Towards a Liveable and Breathing City

Edward NG

香港 HONG KONG 2030+

"… the earth is our mother. Whatever befalls the earth befalls the sons of the earth. The earth does not belong to man; man belongs to the earth. Man did not weave the web of life; he is merely a strand in it. **We do not inherit the earth from our ancestors; we borrow it from our children**."

Chief Seattle (1780-1866)

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“The public space is an extension of our personal space and therefore should be functional, welcoming and shared by all.” ….

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“The public space is an extension of our personal space and therefore should be functional, welcoming and shared by all.” …. AND comfortable

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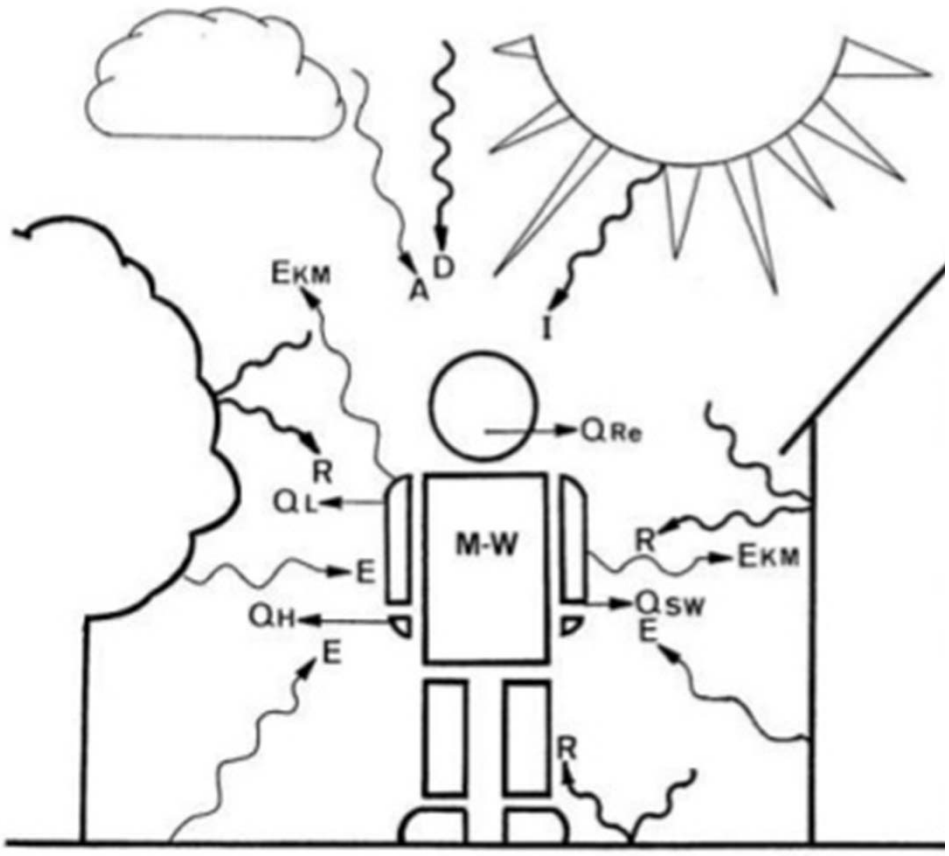
What is COMFORTABLE ?

photo

What is COMFORTABLE ?



Air temperature
Humidity
Solar radiation
Air movement
Clothing
Activity

(明報)2010年7月5日 星期一 08:05

天氣酷熱90長者不適10人送院

長者安居服務協會截至凌晨，接獲超過1800名長者按動平安鐘　，108 人因為頭暈及痛症要送院治理。

Results An average 1°C increase in daily mean temperature above 28.2°C was associated with an estimated 1.8% increase in mortality. Heat-related mortality varied with sociodemographic characteristics;

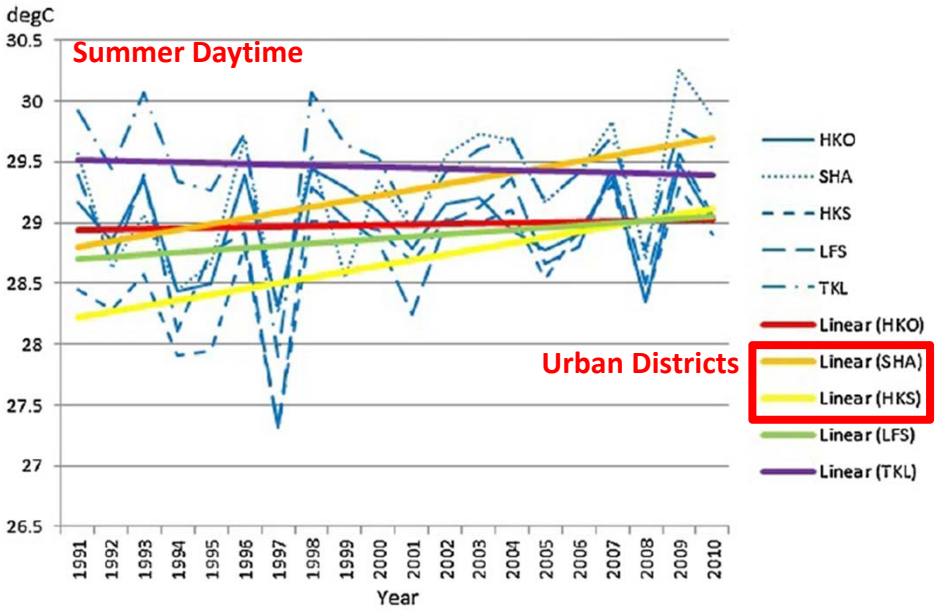
星島日報 天氣酷熱千八長者按平安鐘

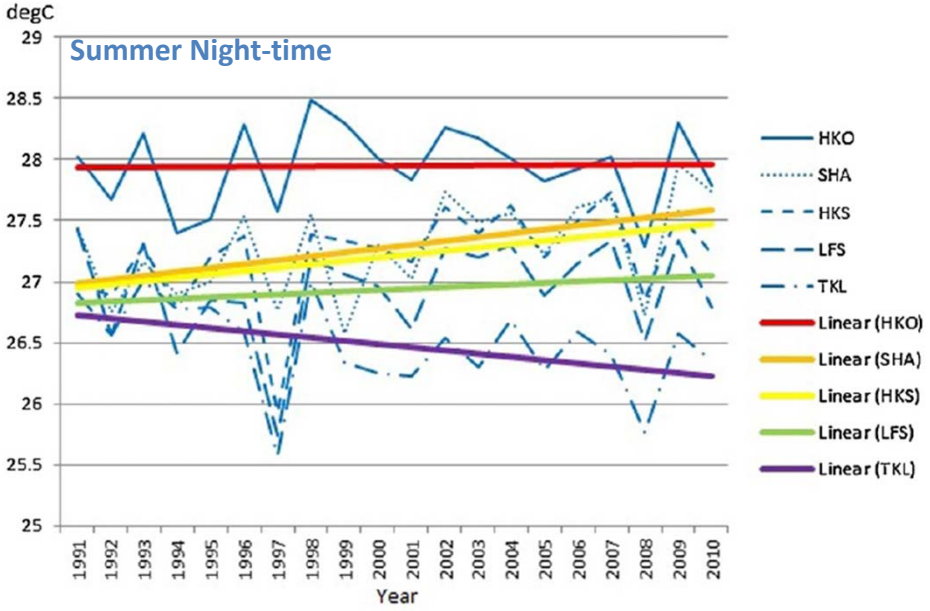
酷熱天氣警告　持續生效，由午夜至清晨6時，90名長者按平安鐘　，其中10人送院，主要因為嘔吐及痛症。

photo

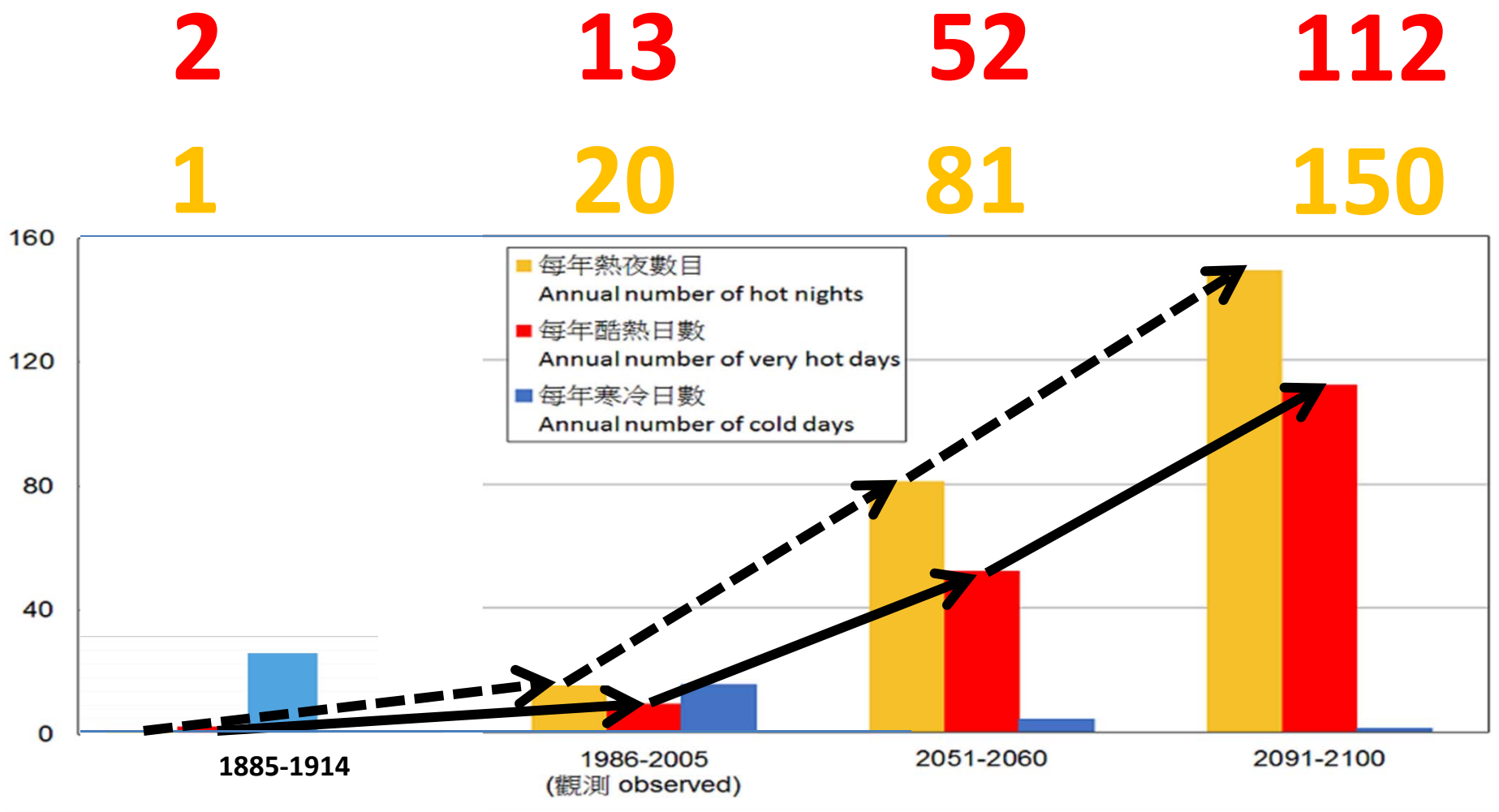
Hong Kong

- 40-year air temperature record
- Higher increasing rate in urban areas, particularly during night-time





Lau K.L. and Ng E., 2013. An investigation of urbanization effect on urban and rural Hong Kong using a 40-year extended temperature record. Landscape and Urban Planning 114: 42–52.



