

Faculty of Engineering
Division of Infrastructure, Geomatics and Architecture



Architecture, Climate & Environment **RESEARCH REVIEW | 2012-2013**

Professor Edward Ng: URBAN CLIMATIC MAPPING
Invited Lecture - Wednesday 23rd October 2013
Architecture, Climate and Environment Re

PROGRAMME

AM: GROUP ACTIVITY REVIEW - Chaired by Saffa Riffat and Mark Gillott

1040 Welcome & Introductions, Coffee & Tea AG + RS
TPG

1100 Research Group Introduction by Saffa Riffat

1105 Research Highlights for 2013 by Mark Gillott

1120 Speed upDating from Groups PhD students - Chaired by Guillermo Guzman

1155 Q&A - Chaired by Guillermo Guzman

1210 European Research Collaboration Opportunities by Hitendra Hirani

1220 Research Group Photo outside the CEH

1230 Tour and demonstration of Smart Energy Community by Mark Gillott & Rob Shipman

1250 Lunch

PM: ADVISORY GROUP FEEDBACK SESSIONS - Chaired by Robin Nicholson

1400 Looking back: Advisory Group Feedback on Research Group Activity 2013 AG + RS
TPG

1445 Looking forward: Responding to the Group Research Themes & Future Grand Challenges **1530**

close for the AG members not attending the lecture)

1540 Prize Giving - Most Creative PhD student presentation

1545 Guest Lecture: 'Urban Climatic Mapping' by Prof Edward Ng - Chaired by Brian Ford

1645 Close

AG + RS
TPG

ALL
SRB-LT

BREAK (or

Architecture, Climate and Environment Research Group
Activity Review

URBAN CLIMATIC MAPPING

Invited Lecture by Prof Edward Ng

Over 50% of the world's population now lives in cities. The number of mega and high density cities are on the increase. How to design for a quality, livable and sustainable urban environment is a task for engineers, architects, planners and policy makers. The lecture walks a journey, that started after the SARS episode in 2003, on how Hong Kong - a high density city - has since tried to address the issue. The Air Ventilation and the Urban Climatic Map studies epitomize the efforts. The concerted attempt by the Hong Kong government, planners and researchers has resulted in a set of policies that the industry must follow. New towns and a few metro redevelopments have been redesigned and these will be illustrated during the talk.

Architecture, Climate and Environment Research Group
Activity Review

URBAN CLIMATIC MAPPING

Invited Lecture by Prof Edward Ng

Prof Edward Ng is an architect and the Professor of Architecture in the School of Architecture, the Chinese University of Hong Kong (CUHK). He is the Director of the M.Sc. Sustainable and Environmental Design Programme at CUHK. As an environmental consultant to the Hong Kong Government, he developed the performance based daylight design building regulations, the Air Ventilation Assessment (AVA) Technical Guidelines, and the Urban Climatic Map for planners. Among many other honours, he has twice been the recipient of the International Awards of the Royal Institute of British Architects.

An event organised by the ARCHITECTURE, CLIMATE & ENVIRONMENT RESEARCH GROUP, Infrastructure, Geomatics & Architecture Research Division.

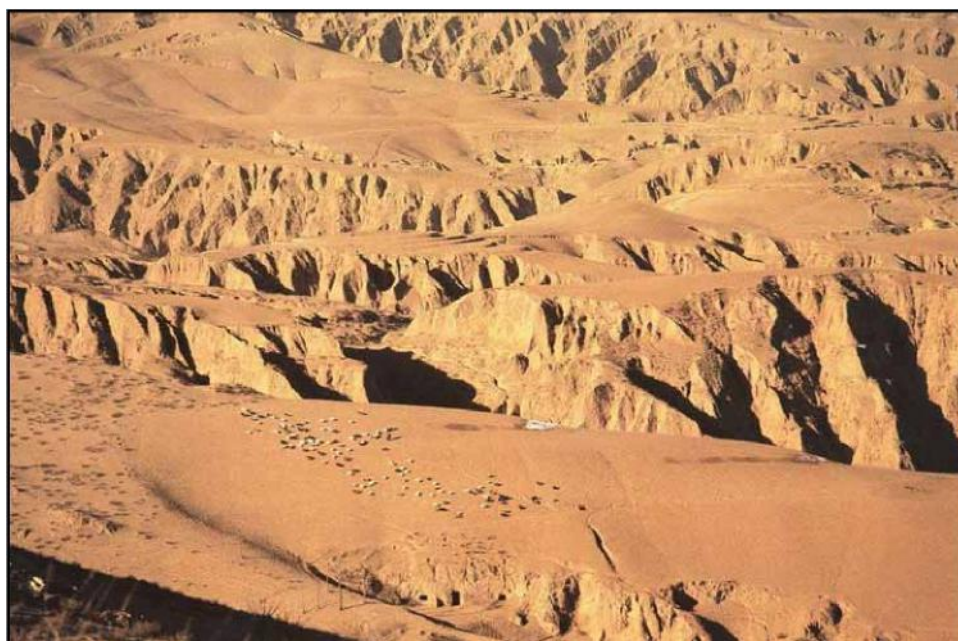
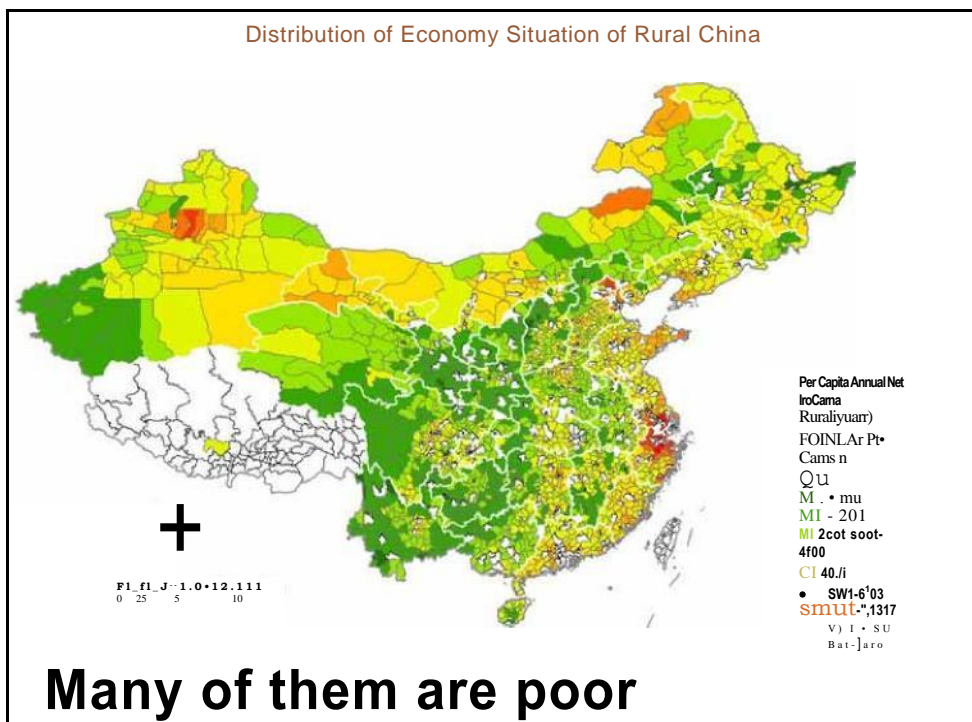
Architecture, Climate and Environment Research Group
Activity Review



50% of the problem



China has 1 million villages (a third of the world's total)



They are remote and desperate



Fighting with life everyday ...



... in poor conditions



... in poor conditions



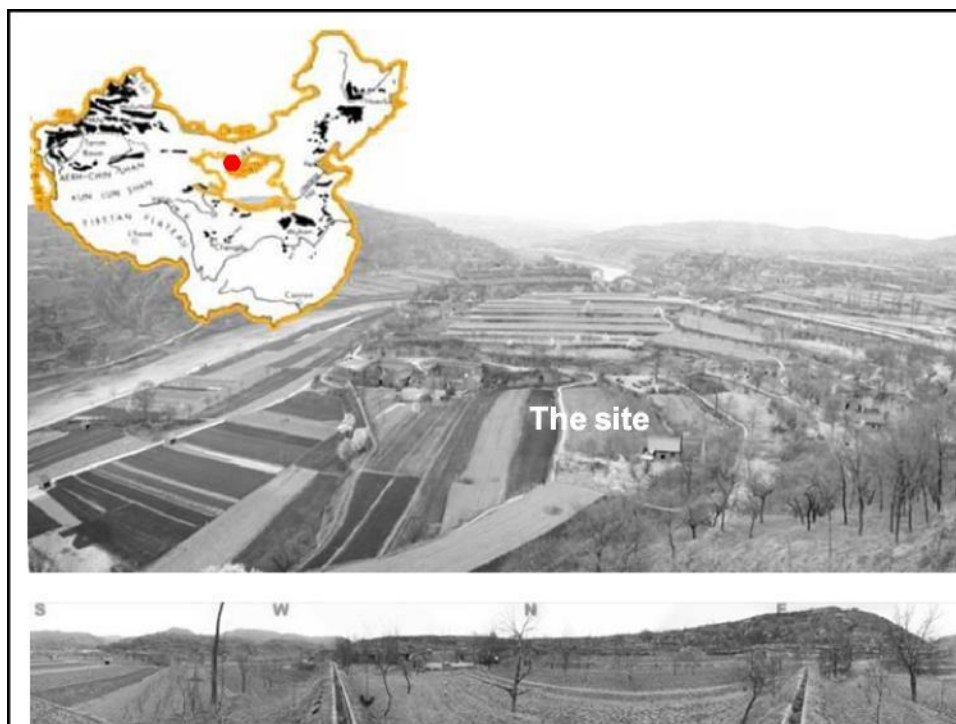
... can we do something?

Maosi Ecological Primary School

"Our school **empowers** the villagers,
... but it needs no **power** to run."



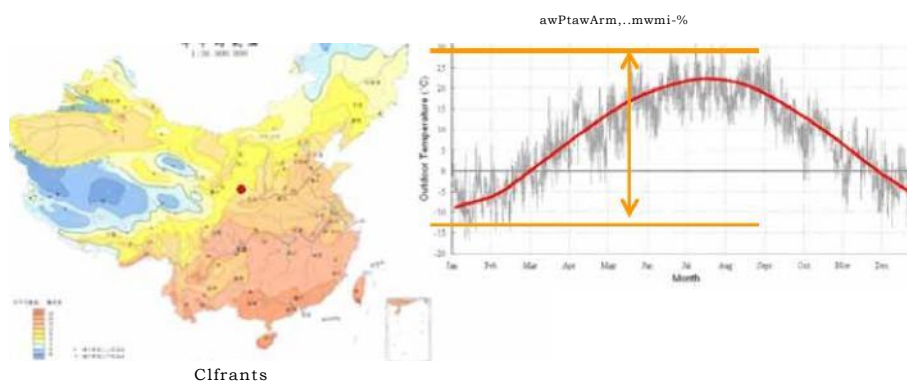


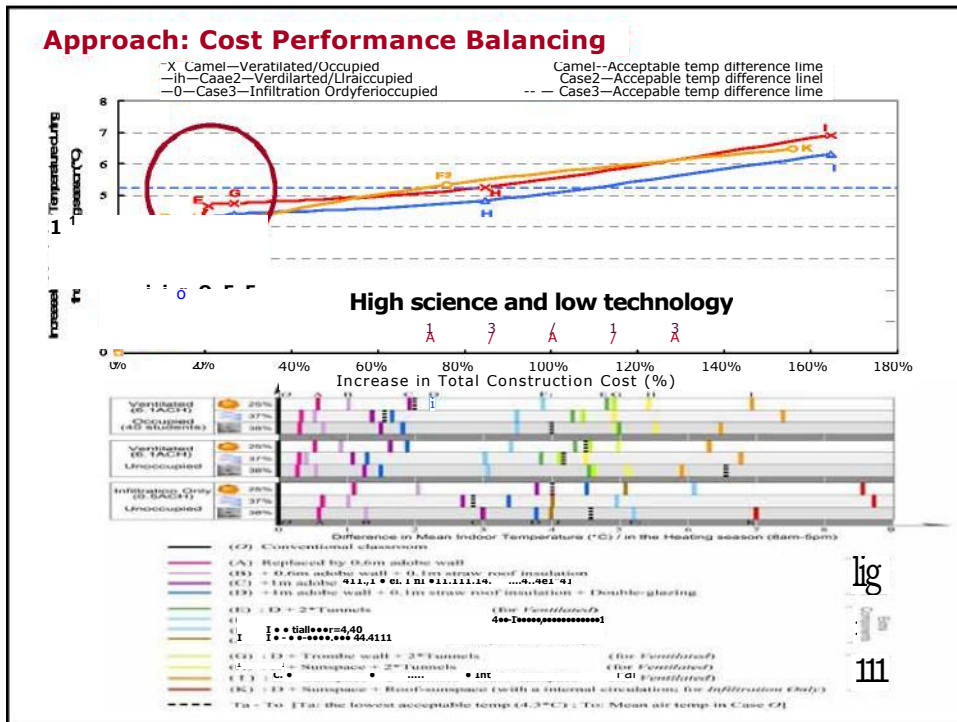
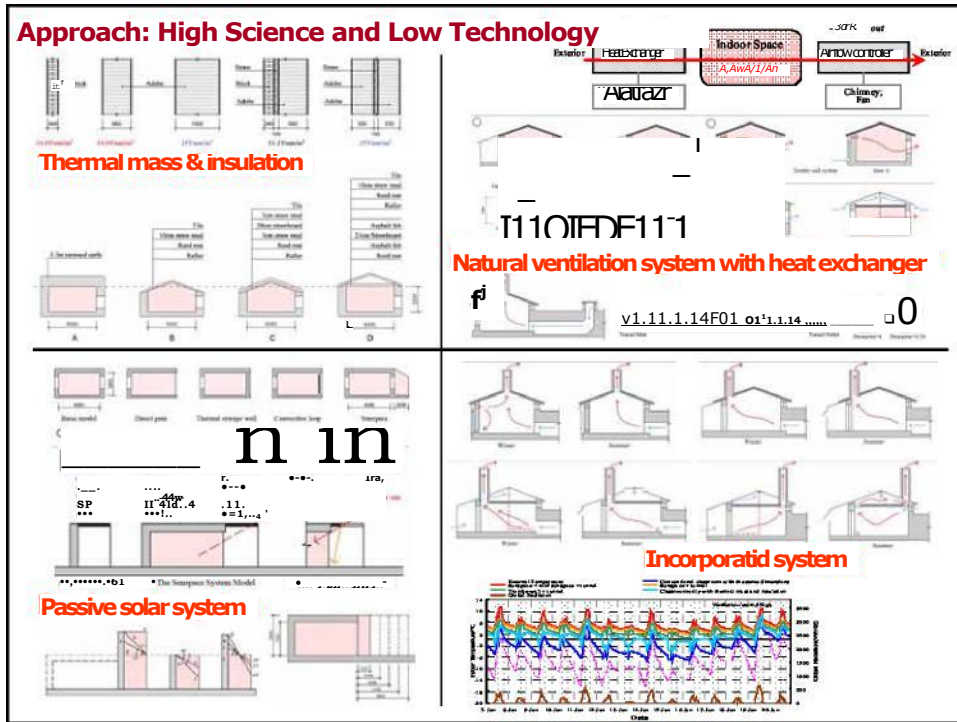


