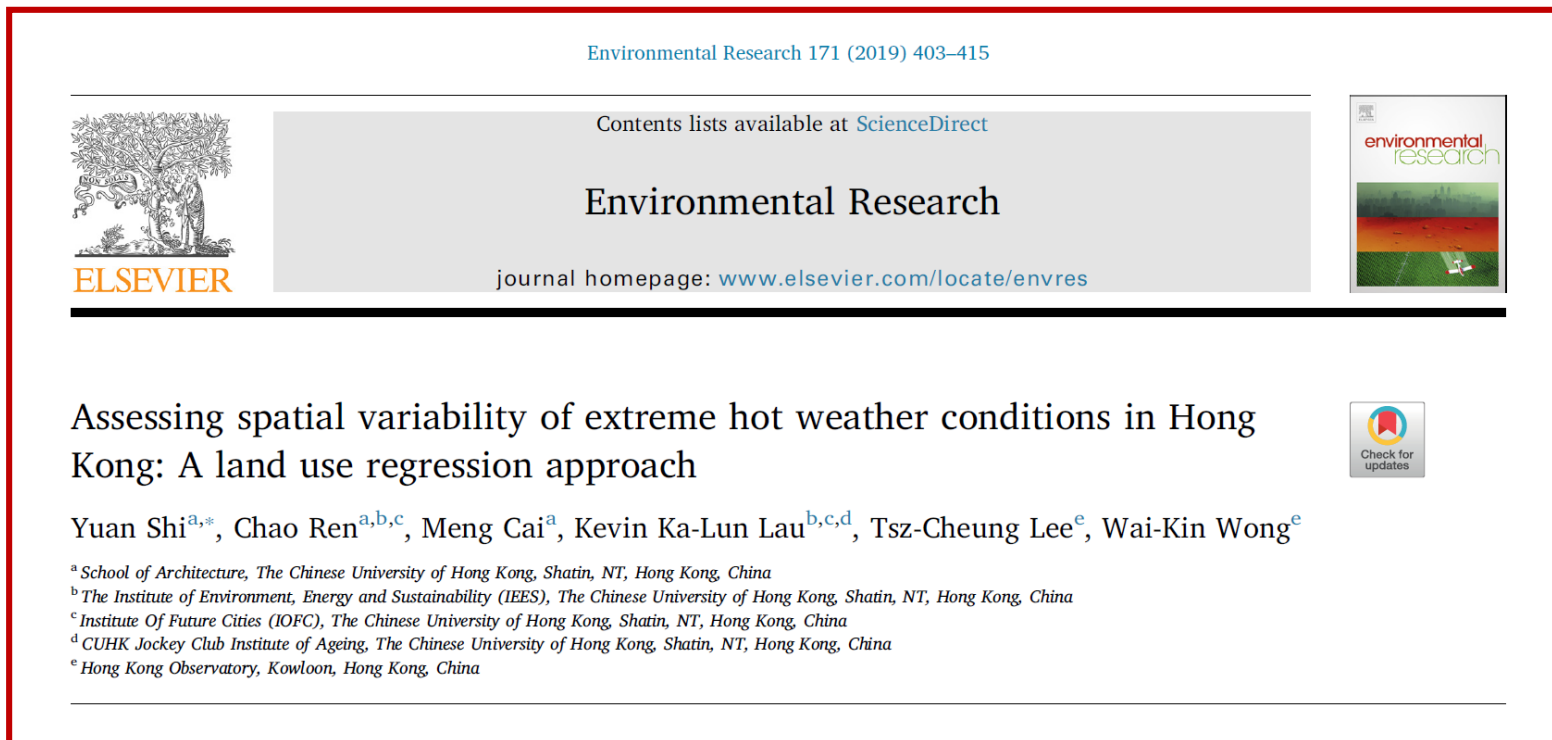
- Hot nights are associated with higher mortality risk than very hot days.
熱夜比酷熱日與較高死亡風險有更密切的關聯。
- Extreme hot weather during night-time prevents citizens relieving from the heat.
市民難以從夜間酷熱天氣中得以喘息，減弱人體恢復的效果。
- Female and elderly citizens are more affected by hot weather during night-time.
女性及長者更容易受連續夜間酷熱天氣影響。
- It is important for citizens to increase their awareness preparedness to extreme heat during night-time.
市民需提升對夜間酷熱天氣的意識及準備。
- Cooling the body is effective in preventing heat exhaustion or heat stroke during extreme hot weather.
於酷熱天氣期間，市民應多加注意為身體降溫，以免出現熱衰竭或中暑等情況。



Objective of the Study

研究目的

- To investigate the spatial pattern of extreme hot weather conditions in Hong Kong
研究香港極端酷熱天氣的空間分佈
- To determine the factors of the built environment potentially contributing to the spatial variability of extreme hot weather
判定導致極端酷熱天氣的空間變異性的潛在因素