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

Climate Change in Hong Kong. from Hong Kong Observatory: http://www.hko.gov.hk/climate_change/obs_hk_extreme_weather_e.htm

信報財經新聞

啟德1號2期

呎售

3 萬新高

photo

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建築面積 **105**呎　　呎價 **HK$12,400**

實用面積 **54**呎　　呎價 **HK$24,000**

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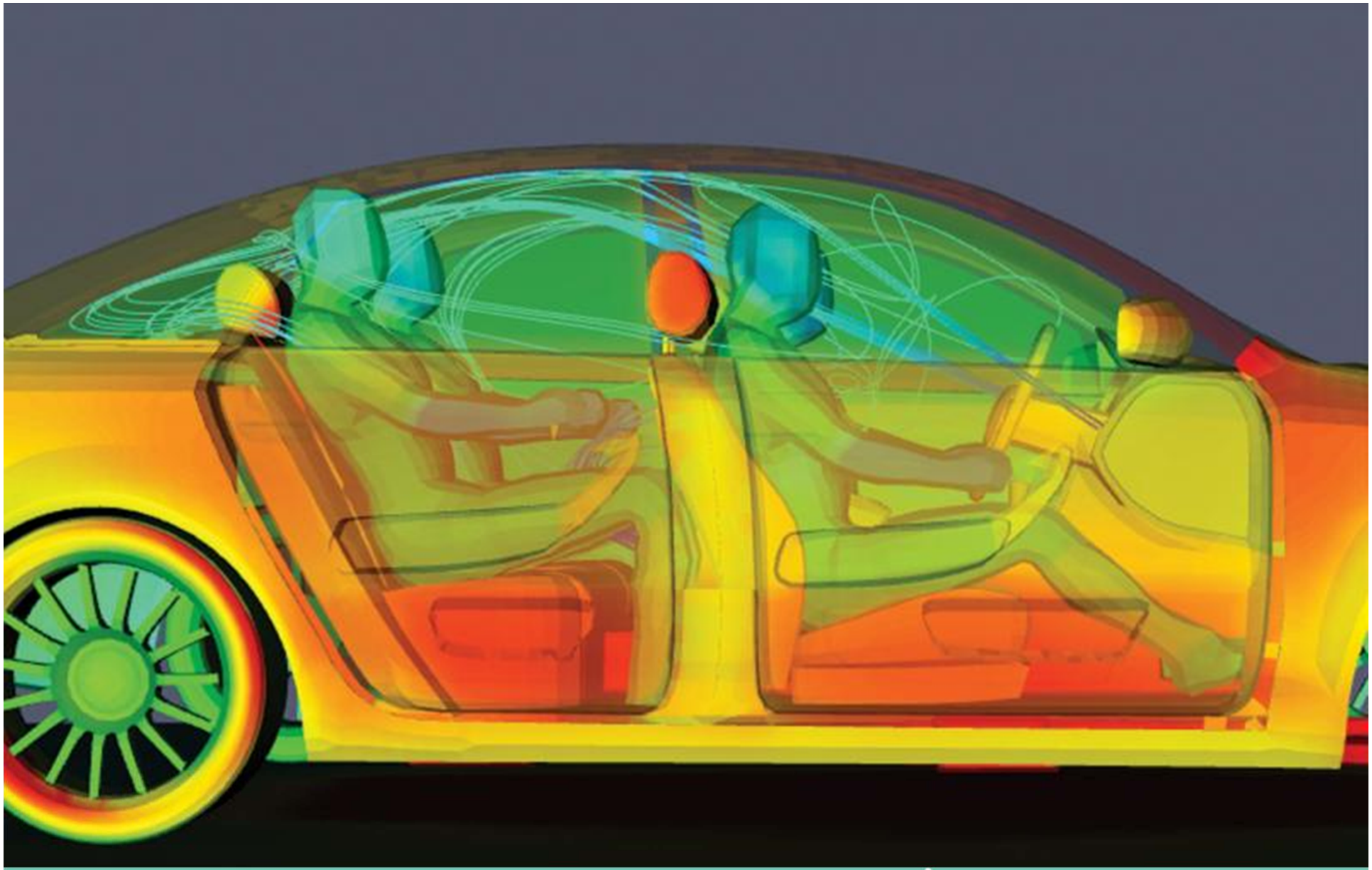

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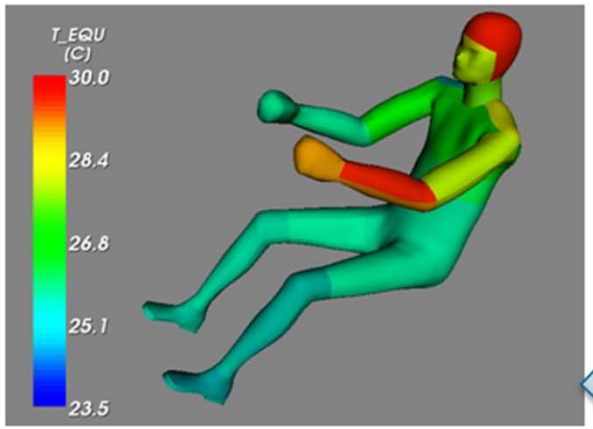
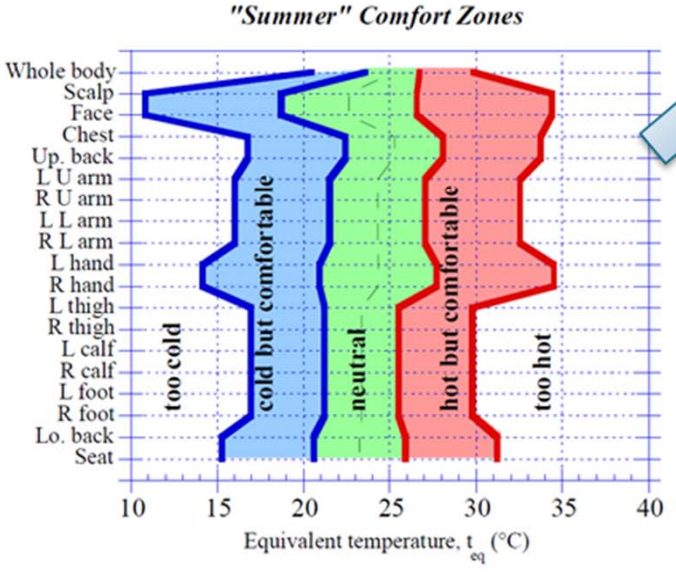
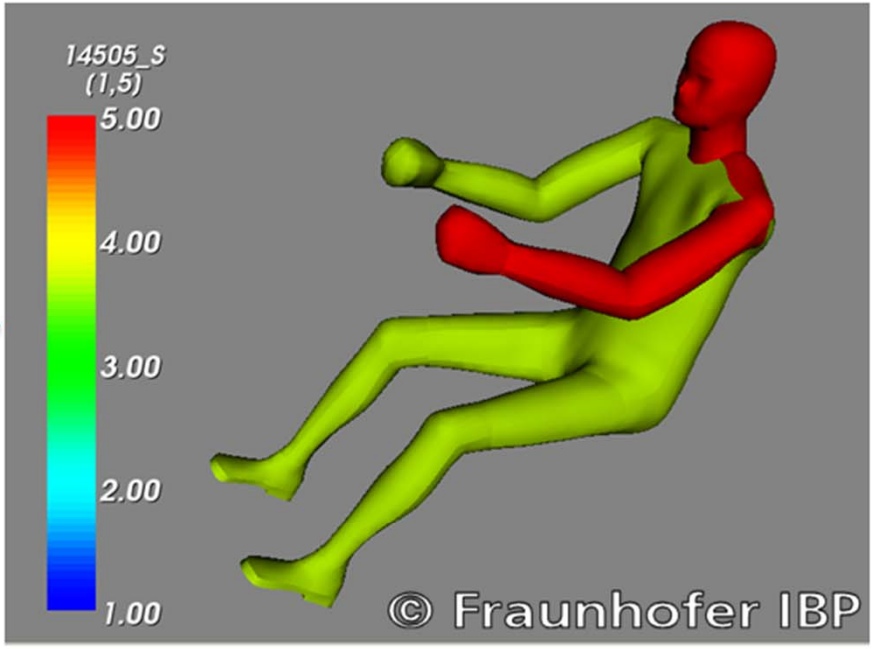


Äquivalenttemperaturen





Lokale thermische Beanspruchung
(Sommerbekleidung)

Should we design our city with the same amount of care ?

