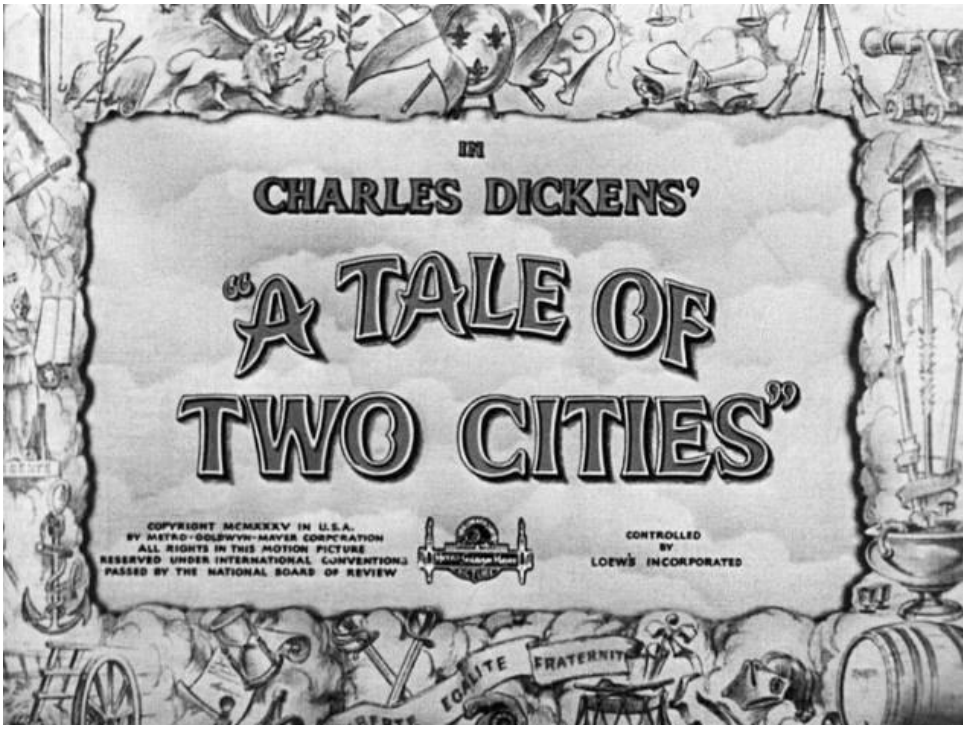
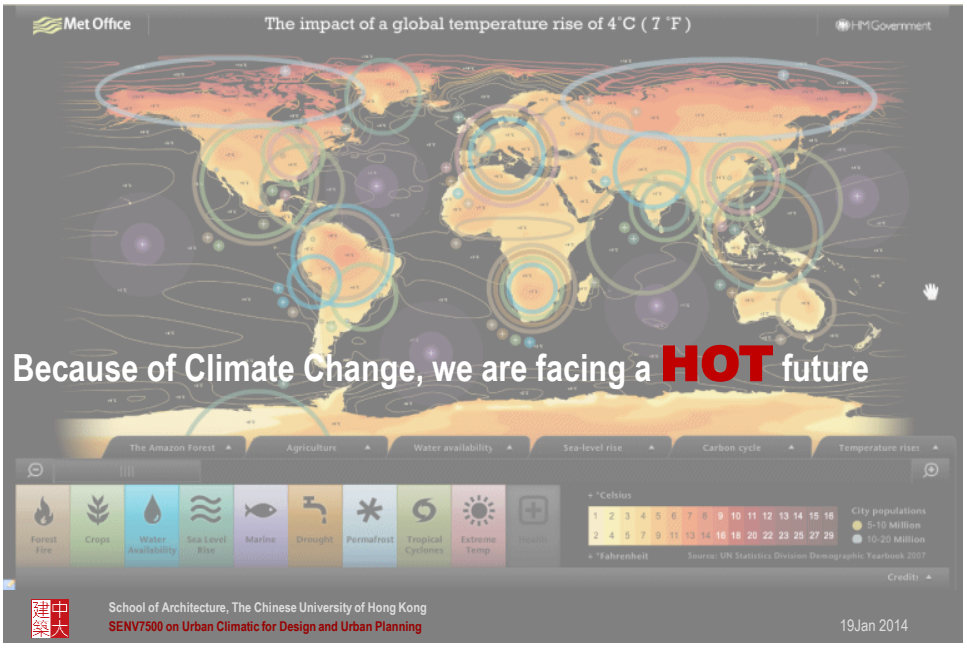
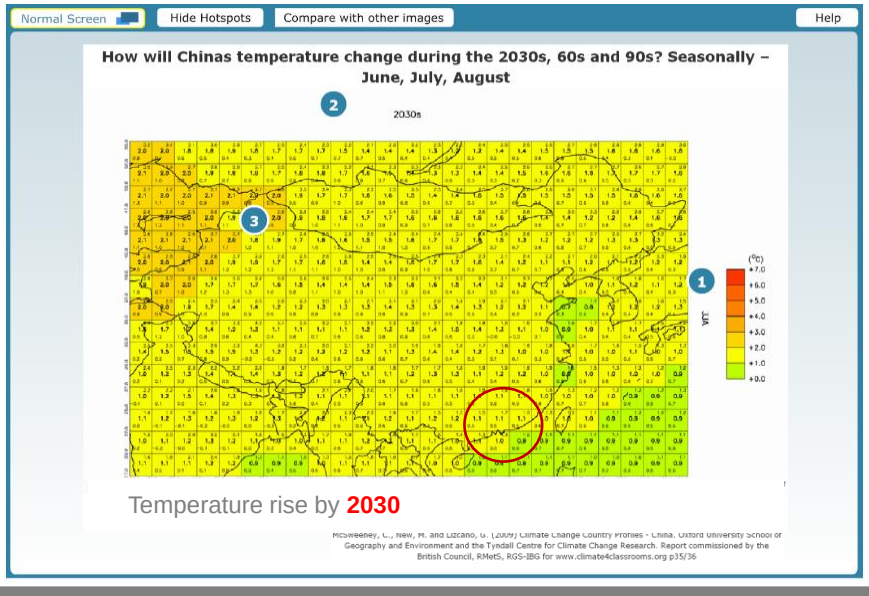

IN
CHARLES DICKENS'
"A TALE OF TWO CITIES"
COPYRIGHT MCMXXXV IN U.S.A.
BY METRO-GOLDWYN-MAYER CORPORATION
ALL RIGHTS IN THIS MOTION PICTURE
RESERVED UNDER INTERNATIONAL CONVENTIONS
PASSED BY THE NATIONAL BOARD OF REVIEW
CONTROLLED
BY
LOEW'S INCORPORATED


In Times of *Climate* Change:
Hong Kong & Macau
Chao REN, Steve YIM, Gabriel LAU, Justin HO
The Chinese University of Hong Kong

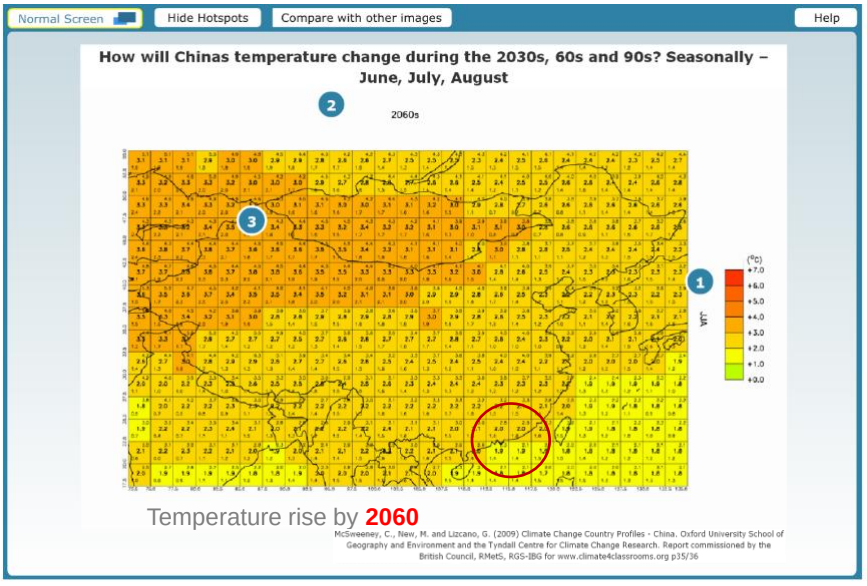
GLOBAL



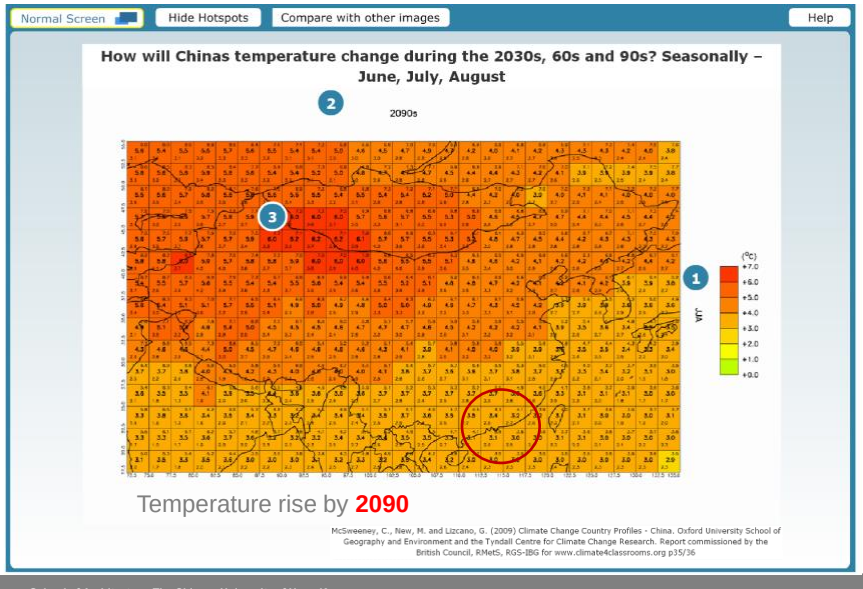
COUNTRY



COUNTRY

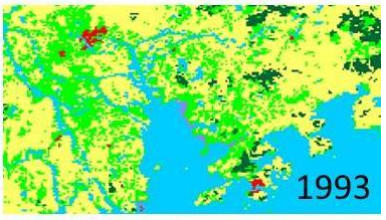


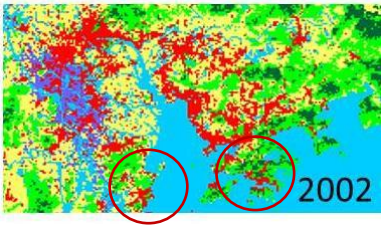
COUNTRY

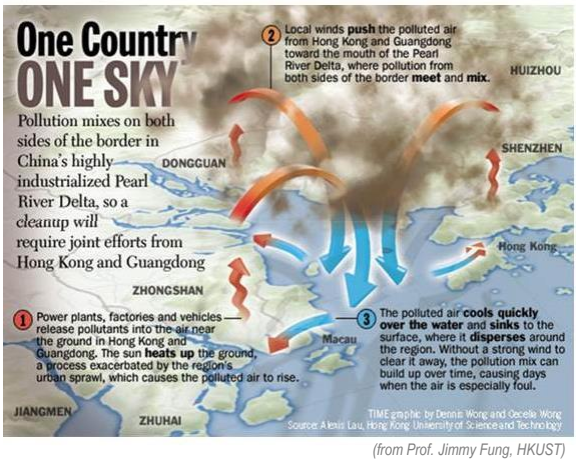


School of Architecture, The Chinese University of Hong Kong
SENV7500 on Urban Climatic for Design and Urban Planning
19Jan 2014