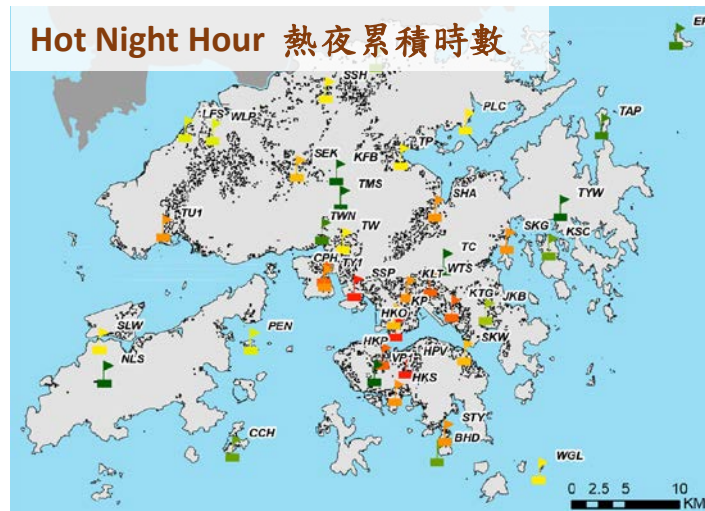
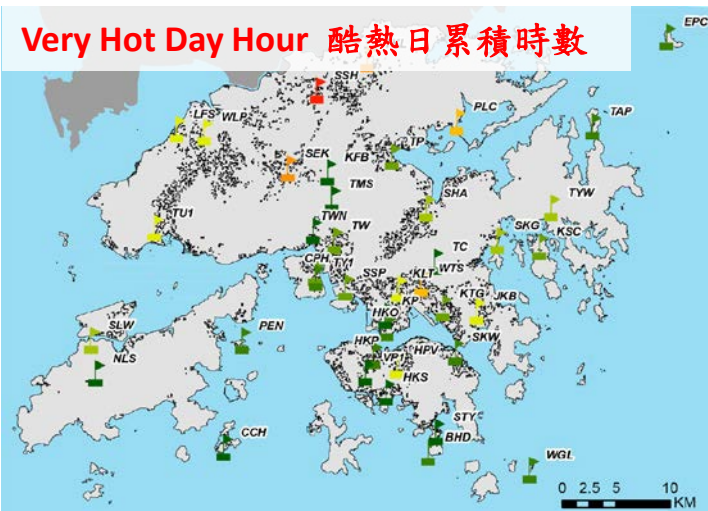
Spatial Pattern of Extreme Hot Weather in Hong Kong

香港極端酷熱天氣的空間分佈

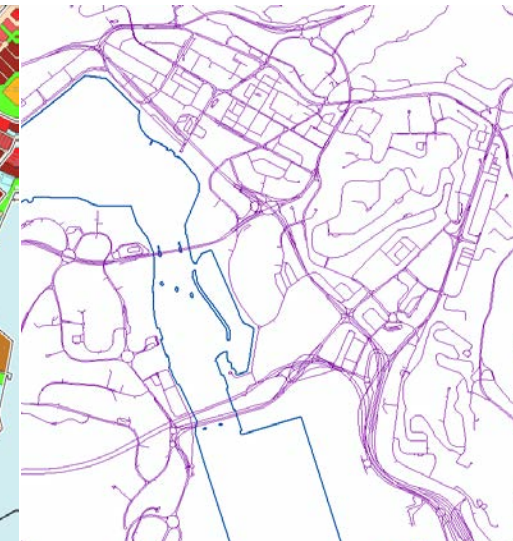
Data of the Study

研究數據

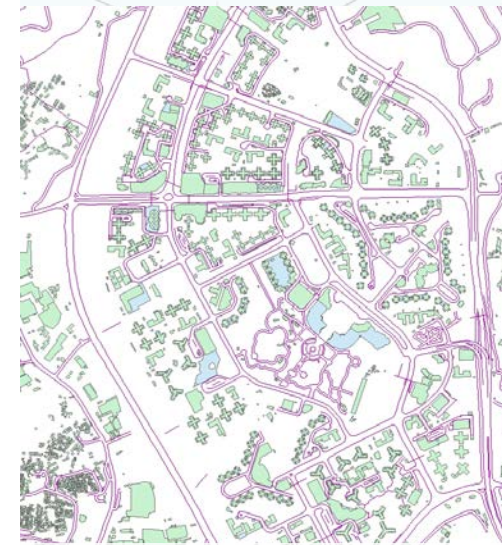
- Hourly air temperature data from 40 HKO Stations (2011-2015)
 - 取自40個天文台氣象站的每小時氣溫記錄
- Very Hot Day Hour 酷熱日時數 and Hot Night Hour 熱夜時數
 - VHDH: Total number of hours $\geq 33^{\circ}\text{C}$ during daytime (0700-1800)
日間溫度攝氏33度或以上的累積時數
 - HDH: Total number of hours $\geq 28^{\circ}\text{C}$ during night-time (1900-0600)
夜間溫度攝氏28度或以上的累積時數
- Land Use Regression Approach 土地利用迴歸模式
 - Spatial Mapping 製作酷熱日時數及熱夜時數地圖