So that,

we are comfortable  **living, working, playing in it ?**

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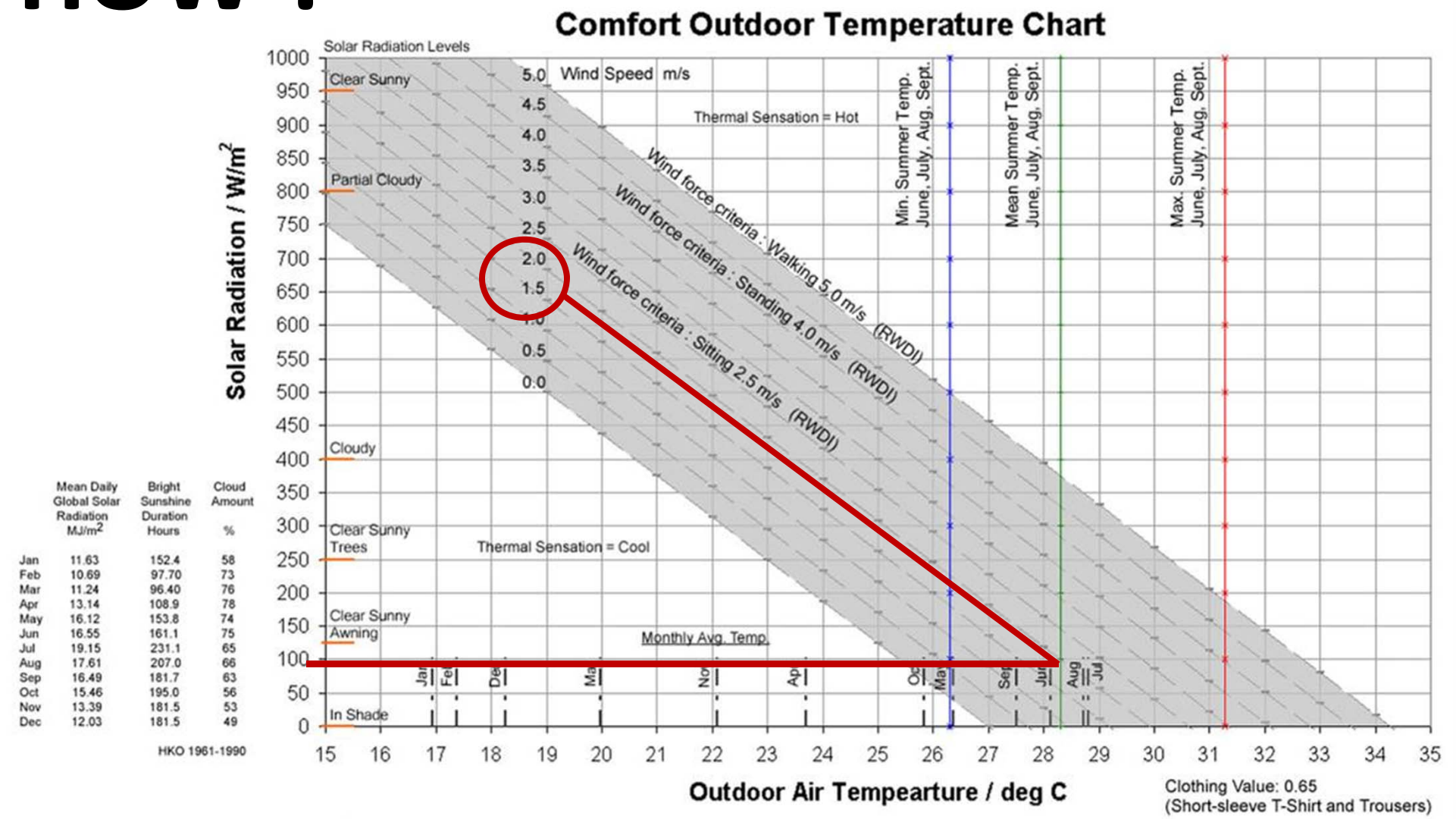
HOW ?



	Mean Daily Global Solar Radiation MJ/m^2	Bright Sunshine Duration Hours	Cloud Amount %
Jan	11.63	152.4	58
Feb	10.69	97.70	73
Mar	11.24	96.40	76
Apr	13.14	108.9	78
May	16.12	153.8	74
Jun	16.55	161.1	75
Jul	19.15	231.1	65
Aug	17.61	207.0	66
Sep	16.49	181.7	63
Oct	15.46	195.0	56
Nov	13.39	181.5	53
Dec	12.03	181.5	49

HKO 1961-1990

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Physiological Equivalent Temperature

to create the Hong Kong Urban Climatic Analysis Map

人體熱能(等效)溫度

Humidity, solar radiation and other physiological factors

Survey on Thermal Sensations

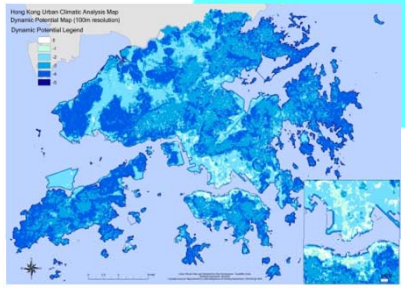
AIR VENTILATION

PET

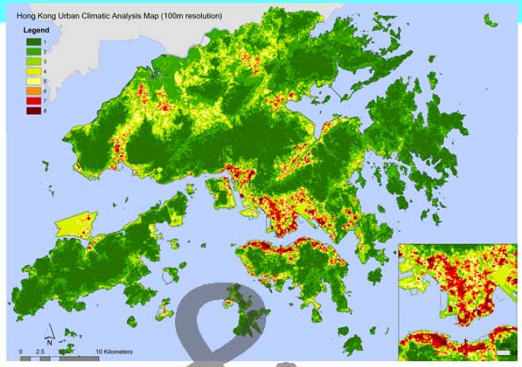
AIR TEMPERATURE

Human Thermal Comfort evaluated

Dynamic potentials

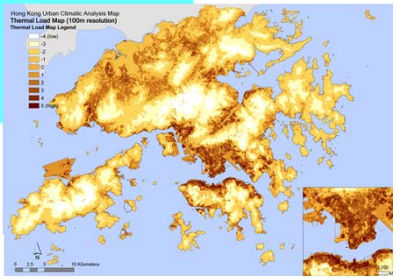


城市通風潛力



都市氣候環境圖

Thermal load



城市熱負荷

Wind & Green

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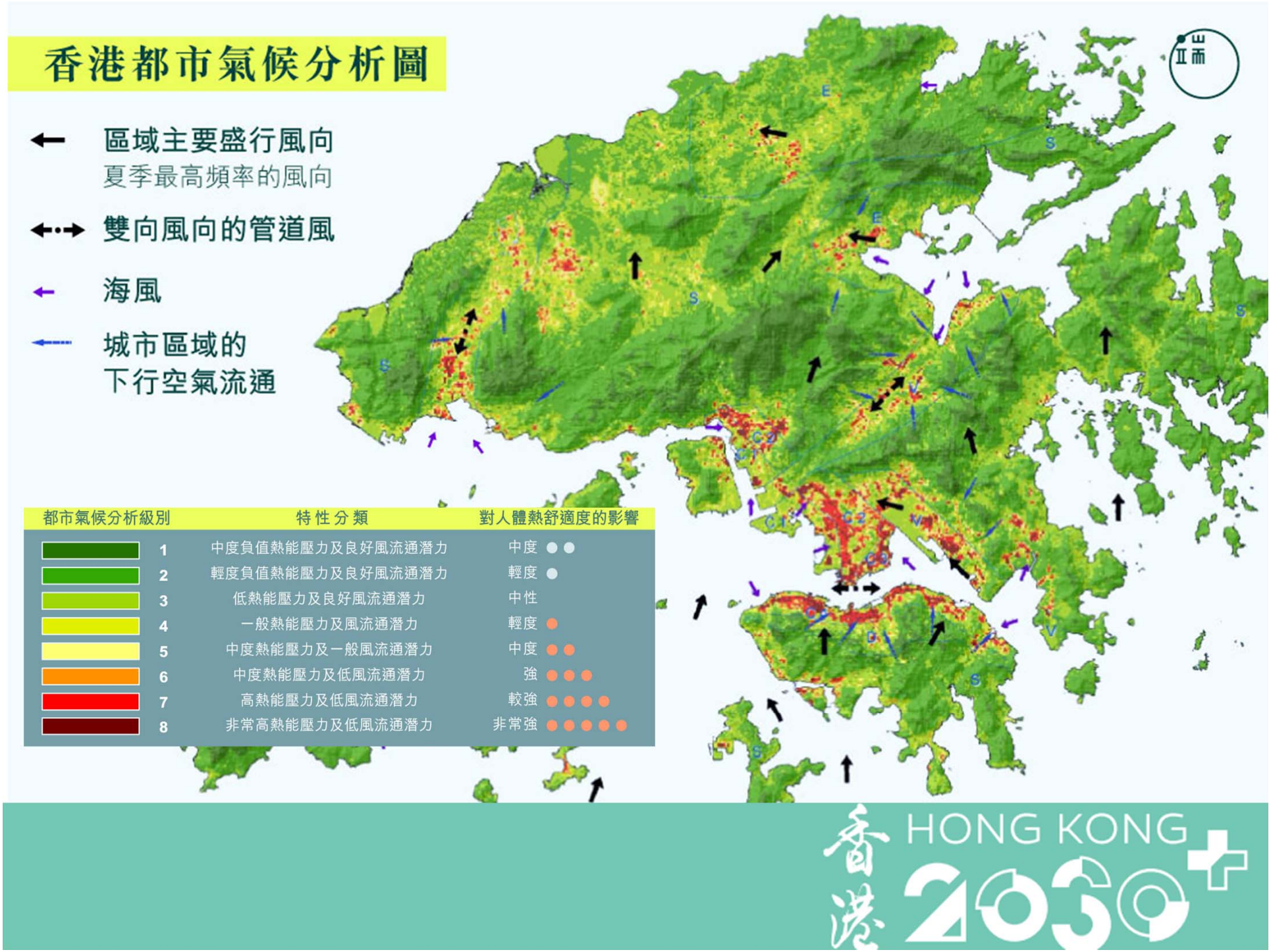
香港都市氣候分析圖


區域主要盛行風向
夏季最高頻率的風向
雙向風向的管道風
海風
城市區域的
下行空氣流通
E
S
C1
C2
C3
V
N
都市氣候分析級別
特性分類
對人體熱舒適度的影響
1 中度負值熱能壓力及良好風流通潛力 中度
2 輕度負值熱能壓力及良好風流通潛力 輕度
3 低熱能壓力及良好風流通潛力 中性
4 一般熱能壓力及風流通潛力 輕度
5 中度熱能壓力及一般風流通潛力 中度
6 中度熱能壓力及低風流通潛力 強
7 高熱能壓力及低風流通潛力 較強
8 非常高熱能壓力及低風流通潛力 非常強
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由於城市內溫度升高 3攝氏度 增加之 酷熱日 和 酷熱夜

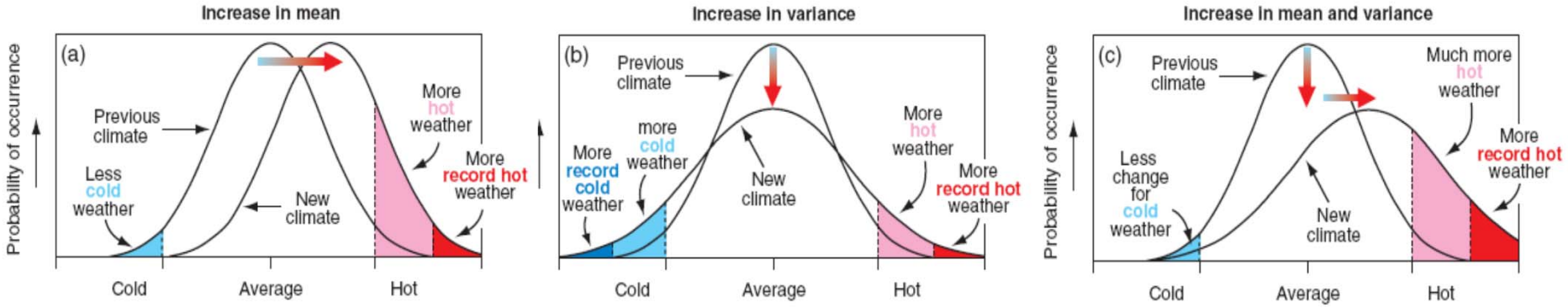
Increase of Very Hot Days and Very Hot Nights due to intra-urban temperature rises of **3** degree C.