REGIONAL







(from Prof. Jimmy Fung, HKUST)

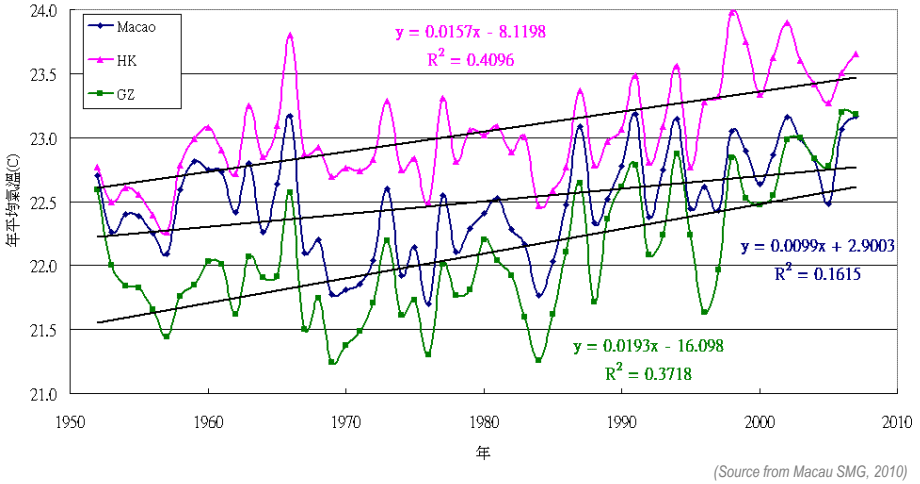
REGIONAL

Impacts

Higher Temperatures
Erratic Rainfall
Rising Sea Levels
More intense typhoons

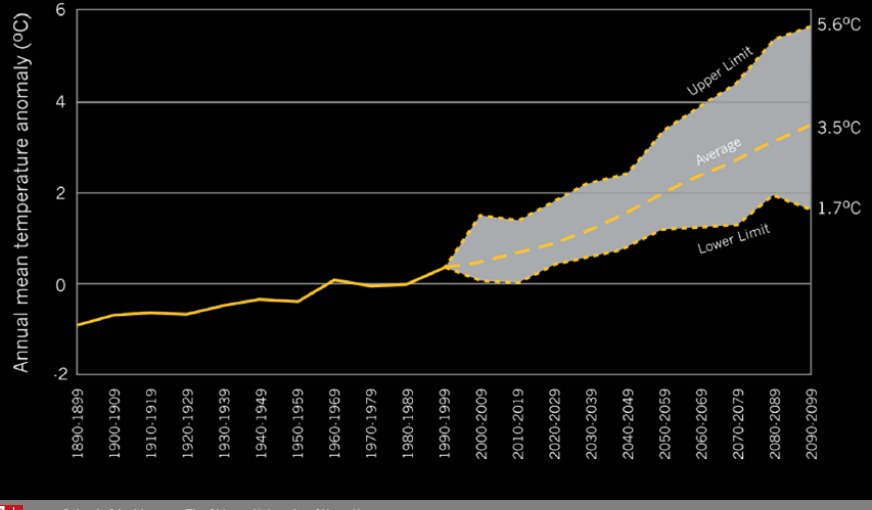
School of Architecture, The Chinese University of Hong Kong
SENV7500 on Urban Climatic for Design and Urban Planning
19Jan 2014

Annual Air Temperature Trend from 1952-2007
Macao, Hong Kong(HK), Guangzhou(GZ)



(Source from Macau SMG, 2010)

Higher Temperatures



Yes, heat can KILL…

Sometimes quicker than "slowly"

(明報)2010年7月5日 星期一 08:05

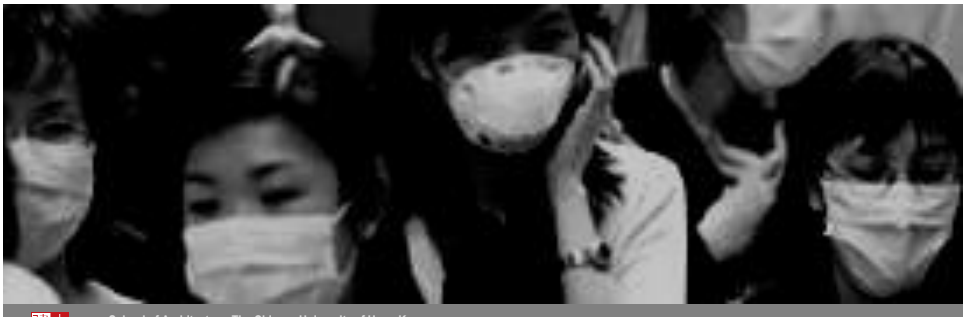
天氣酷熱90長者不適

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;

A study of intracity variation of temperature-related mortality and socioeconomic status among the Chinese population in Hong Kong

Emily Ying Yang Chan, William B Goggins, Jacqueline Jekyoung Kim, Sian M Griffiths



ELSEVIER
Available online at www.sciencedirect.com
ScienceDirect
Energy 31 (2006) 2623–2637
ENERGY
www.elsevier.com/locate/energy

Review

Impact of urban temperature on energy consumption of Hong Kong

W.Y. Fung[a], K.S. Lam[a,*], W.T. Hung[a], S.W. Pang[b], Y.L. Lee[b]

[a]Department of Civil and Structural Engineering, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong
[b]Air Management Group, Environmental Protection Department, HKSAR, 33/F Revenue Tower, 5 Gloucester Road, Wan Chai, Hong Kong

Increase in Energy Consumption

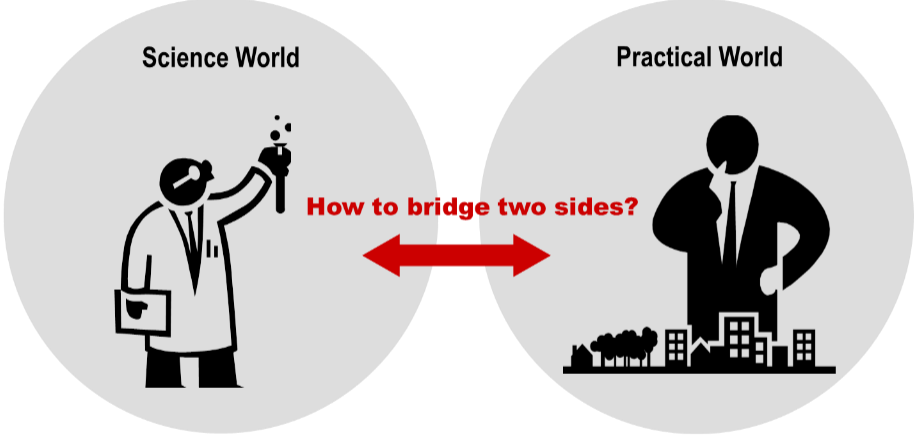
EPD's Project:
Provision of Service for Characterising the Climate Change Impact in Hong Kong

Increasing electricity demand percentage per year	Temperature increase by		
	1°C	2°C	3°C
Domestic	9.02%	16.15%	30.97%
Commercial	3.13%	6.26%	9.38%
Industrial	2.64%	5.28%	7.91%
Total	4.53%	9.52%	14.98%

Table 3.4 Percentage Increase of Energy Consumption due to Temperature Rise

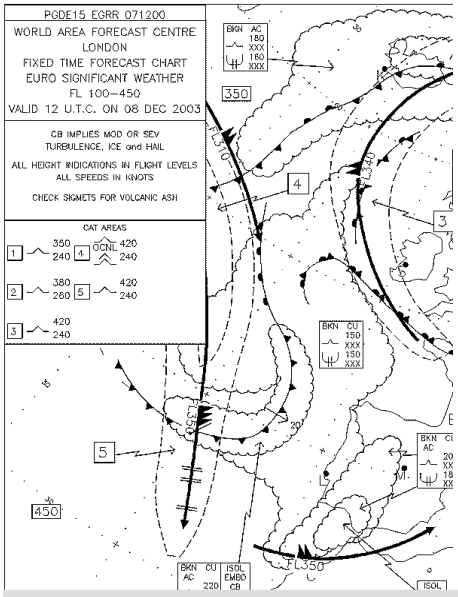
High Density, but High Quality

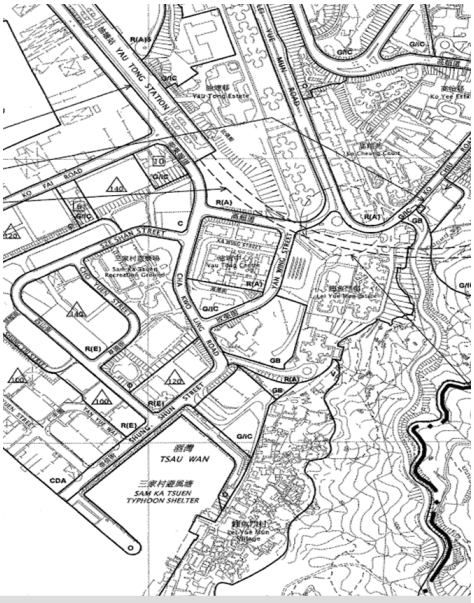
Gap & Linkage



Climatologists, RS Experts,
Wind Engineers

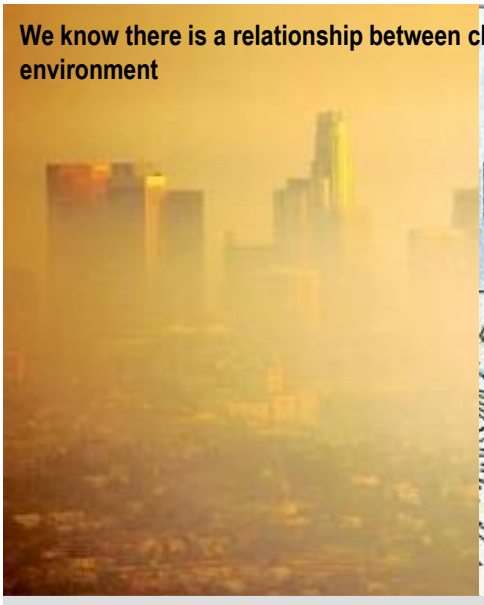
Planners, Designers,
Policy Makers

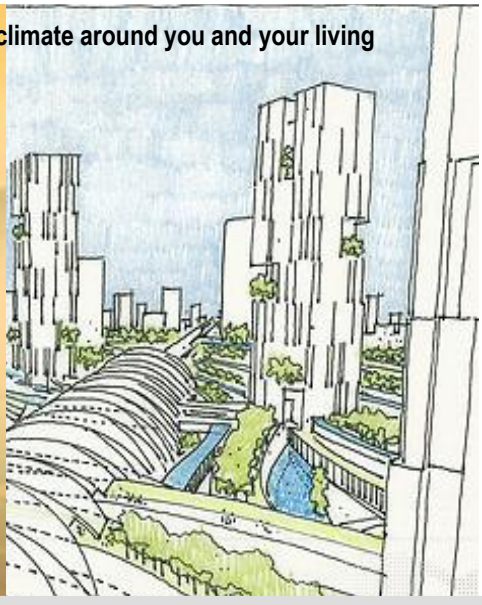




DIFFERENT LANGUAGE

Urban Climatology vs. Town Planning





RELATIONSHIP & INTERACTION

Urban Climatology vs. Town Planning

So, in a short, what do we need?

an **appropriate TOOL** to present information,

a **right TRANSLATION** from the science world to the planning field,

clear MEASURES/STRATEGIES for practice,

an **effective COMMUNICATION** between researchers and planners

Optimise planning and design based on Urban Climatic understanding

What action is needed?