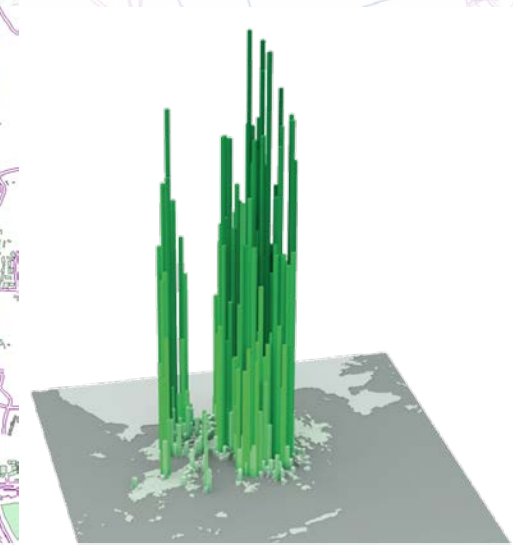
Land Use 土地用途



Road Network 道路網絡



Urban Morphology 城市形態



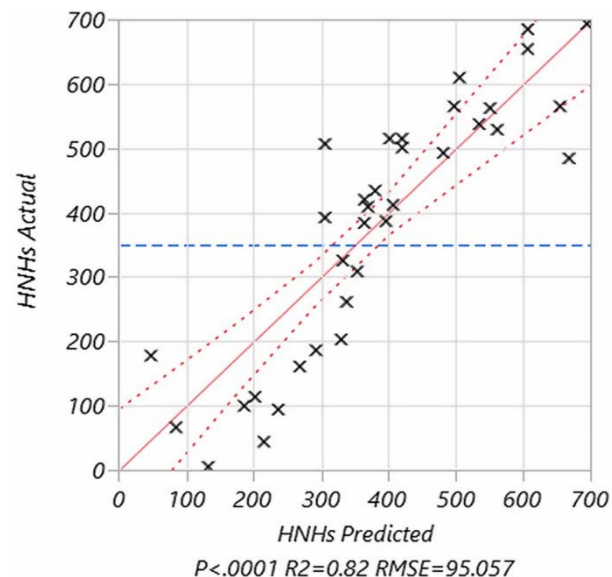
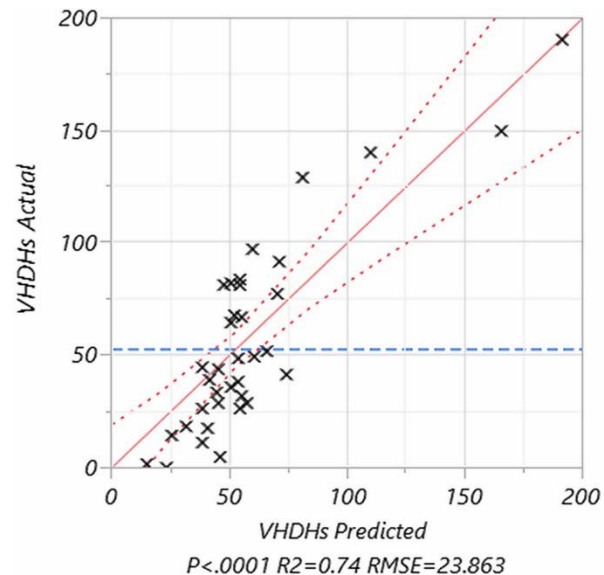
Population 人口數據



