The Guidebook on the

# Built Environment for Senior Citizens in Extreme Hot Weather

# The Guidebook on the Built Environment for Senior Citizens in Extreme Hot Weather

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# Draft Version

The current version is only a draft representing work in progress. Therefore, we welcome any of your comments for our improvement.

# Disclaimer

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# Purpose of The Guidebook

Extreme heat is a growing threat to urban areas worldwide, and as our planet continues to warm, the need to manage this threat is becoming increasingly urgent. Cities are particularly vulnerable to the negative impacts of extreme heat on human health, energy consumption, and the environment. In particular, senior citizens are more susceptible to heat-related health problems, and the increasingly ageing population intensifies these adverse outcomes.

The built environment plays a critical role in shaping our urban landscapes and has a significant impact on our quality of life. The purpose of this guidebook is to raise awareness among building professionals and policymakers about the importance and urgency of mitigating and adapting to urban heat, and to provide strategic guidance for designing resilient built environments. It also creates a platform for fostering dialogues between senior citizens and building professionals where their needs and concerns can be understood and effectively addressed.

This guidebook serves as a useful starting point for architects, urban planners, landscape architects, engineers, interior designers and other professionals who are passionate and committed to creating a positive impact.

To achieve this, we suggest the following steps:

1. Review the general strategies outlined in this guidebook and consider their relative importance.
2. Consult technical experts to determine the best way to implement these strategies.
3. Address conflicts and strive to achieve a sustainable balance that benefits all stakeholders.

Initiating efforts to create a sustainable built environment may be challenging at first, but by setting an example and inspiring others, we can create lasting impacts on our built environments and our society.

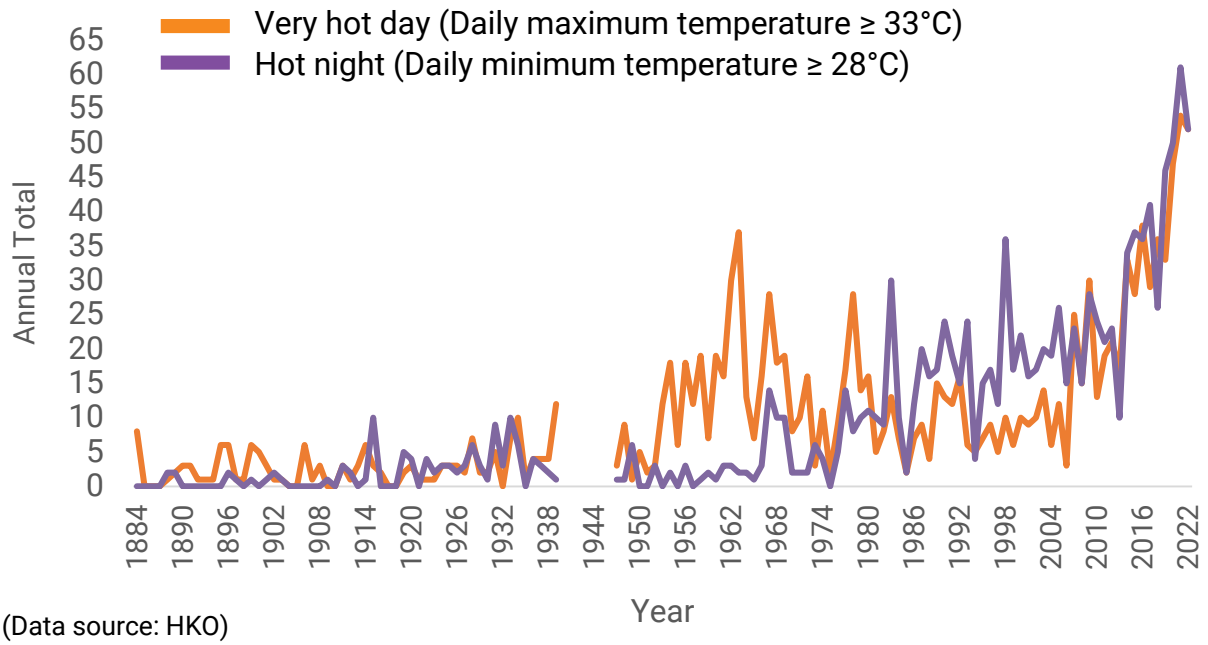
Design for resilience, not just for the present, but also for the future and for the benefit of future generations. We are all growing older and it is our responsibility to ensure that future generations can thrive in a resilient and sustainable built environment with a greater sense of well-being.

# CHALLENGES

# Climate Change and Extreme Heat

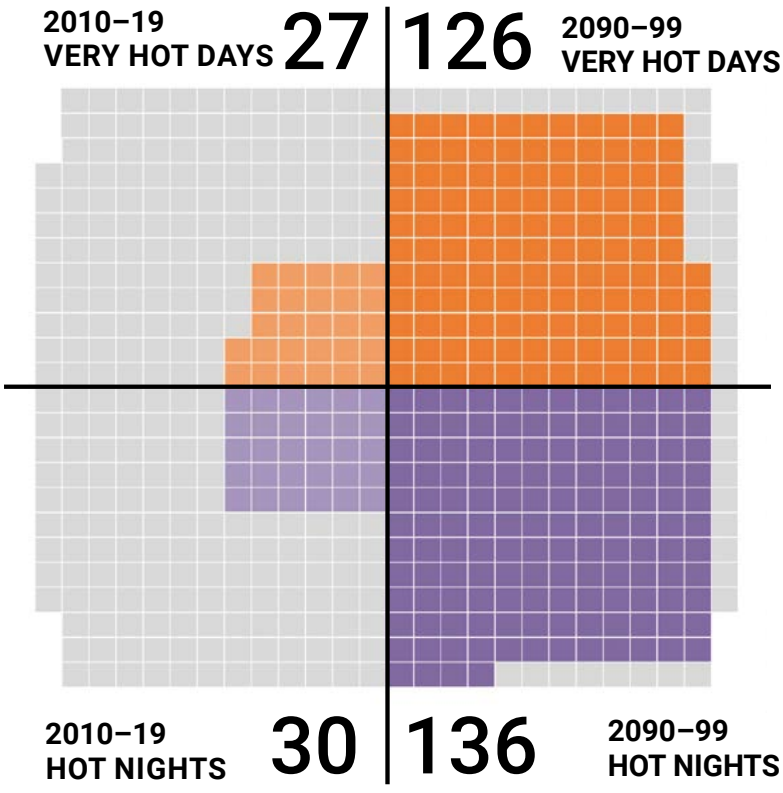
Climate change leads to significant increases in frequency, intensity and duration of extreme heat events across the globe.