Where is it most needed?

How much effort is needed?

What benefits can be expected?

Our research results SHOULD give planners a better evidence basis to balance their planning decision making not only for the existing urban fabric, but also for new and to-be-planned districts and areas.

Hong Kong

- Area: 1,104 KM2
- Population Density: 7.23 Million
- Density: 6,544/km2
- GDP: 2014 estimate $302.8 Billion
- HDI: 0.891 (very highly urbanized, 15th)

Climate Change in Hong Kong 香港氣候變化

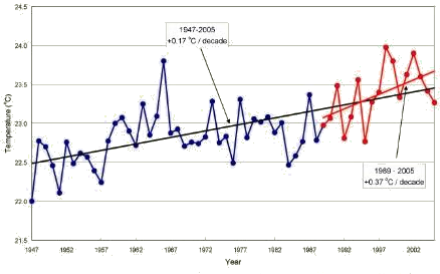


Fig.1 Annual mean temperature recorded at the Hong Kong Observatory Headquarters (1947-2005)

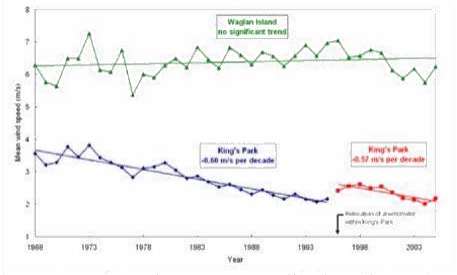
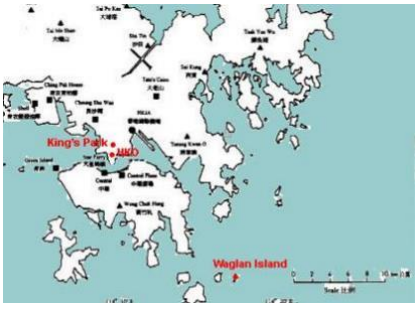


Fig. 4 Annual average of 12-hourly 10-minute mean wind speed of King's Park and Waglan Island (1968-2005)

1. The temperature rose at 0.17° C per decade over the entire period; 0.37° C over last decade in HK urban areas
2. The wind speed in urban area reduced

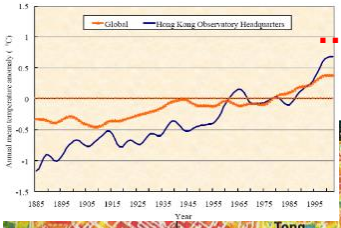
C.Y.Lam: (2006)."On climate changes brought about by urban living", PGBC Symposium 2006, P17

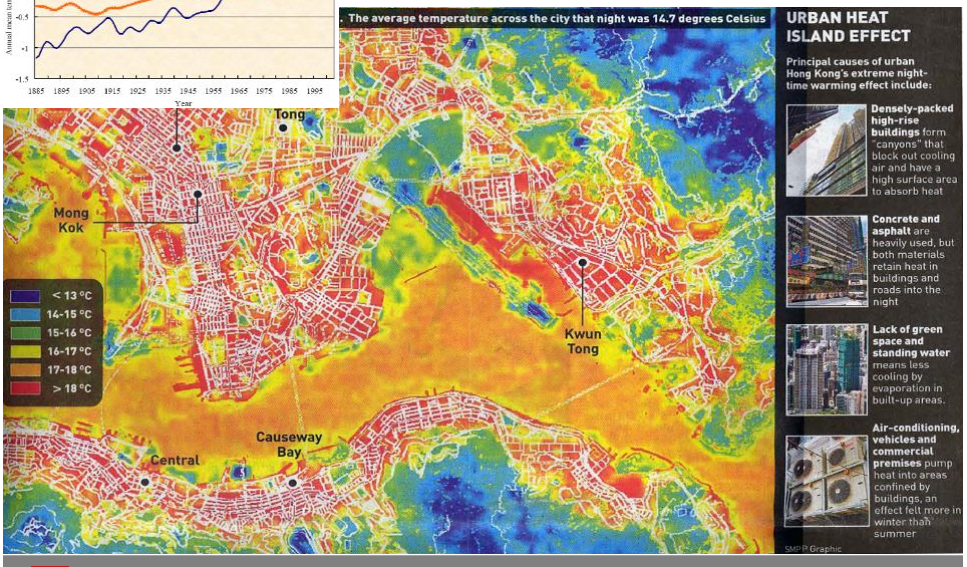


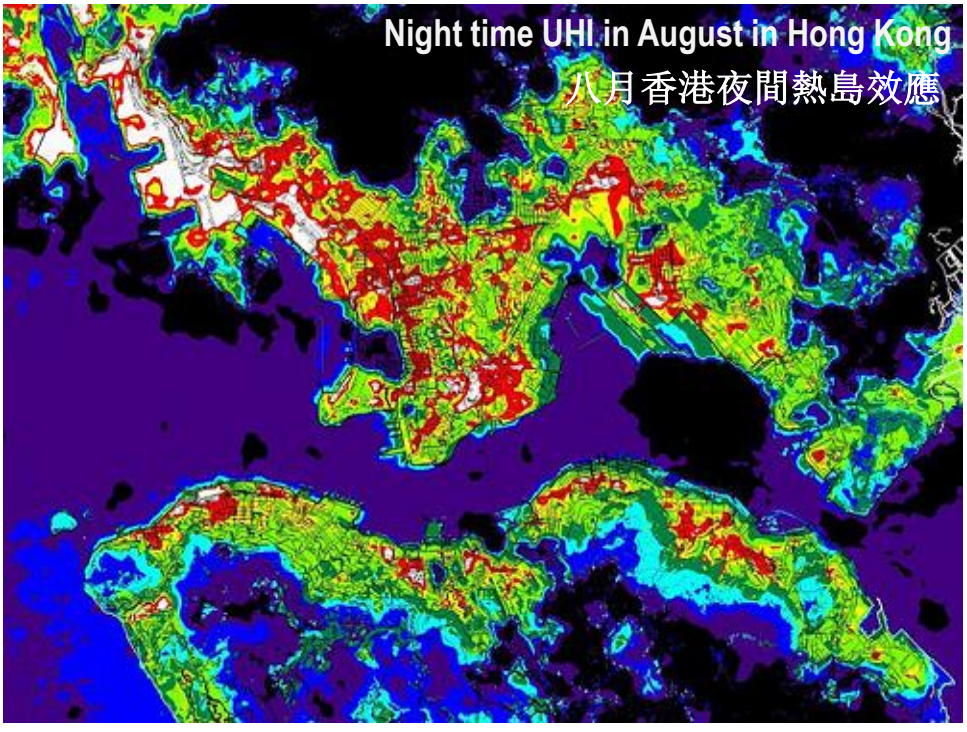
http://www.timesofmalta.com/articles/view/20100323/world/hong-kong-air-pollution-soars-to-record-levels.299536

… Urban Heat Island & heat stress

Professor Janet Nicol

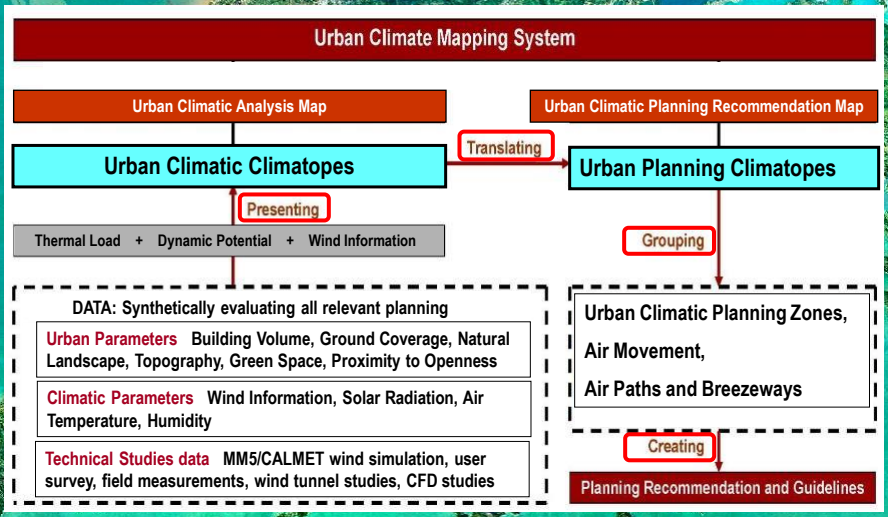






The draft HK Urban Climatic Analysis Map

Framework of Hong Kong Urban Climatic Maps



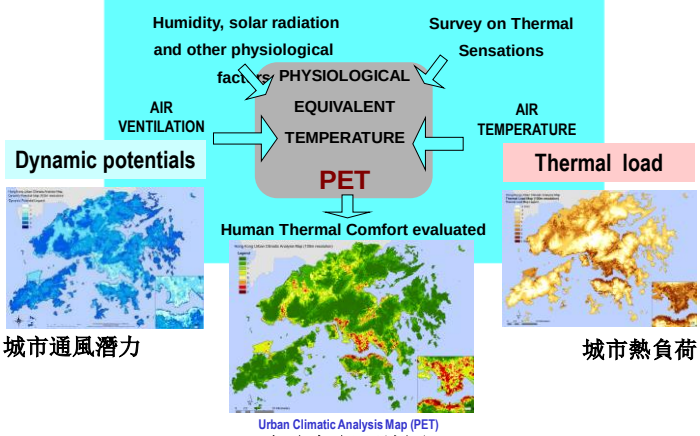
The draft HK Urban Climatic Analysis Map

