The Overheating Cities and Adaptions

Dr. Chao REN
Faculty of Architecture, The University of Hong Kong
Residents in Hong Kong’s poorest neighbourhoods struggle to keep cool as city endures record long heatwave (PUBLISHED : Saturday, 07 July, 2018, 3:42pm)
Climate: sub-Tropical (hot and humid summer, mild winter)

Land area: 1000 sq.km

Urban area: 220 sq.km (23% of total land)

Population: 7.5 million
50% population lives in public housing

2017 The Thematic Household Survey Report No. 60, published by The Census & Statistics Dept. of HK Gov.,
0.2 Million people live in subdivided units

0.1 Million cage home dwellers

Ageing Society & Poverty

老年与贫困

本港去年長者貧窮人口在政策介入後，回升至30.85萬，較前年增加1.47萬人，創2009年以來新高；貧窮率升至30.1%，即每三個長者就有一個要捱窮。(苹果日报，要闻港闻，16/10/2016)

香港的人口將急速高齡化，由2015年至2064年，65歲或以上的長者人數預期會由約112萬上升2.3倍至258萬，長者安老服務的需求更見殷切。

http://www.rthk.hk/tv/dtt31/programme/hkcc/episode/444380
<table>
<thead>
<tr>
<th>Time &amp; Dept.</th>
<th>Government Projects</th>
<th>Technical Note, Practice Note and Guidelines</th>
<th>Design Levels</th>
</tr>
</thead>
</table>
| **2003-2005**<br>Planning Dept. | Air Ventilation Assessment | 2005: Development Bureau published the Technical Note on Air Ventilation Assessment | • District Planning  
• Building Site Plan  
• Building Design  
• Urban Design |
| **2006-2009**<br>Building Dept. | Building Design that Supports Sustainable Urban Living Space in Hong Kong | Apr 2006: Hong Kong Planning & Standard Guideline - Chap.11  
June 2009, the Council for Sustainable Development launched a public engagement process entitled ‘Building design to foster a quality and sustainable built environment’ | • Building Design |
| **2006-2012**<br>Panning Dept. | Urban Climatic Map and Standards for Wind Environment - Feasibility Study | From 2007: Update & renew the 109 outline zoning plans of Hong Kong  
From 2007 to now: new town development and urban renewal projects | • Urban Planning and Design |
| **2010-2013**<br>Panning Dept. | Consultancy study on establishment of simulated site wind availability data for air ventilation assessment in Hong Kong | Since 2013, the site wind availability data for Hong Kong have been available online | • District Planning  
• Building Site Plan  
• Building Design |
| **2004-Now**<br>Housing Authority | 「Micro-climate」Study | Public Housing Estate Projects: master plan, design: air ventilation and heat island assessment, daylight design, shading and thermal comfort study. | • District Planning  
• Building Site Plan  
• Building Design |
| **2016-2018**<br>HKGBC | Microclimate Guidebook | HKGBC Guidebook on Urban Micro-climate study | • Building Design  
• Building Site Plan |
Urban Climatic Classes

8 Urban Climatic Classes

Urban Climates Analysis Class

<table>
<thead>
<tr>
<th>No</th>
<th>Urban Climatic Analysis Class</th>
<th>Impact on Thermal Comfort</th>
<th>Urban Climatic Planning Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Moderate negative Thermal Load and Good Dynamics Potentials</td>
<td>Moderate</td>
<td>UCPZ 1 Urban climatically valuable area</td>
</tr>
<tr>
<td>2</td>
<td>Some negative Thermal Load and Good Dynamics Potentials</td>
<td>Slight</td>
<td>UCPZ 2 Neutral urban climatically sensitive area</td>
</tr>
<tr>
<td>3</td>
<td>Low Thermal Load and Good Dynamics Potentials</td>
<td>Neutral</td>
<td>UCPZ 3 Moderate urban climatically sensitive area</td>
</tr>
<tr>
<td>4</td>
<td>Some Thermal Load and Some Dynamics Potentials</td>
<td>Slight</td>
<td>UCPZ 4 High urban climatically sensitive area</td>
</tr>
<tr>
<td>5</td>
<td>Moderate Thermal Load and Some Dynamics Potentials</td>
<td>Moderate</td>
<td>UCPZ 5 Very highly urban climatically sensitive area</td>
</tr>
<tr>
<td>6</td>
<td>Moderately High Thermal Load and Low Dynamics Potentials</td>
<td>Moderately strong</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>High Thermal Load and Low Dynamics Potentials</td>
<td>Strong</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Very High Thermal Load and Low Dynamics Potentials</td>
<td>Very strong</td>
<td></td>
</tr>
</tbody>
</table>

Urban Climatic Planning Zones

5 Urban Climatic Planning Zones

UC-PanMap Urban Climate Analysis Map

UC-ReMap Urban Climate Planning Recommendations Map

Hong Kong UCMap Development Process

Planning Department
INFORMATION

User survey
Bio-meteorological modelling
Wind Tunnel tests
Field studies
Traverse measurements
Remote sensing
Micro-climatic monitoring
Theoretical calculations

Human Heat Balance Model

Meso-scale modelling

Model simulations

References:
https://www.pland.gov.hk/pland_en/p_study/prog_s/ucmapweb/ucmap_project/content/reports/final_report.pdf
Mortality Risk

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.