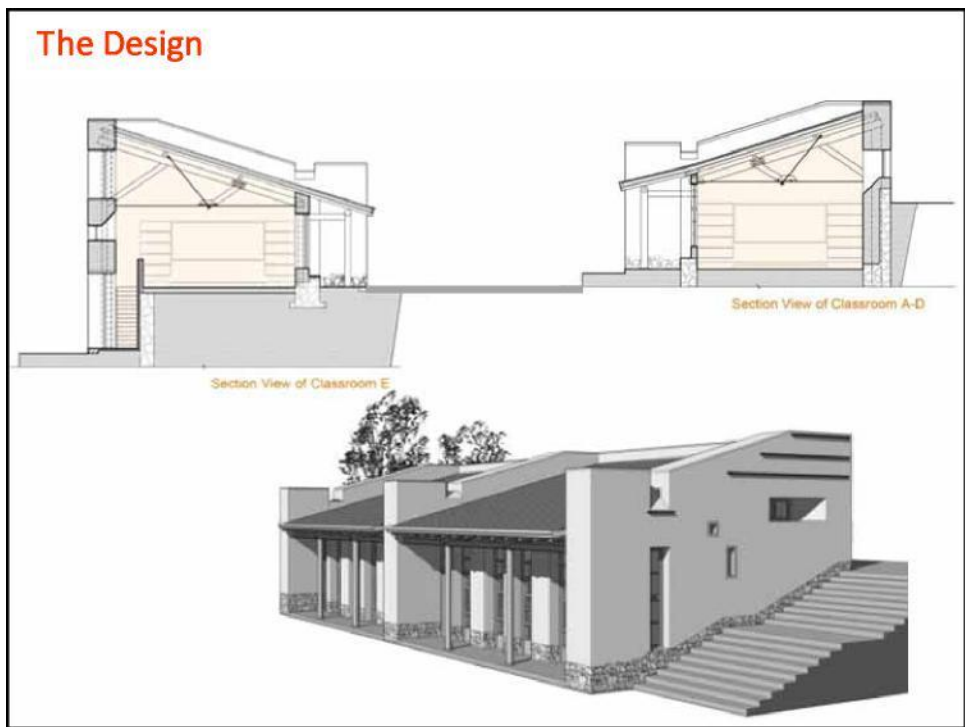
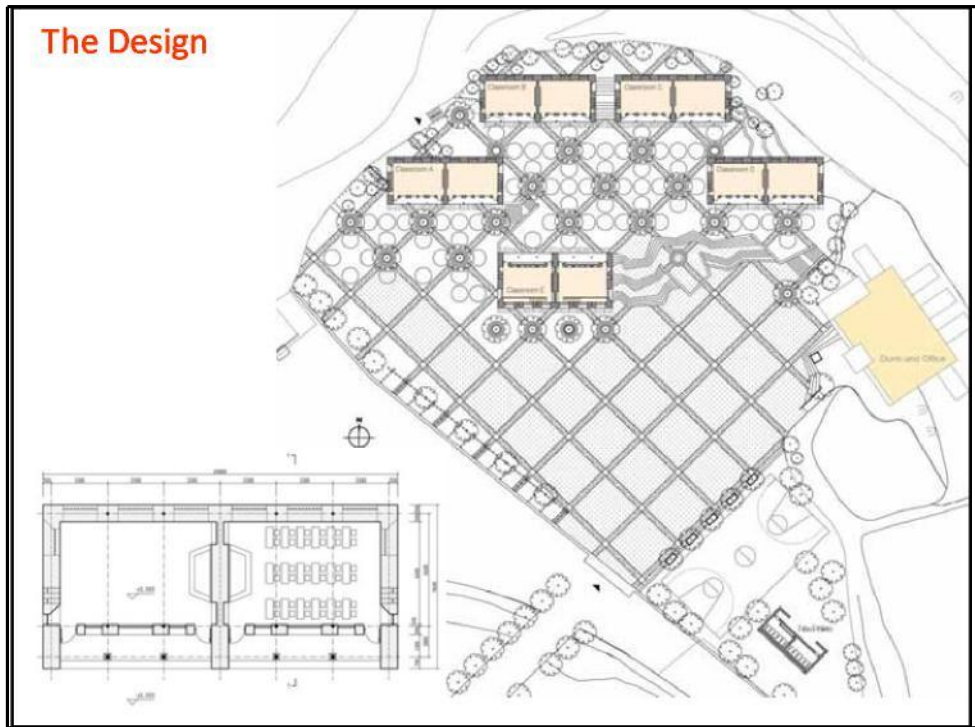
The site has extreme continental climatic conditions

Summer day time temperature 38 degree C



Winter night time temperature minus 15 degree C







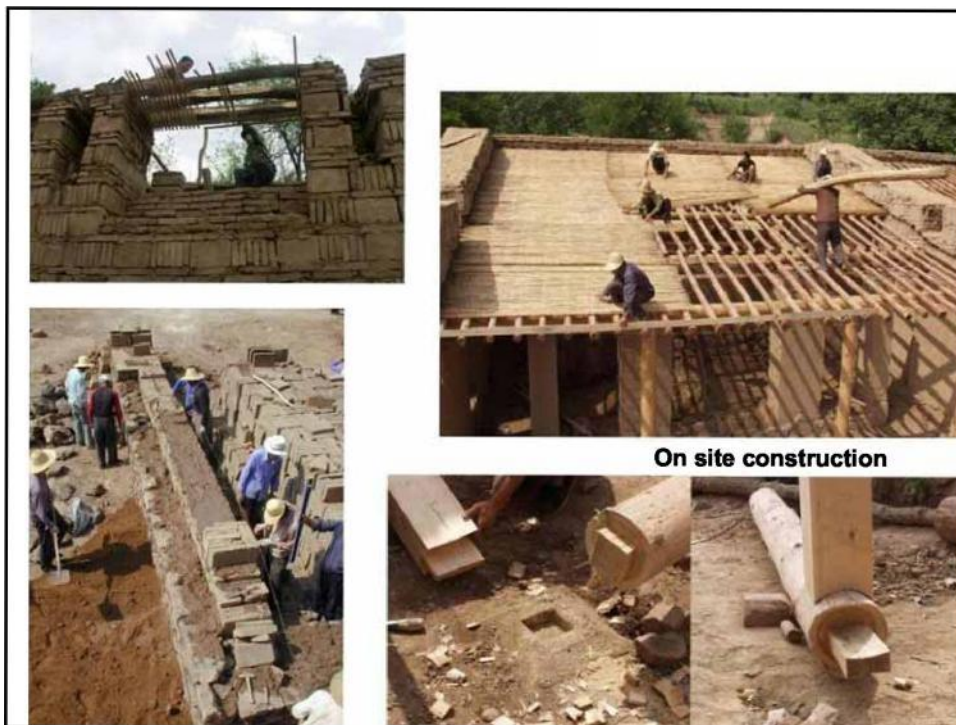


Most materials are natural and sourced on site.
All construction wastes are reused.

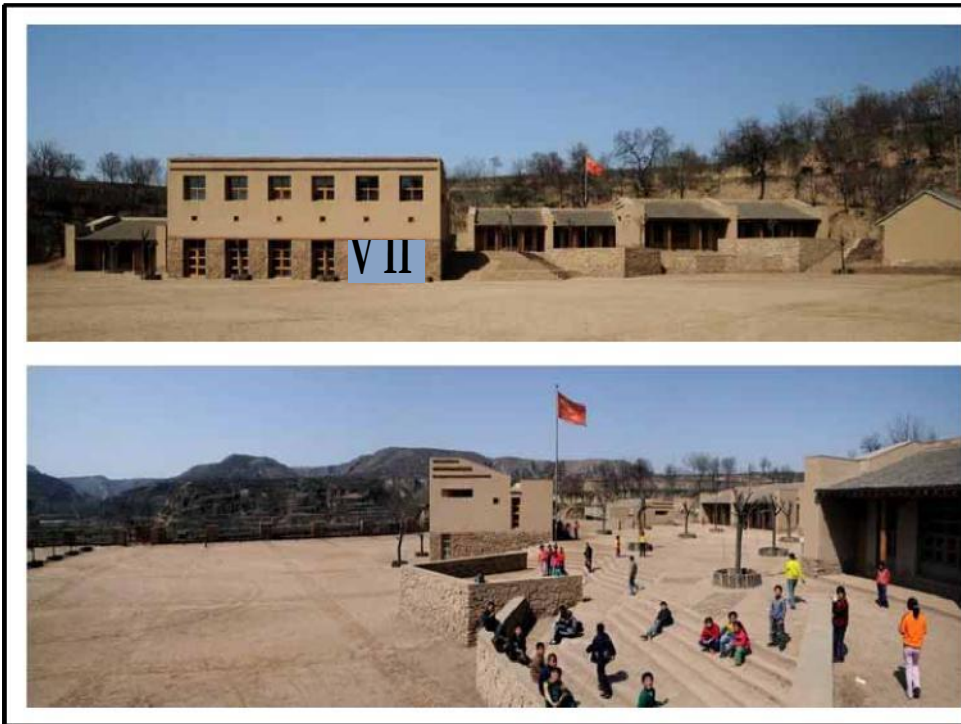
 Straw	 Eulrush	 Timber	 Straw mud
 Rubble	 Sand	 Lobby	 Block stone

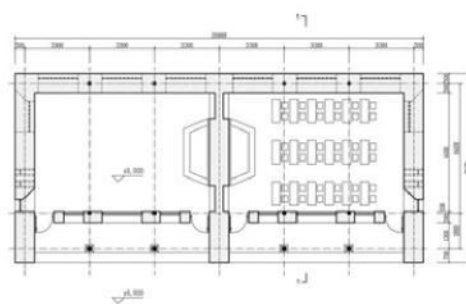
Natural / Industrial Materials


 Polystyrene	 Recycle tile	 Lime	 Asphalt
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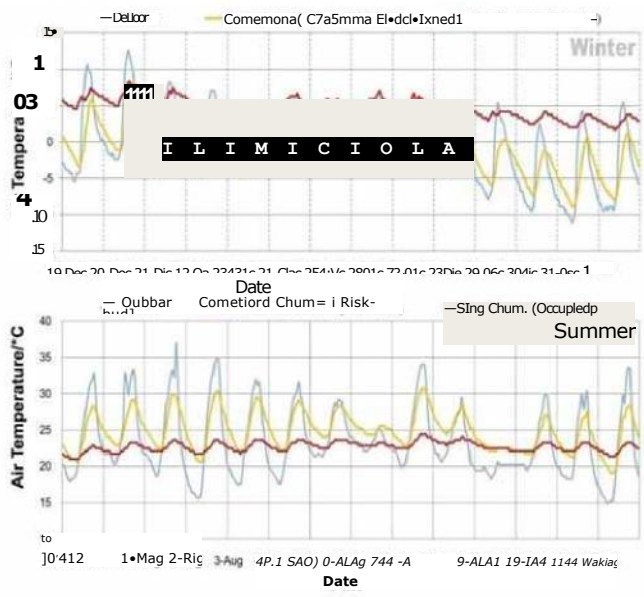
Evaluation
Energy Consumption and CO2 Emission
Low embodied energy
Low operation energy

Costs
"It costs no more to build, and it is almost free to run."

Total Construction Cost 574.8HKD/m²
 Life-cycle cost (renovation br wall surface every 10 years) 600 HKD/yr



Evaluation - Indoor Environmental Quality



Winter

Summer

Temperature/C

Date


Feedback
 Student A—
"We suffer frostbite no more."

Student B —
"I think the school is beautiful."

Student C —
"the classroom is brighter."

Press
"Not too long ago, a tragedy happened in Shamoci's Dingbin Prefecture. Eleven students died of CO poisoning due to coal burning for warmth. Memory still hurts. I wondered then if we could find a way to build a coal free school. I believe Maosi has provided an answer."

Times Weekly China ... 2Jan2009



6 Examples of RIBA International Award 2009 Winners:

 <p>The Water Cube</p>	 <p>National Stadium Beijing</p>	 <p>British High Commission</p>
 <p>Maosi Primary School</p>	 <p>Beijing Airport Terminal 3</p>	 <p>European Investment Bank</p>

social
economic &
Environmental



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Acknowledgement: I would like to thank KFGB and Mr HM Chan for funding our work.