The concept of

人體熱能(等效)溫度

Physiological Equivalent Temperature (PET)

as the synergizing variable for the HK Urban Climatic Analysis Map

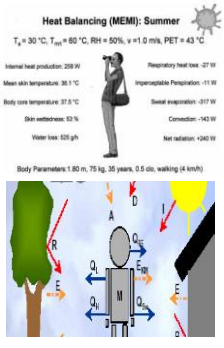


城市通風潛力

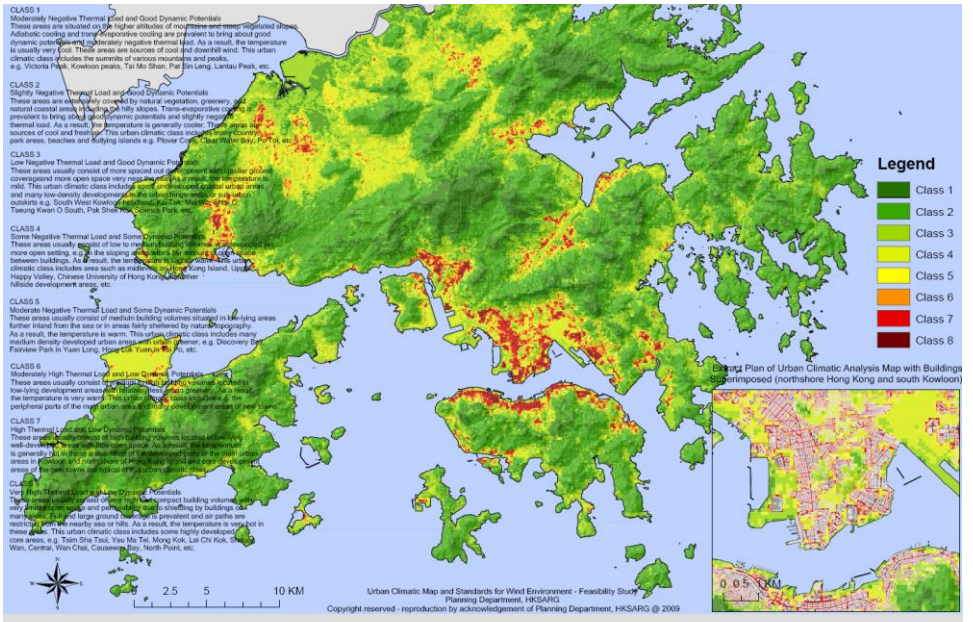
城市熱負荷

Urban Climatic Analysis Map (PET)

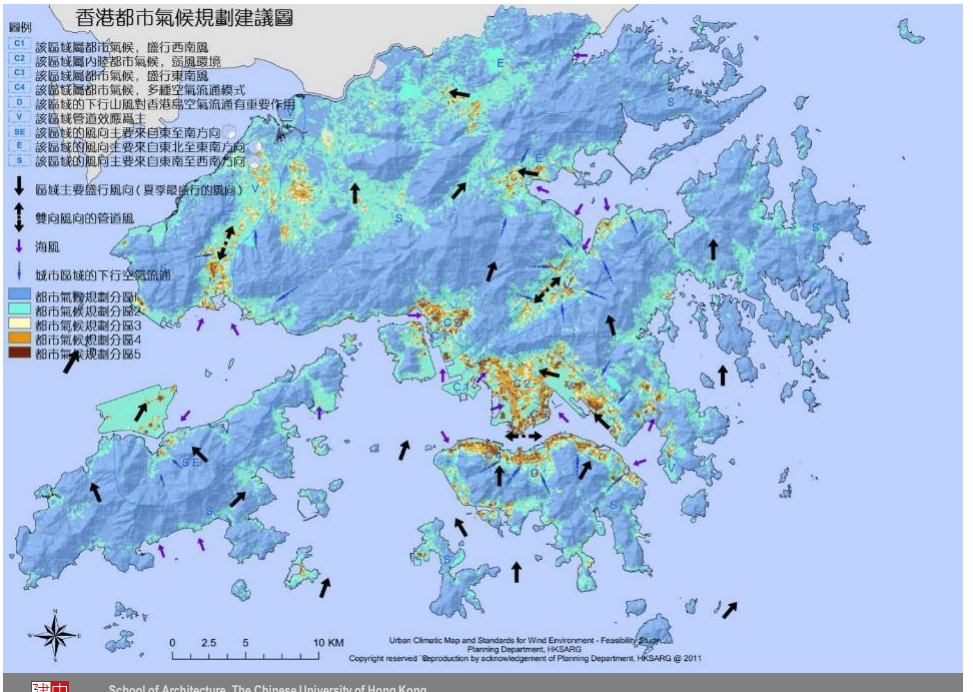
都市氣候環境圖



note
Physiological Equivalent Temperature (PET) is the temperature of a reference environment based on a heat balance model that combines various climatic and physiological variables including air temperature, relative humidity, solar radiation, air movement, clothing and metabolic rate to give a synergetic indication of human thermal comfort. It is an index widely used to understand the thermal comfort environment


Legend
Class 1
Class 2
Class 3
Class 4
Class 5
Class 6
Class 7
Class 8
0 2.5 5 10 KM
Urban Climatic Map and Standards for Wind Environment - Feasibility Study
Planning Department, HKSARG
Copyright reserved - reproduction by acknowledgement of Planning Department, HKSARG @ 2009

香港的城市氣候圖

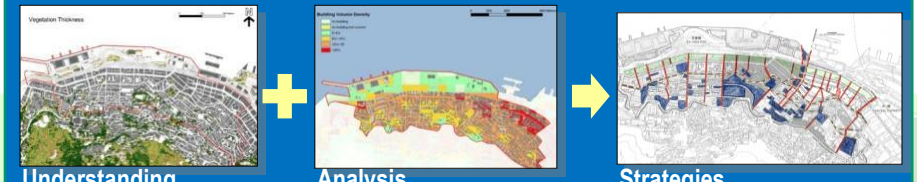

香港都市氣候規劃建議圖
圖例
C1 該區域屬都市氣候，盛行西南風
C2 該區域屬內陸都市氣候，弱風環境
C3 該區域屬都市氣候，盛行東南風
C4 該區域屬都市氣候，多種空氣流通模式
D 該區域的下行山風對香港局空氣流通有重要作用
V 該區域管道效應爲主
SE 該區域的風向主要來自東至南方向
E 該區域的風向主要來自東北至東南方向
S 該區域的風向主要來自東南至西南方向
區域主要盛行風向（夏季最盛行的風向）
雙向風向的管道風
海風
城市區域的下行空氣流通
都市氣候規劃分區1
都市氣候規劃分區2
都市氣候規劃分區3
都市氣候規劃分區4
都市氣候規劃分區5
0 2.5 5 10 KM
Urban Climatic Map and Standards for Wind Environment - Feasibility Study
Planning Department, HKSARG
Copyright reserved - reproduction by acknowledgement of Planning Department, HKSARG @ 2011

Urban Climatic Maps

UC-AnMap | UC-ReMap

Application:-

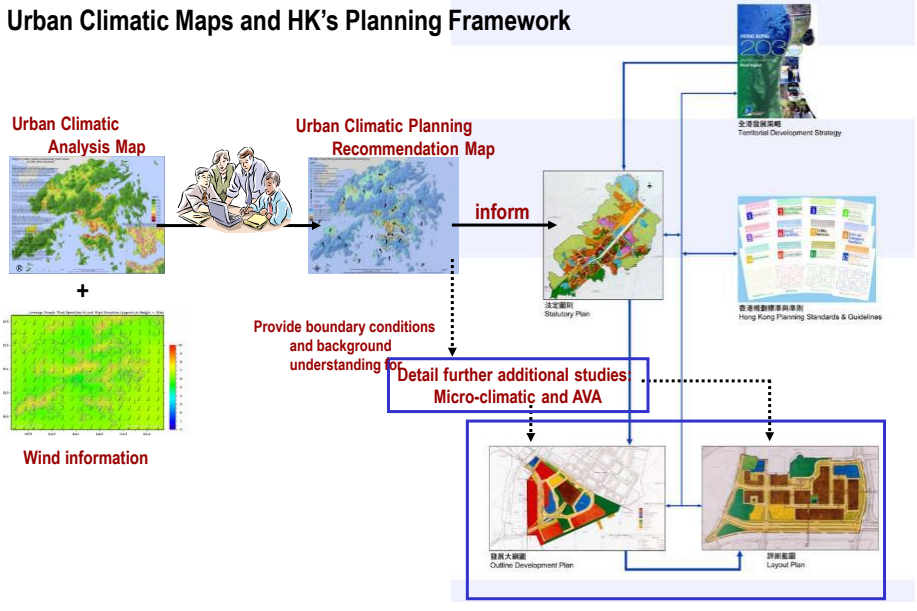
- Identifies appropriate planning and design measures to improve urban climate
- Provides a strategic urban climatic information platform for guiding the planning and development process for future development, e.g. the location of new development areas in UCPZ 2
- Provides an urban climatic planning framework for reviewing statutory town plans and formulating suitable planning parameters



Reference should also be made to strategic and district considerations and site circumstances

Urban Climatic Maps and HK's Planning Framework

Urban Climatic Maps and HK's Planning Framework



Macau

- Area: 31.3KM2
- Population Density: 0.62 Million
- Density: 18,568/km2
- GDP: 2011 estimate US$47.19 Billion
- HDI: 0.868 (very highly urbanized, 25th)

Stage 1 - A Pilot Study towards Urban Climatic Map for Macau (Completed)

Stage 2 – Macau Wind Environment (Processing)

Stage 3 – Macau Thermal Environment

Macau (22° 12'N, 113° 33'E)

Located: Coastal

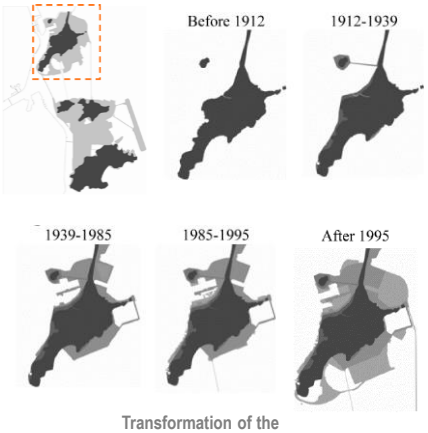
Total Area: 29.2 KM2

Population: 0.542 Million

Population Density: 18,568/ KM2

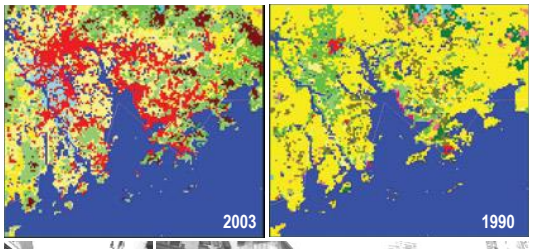
Climate: Sub-tropical

Summer: Hot & Humid



Transformation of the coastline

(Drawn by CUHK)



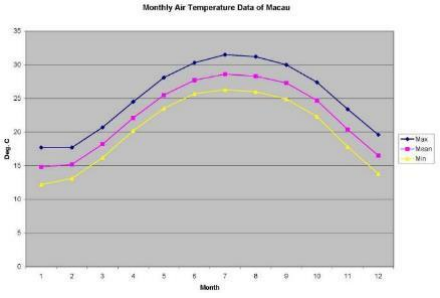
Urbanization

- Much more land is under concrete
- More rapid developments of tall and bulky buildings with large podium appear
- High-dense urban context with narrow streets

Macau

In 2009, Macau Gov. commissioned a pilot study towards producing Urban Climatic Map for Macau.