<table>
<thead>
<tr>
<th>Model</th>
<th>All-cause mortality</th>
<th>Cardiovascular mortality</th>
<th>Respiratory mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline ($T_{max} \geq 33^\circ$C)</td>
<td>3.67% [3.53, 3.81]</td>
<td>3.87% [3.55, 4.18]</td>
<td>3.55% [3.24, 3.86]</td>
</tr>
<tr>
<td>Three consecutive VHDS</td>
<td>7.97% [7.14, 8.80]</td>
<td>8.42% [6.59, 10.25]</td>
<td>7.06% [5.32, 8.80]</td>
</tr>
<tr>
<td>Three consecutive HNs</td>
<td>7.37% [7.14, 7.61]</td>
<td>7.41% [6.88, 7.93]</td>
<td>7.26% [6.77, 7.75]</td>
</tr>
<tr>
<td>Five consecutive HNs</td>
<td>7.99% [7.64, 8.35]</td>
<td>7.74% [6.93, 8.55]</td>
<td>8.14% [7.39, 8.89]</td>
</tr>
<tr>
<td>At least three VHDS and three HNs within a 7-day period</td>
<td>1.46% [1.22, 1.71]</td>
<td>1.83% [1.29, 2.36]</td>
<td>1.81% [1.28, 2.33]</td>
</tr>
<tr>
<td>At least five VHDS and five HNs within a 7-day period</td>
<td>5.31% [4.59, 6.04]</td>
<td>5.73% [4.18, 7.29]</td>
<td>6.23% [4.62, 7.85]</td>
</tr>
</tbody>
</table>


Significant short-term effect of prolonged heat events

Higher risk under nighttime prolonged heat

Reduced risk if they are not continuous
Hotspot Areas Detection in Summer Nighttime
(red colour: $T \geq 28\text{deg C}$)

It is found that urban areas in Hong Kong cannot be cooled down in the night.
Potential **Heat-related Health Impact**

Sensitive Population & People cannot access or afford air conditioning in Summer

<table>
<thead>
<tr>
<th>Location within region</th>
<th>All times</th>
<th>Daytime</th>
<th>Nighttime</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Prison, Correctional Institution, Rehabilitation Centre (n=299)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) School (n=3432)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Hospital (n=44)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Infirmary Unit (Services for the Elderly) (n=19)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) Public Housing Estate (n=223)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Breezeway / Air path
Orientation of Street Grids
Linkage of Open Spaces
Non-building Area
Waterfront Sites
Building Heights
Building Disposition
Shading and greenery

Ng, E., ‘Designing for Thermal Comfort and Air Ventilation in High Density City Conditions – Air Ventilation Assessment System (AVAS), invited paper, HKIA Journal, The Hong Kong Institute of Architects, Hong Kong, 1st Q, 2007, pp.24-31. [ISSN 1028-4842]
Different Levels of Urban Climatic Planning Actions

**UHI Thermal Comfort**

**Objectives**

- Albedo
  - Cool building-material & pavement;
  - Cool roof & facade;
  - Water retention paving;

- Vegetation
  - Planting & greeneries;
  - Parks & open spaces;

- Shading
  - Building geometric design;
  - Shelter design;
  - Street orientation;
  - H/W ratio;
  - Trees;

- Ventilation
  - Air paths;
  - Building ground cover & building bulks;
  - H/W ratio;
  - Street orientation;
  - Open spaces;
  - Building disposition;

**Planning Time Scale**

- **Immediate**
  - Material & Surface Level Intervention

- **Building Level Intervention**

- **Urban & Planning Level Intervention**

**Spatial Scale**

- City Effect
- Local Effect (neighbourhood scale)
Building Block 1
Planning for a Liveable High-density City
A Healthy City

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

We propose to incorporate "active design" considerations in shaping the built environment to promote physical activities and health through responsive urban design and building design by promoting walking, cycling, exercising and a healthy lifestyle. We propose to rekindle our connection with nature in the city. We propose to strengthen our commitment to enhancing biodiversity, promoting environmentally friendly initiatives, and creating a clean and healthy built environment. To alleviate the urban heat island effect, to improve the urban climate and to respond to climate change, we seek to further incorporate urban climatic and air ventilation considerations in planning and urban design.