Results of the Analysis

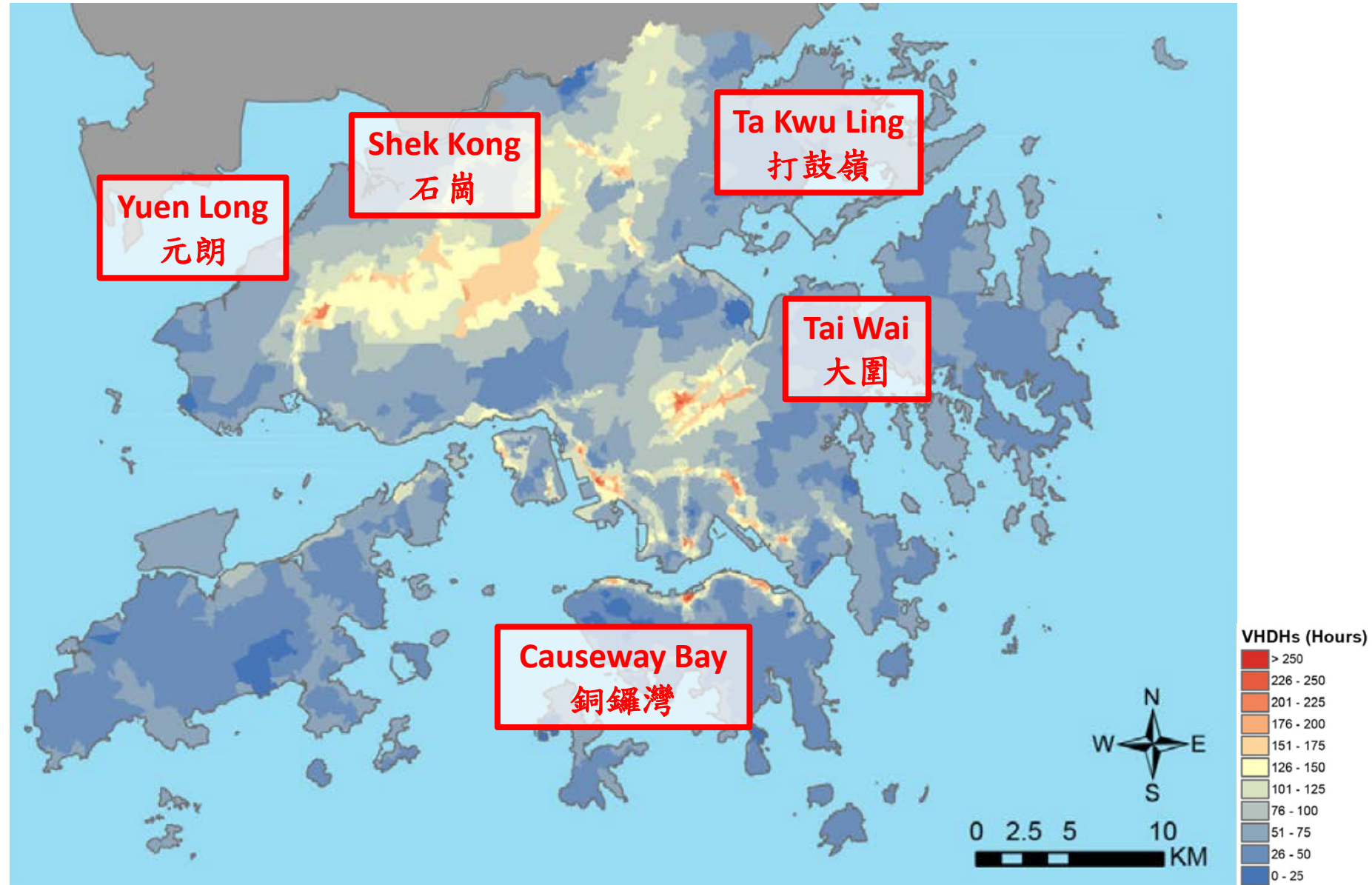
分析結果

- Factors affecting the spatial pattern of VHDHs 影響酷熱日累積時數空間分佈的因素
 - Government, institution and community land use 政府、機構或社區用地（普遍建築密度不高，建築設計考慮微氣候因素）
 - Altitude 海拔高度（
 - Immediate area around expressway 高速公路附近範圍（空曠環境與柏油路令路面吸收大量熱力）
 - Proximity to waterfront or water bodies 與海濱地段的距離（水體為鄰近地方帶來降溫效果）
- Factors affecting the spatial pattern of HNHs 影響熱夜累積時數空間分佈的因素
 - Open space land use 開放空間用地（夜間釋放日間累積的熱力）
 - Altitude 海拔高度
 - Tertiary road 較次要的道路，例如社區內的街道或市區內的小街（狹窄的環境令熱力難以釋放）
 - Frontal Area Ratio 迎風面比率（影響市區空氣流通的重要因素）



Spatial Pattern 空間分佈

- VHDHs are generally higher in New Territories than in Kowloon or on Hong Kong Island.
新界地區酷熱日時數普遍較港九市區為高。