## Rapid increase in extreme heat events in Hong Kong




(Data source: HKO)

## Projections of extreme heat events for Hong Kong




By the late 21st century, the numbers of very hot days and hot nights, from May to September, will increase to

**four times**

the average annual records in 2010–19 under very high greenhouse gas emissions

(Data source: HKO & CUHK)

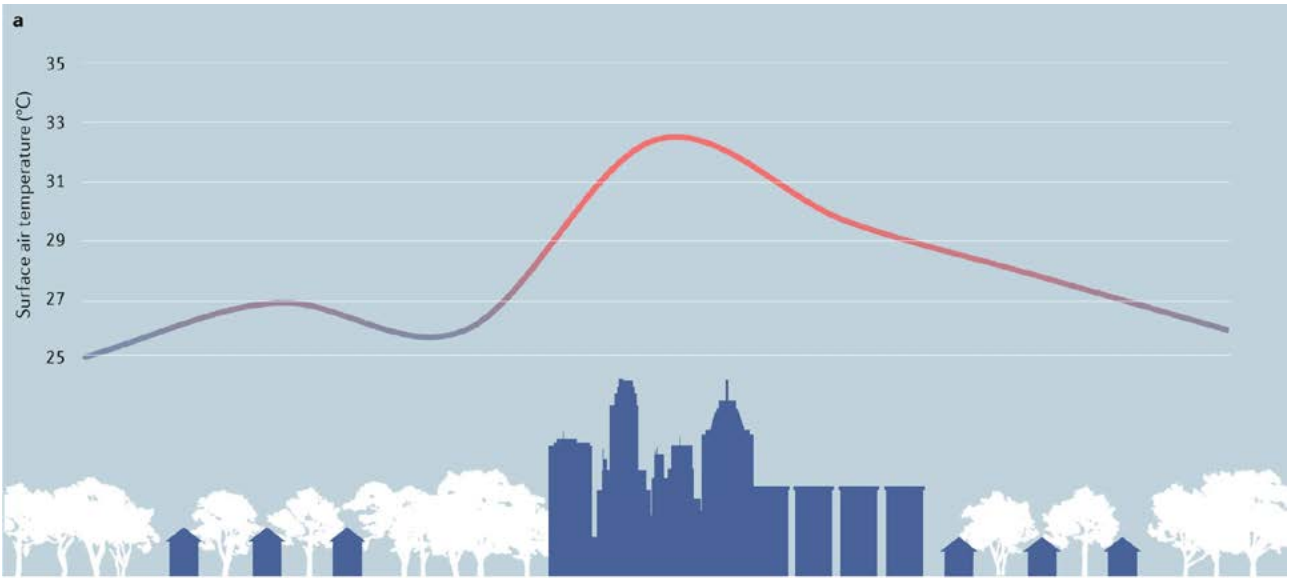
# Urban Heat Island Effect

The sub-tropical heat in Hong Kong has been exacerbated by the urban heat island (UHI) effect. It refers to the environmental phenomenon with warmer temperatures in urban areas than the surrounding rural areas due to dense-built environment, urban activities, urban emissions and insufficient greenery, etc.

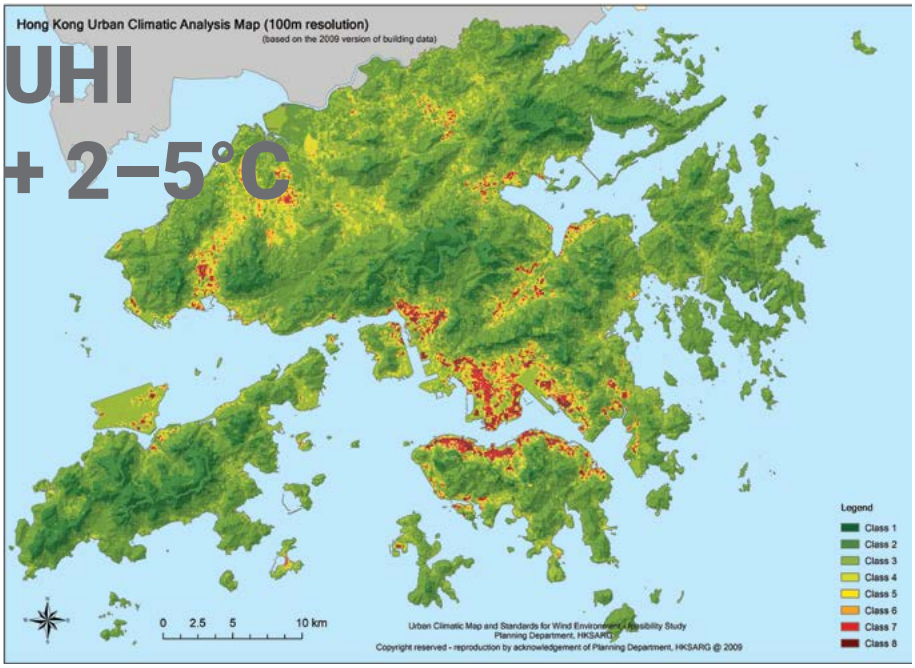
The Hong Kong Urban Climatic Map categorised different levels of urban climatic classes considering the impact of thermal load and wind potential on human thermal comfort (Planning Department, 2012). The increase in temperature compared to daily average are as follows:

Class 4-5: + 1 degree C
Class 6: +2 degree C
Class 7-8: + 2-3 degree C

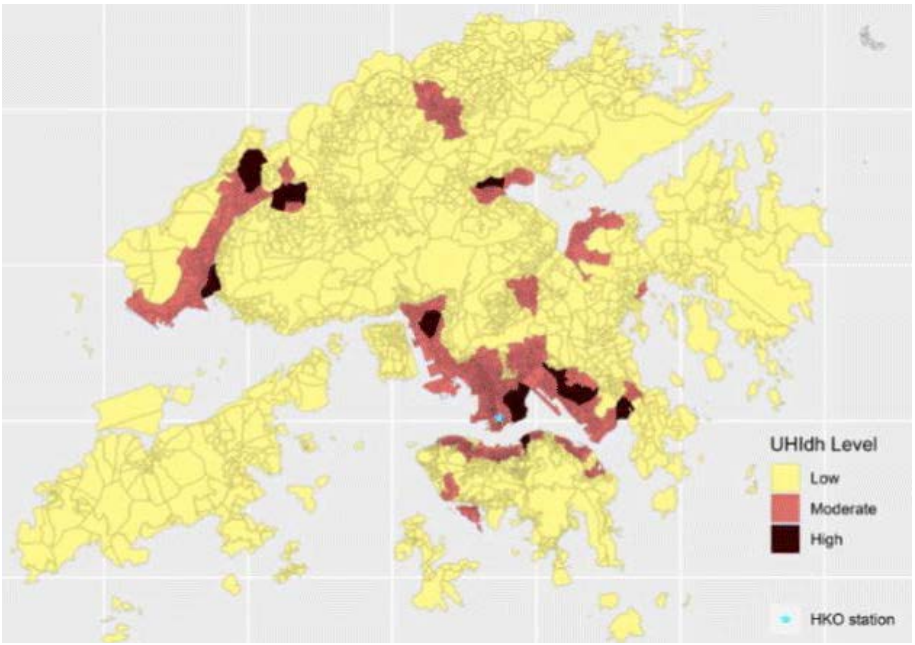
Under extreme heat scenario, mortality risk was higher in areas with stronger urban heat island effect (Ho et al., 2023)..