The other 50% of the problem

Urban Heat Islands: Processes

Mesoscale

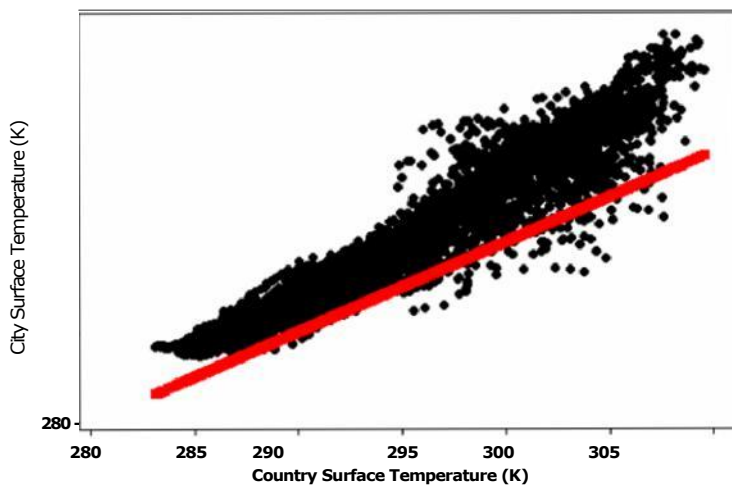
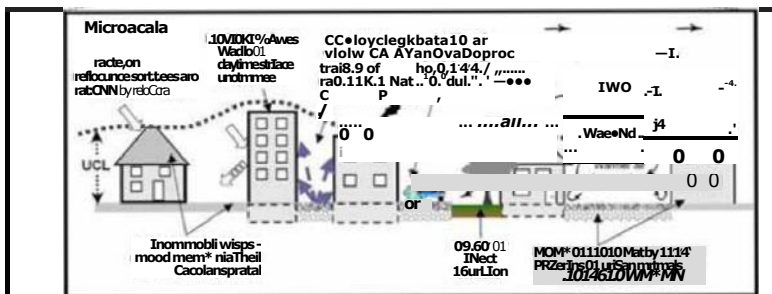
Urban "phlrltP"

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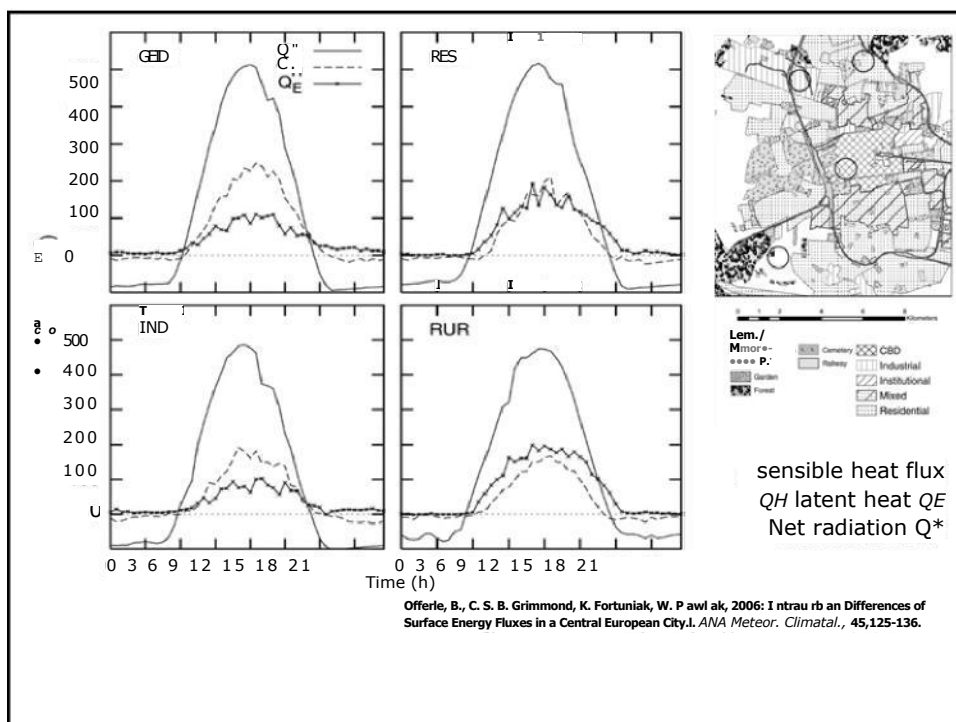
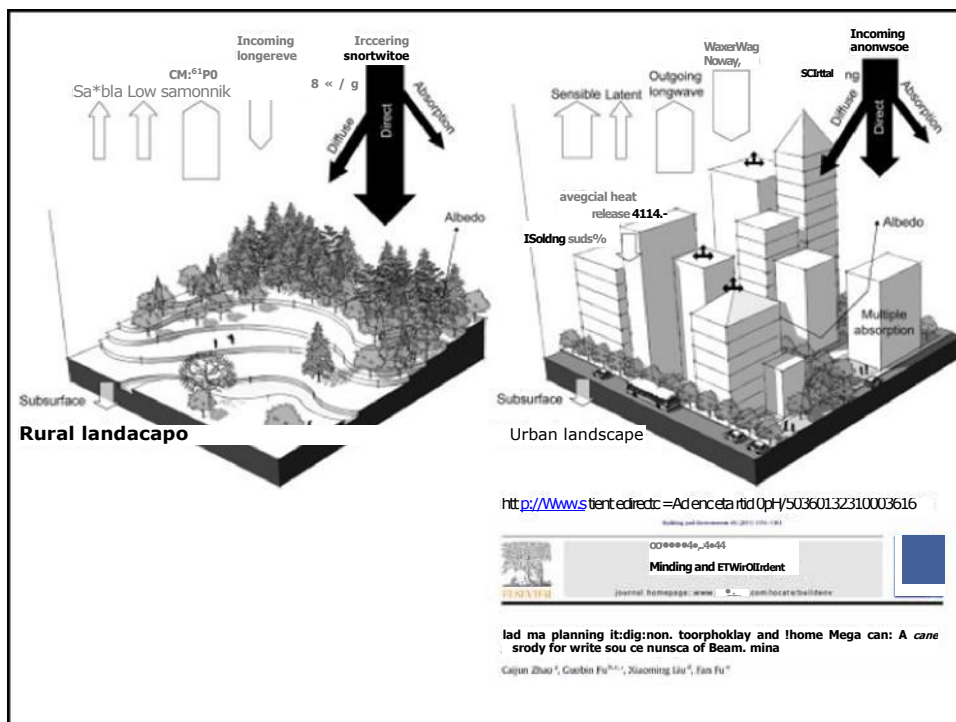
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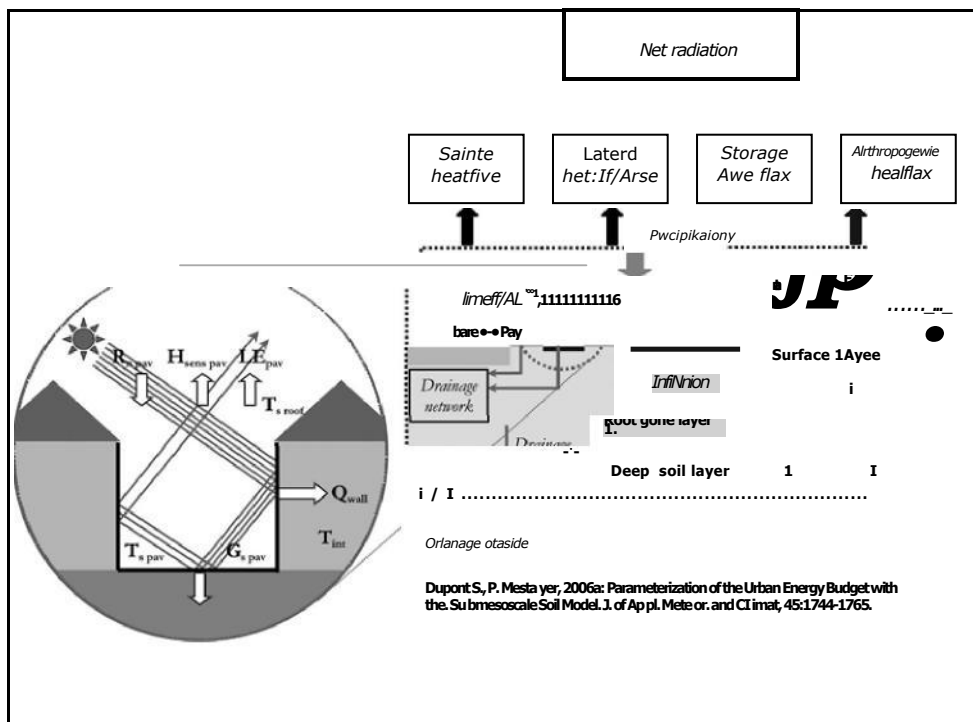
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The Energetics of Urban and Rural Microclimates (John E. Frederick)





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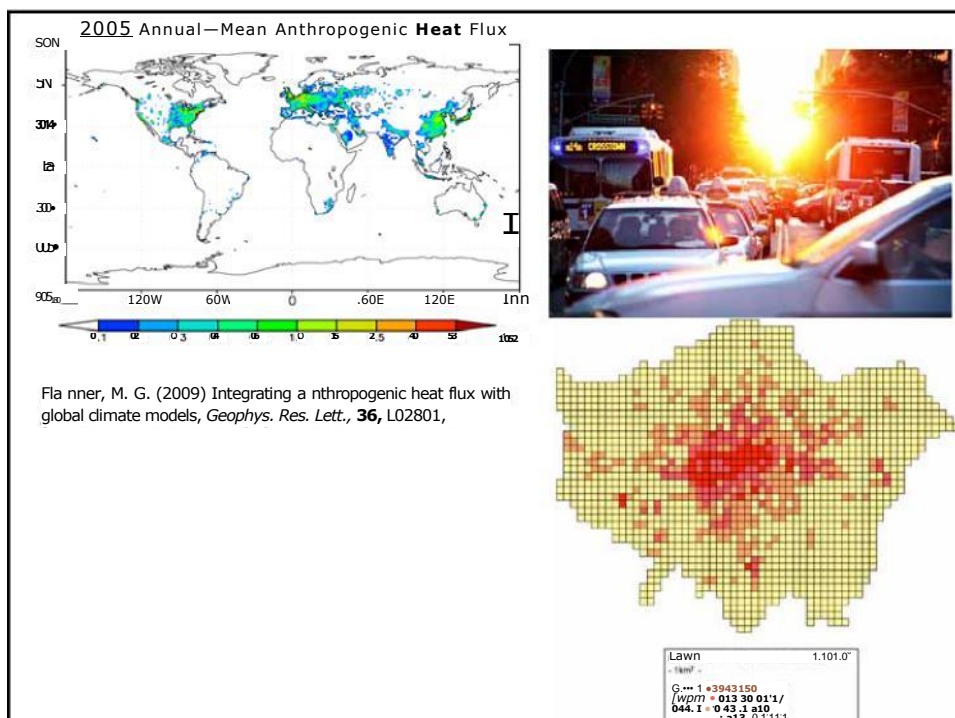
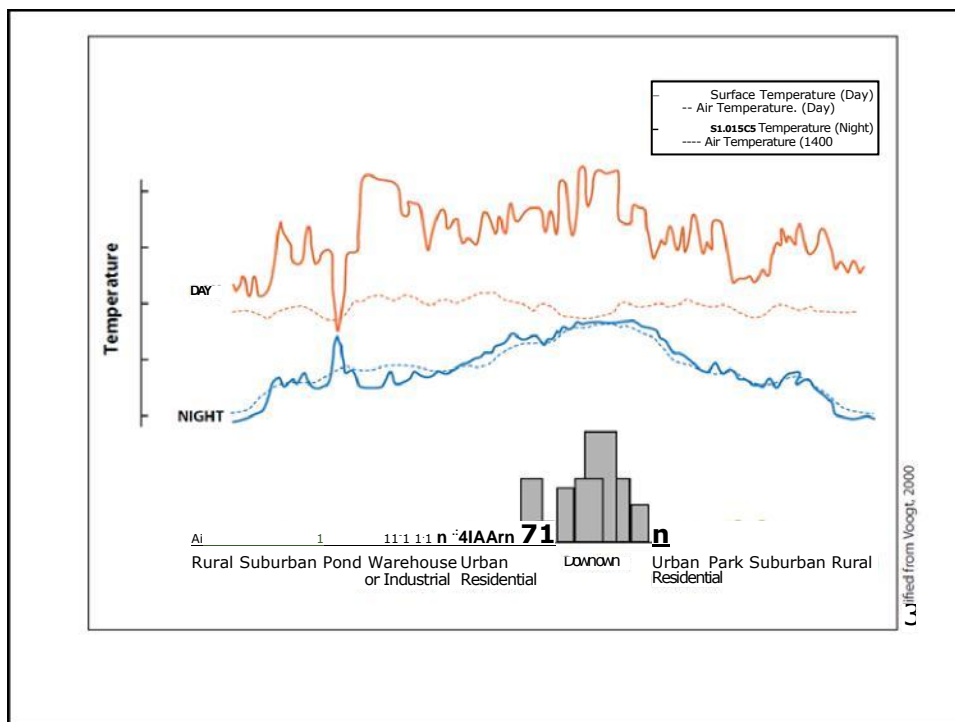
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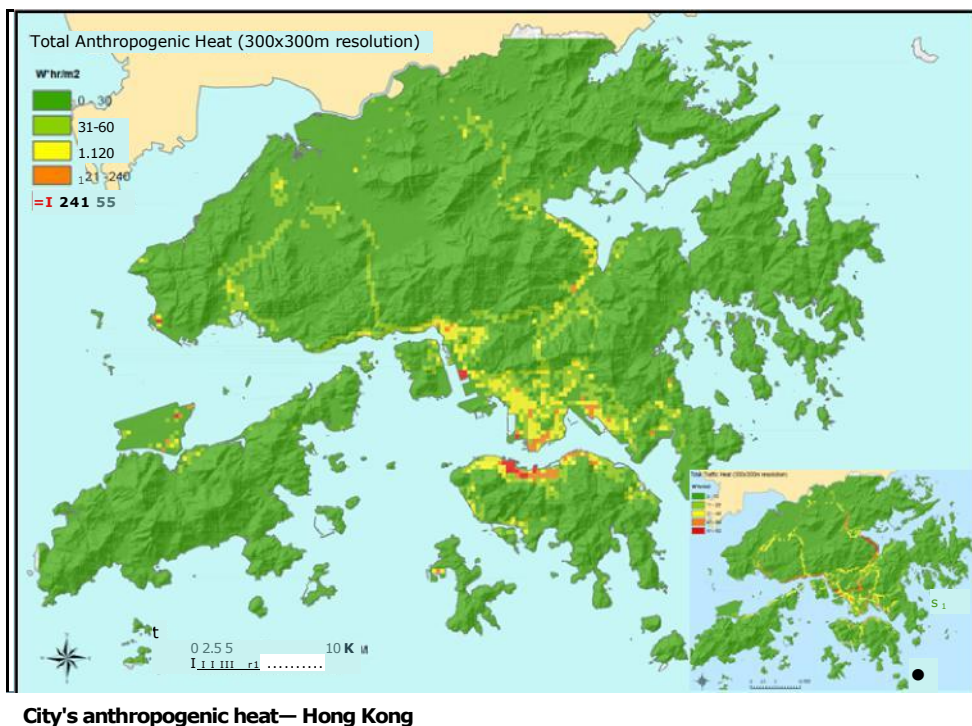
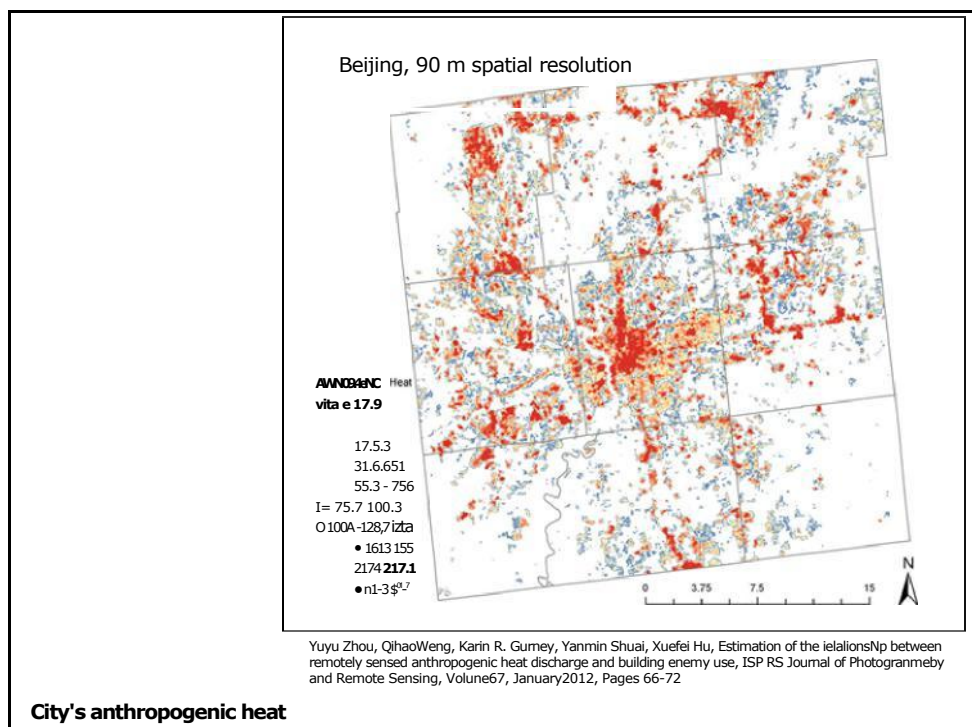
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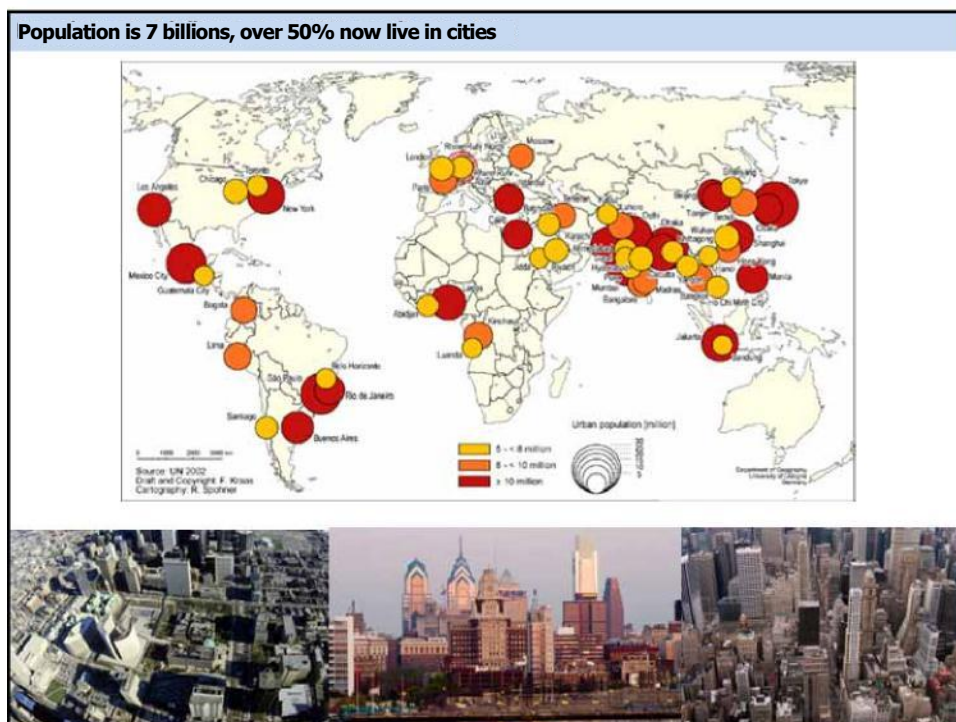