Impact (morality) **= Intensity, duration, frequency**

HKO data	**Very hot days** (Tmax>=33)	(Tmax>=32)	Hot days (Tmax>=30)	Hot nights (Tmin>=25)	(Tmin>=27)	**Very hot nights** (Tmin>=28)
T_{iu} increase	T_{iu}= 0	T_{iu}= +1	T_{iu}= +3	T_{iu}= +3	T_{iu}= +1	T_{iu}= 0
	No., of very hot days			No., of very hot nights		
2008	**15**	42	74	115	48	**15**
2007	**25**	61	117	121	52	**23**
2006	**3**	25	82	117	53	**15**
2005	**12**	33	93	135	51	**26**
2004	**6**	26	94	123	47	**19**
2003	**14**	40	91	139	62	**20**
2002	**10**	32	93	133	45	**17**
2001	**9**	38	90	121	41	**16**
2000	**10**	40	99	124	51	**22**
1999	**6**	49	113	133	55	**17**
average	**10.6**	38.2	96.9	127.3	50.8	**19.5**

(no. of very hot days) = 28.85*(Tiu)+ 10.1 R2 = 0.99

(no. of very hot nights) = 36.26*(Tiu) +17.5 R2 = 0.99



Mortality Risk 死亡風險

Table 2. Excess mortality of prolonged heat (lag 0 – 3). The results indicate the percentage increase in mortality in 1°C increase in daily minimum air temperature at lag 0 – 3 and the corresponding 95th confidence intervals of each model. Significant results are marked with asterisks.

Model	All-cause mortality	Cardiovascular mortality	Respiratory mortality
Baseline ($T_{max} \geq 33°C$)	3.67% [3.53%, 3.81%]*	3.87% [3.55%, 4.18%]*	3.55% [3.24%, 3.86%]*
Three consecutive VHDs	7.97% [7.14%, 8.80%]*	8.42% [6.59%, 10.25%]*	7.06% [5.32%, 8.80%]*
Three consecutive HNs	7.37% [7.14%, 7.61%]*	7.41% [6.88%, 7.93%]*	7.26% [6.77%, 7.75%]*
Five consecutive VHDs	4.90% [3.59%, 6.21%]*	9.68% [6.79%, 12.6%]*	0.63% [-2.16%, 3.42%]
Five consecutive HNs	7.99% [7.64%, 8.35%]*	7.74% [6.93%, 8.55%]*	8.14% [7.39%, 8.89%]*
At least three VHDs and three HNs within a 7-day period	1.46% [1.22%, 1.71%]*	1.83% [1.29%, 2.36%]*	1.81% [1.28%, 2.33%]*
At least five VHDs and five HNs within a 7-day period	5.31% [4.59%, 6.04%]*	5.73% [4.18%, 7.29%]*	6.23% [4.62%, 7.85%]*

Higher risk under night-time prolonged heat

Reduced risk if they are not continuous

Table 3. Excess mortality of prolonged heat (lag 0 – 1 and lag 2 – 3). The results indicated the percentage increase in mortality in 1°C increase in daily minimum air temperature at lag 0 – 1 and lag 2 – 3, and the corresponding 95th confidence intervals of each model. Significant results are marked with asterisks.

Model	All-cause mortality (lag 0 – 1)	All-cause mortality (lag 2 – 3)
Baseline ($T_{max} \geq 33°C$)	5.91% [5.72%, 6.10%]*	1.09% [0.88%, 1.30%]*
Three consecutive VHDs	10.24% [9.02%, 11.45%]*	6.60% [5.68%, 7.53%]*
Five consecutive HNs	10.95% [10.48%, 11.42%]*	5.24% [4.72%, 5.76%]*
At least five VHDs and five HNs within a 7-day period	15.61% [14.52% 16.70%]*	-2.00% [-2.83%, -1.17%]*

Significant short-term effect of prolonged heat events

Ho HC, Lau KKL, Ren C, Ng E, 2016. Characterizing prolonged heat effects on mortality in a sub-tropical high-density city. International Journal of Biometeorology (under review).

$$PET = 1.2*Ta - 2.2*v + 0.5\,[Tmrt-Ta]$$

To decrease Ta:

increase greening

reduce anthropogenic heat

improve air ventilation

To increase v:

no wall building

increase building permeability

reduce site coverage

To reduce Tmrt:

use cool materials

increase greening

provide shading

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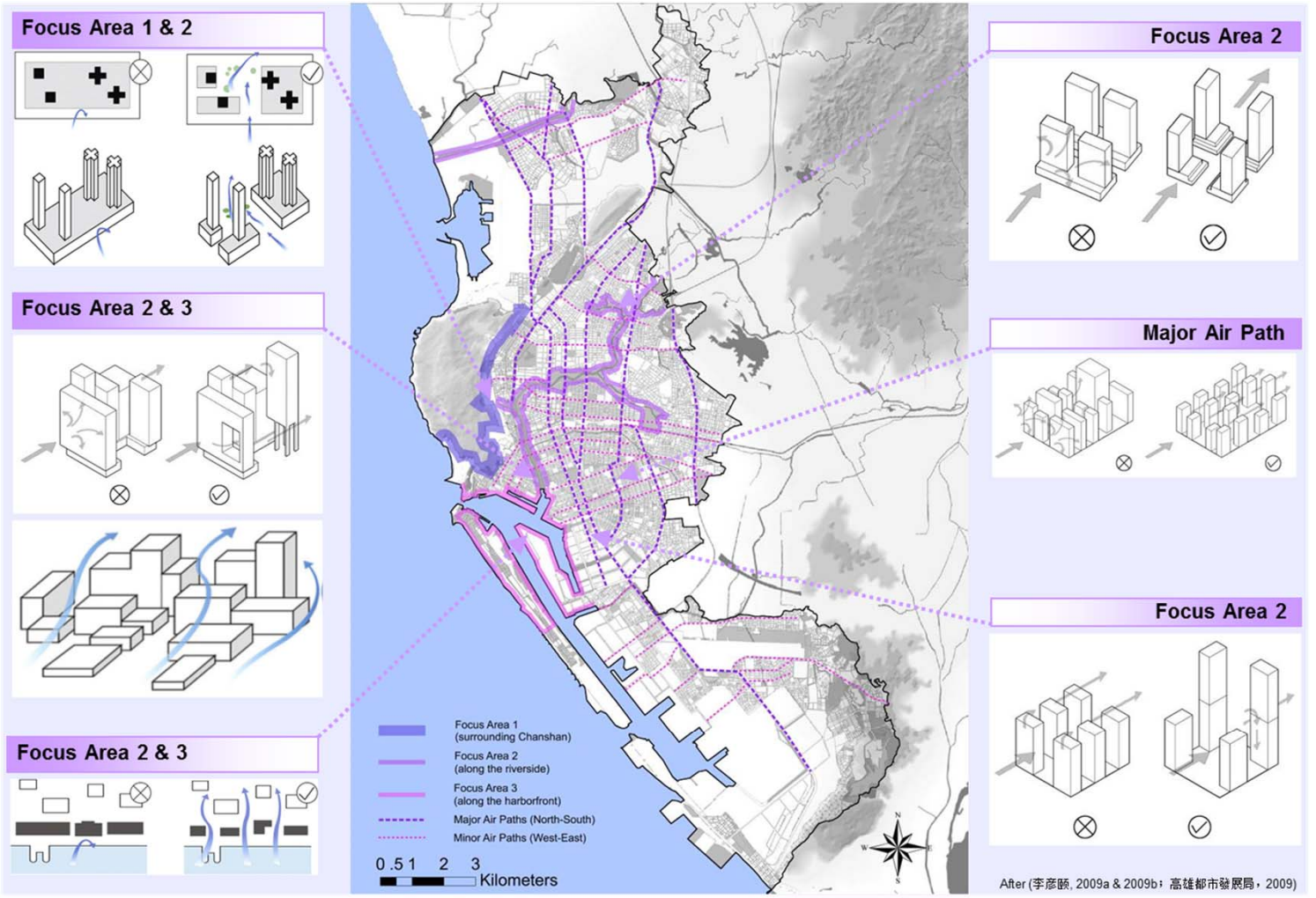
Recommendation on Wind Aspect

1. Respect the cooling effect from the Eastern Chanshan; minimize the development's impact; and form air path from hillside to downtown areas.
2. Respect the cooling effect from the river; Building blocks with various height to allow the penetration of cooling effect from riverside to inner urban areas;
3. Respect the sea breeze penetration; Do not form the Wall Effect Buildings at the Harbour front;
4. N-S orientated main roads are important major air paths; Buildings should be orientated with respect to the major air paths (annual & summer).
5. W-E orientated main roads are important minor air paths, esp. in summer; Building should be orientated with respect to the minor air paths.



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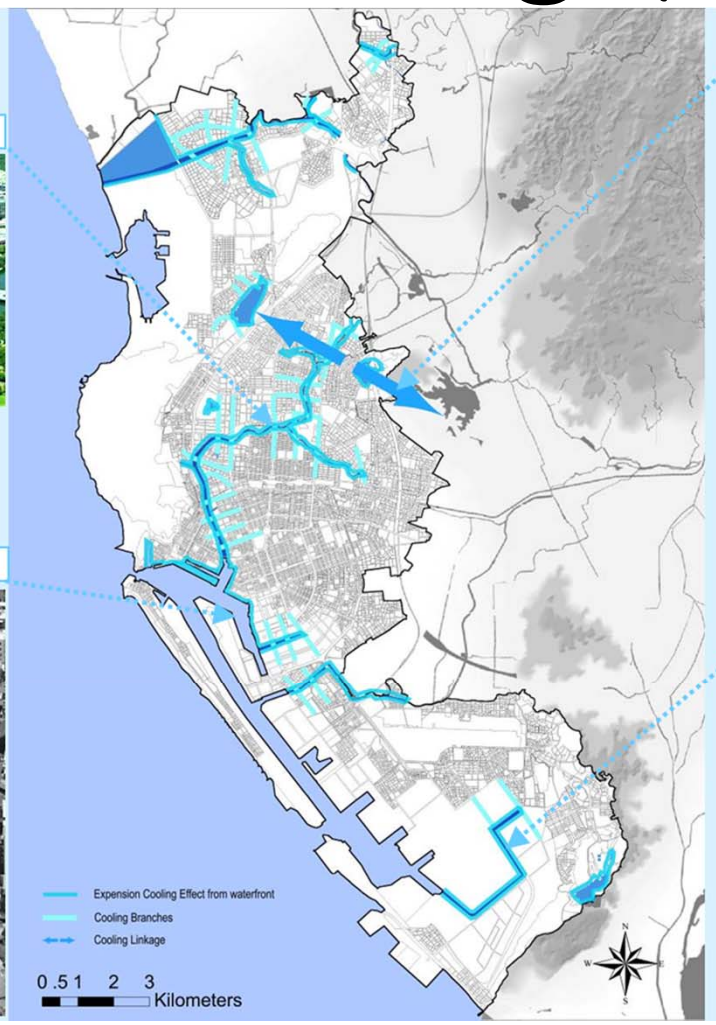
Recommendation on Water Aspect