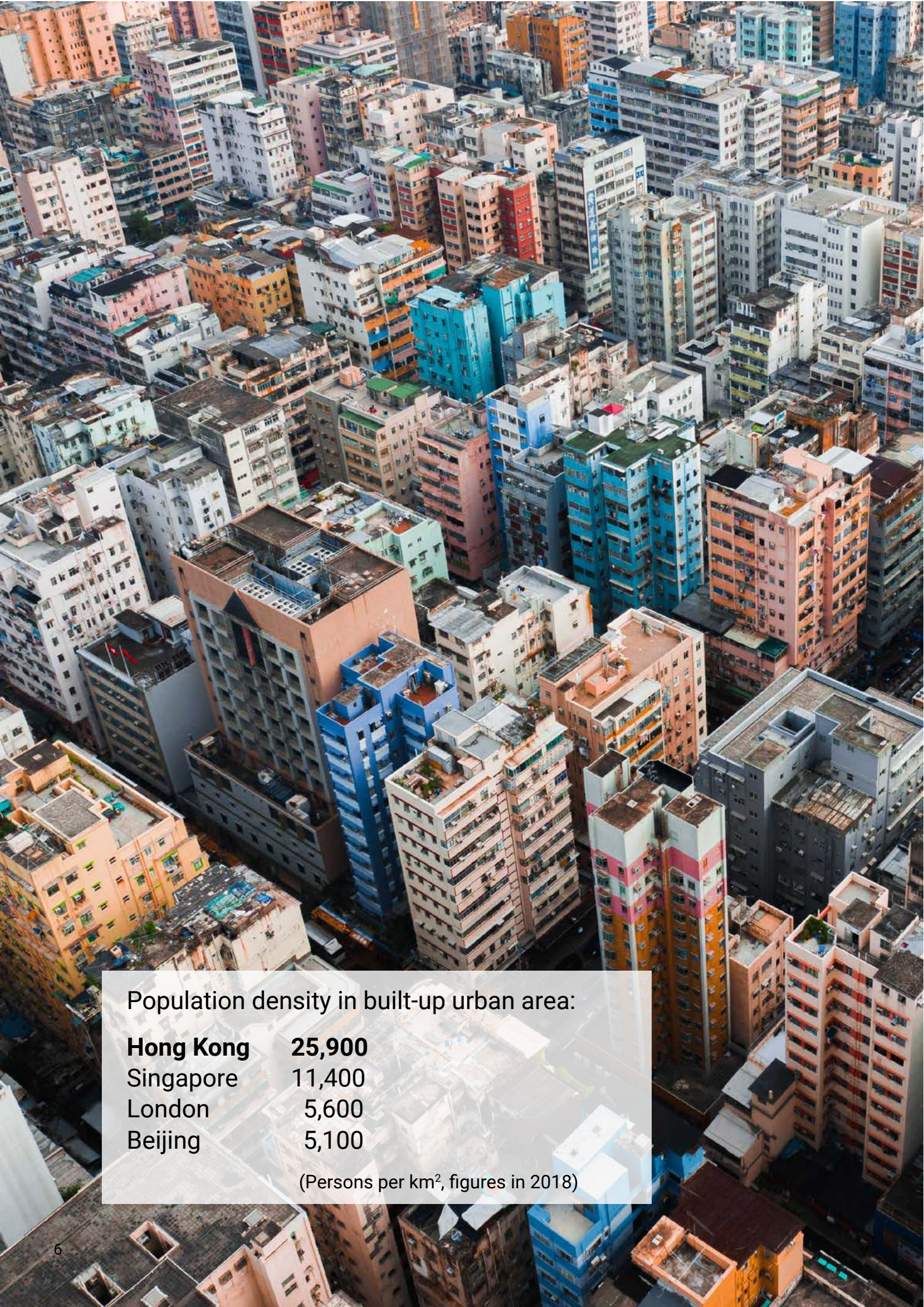

Urban heat island phenomenon
(Source: Wong et al., 2021)




The Hong Kong Urban Climatic Map (Source: Planning Department, HKSAR)




Urban heat island effect-related mortality under extreme heat scenario (Source: Ho et al., 2023)



Population density in built-up urban area:

| | |
|---|---|
| **Hong Kong** | **25,900** |
| Singapore | 11,400 |
| London | 5,600 |
| Beijing | 5,100 |

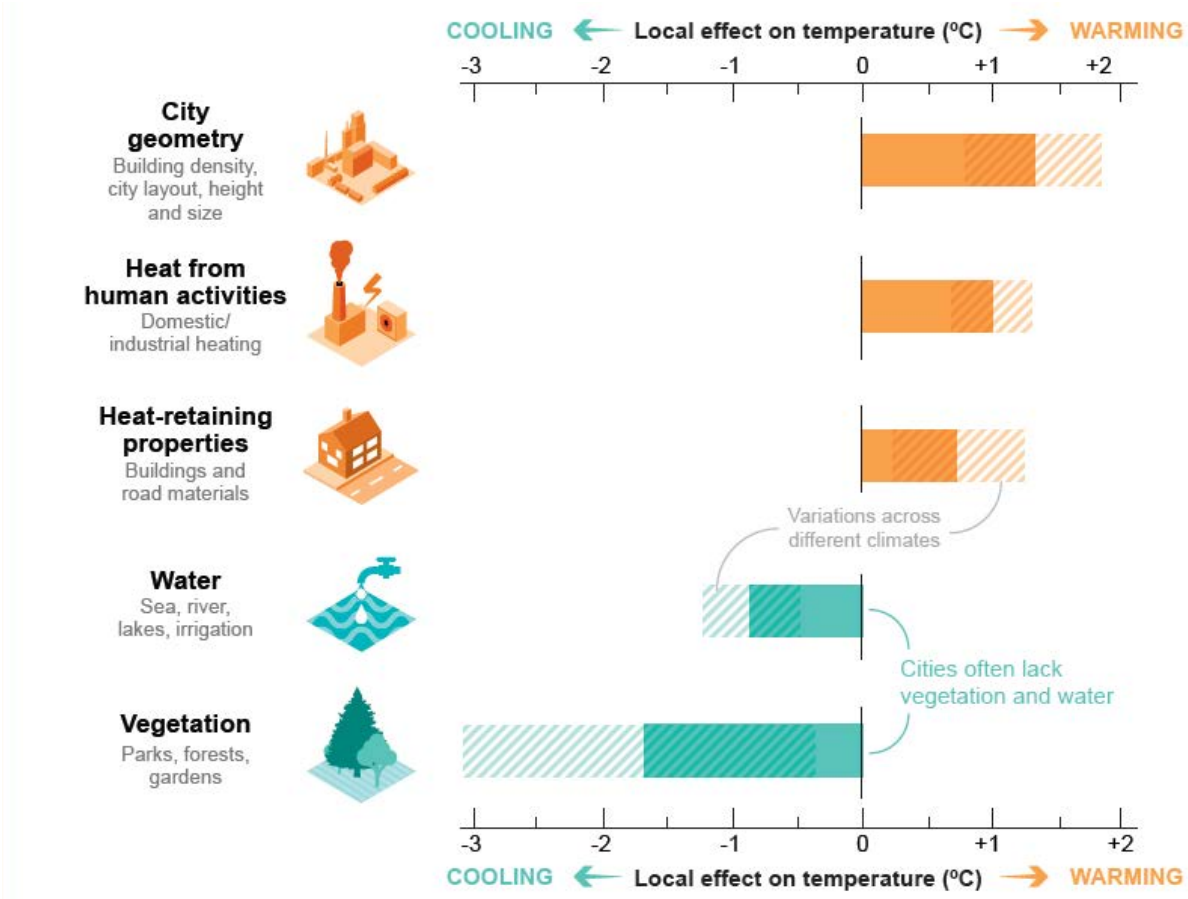
(Persons per $km^2$, figures in 2018)