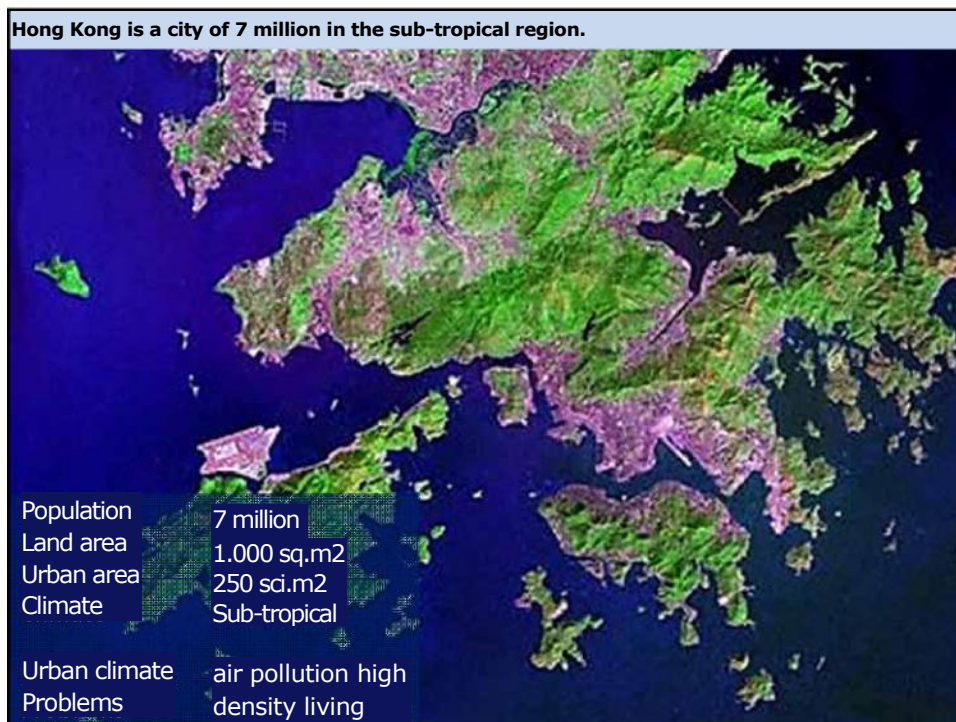
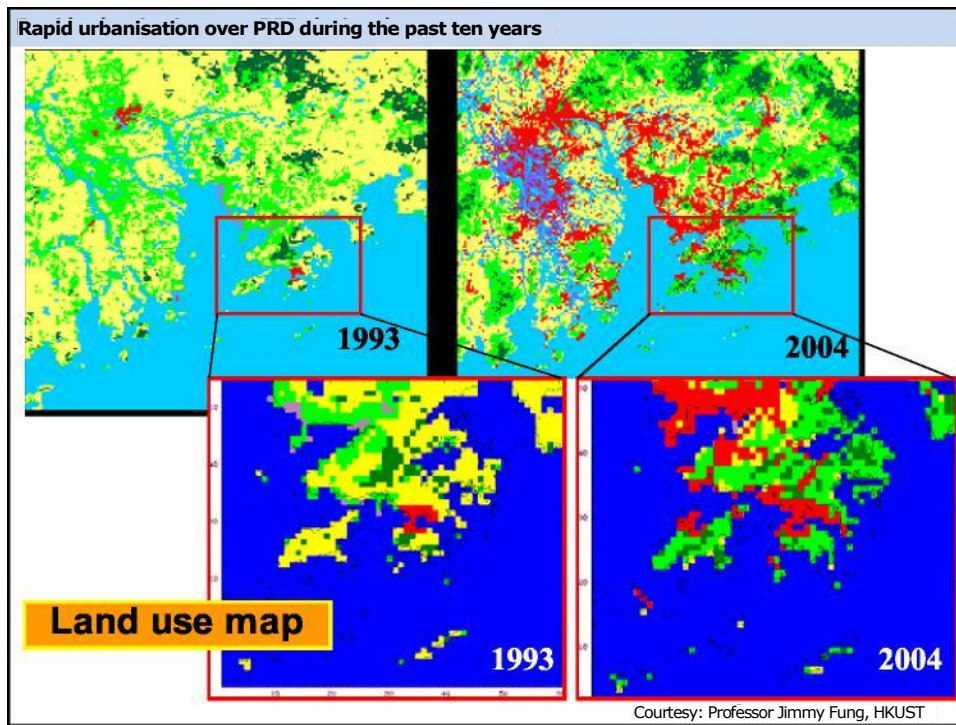


$T_a = 32\text{ }^\circ\text{C}$
 $PET = 36\text{ }^\circ\text{C}$

$T_a = 28\text{ }^\circ\text{C}$
 $PET = 29\text{ }^\circ\text{C}$

It is therefore important for one to know the climate we can **feel**.

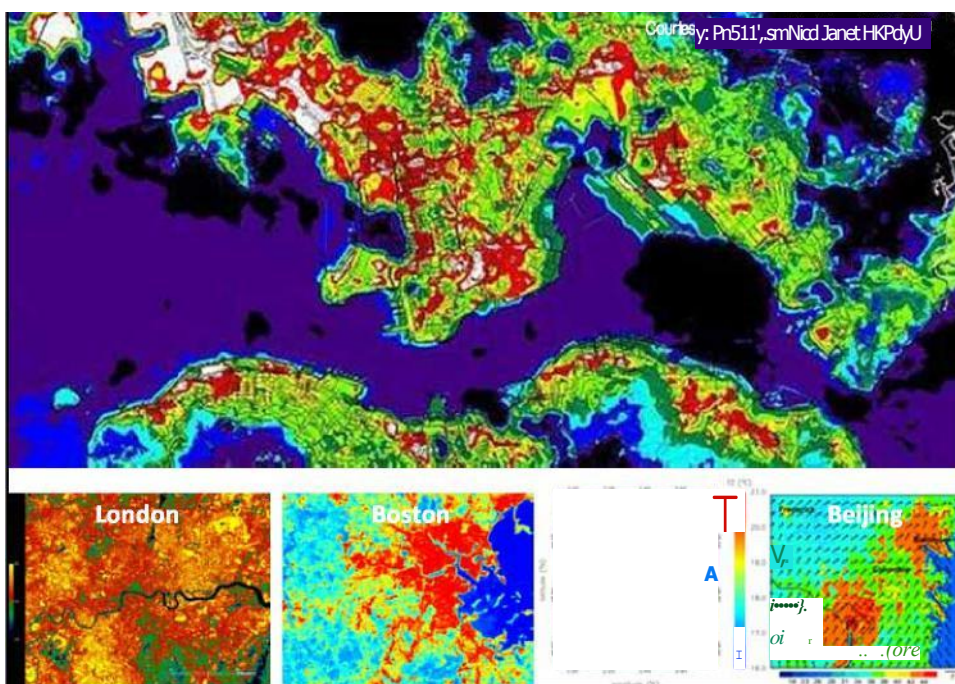




Due to our compact, high density living, ...



we suffers higher Urban Heat island (UHI) intensity.



Stronger Urban Heat Island (UHI) intensity & weaker urban wind is impacting life

Increase heat stress related mortality

Increase hot days and nights

Higher energy consumption

Results An average increase in daily mean temperature above 28.2°C was associated with an estimated 1.8% increase in mortality. Heat-related mortality was associated with stronger UHI intensity and weaker urban wind.

A Study 01 301 rscay modal 01 *rtoraturamlated 959192/ay 1101 96941ka0030 01510E IOWN 91% plume populatL09 in Nona 199493

Ying Ying Ding, Willem B. Stappert, Jacqueline Jansung Kim, Sam M. Griffiths

Year	Hot days	Hot nights	Hot days + nights	Hot days + nights + nights	Hot days + nights + nights + nights
2008	15	15	115	23	23
2007	93	01	25	117	121
2040	1	25	432	117	53
2005	-12	aa	93	135	51
2004	4		0e	121	47
2003	-11	.40	-91	159	62
2002	11	.32	93	133	45
2003	9	aa	an	121	41
3000	-10	.40	-93	124	51
1990	4	.49	113	133	55
9.9444	11	302	909	1177	143.5

032 44 994 110 ds\k1 20.0071710 10 1 /K. of ray wt no 35.2610m *17 5 R2=099 R2a099

City	Temprowth masse by		
	IT	IC	Yr
D001.50C	9.02%	16.15%	3697%
Comex...11	3-13%	6.26%	9.38%
Leonial	244%	5.26SS	7.91%
Tall	453%	9.52%	14913%

Tble 3.4 Percent.ge Increase crEklrity Casamptioa due b Ike Rise

There is a need

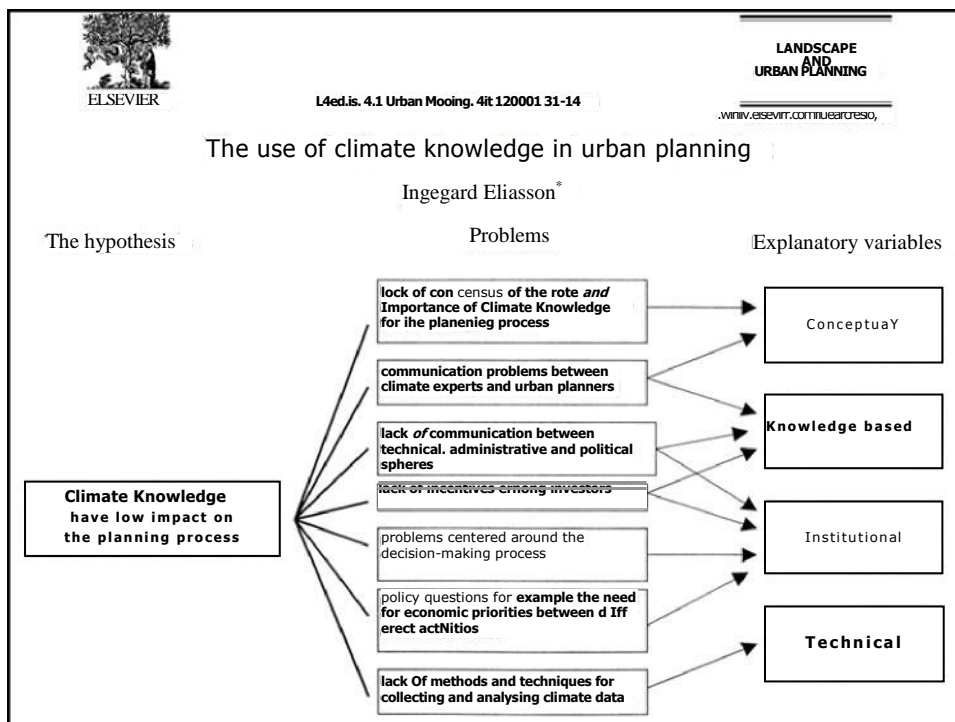
43 World Climate Conference - 3

Planners around the world has increasing asking for help assisting them making better planning decision to cope with issues of climate change, rapid urbanization, rising aspiration and changing habits, and resources allocation. Urban Climate Map will provide a tool. Such tool is particularly important for developing countries like China

ScienceDirect **Procedia**

Climate Information for Improved Planning and Management of Mega Cities (Needs Perspective)

G. Mills, H. Ckrug, R. Eiummucr, W. Endlicha, E. Era, G. MoGranahan, A. tdirbon, J. Rmenihal and k. Scejneri



INTERNATIONAL JOURNAL OF CLIMATOLOGY
Mr. Ninu A. Inn
Published online in Wiley Online Library
www.interscience.wiley.com DOI: 10.1042/ijc.2008.0292

RMetS
Royal Meteorological Society

Towards planning and practical understanding of the need for meteorological and climatic information in the design of high-density cities: A case-based study of Hong Kong

E. Ns
The Chinese University of Hong Kong, School of Architecture, Shatin, N.T. Hong Kong

Conclusion
Urban climatic information must be presented sequentially to fit the hierarchical process of planning and land use decision making. For better transfer of knowledge and communication, 'prevailing' and 'criticality' should be observed; information overload must be avoided, and spatial information must be presented graphically whenever possible. Scholars have argued that instead of the need for precision and accuracy, most of the time planners need to make balanced and reasonable decisions. Simplicity is the key.