1. Respect the cooling effect from water systems, including river, lake, ponds & seafront; minimize the development's impact at waterfront and landscape the waterfront.
2. Form cooling branches along major transportation links highlighted in light blue color in the right map; appropriate greenery or landscape designs along these branches are strongly recommended.
3. Link the Lian Chinh Pond, Jinshih lake and Chengcing Lake by using greenery or vegetations to benefit the surround areas of these water bodies and mitigate the urban heat island intensity;

Cooling Branches at Waterfront

Cooling Branches at Seafront



Cooling Linkage

Expansion Cooling Effect from Waterfront

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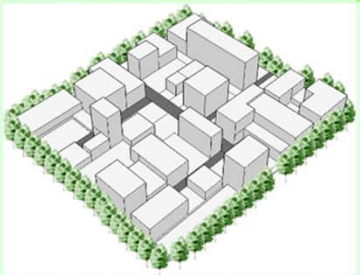
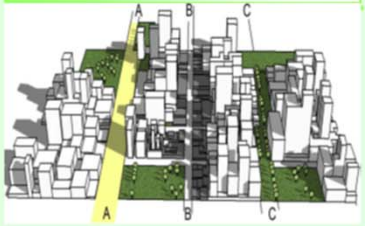
Recommendation on Greenery Aspect

1. Green rail track can be adopted to mitigate the anthropogenic heat release and air pollution along railways in dense urban areas;
2. Form green circles in the central urban areas to mitigate urban heat island intensity and anthropogenic heat releases. Provide shading at pedestrian level to create comfortable walking systems.
3. Form green circles around the industrial areas to mitigate the distribution of air pollution;
4. Create Green linkage between Chanshan, Lianchih Pond and Banpinshan to maximize the cooling effect;
5. Develop Green Fingers to let the cooling effect from Chanshan East hillsides to high-dense centre urban areas;
6. Create Green Belt to bring sea breezes to inner areas and improve the air exchange;

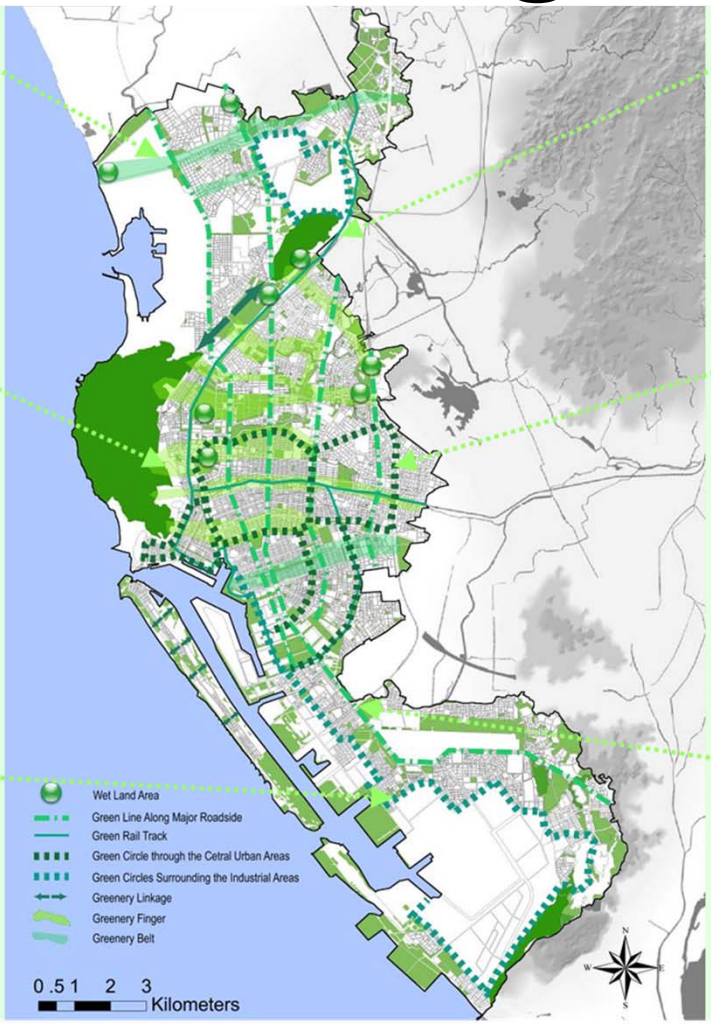
Green Belt



Greenery Finger

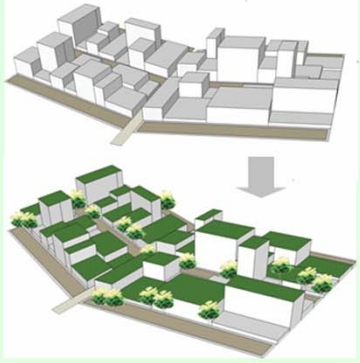


Green Circle surrounding the Industrial Areas



Green Rail Track

Green Circle in Central Urban Areas



Green Line Along Major Roadside

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家園

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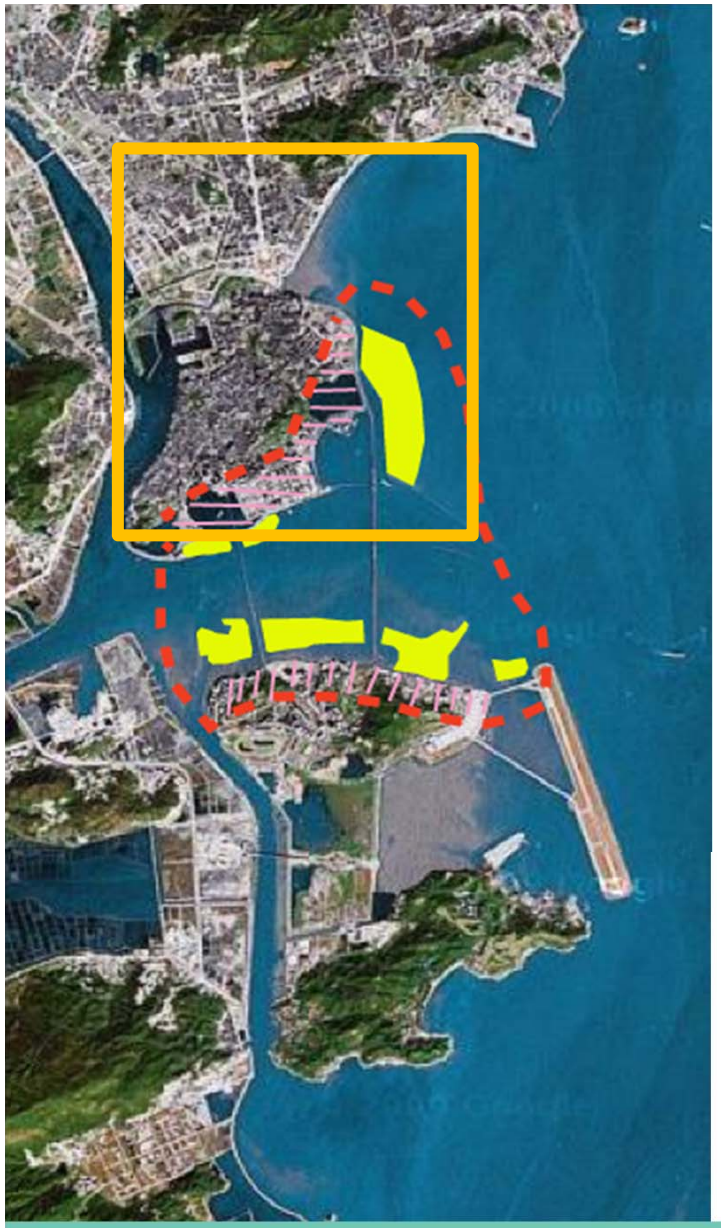