# Dense Urban Living Environment

Hong Kong is characterised with high-density, high-rise residential environment due to dense urban development.

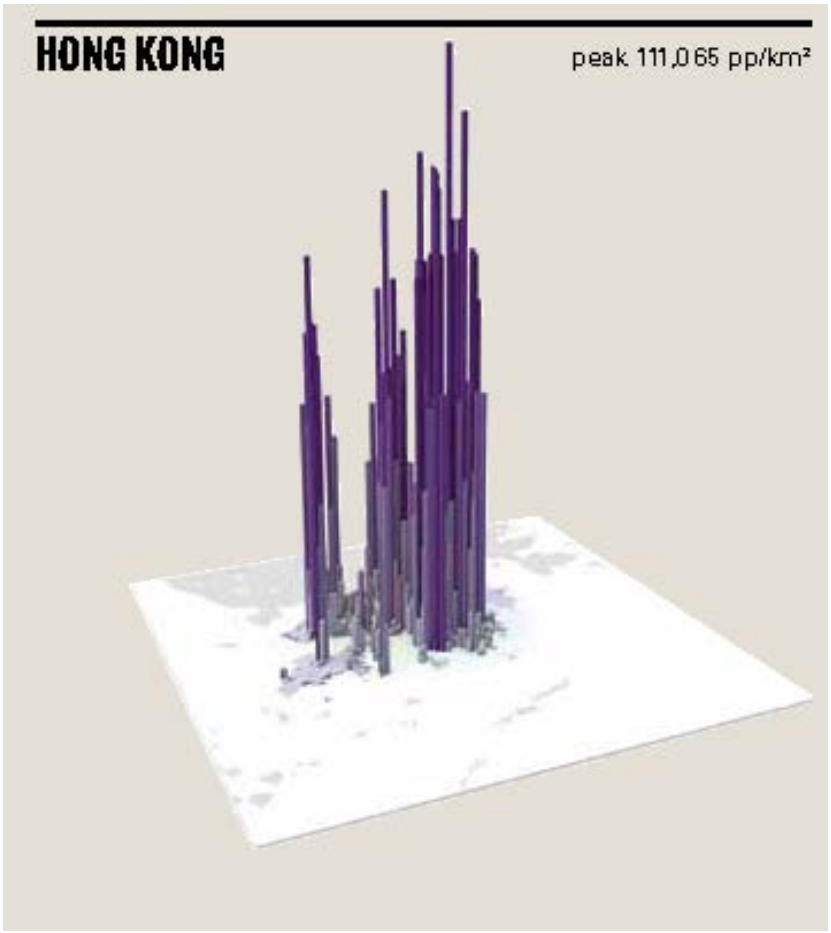
Tall buildings trap the heat and reduce air ventilation, while the environment cannot be cooled down naturally due to insufficient water bodies and vegetation.

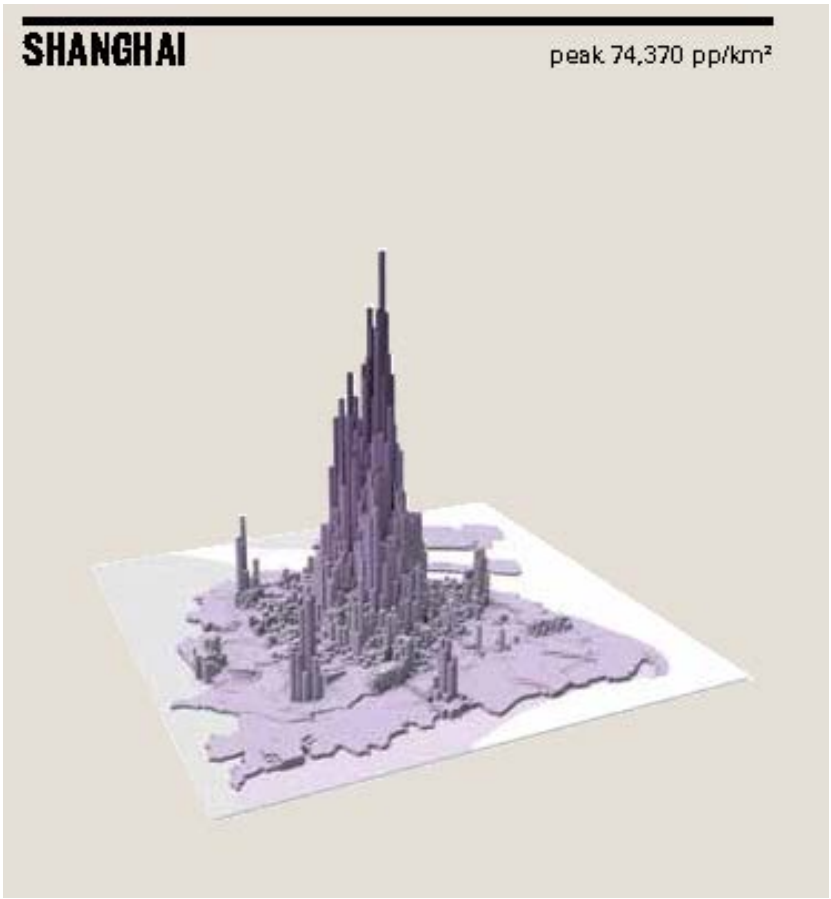
More frequent and increasing extreme heat events will intensify uncomfortable urban living conditions, heat stress and related health problems.