- It is found that the summer months, especially June to August, have higher air temperature than other month and the daily heat period appears between 12pm to 17pm.
- The most comfortable period begins from the middle of October to December.
- Thus, the summer months especially June to August are considered more critical for human thermal comfort in Macau.

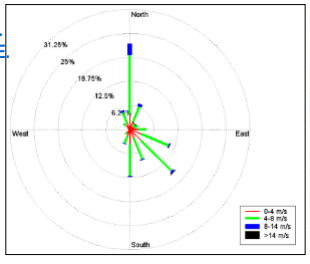


Hour	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	14.65	14.35	16.01	21.19	24.90	26.76	27.55	27.03	25.47	24.55	19.75	16.11
2	14.18	14.18	17.90	21.20	24.79	26.76	27.05	26.94	26.26	24.18	19.50	15.69
3	14.28	13.96	17.79	21.00	24.51	26.63	27.31	26.93	26.21	24.01	19.29	15.59
4	14.07	13.82	17.89	20.92	24.52	26.74	27.63	26.76	25.96	23.84	19.08	15.42
5	13.88	13.87	17.90	20.86	24.45	26.47	26.90	26.64	24.93	23.69	18.97	15.31
6	13.70	13.65	17.47	20.78	24.37	26.41	26.84	26.67	24.91	23.53	18.89	15.11
7	13.52	13.48	17.41	20.81	24.02	25.45	27.00	26.66	24.85	23.51	18.87	14.93
8	13.61	13.67	17.68	21.16	25.16	26.26	26.87	27.26	26.48	24.09	18.98	15.02
9	14.22	14.13	18.29	21.78	25.89	26.92	26.77	28.28	26.16	25.11	19.97	15.91
10	15.06	14.88	18.98	22.26	26.62	27.43	26.93	28.54	27.28	26.11	20.92	16.84
11	16.02	15.71	19.73	23.06	27.74	27.91	29.81	29.67	27.94	26.97	21.89	17.85
12	16.89	16.36	20.53	23.95	27.57	28.07	30.26	30.06	28.47	27.61	22.53	18.63
13	17.49	16.91	20.72	23.68	27.76	28.17	30.43	30.19	28.78	28.09	23.09	19.07
14	17.87	17.04	20.79	23.62	27.78	28.14	30.46	30.24	28.85	28.15	23.28	19.02
15	17.87	17.06	20.71	23.66	27.80	28.06	30.36	30.11	28.63	27.93	23.18	19.79
16	17.53	16.68	20.44	23.52	27.29	27.57	30.03	29.83	28.03	27.41	22.79	18.59
17	16.87	16.10	19.83	23.02	26.81	27.07	29.35	29.09	27.08	26.51	21.84	18.49
18	16.07	15.30	19.30	22.40	26.24	27.02	28.96	28.71	26.96	25.66	20.90	17.54
19	16.18	14.87	18.79	21.91	25.61	26.35	28.37	28.08	26.38	25.13	20.53	17.02
20	15.38	14.71	18.60	21.68	25.33	26.25	27.93	27.67	26.14	24.93	20.35	16.84
21	15.15	14.58	18.43	21.64	25.19	26.12	27.73	27.44	25.93	24.75	20.20	16.69
22	15.02	14.51	18.37	21.68	25.08	26.04	27.62	27.31	25.78	24.62	20.07	16.64
23	14.90	14.43	18.31	21.44	25.00	25.98	27.55	27.23	25.67	24.49	19.90	16.50
24	14.80	14.37	18.27	21.40	24.93	25.91	27.46	27.19	25.55	24.38	19.75	16.24

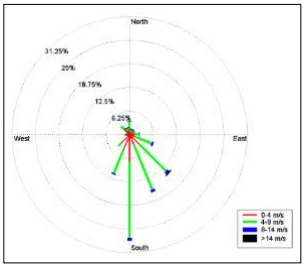
Wind Condition of Macau

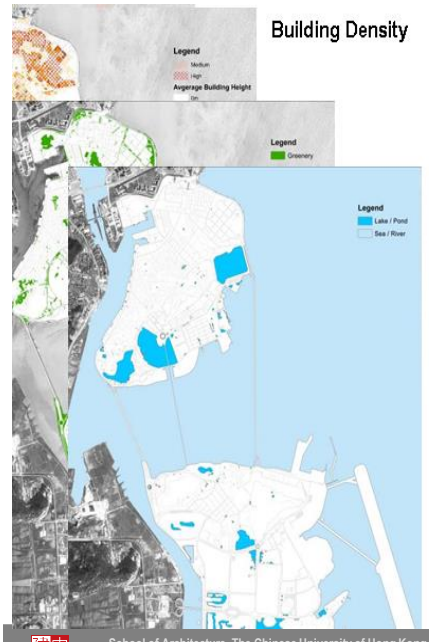
Macau is situated on the southern coast of Asia.
The winter prevailing wind is mainly from the NE.
The summer prevailing wind is mainly from the SW

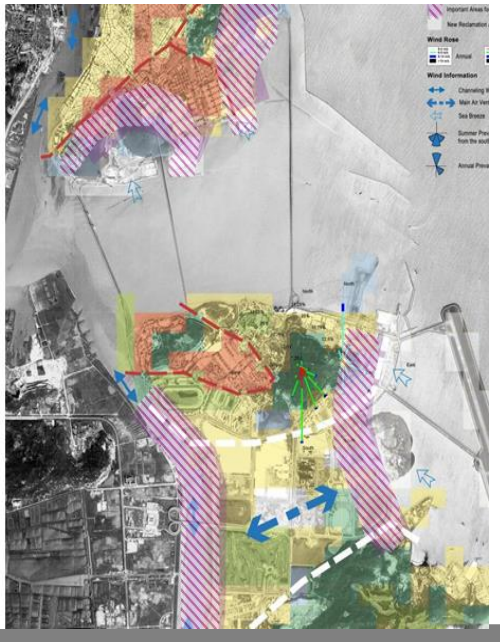
Flow Pattern (Annual Condition)



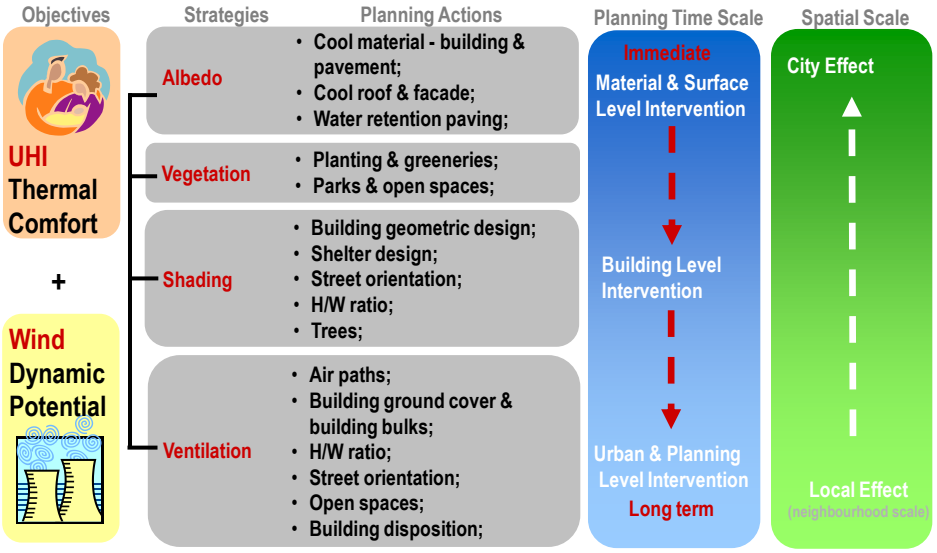
Flow Pattern (Summer Condition)



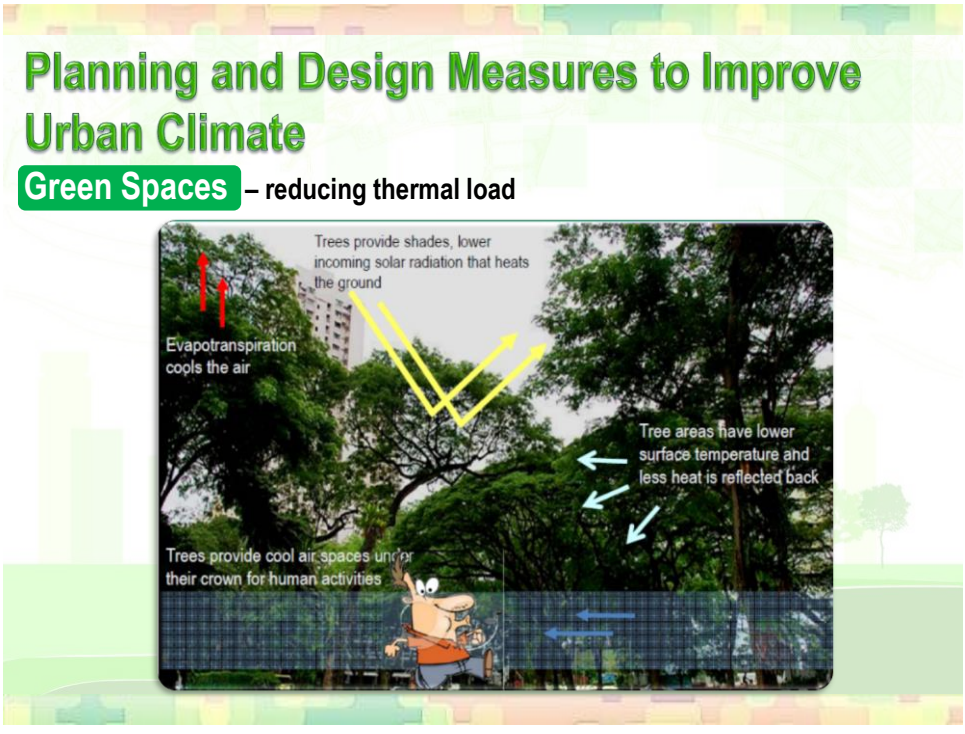




Wait, Accept or Adopt?



Planning strategies



Planning and Design Measures to Improve Urban Climate

Green Spaces – reducing thermal load

- Increase greenery, preferably tree planting at grade
- Create urban green oasis
- Establish networks of connected green spaces


Planning and Design Measures to Improve Urban Climate

Green Spaces – reducing thermal load: improvement of greenery

Country	Greening benefit of reducing air temperature at the pedestrian level	Remarks	Researcher
Japan	Around 0.5 – 1.2 °C	Increasing green area in a city from 5% to 30%	Gao (1993)
	Around 1 °C	With greenery coverage from 0% to 30%	Takahashi & Moriyama (1992); Moriyama (2009)
	Around 0.3 – 1 °C	Greening on roads and grounds within a densely built urban area	Chen, H., Ooka, R., Huang, H., Tsuchiya, T. (2009)
	Negligible	100% roof greening on roof top of tall buildings	Chen, H., Ooka, R., Huang, H., Tsuchiya, T. (2009)
Greece	Around 0.8 K	10% increase of greening to a built up area	Dimoudi and Nikolopoulou (2003)
Brazil	Around 0.5 – 1.1 °C	Street canyon, height-to-width-ratio of 2, with trees coverage at the ground level	Spangenberg (2008)
Germany	Around 1.5 K	Height-to-width-ratio of 1-2, full tree planting at the ground level	Ali-Toudert and Mayer (2007)

A summery of various studies around the world on the benefits of greening to human thermal comfort in urban areas. On the whole, tree planting yields a benefit of around 1°C

Gao, W., (1993). Thermal effects of open space with a green area on urban environment. Journal of Architectural and Planning Environment Engineering, AIJ, No. 448.