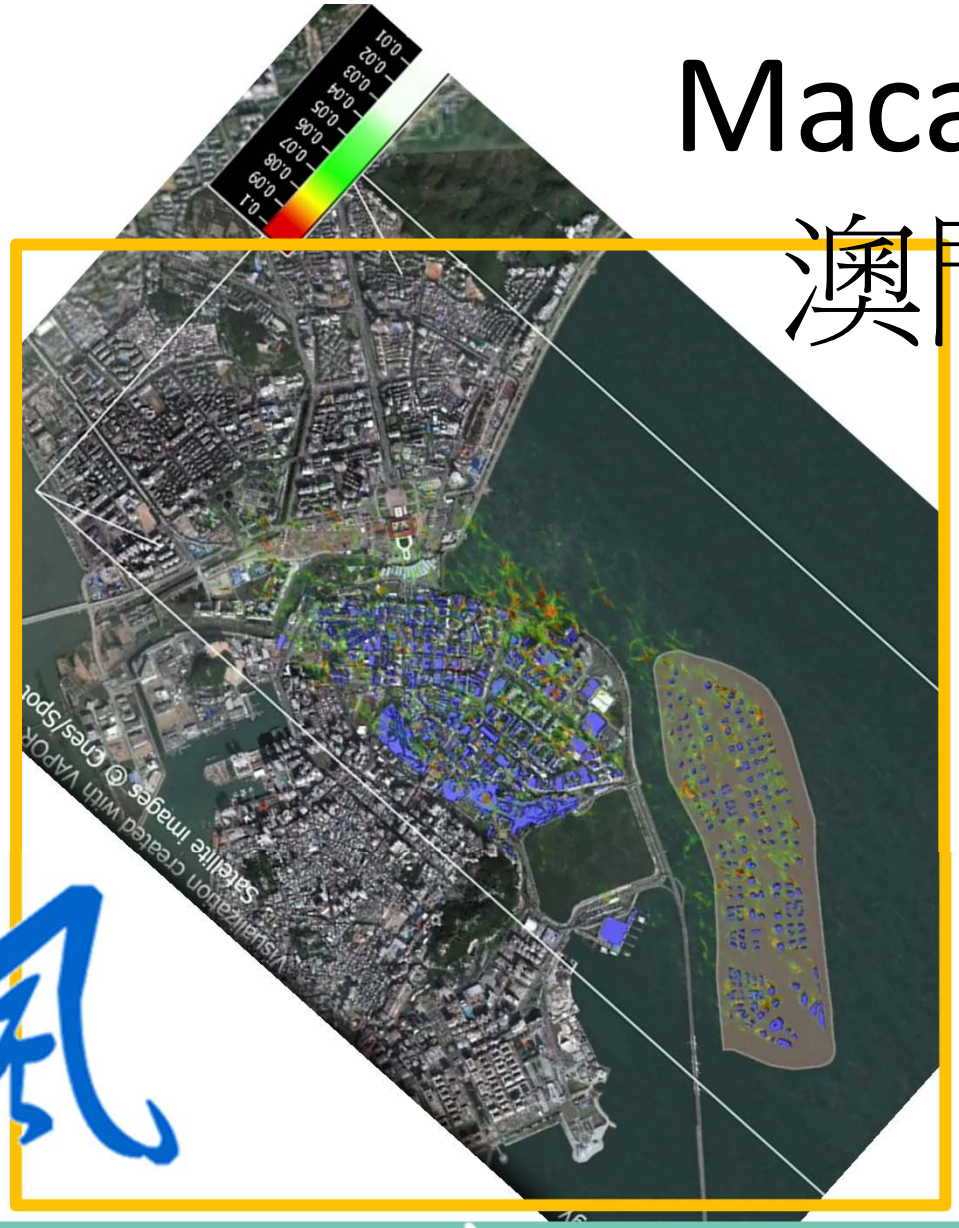

Macau
澳門

風

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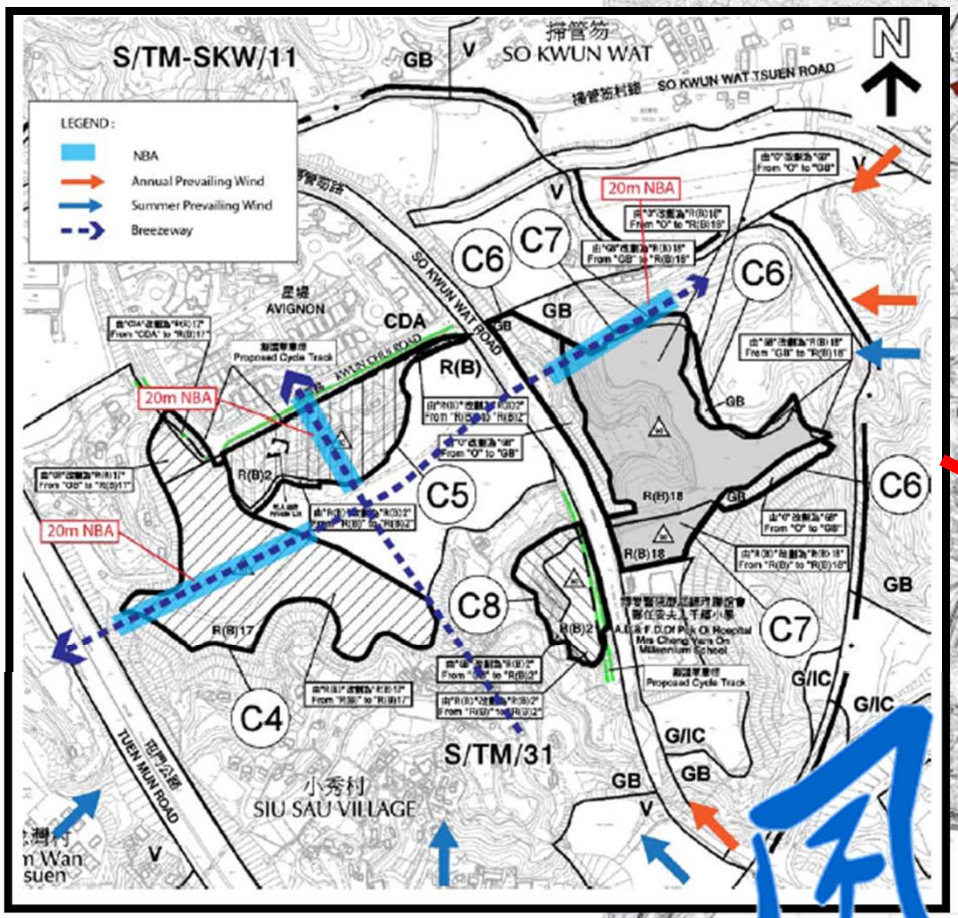
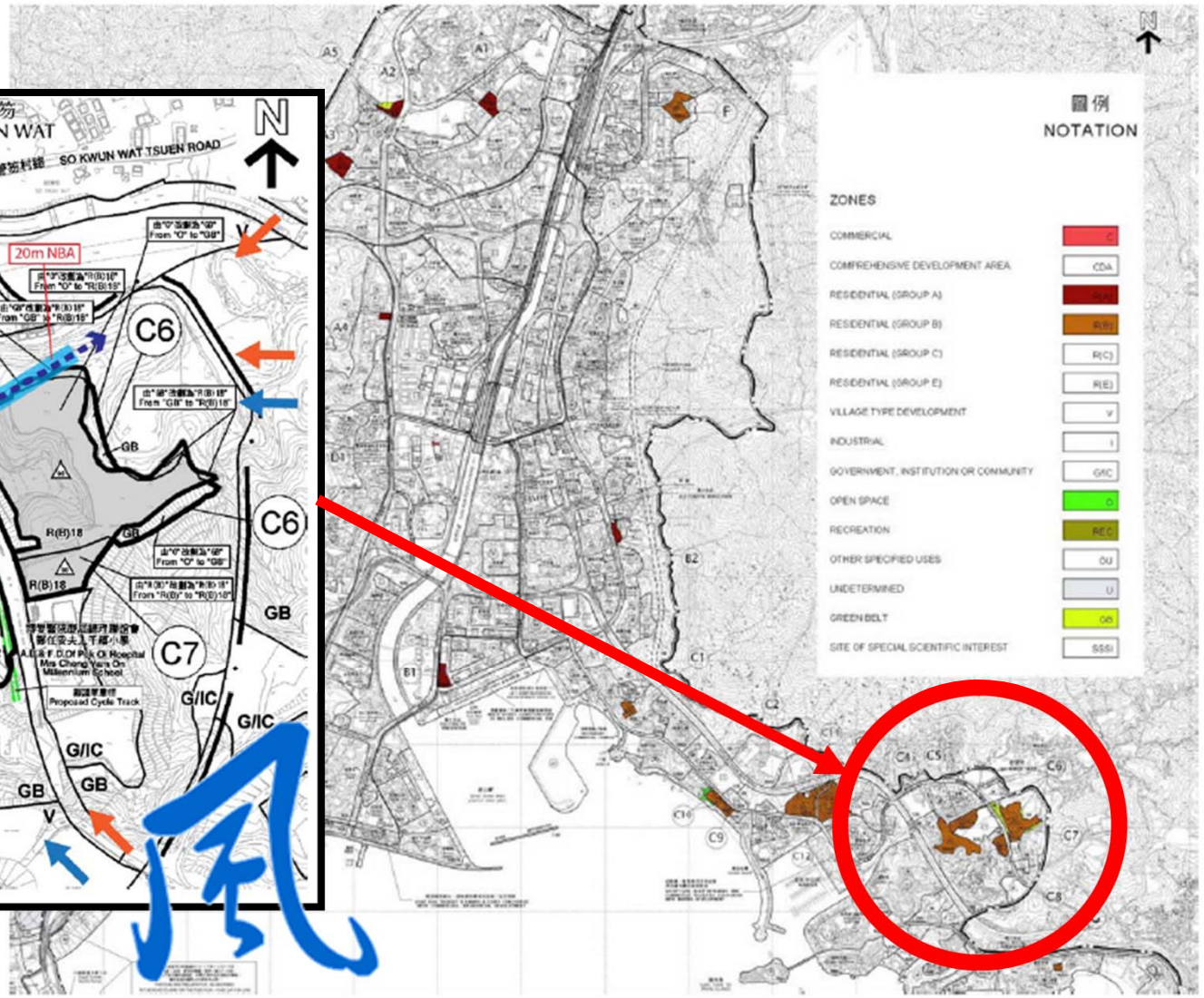
video





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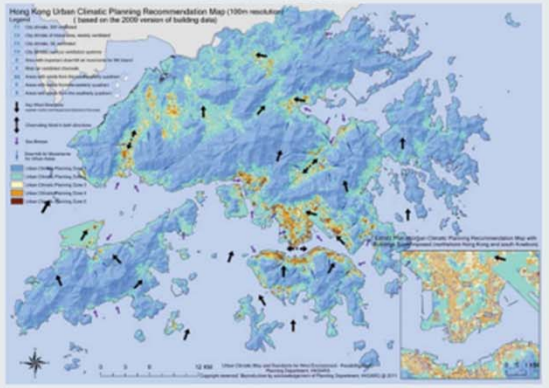
- **香港規劃標準與準則（HKPSG）**
  在地區層面實踐良好的城市設計，有助提升高密度環境的宜居程度。香港規劃標準與準則在結集程度、高度輪廓、街道布局及通風廊等方面提供設計指引，以促進市區空氣流通，並因而有助應對市區熱島效應的影響和改善市區環境的微氣候。在城市設計和空氣流通方面，政府在規劃新發展區時，均遵循這些在香港規劃標準與準則頒布的意向指引。在已建設區，我們鼓勵項目倡議人在規劃和設計他們的發展／重建項目時採用這些設計原則，以達至逐步改善市區的風環境。

- **空氣流通評估**
  自2006年起，政府規定所有重大政府工程項目均需要進行空氣流通評估，以改善設計從而促進對周邊地區的風滲透[28]，並鼓勵私營機構遵循這做法。在新策略性規劃研究中，例如在新界東北新發展區規劃及工程研究－勘查研究，以及對東涌餘下發展計劃的規劃及工程研究－可行性研究中，可以看出建造通風廊和空氣流通走廊的規劃決策中，有意識地納入了空氣流通走廊。

- **都市氣候規劃建議圖**
  規劃署在一份2012年完成的顧問研究中，制訂了都市氣候規劃建議圖，為評估主要發展對都市氣候和空氣流通的影響提供科學依據，並幫助應對熱島效應[29]。

古洞北新發展區通風走廊

香港都市氣候規劃建議圖



- **綠化總綱圖**
  由土木工程拓展署（CEDD）牽頭，政府制訂了一份地區性綠化總綱圖，藉研究各區特徵和獨特需要，全面界定各區綠化框架，並為工程規劃、設計和施工提供指引。該總綱圖辨明了栽種地點，建立綠化主題，以及建議適合栽種的植物物種。多區的總綱圖在2007年至2011年間完成，而進一步的總綱圖則會在餘下地區實施（參考第五章）。

- **可持續建築設計指引**
  自2011年起，政府透過屋宇署（BD）總樓面面積寬免政策，頒布了一份有關樓宇間距、樓宇後移及綠化面積的可持續建築設計指引，並將這份指引納入新買賣土地或1,000平方呎以上的修訂契約/換地的租賃條件中，以達至更佳通風、提供更多綠化地和紓緩熱島效應。

- **綠建環評（BEAM Plus）**
  綠建環評是香港為建築物制訂的綜合性環境評估系統。它是綠色建築的標準，強調以室內健康及環境質素和設施作為關鍵成效指標，並對當地、區域和全球環境影響作適當考慮。