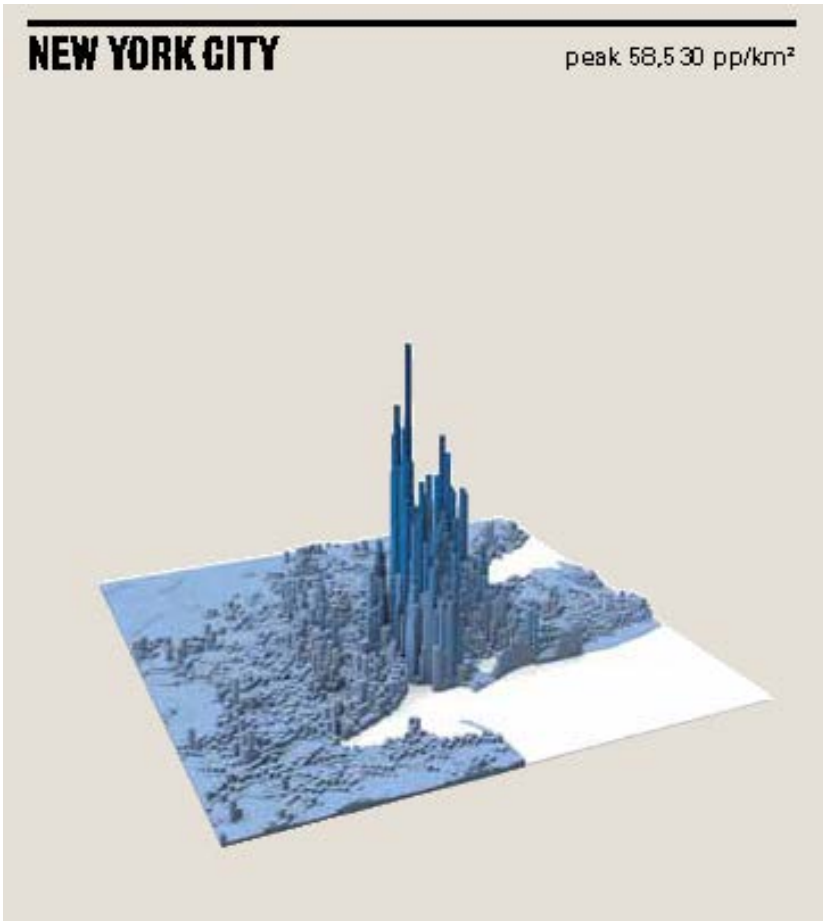



Cities are warmer due to factors that trap and release heat and a lack of natural cooling processes. (Source: IPCC, AR6, WP1, Chapter 10, FAQ 10.2)

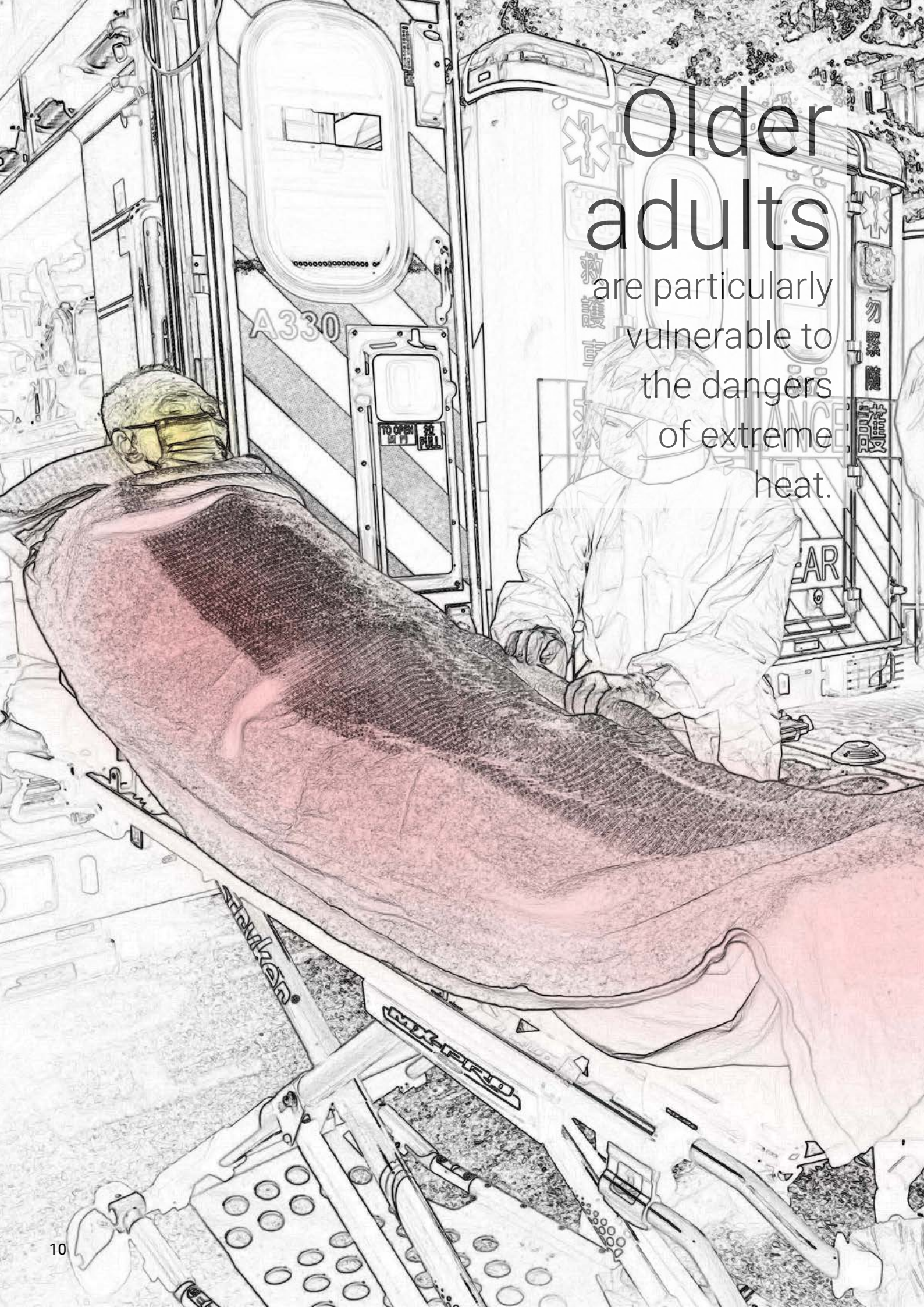
Residential urban density, measuring how many people live in relative proximity, is shown by the number of people living in each square kilometre of a 100 × 100 kilometres urban region. Hong Kong has the highest density, compared with Shanghai, New York City and London.
(Source: LSE Cities, 2011)




NEW YORK CITY
peak 58,530 pp/km²


LONDON
peak 17,324 pp/km²




# Older adults

are particularly vulnerable to the dangers of extreme heat.