The drafting and implementation of Urban Climate Map

Urban Climatic Maps by our team

Nm

Ho Chi Minh City

Macau urban climatic analysis map

A bio-meteorological understanding

The concept of **Physiological Equivalent Temperature (PET)** as the synergizing variable for the HK Urban Climatic Analysis Map

Humidity, solar radiation and other physiological factors

Survey on Thermal sensations

PHYSIOLOGICAL

AIR VENTILATION EQUIVALENT TEMPERATURE

AIR TEMPERATURE

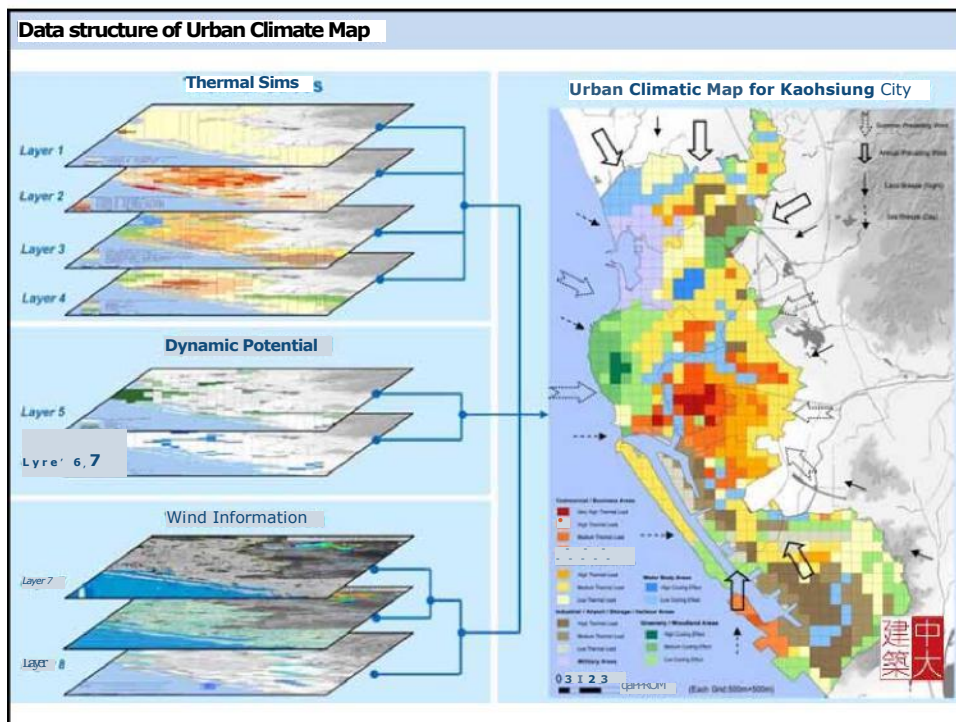
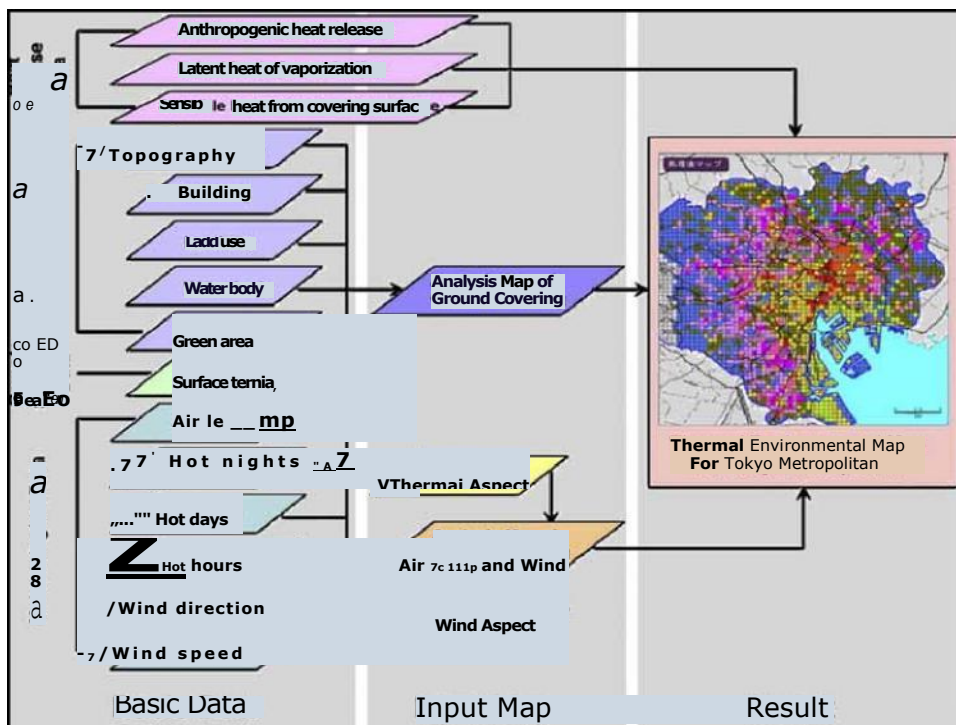
Dynamic potentials

PET

Human Thermal Comfort

Thermal load

• 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 synergistic indication of human thermal comfort. It is an index widely used to understand the thermal comfort environment.



Scientific investigations

User survey



The 'User survey' section includes a diagram of a person interacting with a mobile device, a photo of a person using a mobile device, and a photo of a person using a mobile device.

Model simulations



The 'Model simulations' section includes a flowchart diagram, a 3D city model, and a 2D map with colored overlays.

Field Works



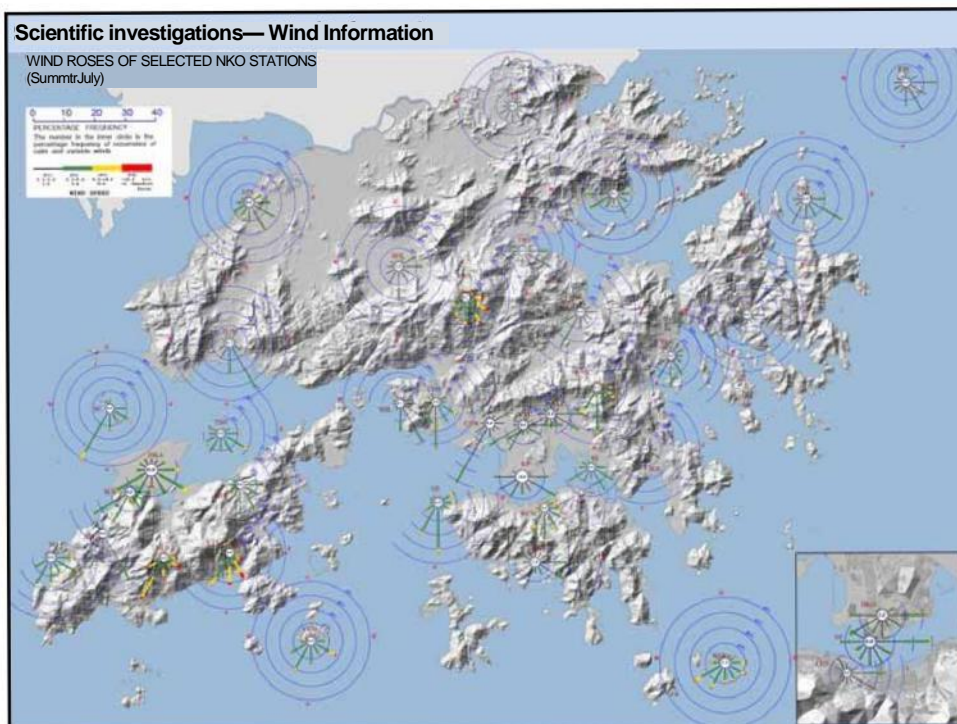
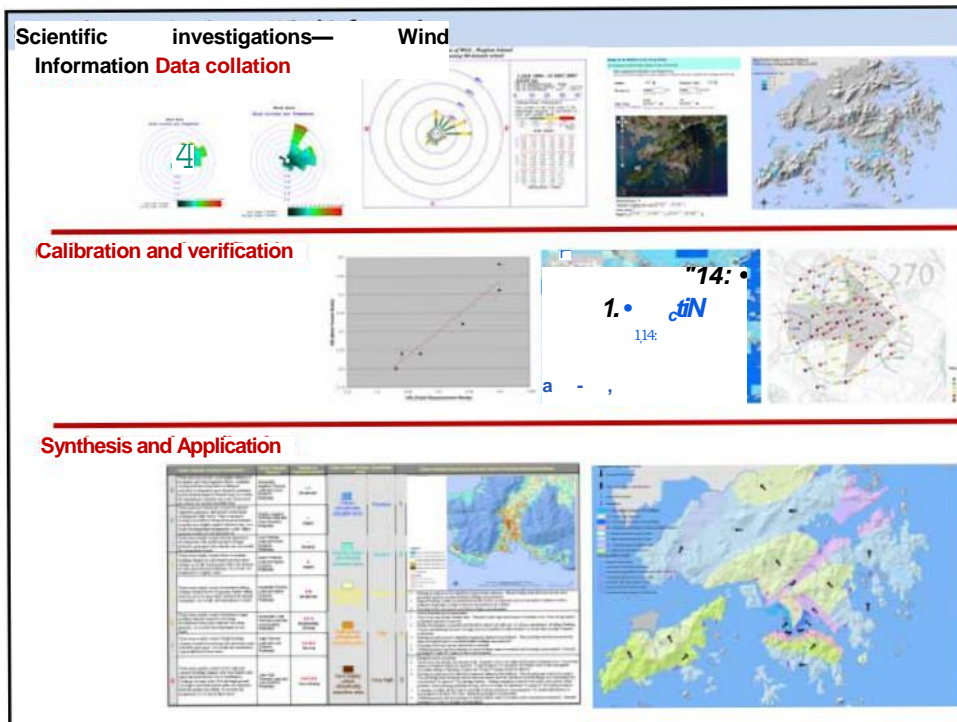
The 'Field Works' section includes a map of a city, a heatmap, a map of a city, and a photo of a person in a car.