九龍灣大業里

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元素
規劃宜居的高密度城市

健康城市

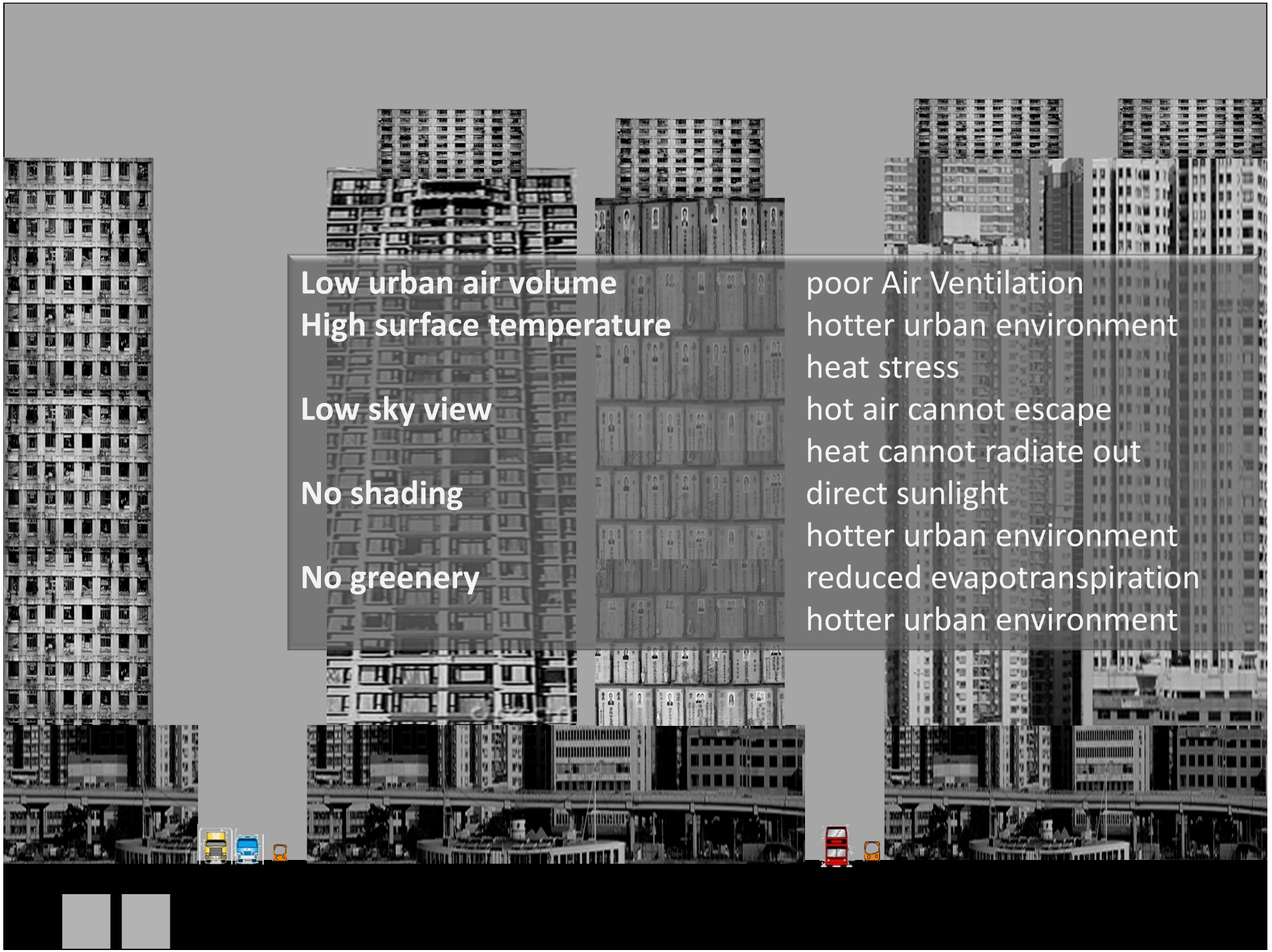
我們建議重塑城市和自然環境之間的融洽關係，促進生物多樣性、推廣環保措施，以及建立潔淨且健康的建設環境。為緩解熱島效應、改善都市氣候及應對氣候變化，我們將在規劃和城市設計時，進一步注入都市氣候及空氣流通的考慮因素。

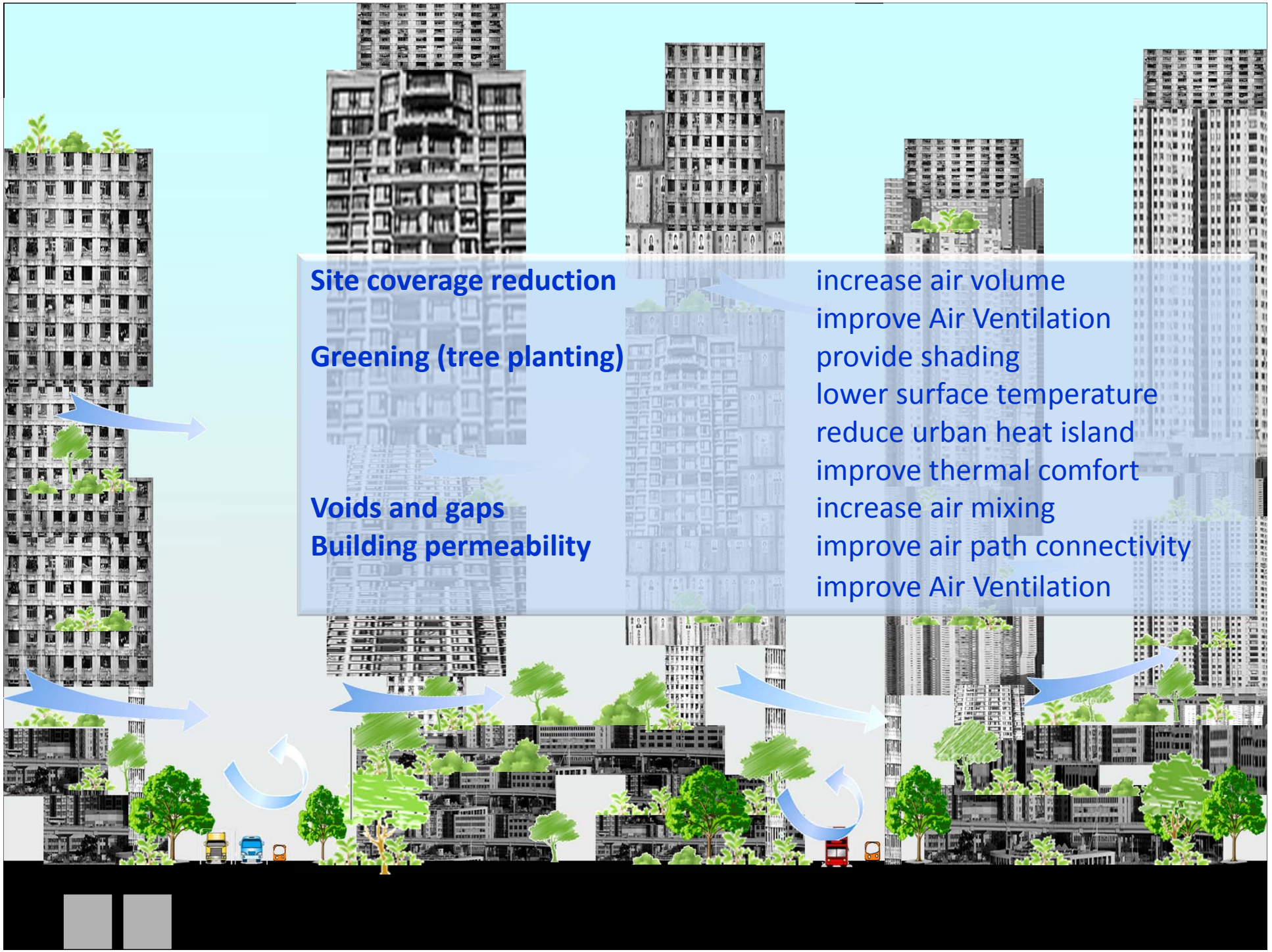
主要策略方針

把都市氣候及空氣流通納入考慮因素，以改善都市氣候

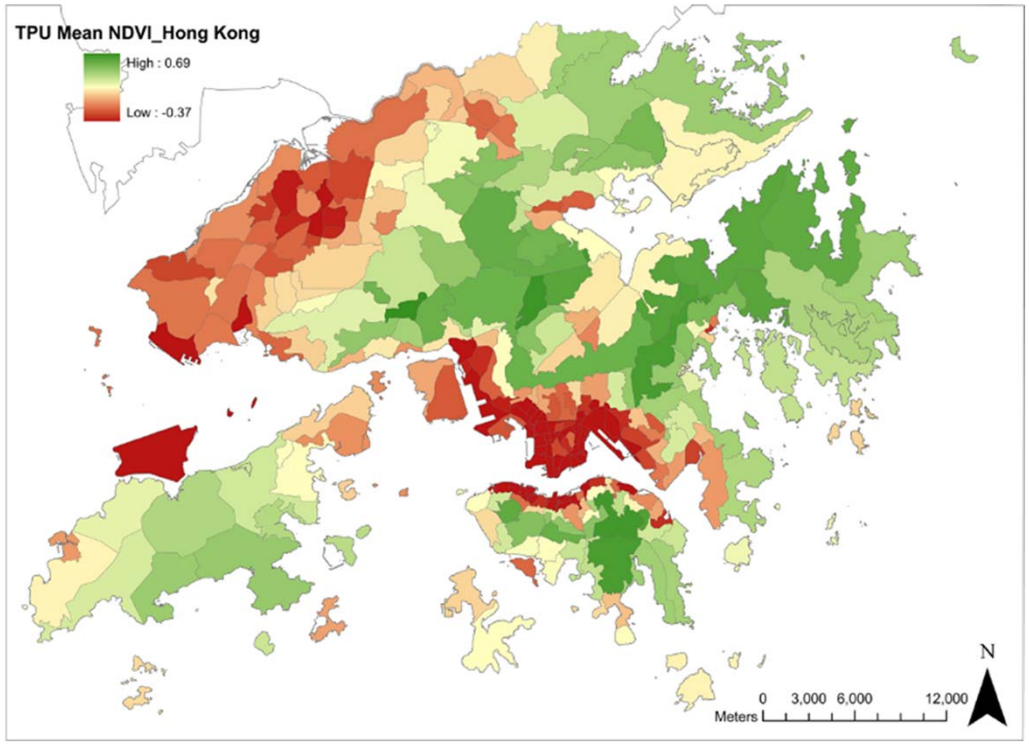
主要措施

- 進一步把都市氣候及空氣流通的考慮因素納入新發展區的規劃及設計中，並考慮香港都市規劃建議圖的指引，適切改造發展稠密的市區。
- 對現有的空氣流通技術通告和《香港規劃標準與準則》作相應更新


Low urban air volume
poor Air Ventilation
High surface temperature
hotter urban environment
heat stress
Low sky view
hot air cannot escape
heat cannot radiate out
No shading
direct sunlight
hotter urban environment
No greenery
reduced evapotranspiration
hotter urban environment


Site coverage reduction
increase air volume
improve Air Ventilation
Greening (tree planting)
provide shading
lower surface temperature
reduce urban heat island
improve thermal comfort
Voids and gaps
increase air mixing
Building permeability
improve air path connectivity
improve Air Ventilation

An Ecological Study relating Green Space to all-cause and cause-specific Mortality in Hong Kong from 2006-2011



An increase of 0.44 units in NDVI was significantly associated with lower **cardiovascular diseases**, and marginally significantly associated with lower **chronic respiratory diseases**. Associations were stronger for residents of low-income areas.