Takahashi, T., Moriyama, M. (1992). Control method of urban thermal environment (in Japanese). Summary of Technical Papers of annual Meeting Architectural Institute of Japan. D. Environmental Engineering, 1109 – 1110.

Moriyama, M., Tanaka, T., Iwasaki, M. (2009). The Mitigation of UHI Intensity by the Improvement of Land Use Plan in the Urban Central Area – Application to Osaka City, Japan. Second International Conference on Countermeasures to Urban Heat Islands (SICCUHI) Sep 21 – 23, 2009 in Berkeley, California.

Chen, H., Ooka, R., Huang, H., Tsuchiya, T. (2009). Study on mitigation measures for outdoor thermal environment on present urban blocks in Tokyo using coupled simulation. Building and Environment, 44 (11), 2290 – 2299.

Dimoudi, A., Nikolopoulou M., (2003). Vegetation in the urban environment: microclimatic analysis and benefits. Energy and Buildings, 35, 69 – 76.

Spangenberg, J., Shinzato P., Johansson E., Duarte D. (2008). Simulation of the Influence of Vegetation on Microclimate and Thermal Comfort in the City of São Paulo. Rev. SBAU, Piracicaba, v.3, n.2, p. 1 – 19.

Ali-Toudert, F., Mayer, H. (2007). Effects of asymmetry, galleries, overhanging facades and vegetation on thermal comfort in urban street canyons. Solar Energy, 81, 742 – 754.

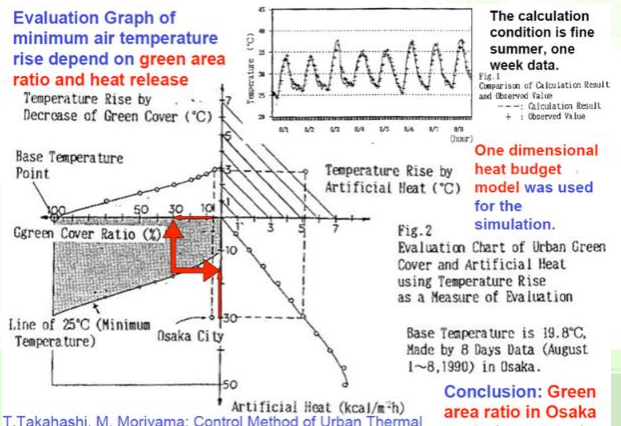
Planning and Design Measures to Improve Urban Climate

Green Spaces – reducing thermal load: improvement of greenery

Studies led by Prof. Moriyama of Japan has pointed to the need of

30% greenery at grade in urban areas to usefully mitigate UHI

Evaluation Graph of minimum air temperature rise depend on green area ratio and heat release



The calculation condition is fine summer, one week data.

Fig.1 Comparison of Calculation Result and Observed Value
——: Calculation Result
+ : Observed Value

One dimensional heat budget model was used for the simulation.

Fig.2 Evaluation Chart of Urban Green Cover and Artificial Heat using Temperature Rise as a Measure of Evaluation

Base Temperature is 19.8°C, Made by 8 Days Data (August 1~8,1990) in Osaka.

T.Takahashi, M. Moriyama: Control Method of Urban Thermal Environment, Summary of technical papers of Annual Meeting Architectural Institute of Japan. D, Environmental Engineering, 1992, 1109-1110 (in Japanese)

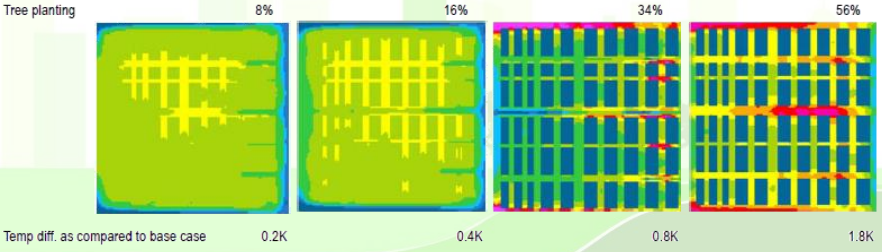
Conclusion: Green area ratio in Osaka central area needs at least about 30%.

Planning and Design Measures to Improve Urban Climate

Green Spaces – reducing thermal load: improvement of greenery

The study has concluded that 1/3 greening (tree planting) may reduce urban temperature by 0.8K in the hot and humid summer daytime conditions of Hong Kong

The base case geometric modelling based on the urban morphology of Mong Kok.

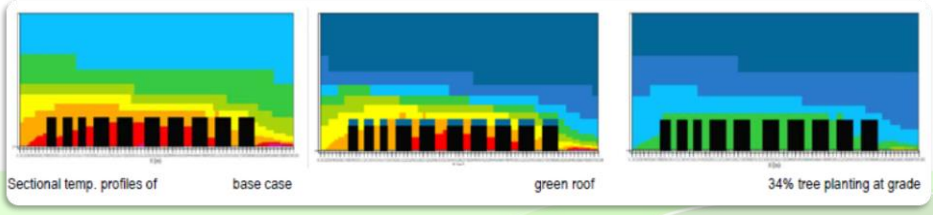


Wang Y and Ng E., Parametric Study on Microclimate Effects of Different Greening Strategies in High Density City, in Proceedings of The joint 3rd PALENC, 5th EPIC and 1st Cool Roofs Conference, Organised by University of Athens, 29 Sept -1 Oct 2010, Rhodes Island, Greece.
Ng E. and Wang U., (2010) A study on the cooling effects of greening in high density city: an experience from Hong Kong, Building and Environment, (in press)

Planning and Design Measures to Improve Urban Climate

Green Spaces – reducing thermal load: improvement of greenery

Furthermore, the study has concluded that due to Hong Kong's high building morphology, roof greening may not be beneficial towards improvement ground level human thermal comfort. **Tree planting at grade is effective**



Wang Y and Ng E., Parametric Study on Microclimate Effects of Different Greening Strategies in High Density City, in Proceedings of The joint 3rd PALENC, 5th EPIC and 1st Cool Roofs Conference, Organised by University of Athens, 29 Sept -1 Oct 2010, Rhodes Island, Greece.

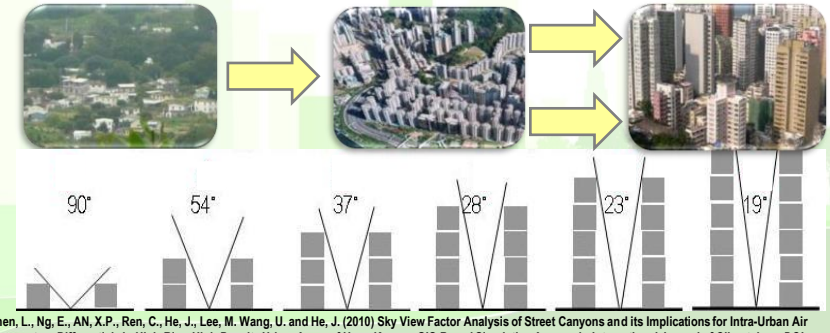
Ng E. and Wang U., (2010) A study on the cooling effects of greening in high density city: an experience from Hong Kong, Building and Environment, (in press)

45

Planning and Design Measures to Improve Urban Climate

Building Volume – reducing thermal load and increasing urban cooling

- Urban cooling depends on **sky view factor**, and thus the building volume
- Higher the **building volume**, higher the thermal load
- In medium/ higher density areas, further development should be accompanied by **appropriate building design** to reduce thermal load

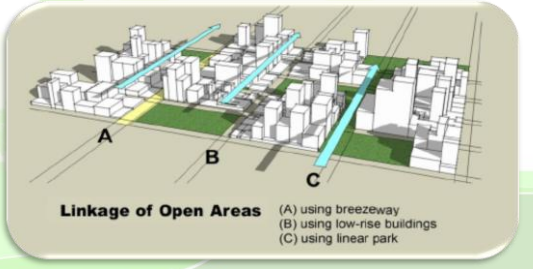


Chen, L., Ng, E., AN, X.P., Ren, C., He, J., Lee, M. Wang, U. and He, J. (2010) Sky View Factor Analysis of Street Canyons and its Implications for Intra-Urban Air Temperature Differentials in High-Rise, High-Density Urban Areas of Hong Kong: a GIS-Based Simulation Approach, *International Journal of Climatology. DOI: 10.1002/joc.2243*

Planning and Design Measures to Improve Urban Climate

Proximity to Openness and Connectivity – for bringing air ventilation into the city

- Preserve/create breezeways/air paths, with greening alongside
- Designate/orientate NBA perpendicular to waterfront/ vegetated hill slopes
- Connect green spaces through air paths

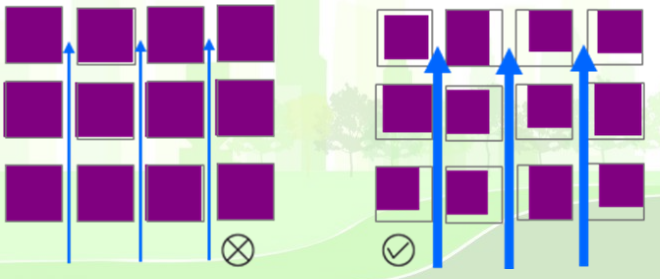


Wong, M. S., Nichol, J.E., Ng, E., (2011) A study of the "wall effect" caused by proliferation of high-rise buildings in Hong Kong, using GIS techniques, Landscape and Urban Planning, 102, 245– 253.

Planning and Design Measures to Improve Urban Climate

Ground Coverage – for wind penetration

- Reduce ground coverage
- Building setbacks along narrow streets, designate non-building areas (NBA)
- Reduce frontage areas of buildings to increase permeability

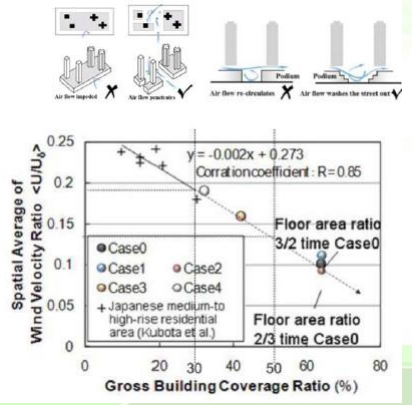


Planning and Design Measures to Improve Urban Climate

Ground Coverage – for wind penetration

Researchers at CUHK and Tokyo PolyU have conducted wind tunnel tests parametrically and can establish that there is a linear relationship between wind VR and Ground Coverage

With the understanding, as reported earlier in WP1B, it has been evaluated that a 1 UC-AnMap class down may be possible if the district ground coverage can be kept under 50%, which means on average in urban Hong Kong, the area average site coverage should be under 70%

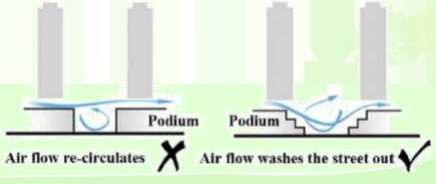


Ryuichiro Yoshie , Hideyuki Tanakaa and Taichi Shirasawa and Edward Ng, Experimental Study on Air Ventilation in a Built-up Area with Closely-Packed High-Rise Buildings, J. Environ. Eng., AIJ, Vol. 73 No. 627,661-667, May, 2008.