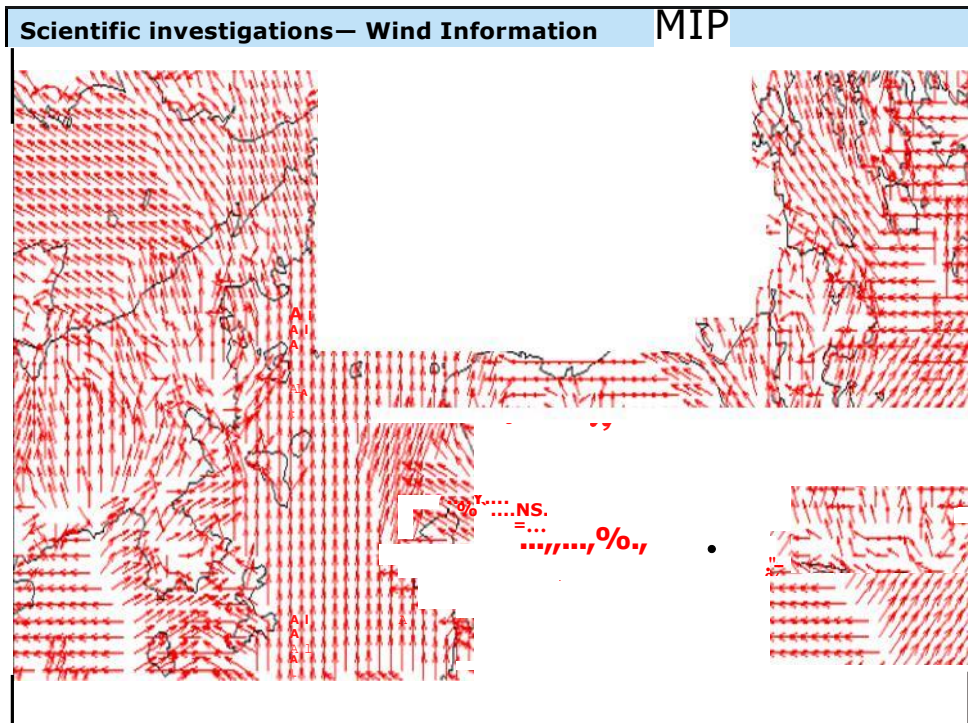
Experiments



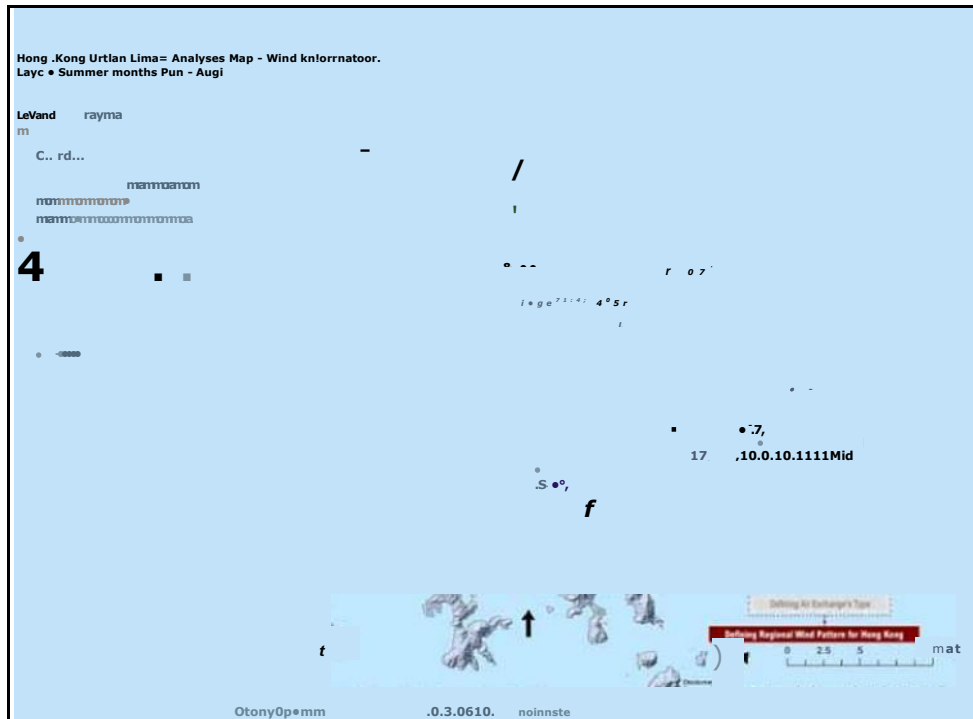
The 'Experiments' section includes a line graph, a grid of data points, a 3D city model, and a 2D map.

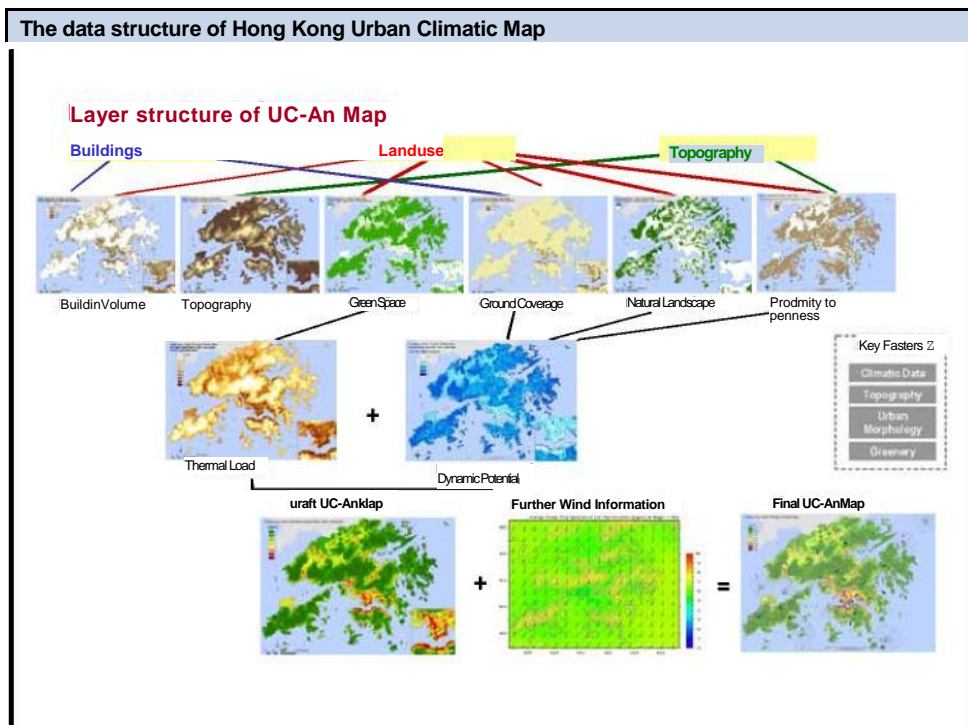






Courtesy Professor Jimmy Fung of HKUST





A layer of the Hong Kong Urban Climatic Map

Urban Climatic Maps

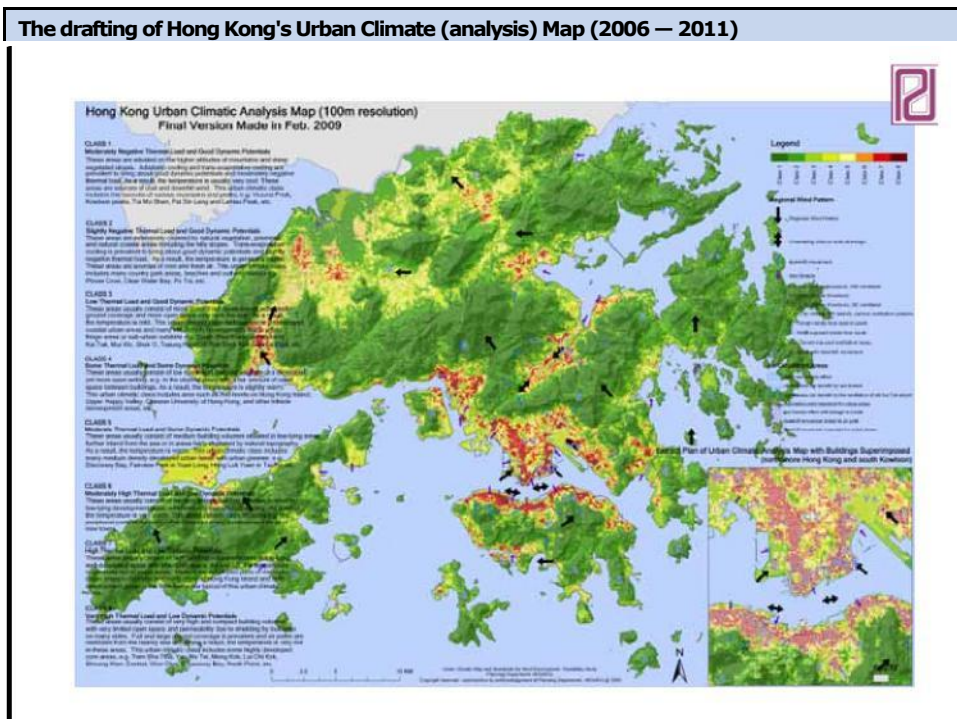
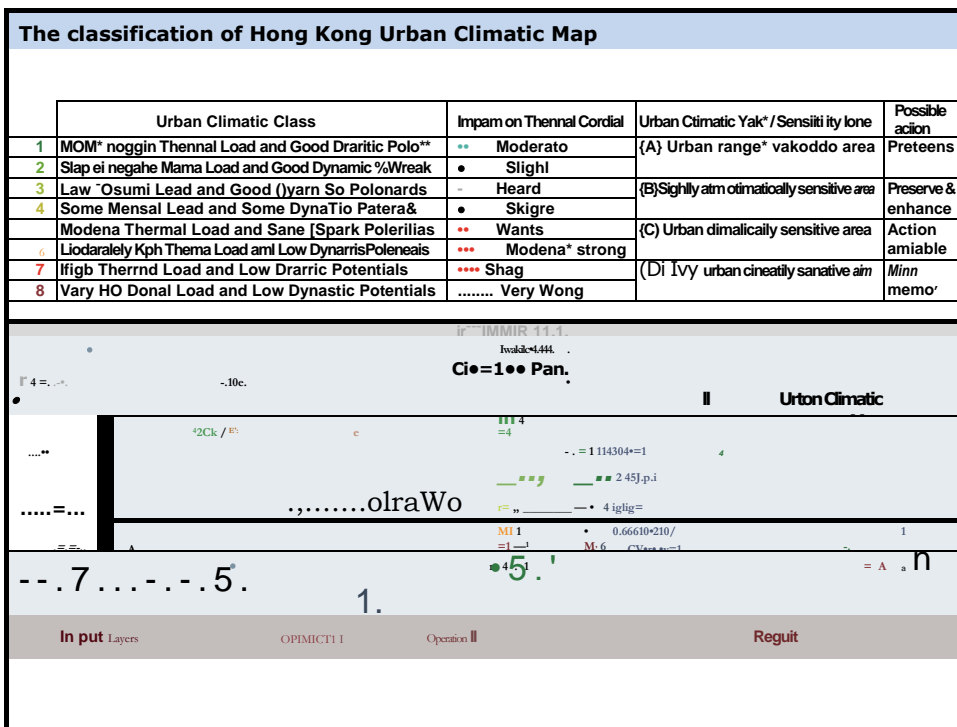
UC-AnMap

Ground Coverage (Roughness)

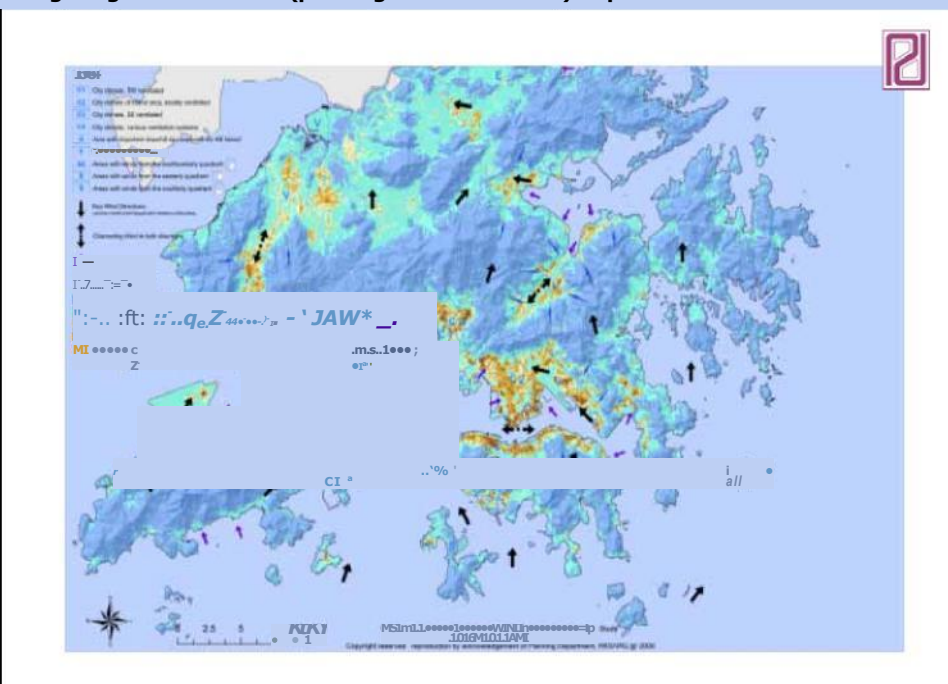
Methodology

Ventilation performance is a key consideration in building design and urban planning. Generally speaking, built-up urban structures block local wind flow and block its outlets for the circulation. In Yoshie's research of both Japanese cities and MongKok in Hong Kong (2007), there is an evident trend in the relationship between gross building coverage ratio (in percentage) and wind velocity ratio. Higher wind velocity ratio is experienced where there is relatively low building coverage, which indicates the relations between urban permeability and ground coverage, and vice versa. Layer 4 synthetically combines the understanding of building coverage and ground roughness. 3 classification values are currently assigned.

Ng, E., Yuan, C., Fung, J.C, Ren, C, & then, 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* Kubota T, Miura M, Tominaga Y, Mochida A. 2008. Wind tunnel tests on the relationship between building density and pedestrian-level wind velocity: Development of guidelines for realizing acceptable wind environment in residential neighborhoods. *Building and Environment 43:1699-1708*



Hong Kong's Urban Climate (planning recommendation) Map



Hong Kong's Urban Climate (planning recommendation) Map

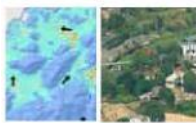
Urban Climatic Planning Zones



UCPZ 1

Urban Climatically Valuable Area

Valuable areas preserving the source of cool air to their adjoining areas are need to be preserved as far as predictable. The majority of this zone has already been subject to different controls and has a general preservation age list development, and it covers mainly country parks, sites of special scientific interest, green belt, etc.



UCPZ 2

Urban Climatically Neutral Area

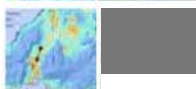
Generally speaking, UCPZ2 is mostly the lowland areas with sporadic low-rise low-density developments. It is climatically neutral, i.e. having neutral PET of 28°C in the summer months.



UCPZ 3

Moderately Urban Climatically Sensitive Area

affected the thermal comfort.