# Why Are Older People More Prone to Extreme Heat?

Reduced physiological ability to dissipate heat and regulate body temperature

Reduced sweating

Prescription medicines for heart diseases and blood pressure

Dehydration due to reduced thirst sensation and kidney function

Chronic diseases such as high blood pressure and heart problems

# Health Impacts on Senior Citizens

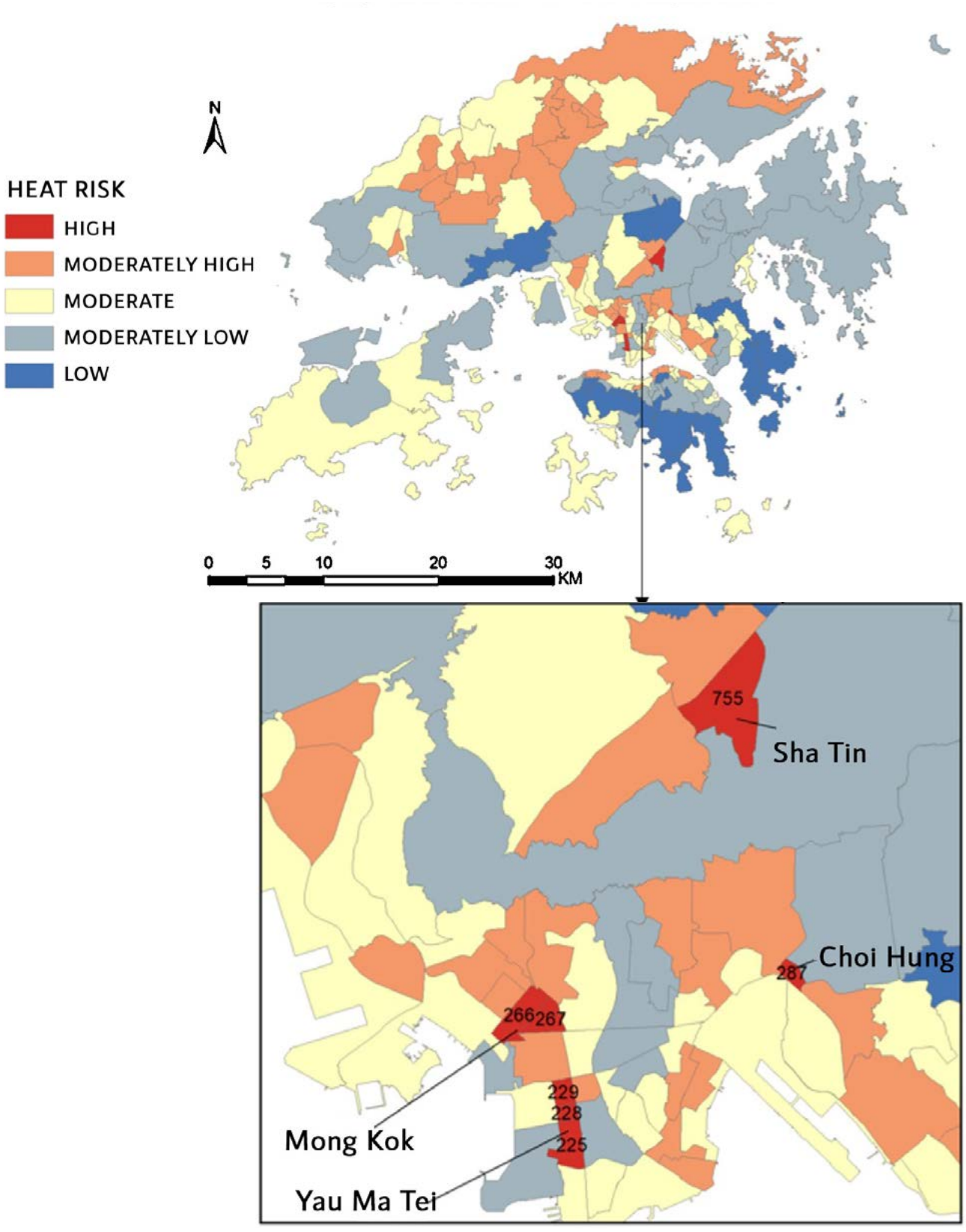
**By the time senior citizens report discomfort, it may already be too late to prevent potential health issues!**

Senior citizens are less sensitive to heat and typically report feeling hot only at very high tempeartures, above 35°C. However, adverse health impacts on senior citizens, including hosiptal admissiona and increased mortality risks, can occur when the daily average temperature reaches 30°C.

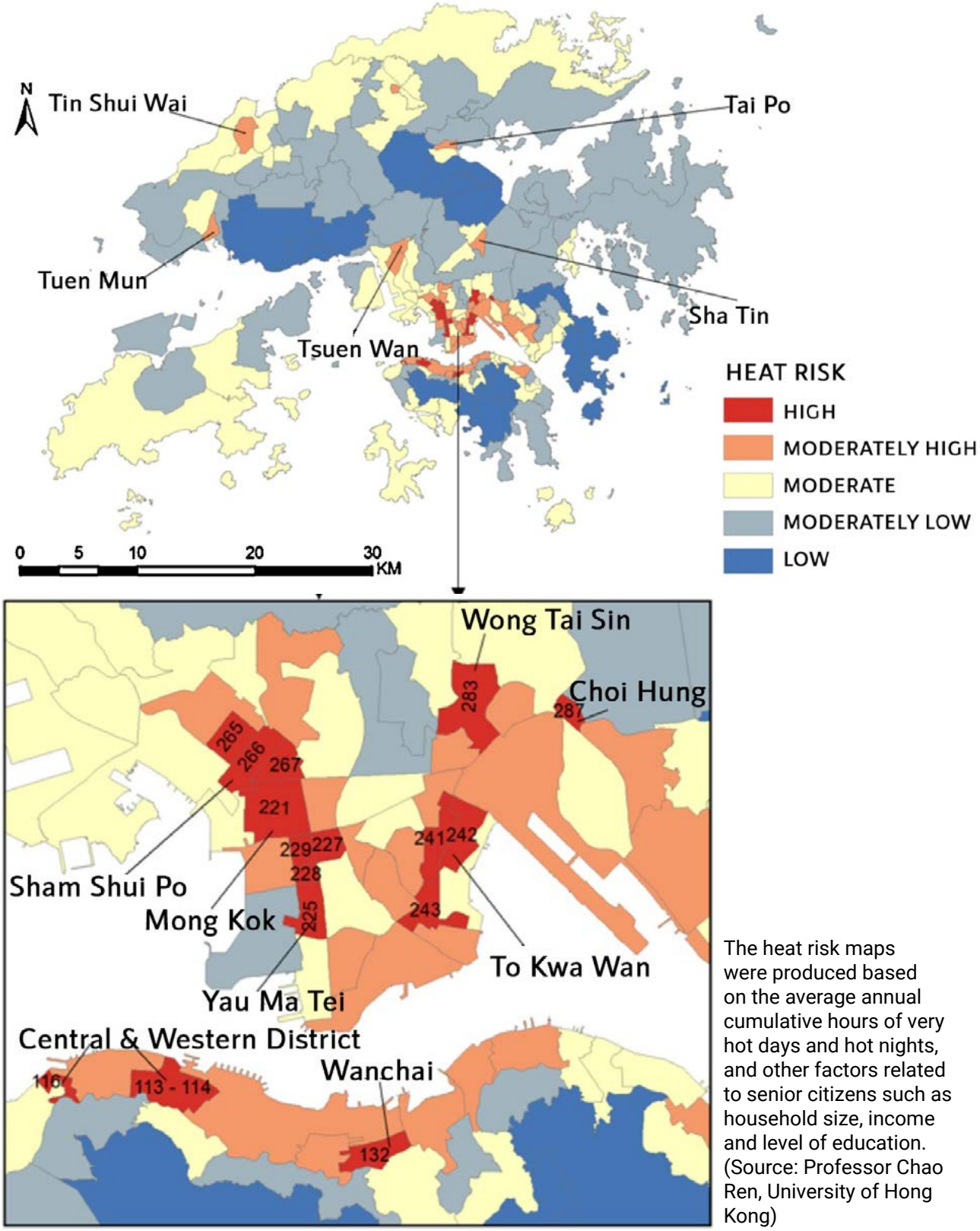
# Some Neighbourhoods Has Higher Heat Risks