VHDH at Community Level 酷熱日累積時數



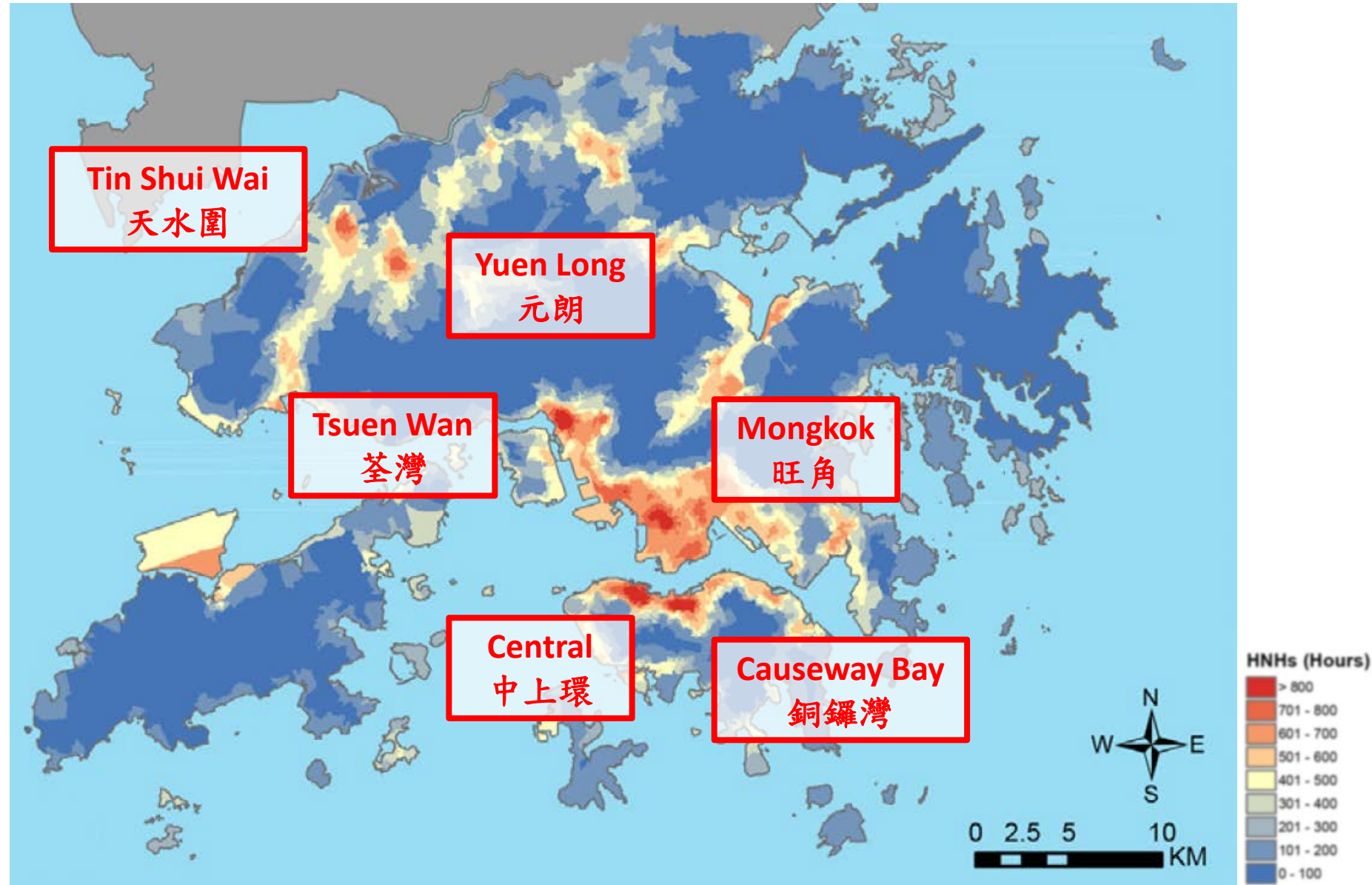
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The Chinese University of Hong Kong



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THE UNIVERSITY OF HONG KONG

Spatial Pattern 空間分佈

- More HNHs are generally observed in urban areas
大部份市區熱夜時數普遍較高，成為熱夜的重災區。



HNH at Community Level 熱夜累積時數

Conclusions of the Study 研究結論

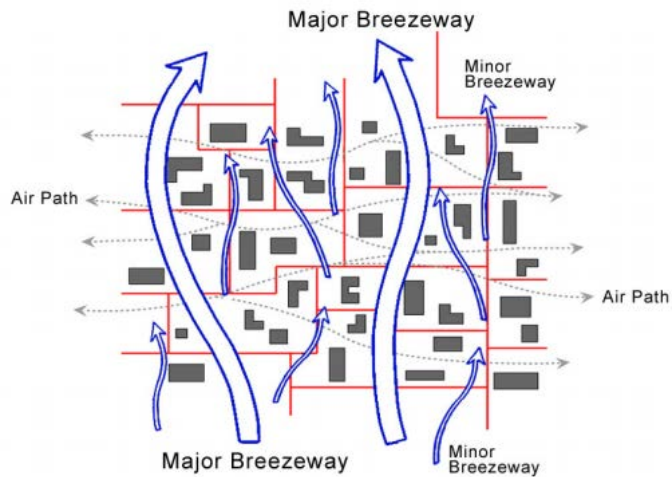
- Urban environment has a strong effect on the spatial pattern of extreme hot weather
城市環境對極端酷熱天氣的空間分佈有重要的影響。
- VHDHs are generally higher in New Territories than in Kowloon or on Hong Kong Island.
新界地區酷熱日時數普遍較港九市區為高。
- More HNHs are generally observed in urban areas.
大部份市區熱夜時數普遍較高，成為熱夜的重災區。
當中包括油尖旺、荃灣、中上環等；元朗及天水圍亦有較多熱夜。
- Improving urban ventilation and greenery mitigates the impacts of extreme heat in urban areas.
改善城市通風和增加綠化能減緩極端酷熱天氣所帶來的影響。