"Active design" is defined as practices and interventions of promoting physical activity and health through responsive urban design and building design by promoting walking, cycling, exercising and a healthy lifestyle.

Fig. 17 Hong Kong Urban Climatic Planning Recommendation Map

"We need a physical city environment that is conducive to healthy and active lives."
TEMPERATURE RISE
Hong Kong will be hotter (cont.)

- **Hong Kong Planning Standards and Guidelines (HPiPSG)** - Promoting good urban design at the local level can contribute to a livable high-density environment. HPiPSG provides design guidelines on aspects such as massing, height profile, street orientation, green areas, etc. to promote better urban, air ventilation, and thereby help tackle Urban Heat Island effect and improve the micro-climate of urban environment. The Government follows these guidelines on urban design and air ventilation that are promulgated in the HPPSG in the planning of NDAs. For existing built-up areas, project proponents are encouraged to take into account these guidelines in planning and designing their development/redevelopment projects so as to pursue incremental improvement of the urban wind environment.

- **Air ventilation assessment** - Since 2005, the Government requires air ventilation assessments to be done for all major government projects so that the result can improve the design to facilitate wind penetration to their surrounding area and the private sector is encouraged to follow this practice. In recent strategic planning studies, such as the Investigation of North East New Territories New Development Areas Planning and Engineering Study and the Feasibility Study of Planning and Engineering Study on the Reusing Development in Ting Kau, air ventilation considerations are reflected in the conscious planning decision to create broadways and air ventilation corridors.

- **Urban Climatic Planning Recommendation Map (UCPSMR)** - PlanD formulated an Urban Climatic Planning Recommendation Map in a consultancy study completed in 2012, which provides a scientific basis for assessing urban climatic and air ventilation impacts of major developments, and helps tackle the heat island challenge.

- **Greening Master Plans (GMPs)** - The Government, led by the Civil Engineering and Development Department (CEDD), has developed detailed Greening Master Plans to define comprehensively the greening framework of an area by studying its characteristics and particular needs, as well as providing a guide to the planning, design and implementation of works. The plans identified planting locations, established greening themes and proposed appropriate planting species. GMPs for the urban areas were completed between 2007 and 2011, and further plans are being implemented in the remaining districts (also see Chapter 5).

- **Sustainable Building Design Guidelines** - Since 2011, the Government promulgated a set of Sustainable Building Design Guidelines on building separation, building set back and site coverage of landscape through the Building Departments (BD) Gross Floor Area concession policy, as well as including these guidelines in tender conditions of new land sales sites or lease modifications/land exchanges of 1,000 square metres or more so as to achieve better air ventilation, provide more greening and mitigate the heat island effect.

- **BEAM Plus** - BEAM Plus is a comprehensive environmental assessment scheme for buildings in Hong Kong. It is a standard for green buildings to emphasize the indoor health and environmental quality and amenities as key performance indicators, with proper consideration of the local, regional and global environmental impacts.
National Standard
Of Urban Climatic Application

Technology for Climatic Feasibility Demonstration in Urban Master Plan

<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master Layout Plan and Urban Ventilation</td>
<td>Wind Corridor, Open Space, City Parks, Linear Green Belt and Wetland Parks</td>
</tr>
<tr>
<td>Greenery Master Layout and Thermal Environment</td>
<td>Waterbodies, agriculture Land, Wood land as fresh air resources</td>
</tr>
<tr>
<td>Allocation of Industries and Intensive Factories Areas</td>
<td>New industrial areas vs air pollution dispersion ability</td>
</tr>
<tr>
<td>Renewable Energy and Energy Structure</td>
<td>Energy Balance, Energy supplies and important facilities</td>
</tr>
<tr>
<td>Rainfall and Sponge City Development, urban flooding management</td>
<td>Annual rainfall, sponge city development, drainage system design</td>
</tr>
<tr>
<td>Extreme Weather and Risk Management</td>
<td>Extreme weather events, urban flooding caused by heavy rainfall, sand storm, lightening, etc</td>
</tr>
<tr>
<td>Integrated Meteorological Evaluation for livable cities</td>
<td>Human Thermal Comfort, Tourism and Relaxation Areas</td>
</tr>
</tbody>
</table>
Data Science in Time, Data Science in Space

Data Science and Informatics Technology

Applications & Implementations

Policy Change

People’s Urban Living Quality Improvement
Thanks! Any question?

Find out more about my publications @