XU Luxia, REN Chao, YUAN Chao & GOGGINS William(2015) An ecological study of the association between area level green space and mortality in Hong Kong, *Journal of Epidemiology & Community Health* (under review)

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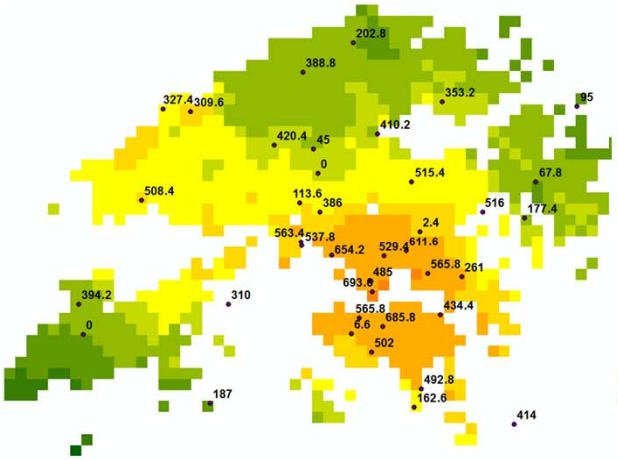
Urban Greenery

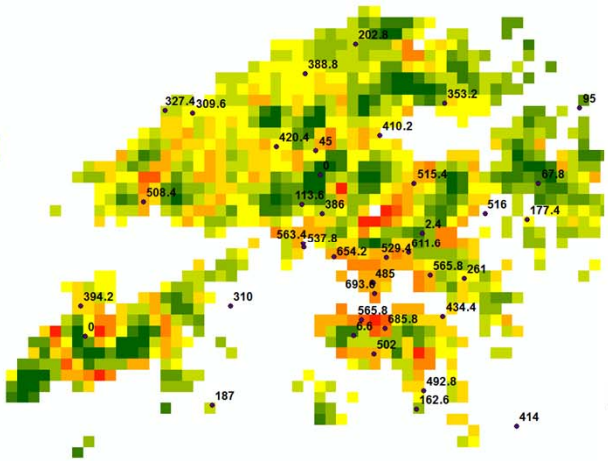
The Impact of **Hot Night** on the Elderly People

hot night hours



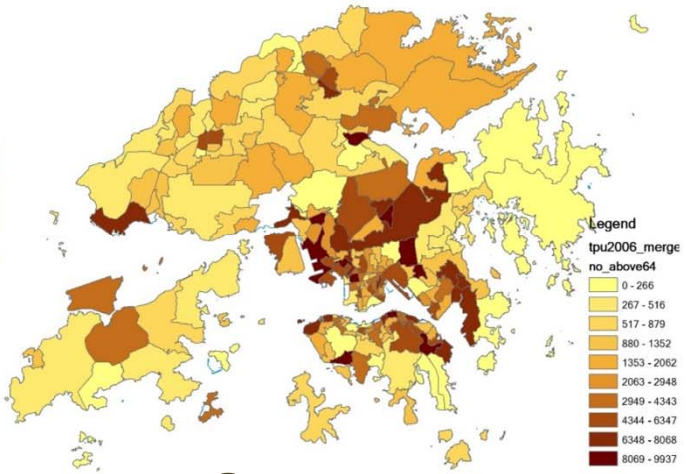
Climate

hot night hours +
SVF + **DEM** +**NDVI**



Built Environment

Total Population of HK Elderly People (>64)
(TPU based, 2006 Census)



Impact

HKO

PlanD, CEDD, HD, ArchSD, BD, …

HA, HAD, LCSD …

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Benefits of Greenery / Greenspace

Urban Climate and Heat-related Health

- Cooling effect: Mitigate the intense heat in the city
- Shading: Improve human thermal comfort

Physical and Mental Health

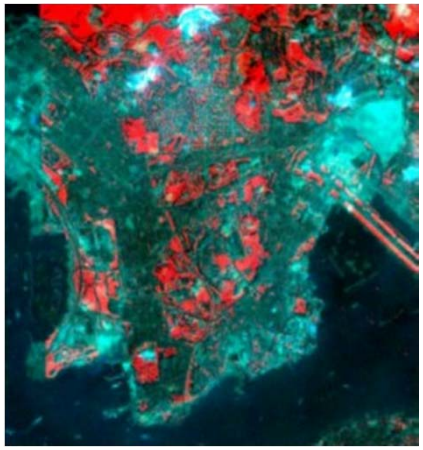
- Restorative effect: Reduce anger, fatigue and feelings of depression
- Physical activity: Improve cognitive function and memory
- Connection to outdoor: Alleviate symptoms of Alzheimers and dementia
- Exercise: Prevent osteoporosis and improve bone health

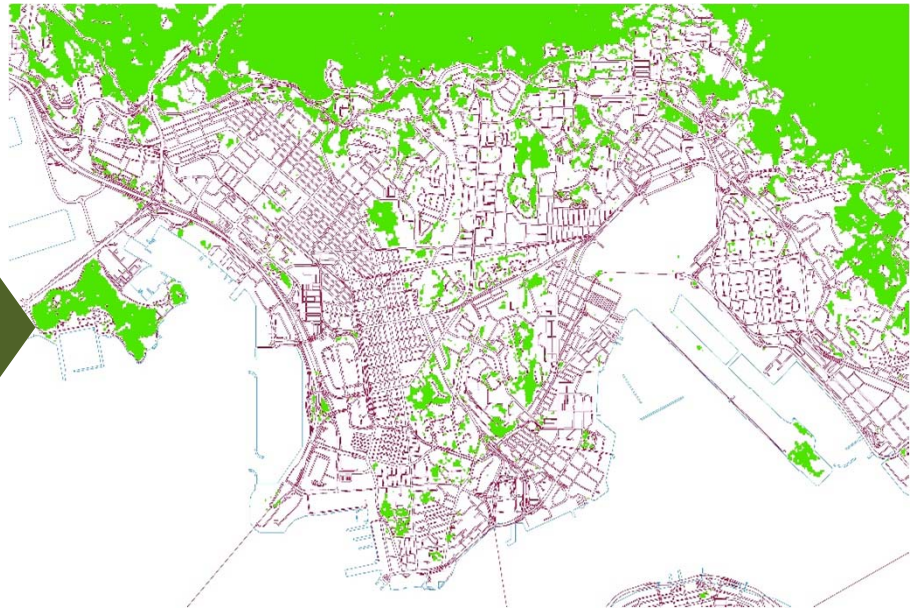
Greenery Data

- Based on the Normalized Difference Vegetation Index (NDVI)
- Derived from satellite images
- Determines potential vegetation cover (NDVI > 0.1)

$$NDVI = \frac{\text{Near Infrared Band} - \text{Red Band}}{\text{Near Infrared Band} + \text{Red Band}}$$

- Land Use Data for comparison





Cohort Study of Elderly Health

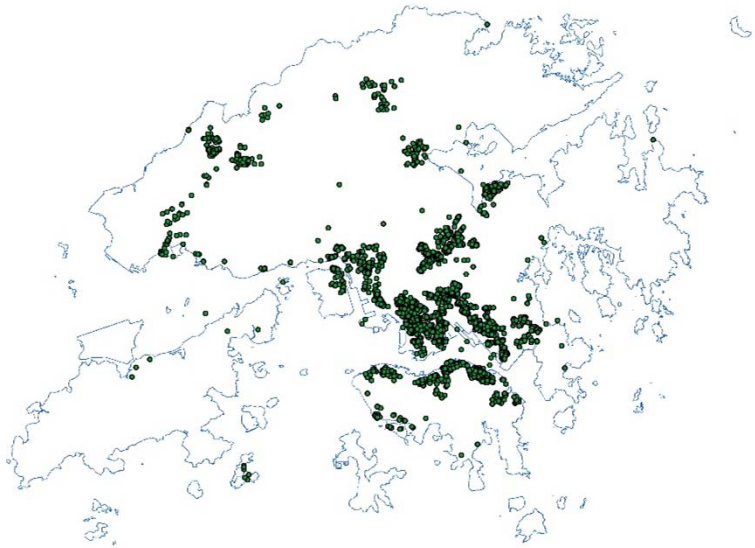
Recruitment:

4000 subjects (2000-2002)

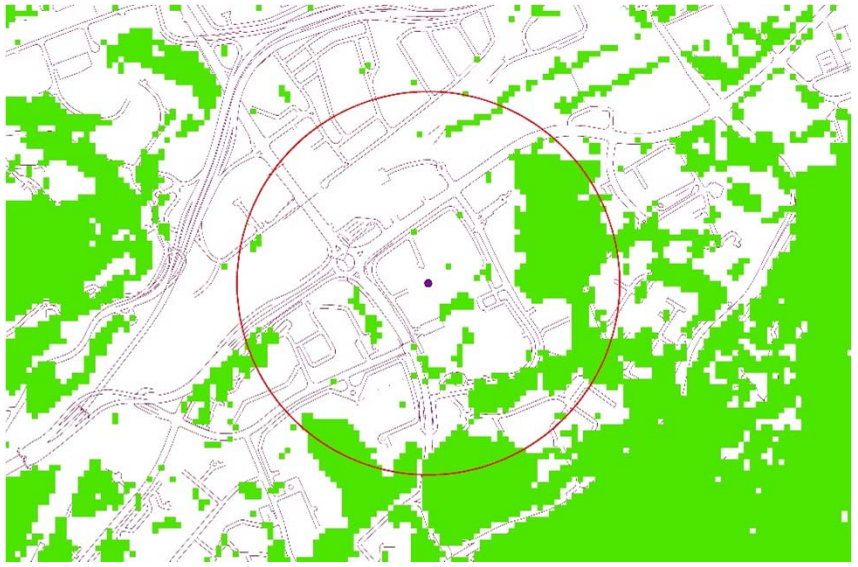
Follow-up: 2Y, 4Y and 11Y

- Physical and mental health outcomes
- Mortality
- Lifestyle and medical history
- Socio-demographic background

Geocoding of addresses



Calculation of greenspace coverage



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Mortality Risk

- 10% increase in neighbourhood green space
  - 4% reduction in all-cause mortality risk
  - 12% reduction in mortality caused by circulatory system diseases
  - 35% reduction in stroke-cause mortality
- Multivariate model shows that physical activity and cognitive function are also found to be associated with mortality
- Greenspace helps to reduce mortality risk by promoting exercise and improving cognitive ability

Wang D, Lau KKL, Yu R, Wong SYS, Kwok TCY, Woo J, 2016. Neighbouring green space and all-cause mortality in elderly people in Hong Kong: a retrospective cohort study. The Lancet 388:S82

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That is all for now, thank you

Edward NG

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