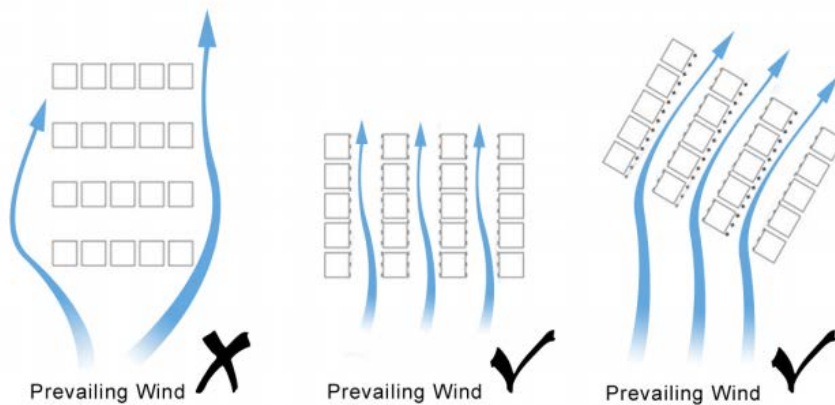
天台屋曾錄38度 95%劏房戶留家抗疫焗熱

本港酷熱天氣溫度一再破頂，上月天文台發出多次酷熱天氣警告，有組織訪問多區共百名的**籠屋、天台屋、板間房、劏房單位住戶**，發現**逾九成半受訪者認為在家比在外更熱**，蟲鼠蚤患問題嚴重。

香港社區組織協會幹事胡加沂指，現時疫情嚴峻，基層市民在家抗疫時十分焗熱，但往日可借以消暑的政府設施卻關門，促請政府於防疫措施下考慮於18區另覓避暑中心。



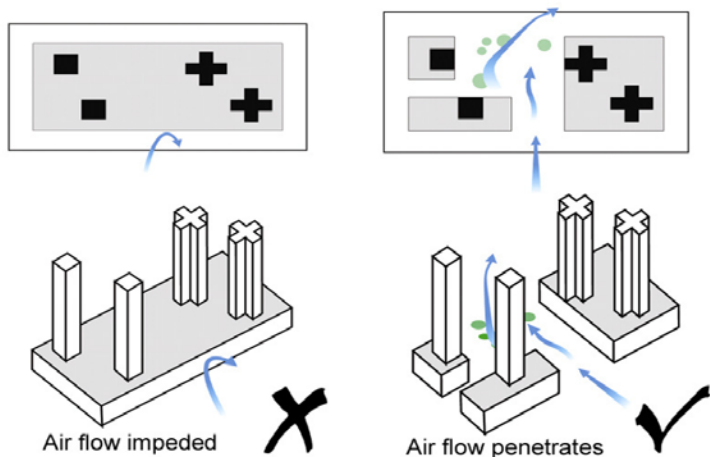
Breezeway and Air Path 通風廊及風道



Orientation of Street Grids 街道布局的定向

- Enhancing air ventilation at site and district level
改善地盤及地區層面的空氣流通

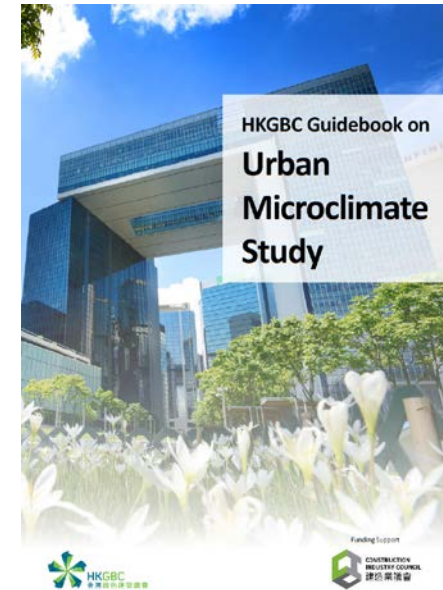
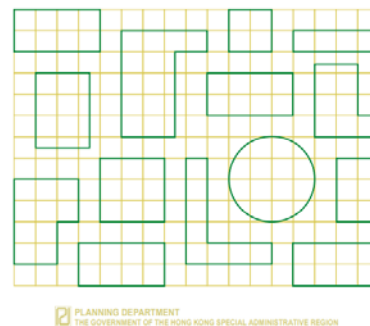
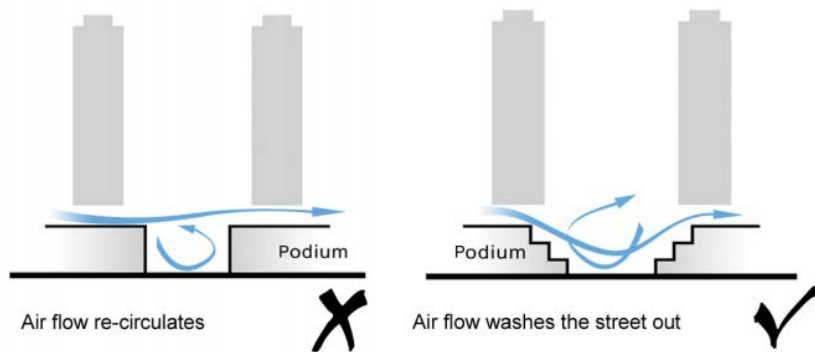
Site Level 地盤層面