Planning and Design Measures to Improve Urban Climate

Ground Coverage – for wind penetration

Based on the wind tunnel benchmarking study results, it can be summarized that high ground coverage can significantly reduce urban air ventilation performance

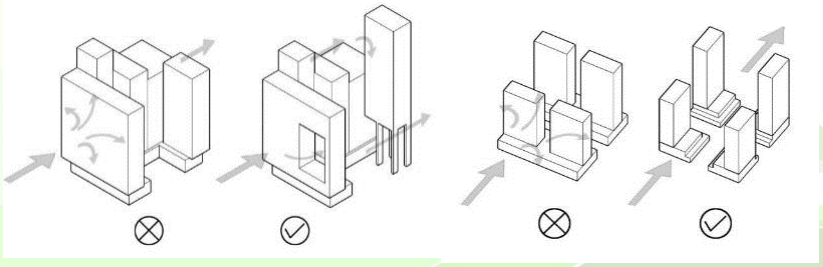


		~ roughly speaking, can be as high as	~ roughly speakign, normally around	~ roughly speaking, can be as low as
D2a	Narrow streets (canyon flow)	0.15	0.05	0.03
D2b	Main streets (canyon flow)	0.2	0.1	0.07
D1a	Narrow streets (parallel flow)	0.15	0.1	0.07
D1b	Main streets (parallel flow)	0.3	0.15	0.1
E2	Narrow streets (non-grid)	0.1	0.07	0.03
G2	Possible downwashes (add)	0.1	0.05	
F1	Isolate roughness flow	Similar to D2b		
F2	Wake interference flow		Similar to D2a & D2b	
F3	Skimming flow			Similar to D2a
C1	High ground coverage	0.15	0.1	0.05
C2	Mid ground coverage	0.2	0.15	0.1
C3	Low ground coverage	-	Similar to B3	-
B3	Waterfront / large open spaces	0.4	0.25	0.2
J1	Under overhead structure		0.05	
B1	Shielding from nearby hills (subtract)		0.05	

Planning and Design Measures to Improve Urban Climate

Building Permeability – for wind penetration

- Closely packed buildings impede air flow
- Provide building gaps and separations

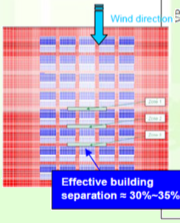


Yim, S.H.L., Fung, J.C.H., Lau, A.K.H., &Kot, S.C.(2009). Air ventilation impacts of the "wall effect" resulting from the alignment of high-rise buildings. Atmospheric Environment, *43 (32), 2894–2982.*

Planning and Design Measures to Improve Urban Climate

Building Permeability – for wind penetration

Buildings Department's permeability parametric results points to an effective (optimum) of 33.3% and a minimum of 20%



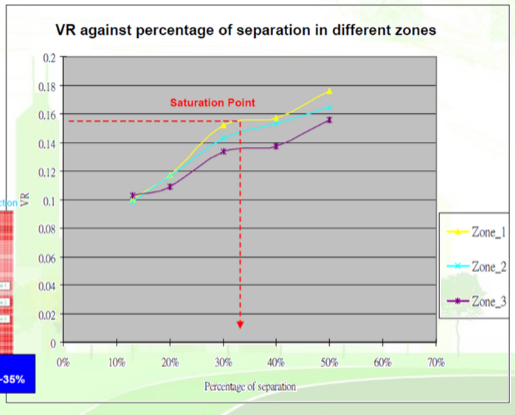


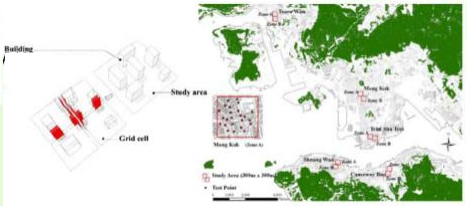
Figure 11 – The curve of VR against building separation for measuring zone 1 to 3 (Result from Model nos. 1a – 1e)

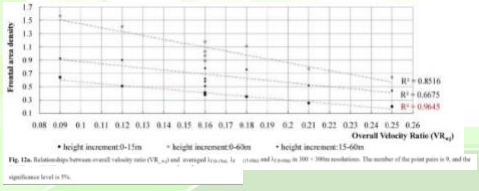
Courtesy of Arup & Partners HK Ltd

Planning and Design Measures to Improve Urban Climate

Building Permeability – for wind penetration

Researchers at CUHK have conducted studies relating the wind tunnel benchmarking test results with Frontal Area Density (FAD) and can establish a significant relationship between wind VR and FAD. For wind VR of 0.1 to 0.15, the area average permeability should be maintained in the order of 25% to 33.3%





$$\lambda_{f(\theta)} = \frac{A_F}{A_T} = L_y \cdot Z_H \cdot \rho_{el}$$

where A_F represents the front areas of buildings that face the wind direction of θ, A_T represents the total lot area, L_y represents the mean breadth of the roughness elements that face the wind direction of θ, Z_H represents the mean building height, and ρ_{el} represents the density (number) of buildings per unit area. The $\lambda_{f(\theta)}$ has been used widely by researchers in plant canopy and urban canopy communities to help quantify drag force.

Fig. 12a. Relationships between overall velocity ratio (VR_{ol}) and averaged λ_f ($\lambda_{f,0-15m}$ and $\lambda_{f,0-60m}$ in 300 × 300m resolutions. The number of the point pairs is 9, and the significance level is 5%.

Wong, M. S., Nichol, J.E., Ng, E., (2011) A study of the "wall effect" caused by proliferation of high-rise buildings in Hong Kong, using GIS techniques, *Landscape and Urban Planning, 102, 245– 253.*

Ng, E., Yuan, C., Fung, J.C., Ren, C., & Chen, L., (2011) Improving the wind environment in high-density cities by understanding urban morphology and surface roughness: A study in Hong Kong, *Landscape and Urban Planning 101 (1) 59-74*

Planning and Design Measures to Improve Urban Climate

Building Permeability – for wind penetration

Closely packed wall like buildings can significantly increase the Frontal Area Density (FAD) of the urban environment, hence greatly reduce its air ventilation performance. It is important to ensure proper urban permeability by having gaps and openings in buildings

Buildings Department recent study has highlighted the need for 20% to 33.3% permeability, with a minimum of 15m building separation, for different zones. This is a useful reference

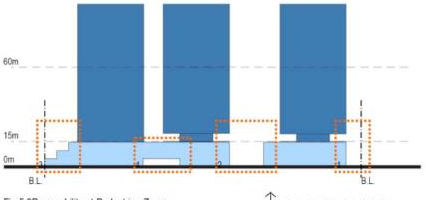
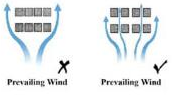
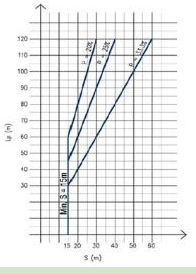


Fig 5.2Permeability at Pedestrian Zone:
1. Building set-back
2. Split podium
3. Stepped podium profile
4. Void deck

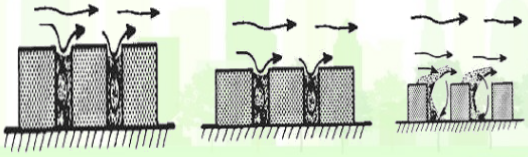




Planning and Design Measures to Improve Urban Climate

Building Heights – for urban ventilation

- Low/ medium density areas (H/W ratio < 2); control building height
- Medium/ high density areas (H/W ratio > 3); control building height and adopt other parallel measures, e.g. building separation, air paths, setbacks, greenery, reducing ground coverage, etc.
- Avoid excessive floor-to-floor heights



H/W > 4 not effective | H/W of 3 less effective | H/W of 2 effective

T.R. Oke, Street design and urban canopy layer climate, Energy and Buildings, Volume 11, Issues 1-3, 22 March 1988, Pages 103-113, ISSN 0378-7788, 10.1016/0378-7788(88)90026-6.

Government Studies & Documents

香港政府規劃署Planning Department

技術通告 空氣流通評估方法技術指南
房屋及規劃地政局 + 環境運輸及工務局

HOUSING, PLANNING AND LANDS BUREAU TECHNICAL CIRCULAR NO. 1/06 ENVIRONMENT, TRANSPORT AND WORKS BUREAU TECHNICAL CIRCULAR NO. 1/06

HONG KONG PLANNING STANDARDS AND GUIDELINES

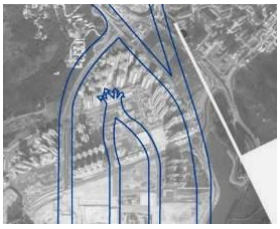
11章 城市設計指引
Ch11 Urban Design Guidelines

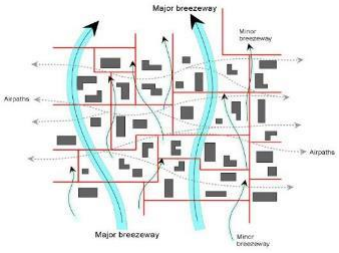
11.空氣流通意向指引
11. Qualitative Guidelines on Air Ventilation

http://www.pland.gov.hk/pland_en/tech_doc/hkpsg/index.html

Qualitative Guidelines I 意向指引 I

香港政府規劃署Planning Department





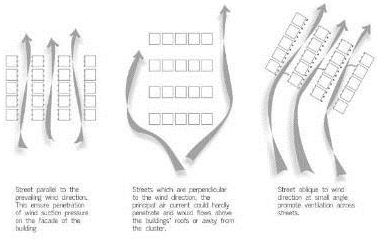
主風道 / 風道 Breezeway / Air path

在人煙稠密、悶熱潮濕的都市中，必須讓充足的空氣流通市區，保持良好通風效果。主風道可以道路、空曠地方及低層樓宇走廊形成，能引導氣流深入高樓大廈林立的都市內部區域。在主風道或風道上，應避免有伸延出來的障礙物，以免氣流受到阻擋。

It is important for better urban air ventilation in a dense, hot-humid city to let more wind penetrate through the urban district. Breezeways can be in forms of roads, open spaces and low-rise building corridors through which air reaches inner parts of urbanised areas largely occupied by high-rise buildings. Projecting obstructions over breezeways /air paths should be avoided to minimize wind blockage

Qualitative Guidelines II 意向指引 II

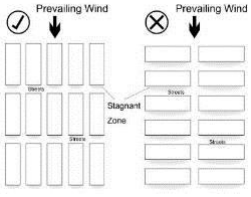
香港政府規劃署Planning Department



街道佈局的定向
Orientation of Street Grids

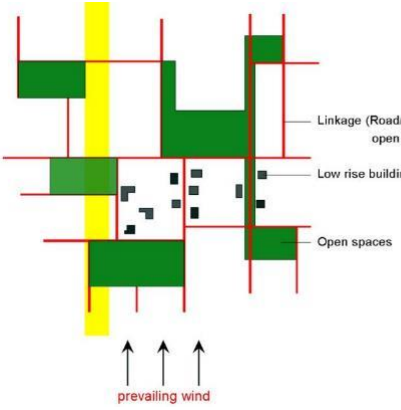
大街、主要橫街及 / 或主風道應該與盛行風的方向平行排列或最多成30度角，這樣，盛行風才可充分引入市區。

An array of main streets, wide main avenues and/or breezeways should be aligned in parallel, or up to 30 degrees to the prevailing wind direction, in order to maximize the penetration of prevailing wind through the district.