UCPZ 4

Highly Urban Climatically Sensitive Area

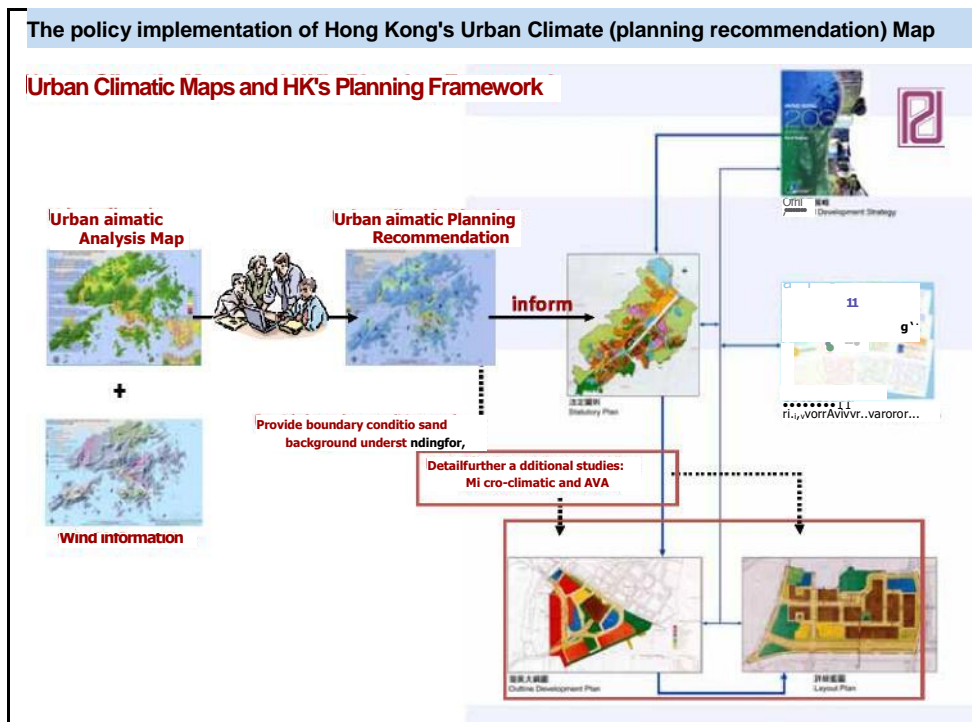
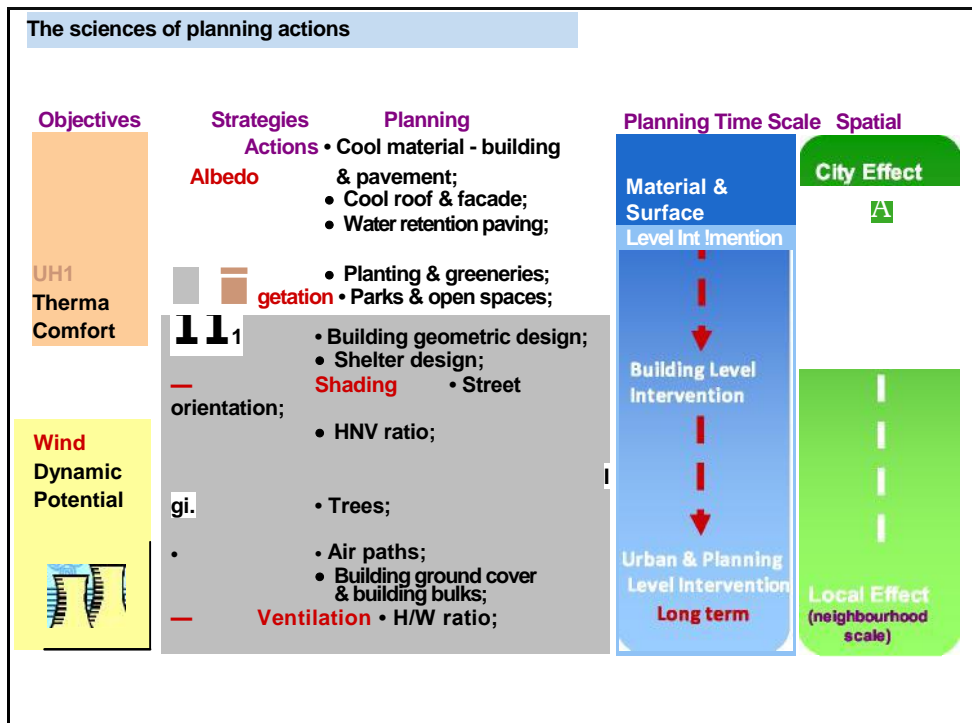
UCPZ4 is the densely developed areas suffering from high thermal load and poor wind environment.



UCPZ 5

Very Highly Urban Climatically Sensitive Area

UCPZ5 is the very densely developed areas suffering from high thermal load and poor wind environment.



Optimise planning and design based on Urban Climatic understand



What action is needed?

Where is it most needed?

How much effort is needed?


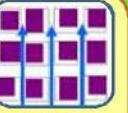

What benefits can be expected?

Planners can now have 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.

Urban Climatic Maps — Air Ventilation

Development sites subject to AVA

Mitigating Design Measures:

 <p>Ground Coverage no more than 65%</p>	<p>Building (Tower Block) Permeability as per PNAP No. APP-152*</p>	 <p>Building Setback requirement near narrow streets as per PNAP No. APP-152*</p>	 <table border="1"> <thead> <tr> <th>Site Area</th> <th>Greenery (preferably Tree Planting)</th> </tr> </thead> <tbody> <tr> <td>≥ 1ha</td> <td>30%</td> </tr> <tr> <td>1,000sqm to < 1ha</td> <td>20%</td> </tr> </tbody> </table> <p>Greenery should preferably be at grade, in particular at ground level*</p>	Site Area	Greenery (preferably Tree Planting)	≥ 1ha	30%	1,000sqm to < 1ha	20%
Site Area	Greenery (preferably Tree Planting)								
≥ 1ha	30%								
1,000sqm to < 1ha	20%								

*Practise Notes for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers No. APP-152 "Sustainable Building Design Guidelines"

Detailed calculation methods for greenery to be worked out in due course

Wind performance of 1Ms as an additional alternative to satisfy PNAP No. APP-152 prescriptive building permeability requirement

72

The policy implementation of Hong Kong's Urban Climate (planning recommendation) Map

Recommendations in action

Outline Zoning Plan Review

Annual prevailing winds

RECOMMENDATIONS:

- Building Density
- Ground Coverage
- Building Height
- Greenery

Air paths

Mapping

An example of Planning Review incorporating Urban Climatic Planning considerations

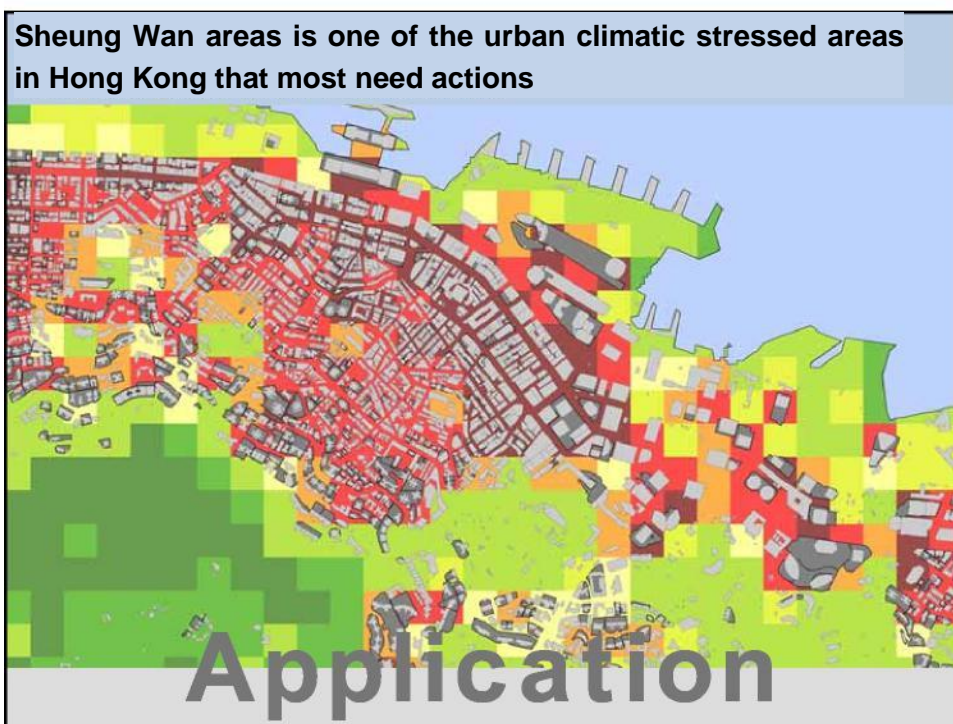
Prevailing wind respected; properly aligned air paths

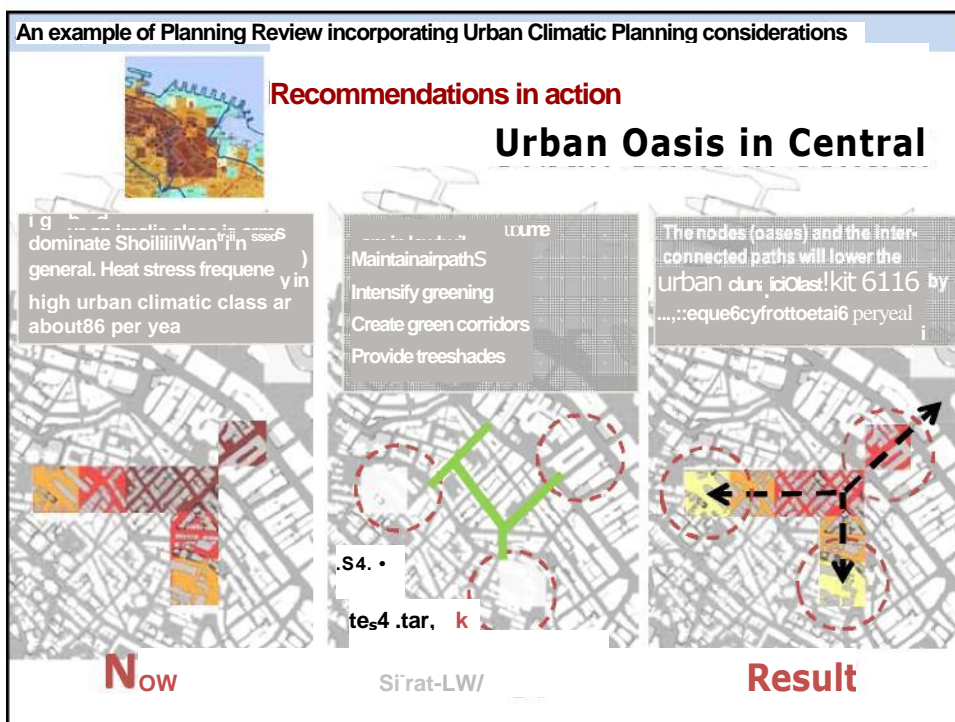
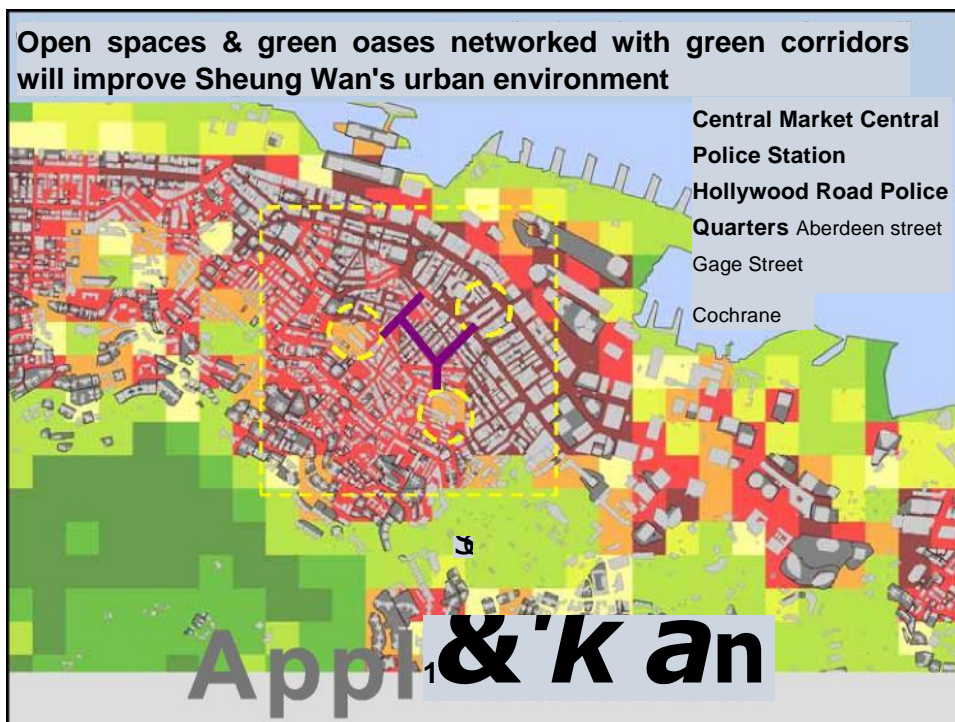
Buildings at north-east corner optimised; impact to neighbourhood, minimised.

Site (podium) coverage reduced

Greening Intensified

Provide excellent starting point for the individual building to achieving **BREEAM+ Platinum** rating







The provision of a Green Oasis where it is most needed

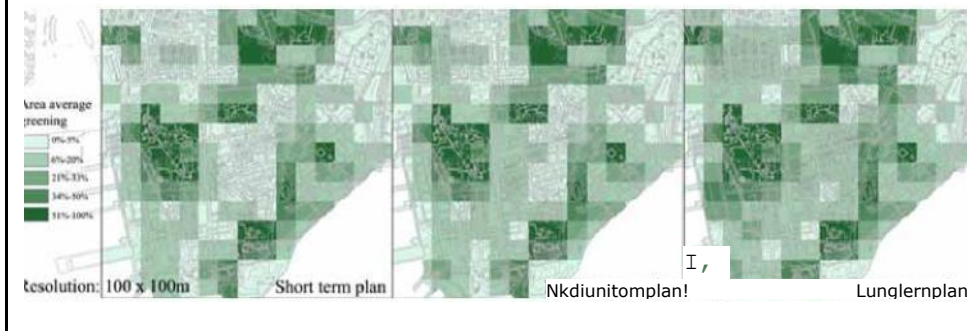




An example of Planning Review incorporating Urban Climatic Planning considerations



Greening Master Plan (TST area)



Revisions to the Hong Kong Planning Standards and Guidelines

kmaRMOMPlanning Department

HONG KONG PLANNING STANDARDS AND GUIDELINES

Breezeway / Air path
Orientation of Street Grids
Linkage of Open Spaces
Non-building Waterfront Sites
Building Heights
Building Disposition
Shading and greenery

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 year same as the year 2000

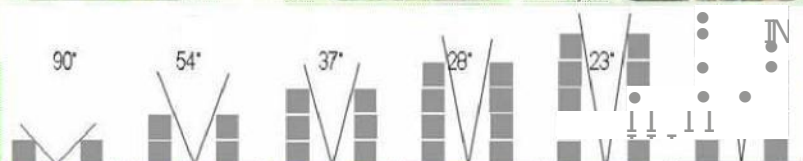
Temp diff. as compared to base case: 0.2K, 0.4K, 0.8K, 1.8K

Wang Y and Ng E., Parametric Study on Microclimate Eff. of Green Roofs Conference, Organised by Uniterkef4IAleek.
 eAiedWang U, (2010) A study on the cooling ler4isoPpberibigiftlaralisValiF
 i PALENG, 5th EPIC
 Avirannent, (in press)

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



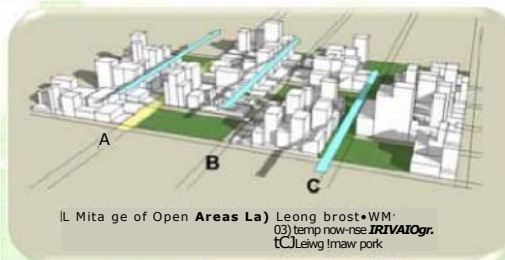
en, L, Ng, E., AN, X P., Ren, C., He, J., Lee, M. Wang, U. and He, J. (2010) Sky View Factor Analysis of Street Canyons and its Implications for Inter-Urban Air Temperature Differentials in High-Rise, High-Density Urban Areas of Hong Kong: a GIS-Based Simulation Approach *International Journal of Climatology*.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

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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, Ng, F., (2011) A study of the "wall effect" caused by proliferation of high-rise buildings in Hong Kong, *TableGIS Techniques Landscape Architecture Planning*, 102, 245-253.