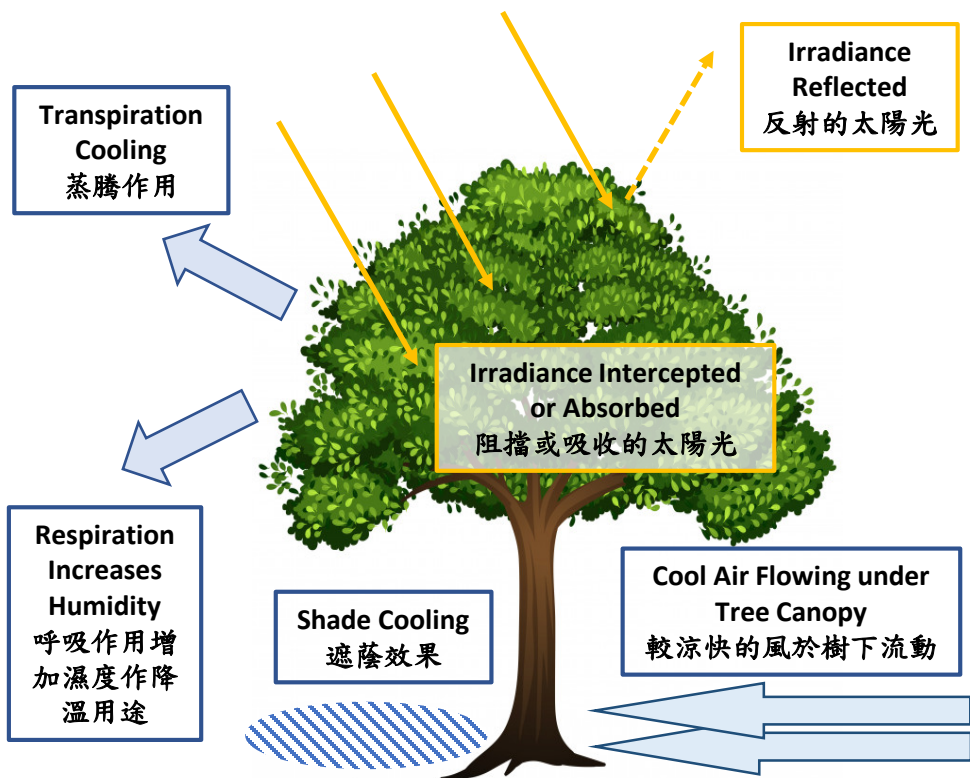
Reducing Site Coverage of the Podia
減少平台的上蓋面積

District Level 地區層面

Terraced Podium Design 梯級式的平台設計



- Promoting urban greenery at different levels
增加城市內的綠化設施



Street Trees 街道樹木



Podium Garden 平台花園



Vertical Greening 垂直綠化



香港 HONG KONG
2030+

Towards a Planning Vision and Strategy Transcending 2030

PUBLIC ENGAGEMENT



Building Block 1 Planning for a Liveable High-density City A Healthy City

The city is our main activity area and is a conducive environment for promoting health and well-being. A healthy city will bring tangible benefits such as improving health, relieving stress, encouraging active ageing, and alleviating the burden on public health services.

We propose to incorporate “active design”^{**} considerations in shaping the built environment to promote physical activities and health through responsive urban design and building design by promoting walking, cycling, exercising and a healthy lifestyle. We propose to rekindle our connection with

nature in the city. We propose to strengthen our continued commitment to enhancing biodiversity, promoting environmentally-friendly initiatives, and creating a clean and healthy built environment. To alleviate the urban heat island effect, to improve the urban climate and to respond to climate change, we seek to further incorporate urban climatic and air ventilation considerations in planning and urban design.

^{**}“Active design” is both an approach to and an ethos of promoting physical activity and health through responsive urban design and building design by promoting walking, exercising and recreational pursuits

Key Strategic Directions	Key Actions
Improving the urban climate by incorporating urban climatic and air ventilation considerations	<ul style="list-style-type: none"> To strengthen urban climatic and air ventilation considerations in the planning and design of new development areas and to retrofit the densely developed urban areas having due regard to proposals in the Hong Kong Urban Climatic Planning Recommendation Map To update the current Technical Circular on Air Ventilation Assessment and the relevant Hong Kong Planning Standards and Guidelines (HKPSG)

Key Strategic Directions	Key Actions
Promoting active design	<ul style="list-style-type: none"> To embrace active design in promoting physical activities and health through urban design and building design To appropriately increase open space provision To promote accessibility to recreational facilities (e.g. country parks and sports facilities) To provide a comfortable walking and cycling environment