Sham Shui Po, Yau Ma Tei, Mong Kok and Choi Hung: high risk at both daytime and nighttime.

# 2016 Daytime Heat Risk Map



# 2016 Nighttime Heat Risk Map




The heat risk maps were produced based on the average annual cumulative hours of very hot days and hot nights, and other factors related to senior citizens such as household size, income and level of education. (Source: Professor Chao Ren, University of Hong Kong)

# Low-income Senior Citizens Suffer More

## About 45% of seniors living in poverty before policy intervention

Among them, around 68% are seniors aged 70 or above, who are more likely to be retired, single or only living with other retired seniors.

The HKSAR government’s Old Age Allowance for senior citizens aged 70 or above:

$1,570 per month

While cooling energy costs are a common concern for senior citizens, it is important to note that the design of a building has a significant impact on energy consumption for air-conditioning compared to a typical flat.

A well-designed flats where various indoor strategies have been incorporated::

Save up to 30-40% for energy cost

For worst cases with fully-glazed façade and small/few openings:

Rise up to 20-30% energy cost

## 長者中心職員 ELDERLY CENTRE STAFF

比較惡劣嘅環境其實都係好多獨居長者…

You will generally find that poor living environments are occupied by senior citizens who live alone...


## 老友記 SENIORS

“一定會影響到見朋友同屋企人啦！夏天冇咩必要就唔出街啦，係唔係先啊，咁熱！

The heat can definitely affect socialising with friends and family. When the weather is so hot, I don’t go out often during the summer unless I have to. ”

老友記 SENIORS

“風扇我都少開，揸住把扇自己響度搖...我頂得順㗎，我唔係好熱㗎咋，我真係好少開風扇...我都冇乜汗出，我真係唔感覺好熱。 暫時我都覺得(熱對健康，生活上)無乜影響。

I hardly ever use electric fans. I prefer to use normal fans and fan myself. I can handle the heat; I don’t get that hot. I really use fans very little. I don’t sweat that much. I really don’t feel very hot. For now, I don’t think the heat affects my health or daily life much. ”

老友記 SENIORS

“樓上樓下冷氣嗰啲熱氣衝入嚟，嗰啲熱氣呀，熱氣沸騰呀，一定要閂窗呀，無開冷氣都要閂窗，好熱㗎焗落嚟！

When the neighbours turn on their air-conditioning, the hot air blows into my unit. I have no choice but to close the windows even when I don’t turn on the air-conditioning. It gets so hot, it’s suffocating!”

長者中心職員

ELDERLY CENTRE STAFF

“老人家好相信天然，又或者中醫個隻天然。佢哋覺得涼冷氣其實唔係咁好，其實熱係一個自然現象，所以佢哋覺得係應該要忍受 。

Elderly people often have a strong belief in natural remedies, such as traditional Chinese medicine. They may think that using air-conditioning is not that good for health, and that heat is a natural phenomenon, so they feel that they have to endure the heat. ”

## 長者中心職員 ELDERLY CENTRE STAFF

“好多時佢哋會坐咗係公園，長者佢哋鍾意一齊吹水一齊傾下計，咁佢哋係公園嘅時候，叫佢哋嚟中心涼下冷氣。佢哋都唔係好感興趣，佢哋話公園都Okay啦，反而有風，仲舒服過冷氣。

Older adults usually like to sit at the parks and socialize. I've once invited them to come to the community centre because it was hot outside. But they seemed not interested in getting rest under air-conditioning. They rather chose the park.”