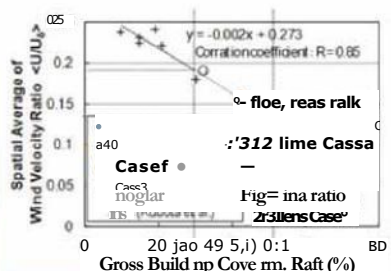
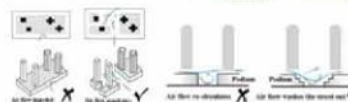
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Planning and Design Measures to Improve Urban Climate

Ground Coverage – for wind penetration

Researchers at CU HK 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%**



gNg Pg Pg

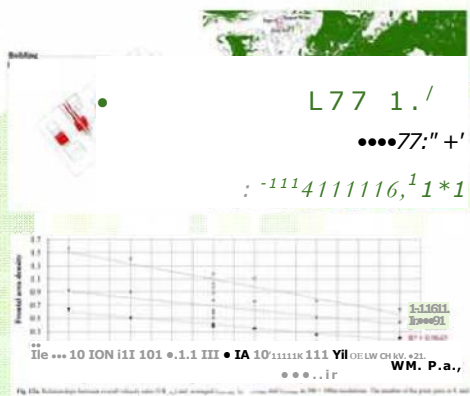
Ryuichiro Yoshie, Hideyuki Tanakawa and Taichi Shiihara and Edward Ng, Experimental Study on Air Ventilation in a Built-up Area with Closely Packed High-Rise Buildings, J. Environ. Eng., AII, Vol. 73 No. 627,661-667, May, 2008.

Planning and Design Measures to Improve Urban Climate

Building Permeability – for wind penetration

Researchers at CU HK 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%**

$$\lambda_{f(s)} = \frac{A_f}{A_T} = L_y \cdot Z_{eff}$$



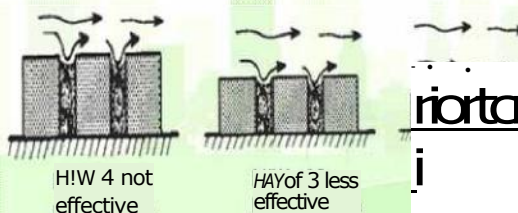
Wong, M. S., Nichol, J.E., Ng, E., (2011) A study of the "wall effect" caused by proliferation of high-rise buildings in Hong Kong, using GIS techniques, Landscape and Urban Planning, 102, 245–253.

E. Yuan, C. Fung, J.C., Ren, C., & then, L. (2011) Morphological 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 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**



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)90026-5.

Revisions to Building Practice Notes

Department of Urban Planning and Design
 Urban Planning Agreement No. BA/O1/2006

Building Separation and Design Guidelines

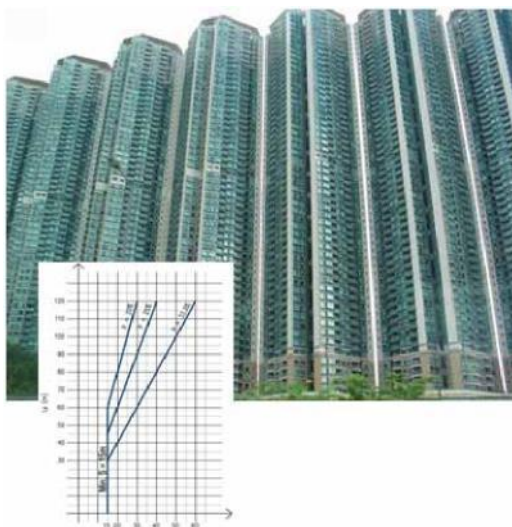
103)16 Hasugmt. Buildin' Se sARATION / Permeability

Design Principle 1: Building Separation

The required building permeability shall firstly be provided in form of **building separation (S)**

The accountable width of which is proportional to the length of adjoining facades in accordance with the stipulated building permeability criteria and **in no case smaller than 15m.**

For the immediate context taken into account, the 1/2S criteria can be applied to the facade ends with separation distance measured from the adjoining boundary line or the



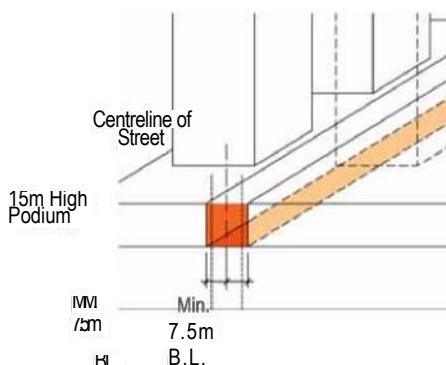
Revisions to Building Practice Notes

Street set back and non building areas

Buildings Department, HKSAR
 - Consultancy Agreement No. BA/O1/2006

Building Set back / Minimum Sectional Area of Urban Canyon at Pedestrian Zone

The minimum sectional area of urban canyon for better air volume at the Pedestrian Zone within the urban canyon abutting the development site should be not less than a **7.5m x 15m** sectional area (or the equivalence) measured from the centerline of the adjoining street.



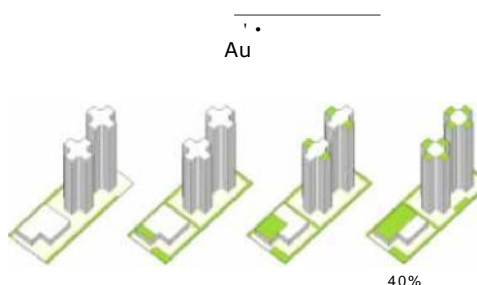
Revisions to Building Practice Notes

Site Coverage of Greenery

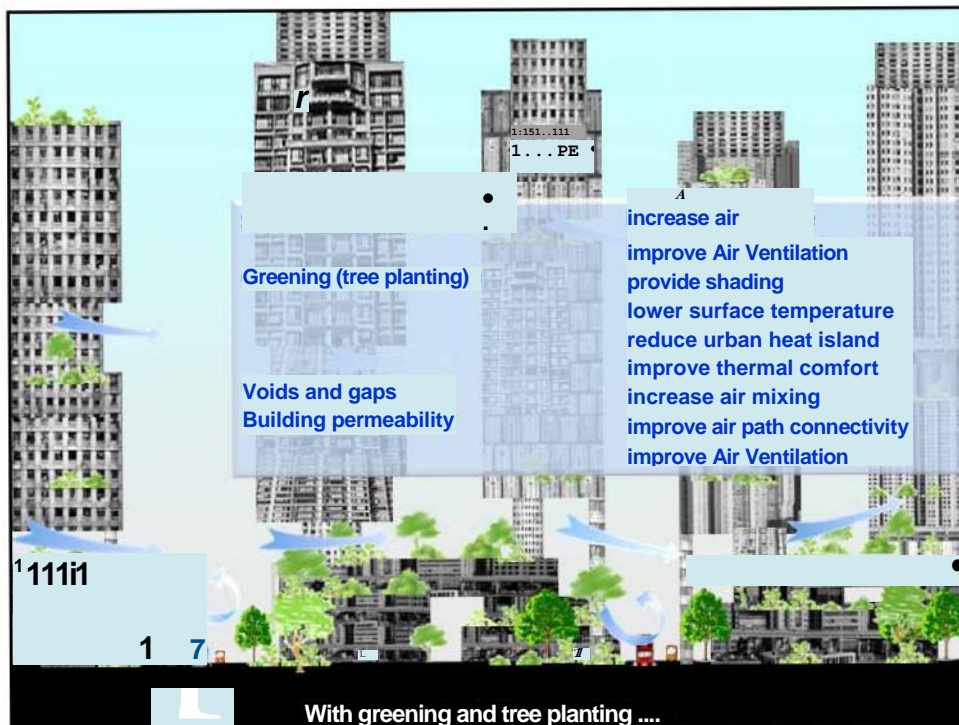
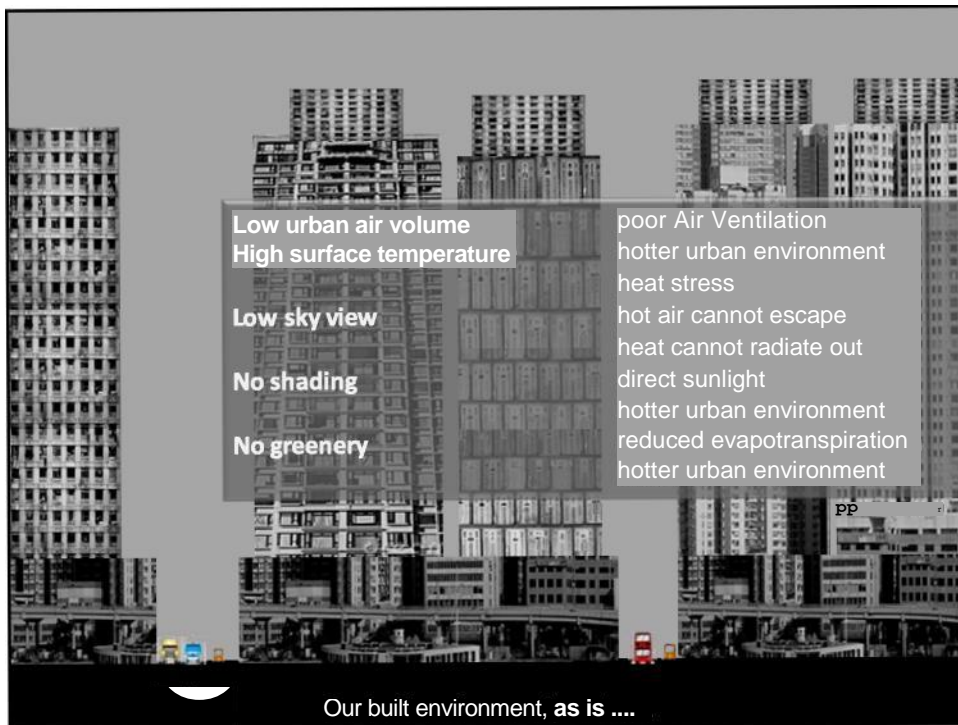
Buildings Department, HKSAR
 - Consultancy Agreement No. BA/O1/2006

To enhance urban greenery, new development sites shall provide the following minimum site coverage of greenery, dependent on the site area:

Site Area	Site Coverage of Greenery
1,000 s.m.	Min. 20%
> 2 ha	Min. 30%



The definition on site coverage of greenery can be similar to the current site coverage control of building in individual development sites. The inspection and maintenance of coverage of such greenery coverage can be checked by aerial photographs.



The need for communication

We recommended the Govt setting up a special **Urban Climate for Planning** section



(World Meteorological Organisation-WCC3) "The consideration of Urban climatology for planning is necessary"

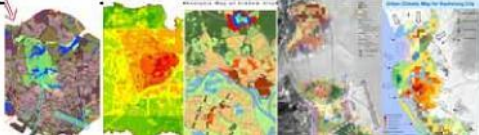
Planners must be **assisted by** and **work with** urban climatologists when interpreting and applying the information of the map.

INTERNATIONAL JOURNAL OF CLIMATOLOGY
Kr. J. Chhnowl- (2010)
 Published online in Wiley Online Library
 www.interscience.wiley.com/jpages/0950-0804/doi/10.1002/joc.2237

RMetS
 Royal Meteorological Society

Urban climatic map studies: a review

Ren Chao, Ng Edward Yan-yung^a and Katzschner Lutz^b
School of Architecture, The Chinese University of Hong Kong, Shatin, New Territories, Hong Kong
Department of Landscape Architecture and Urban Planning, University of Kassel, Kassel, Germany



Conclusion
 Since their introduction 40 years ago, worldwide interest in urban climatic map (UCMap) studies has grown. Today, there are over 15 countries around the world processing their own climatic maps, developing urban climatic guidelines, and implementing mitigation measures for local planning practices. Facing the global issue of climate change, it is also necessary to include the changing climatic considerations holistically and strategically in the planning process, and to update city plans.




We aspire to build a better future ••• for them








Acknowledgement: I would like to thank Planning Department HKSAR Government for funding the research.



**I passed a dying tree one day.
 It bore a single leaf.
 A breeze of smoke swept over it,
 And nothing left was green.
 I looked at my surroundings
 So bleak, so black, so bland.
 It used to flow with life and love,
 What happened to this land?**

**I thought how many others
 Had seen the same or worse.
 How many acts of carelessness
 Did it take to earn this curse?
 How many trees had been cut down?
 How many species gone?
 We seem to have forgotten that
 We've one world to live on.**

**I saw the glow of lights one day,
 While everything was still.
 I thought about our future life
 And felt a sudden chill.
 I wondered just how many times
 Those unused lights burned on,
 To have to see this hell on earth
 And think there's nothing wrong.**

**I thought about a change of
 plan, While we've still time to
 start To revive this dying earth
 of ours With actions from our
 heart. I thought about a life
 where We could see tomorrow's
 dawn, So let us not forget that
We've one world to live on.**

Simon Ng

Air Ventilation Assessment technical guideline:

<http://www.devb.gov.hk/filemanager/technicalcircul arse/niuDload/15/1/itc-2006-01-0-1.pdf>

AVA register:

<http://www.pland.gov.hk/pland en/info serv/ava reRister/Rovernment.html>

Hong Kong Planning Standards and Guidelines:

<http://www.oland.eov.hk/oland en/tech doc/hkose/full/chlllichll text.htm>

Urban Climatic Map and Wind Standard:

<http://www.pland .gov.hk/pland enfp study/prog si uc ma pwelaiindex.htm>

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Professor Edward Ng

School of Architecture, The Chinese University of Hong Kong