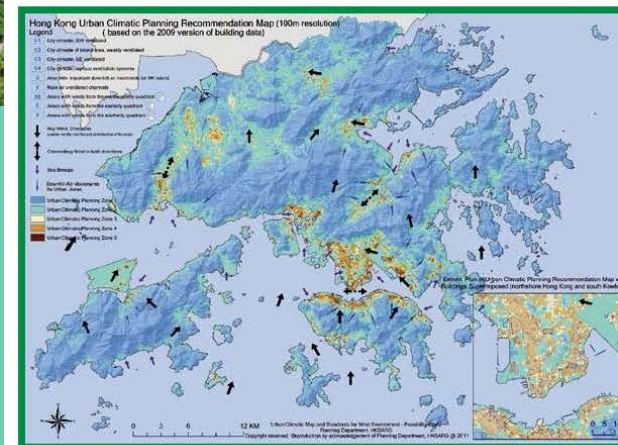


Fig.17 Hong Kong Urban Climatic Planning Recommendation Map

“ We need a physical city environment that is conducive to healthy and active lives.”



Take Home Message

1. Prolonged extreme hot weather is associated with increased health risks, especially for the vulnerable population groups.

長時間的極端酷熱天氣增加市民的健康風險，對弱勢社群影響尤其嚴重。

2. Extreme hot weather (especially during nighttime) is commonly observed in urban areas of Hong Kong due to compact and high-density urban context.

由於高密度的城市環境，極端酷熱天氣（尤其夜間）普遍出現於港島及九龍市區。

3. Citizens need to improve the awareness and preparedness to deal with such extreme heat events.

市民需要提升應對極端酷熱天氣的意識及準備。

4. Improving urban ventilation and greenery especially in downtown areas is highly recommended.

建議改善城市通風和增加綠化，特別是市區較密集的環境。





Prof. Edward Ng (Leader)
Yao Ling Sun Professor of Architecture



Prof. Ren Chao
Associate Professor



Prof. Kevin Lau
Research Assistant Professor



Dr. Wan Li
Postdoctoral Fellow



Dr. Tobi Eniolu Morakinyo
Postdoctoral Fellow



Dr. Shi Yuan
Postdoctoral Fellow



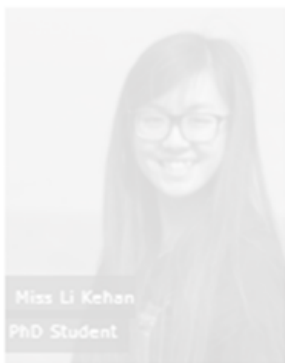
Dr. Tanya Tan
Postdoctoral Fellow



Miss Gong Fangying
PhD Student



Mr. Chi Xinan
PhD Student



Miss Li Kehan
PhD Student



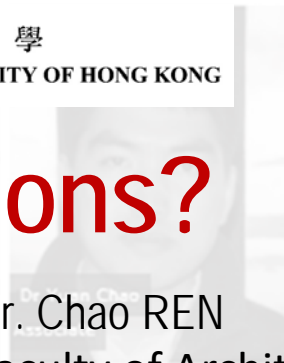
Mr. Sheo Kong
PhD Student



Miss Xiang Luyao
PhD Student



Miss Cai Meng
PhD Student



Miss Kwok Yu Ting
PhD Student



Miss Ouyang Wan Lu
PhD Student



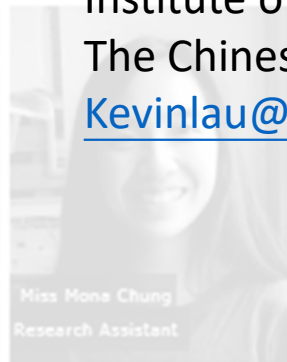
Miss Li Xinwei
Research Assistant



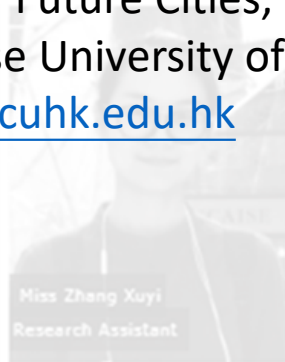
Miss Mona Chung
Research Assistant



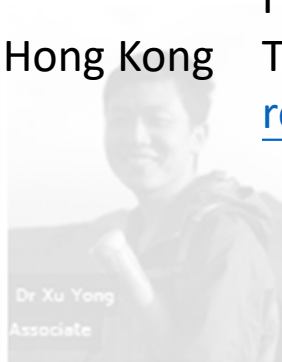
Miss Zhang Xuyi
Research Assistant



Dr. Xu Yong
Associate



Miss Ada Lee
Research Assistant



Miss Wong Sze Wai
Research Assistant



Miss Dai Shan
Research Assistant



Miss Gong Fangying
PhD Student



Miss Kwok Yu Ting
PhD Student



香港中文大學
The Chinese University of Hong Kong



香港大學
THE UNIVERSITY OF HONG KONG

Thanks! Any questions?

Dr. Kevin Ka-Lun LAU
Institute of Future Cities,
The Chinese University of Hong Kong
Kevinlau@cuhk.edu.hk

Dr. Chao REN
Faculty of Architecture,
The University of Hong Kong
renchao@hku.hk