Qualitative Guidelines III 意向指引 III

香港政府規劃署Planning Department



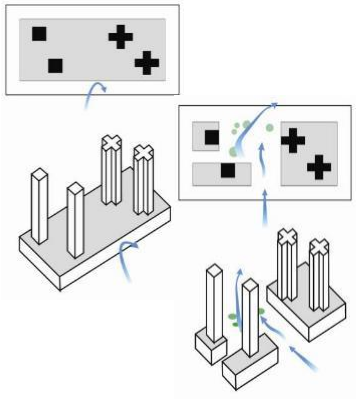
將開敞空間連為一體
Linkage of Open Spaces

如情況許可，應將開敞空間連接、湊拼一起，形成主風道或通風走廊，並應以低層建築為主以減小風阻。

Where possible, open spaces may be linked and aligned in such a way to form breezeways or ventilation corridors. Structures along breezeways/ventilation corridors should be low-rise.

Qualitative Guidelines IV 意向指引 IV

香港政府規劃署Planning Department



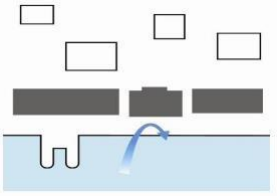
非建築區域 Non-building Area

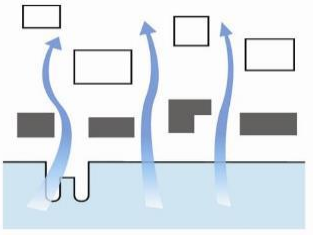
大型而密集的建築群尤其有礙通風。因此，在發展用地的規劃及定向，應讓建築物較長的一面與風向平行，並盡量設立非建築範圍及建築退入區，達到最大的透風效果。

Compact developments on large sites are particularly impeding air movement. Development plots should be laid out and orientated to maximize air penetration by aligning the longer frontage in parallel to the wind direction and by introducing non-building areas and setbacks where appropriate.

Qualitative Guidelines V 意向指引 V

香港政府規劃署Planning Department





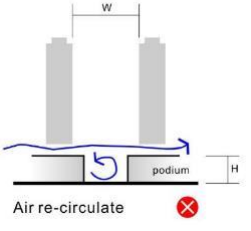
濱水區 Waterfront Sites

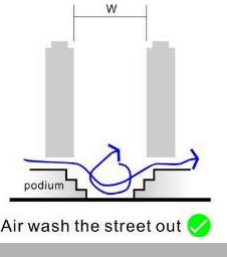
在海水與太陽的冷熱作用下，會出現海陸風，而海傍正是這兩種風的必經大門。因此，在海傍區建造樓宇時，應避免阻擋海陸風及盛行風。

Waterfront sites are the gateways of sea breezes and land breezes due to the sea cooling and sun warming effects. Buildings along the waterfront should avoid blockage of sea/land breezes and prevailing winds.

Qualitative Guidelines VI 意向指引 VI

香港政府規劃署Planning Department





群房尺度 Scale of Podium

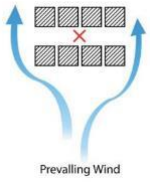
在現時市區中的大型建築或重建地盤，應當於地面設置通風走廊或規定建築物以逐步退入的方式建設，並須與盛行風向平行，這樣，才可改善平台構築物對路面的通風度的影響。如情況許可，應盡量採取梯級型的群房設計，將氣流從上空引導至地面，此舉可令行人路的空氣更加流通。

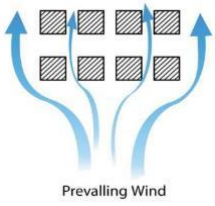
For large development sites particularly in the existing urban areas, increase permeability of the podium structure at the street levels by providing some ventilation corridors or setback in parallel to the prevailing wind.

Where appropriate, a terraced podium design should be adopted to direct downward airflow, which can help enhance air movement at the pedestrian level.

Qualitative Guidelines VII 意向指引 VII

香港政府規劃署Planning Department





建築佈局 Building Disposition

在條件許可的情況下，建築体塊間應保持充分寬度的間隙，使得整個區域空氣流通滲透率最大化。這一間隙最好安置與垂直面向主導風向的部位。

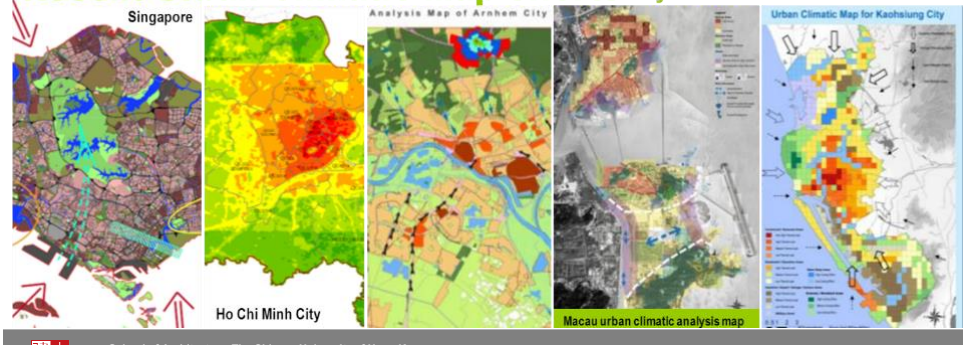
Where practicable, adequately wide gaps should be provided between building blocks to maximize the air permeability of the development and minimize its impact on wind capturing potential of adjacent developments. The gaps for enhancing air permeability are preferably at a face perpendicular to the prevailing wind.

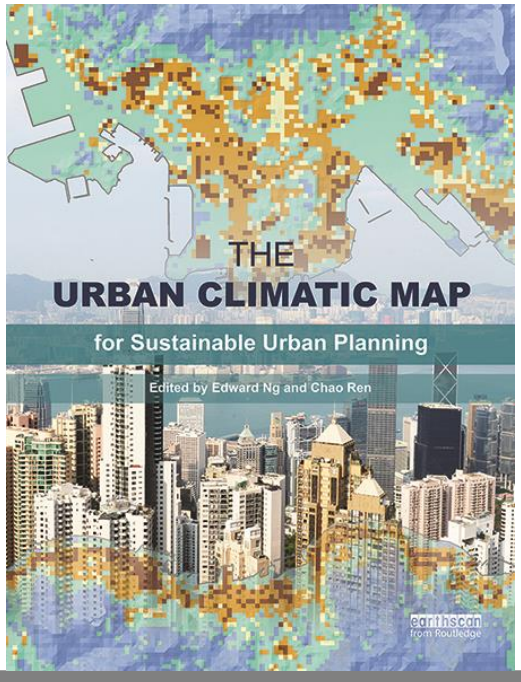
卓越的城市气候规划研究与应用经验 Regional Leadership

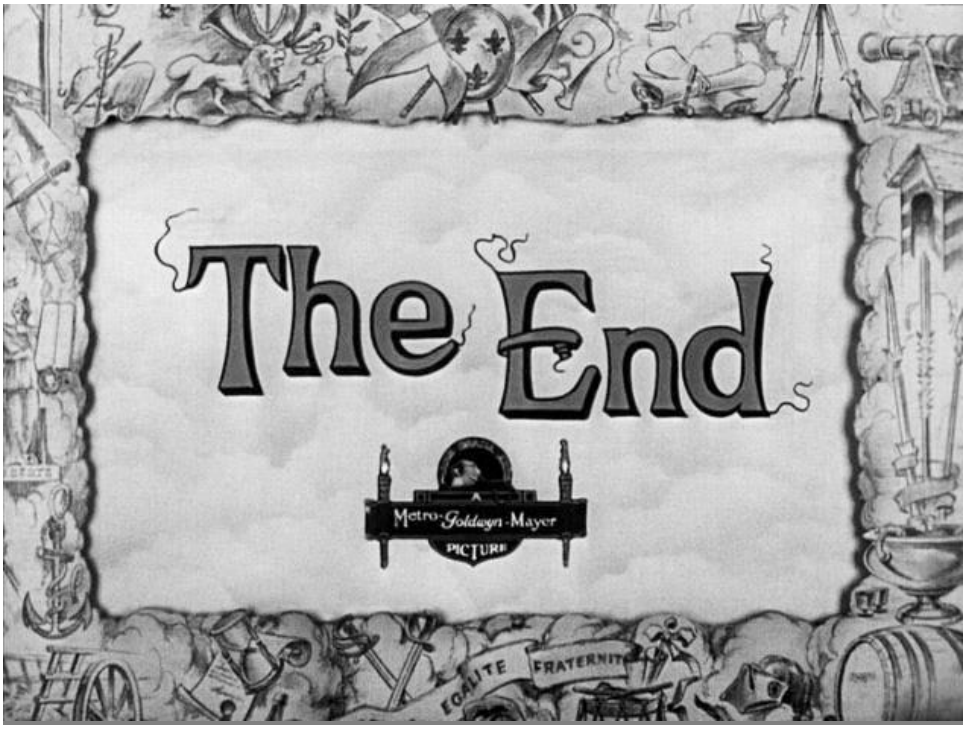
2003年至今开展的气候规划应用研究项目 Project Lists since 2003

- 2009-now, "Macau Urban Climatic Map Study ",
- 2009-now, "Singapore Urban Climatic Map Study ",
- 2012-now, "The Study of Plan and Management of Wuhan Urban Air Path" , China
- 2007-now, "Xian Urban Climatic Application Study", China
- 2003-2012, "(Hong Kong) Urban Climatic Map and Standards for Wind Environment – Feasibility Study", Hong Kong
- 2010-2012, "Hồ Chí Minh Urban Climatic Map Study", Vietnam
- 2009-2010, "Arnhem Urban Climatic Map", The Netherlands
- 2009-2010, "Eco-Planning for Kaohsiung, Taiwan by Using Urban Climatic Map", Taiwan
- ……

Recent Urban Climatic Map efforts by our team




THE
URBAN CLIMATIC MAP
for Sustainable Urban Planning
Edited by Edward Ng and Chao Ren
earthscan
from Routledge


The End
Metro-Goldwyn-Mayer
PICTURE