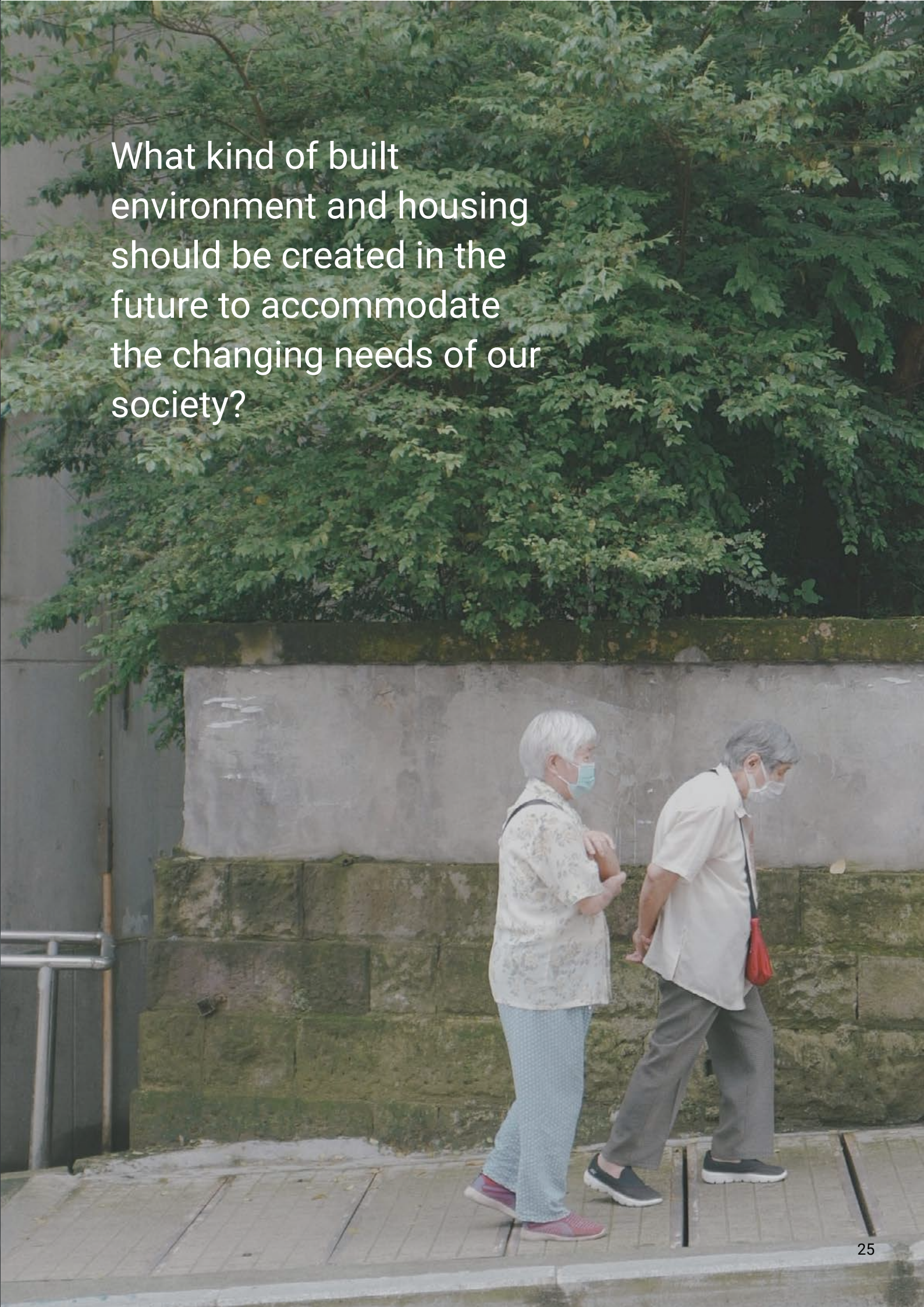
長者中心職員

ELDERLY CENTRE STAFF

“如果要改善就要爭取多啲商場入面嘅凳或者直頭係嗰個公共空間，多啲嘅公共空間可以俾市民，唔好話淨係長者，可以比佢哋使用，坐啊，咩都好……

If we want to make things better, we should aim for more seating areas in shopping malls and public spaces. We need to create more public spaces that everyone can use, not just seniors, to sit and relax however they like. ”


Almost 1/3
of the population
will be aged 65
or above in Hong
Kong by
2036.
And this ratio will
remain high for
another 30 years.


What kind of built environment and housing should be created in the future to accommodate the changing needs of our society?

# CURRENT SITUATION

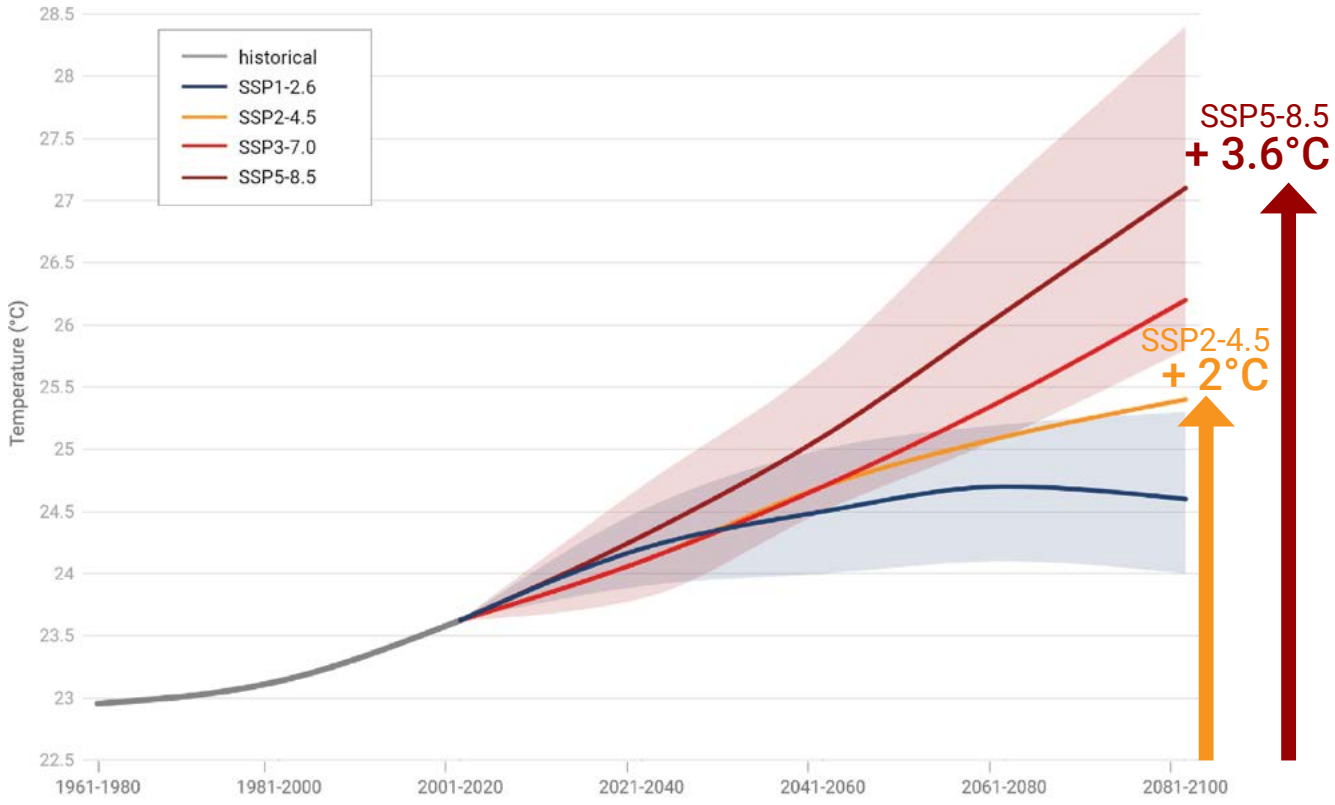
# Getting Hotter

## Annual Projections

The annual average temperature in Hong Kong from 2081 to 2100 is projected to increase by about 2.0°C under the intermediate (SSP2-4.5) greenhouse gases emissions scenarios and about 3.6°C under the very high (SSP5-8.5) greenhouse gases emissions scenarios.

## Summer Period

The projected mean temperature between May and September, will reach about 29.7°C in the 2040s and 30.3°C in the 2090s under SSP2-4.5. Under very high greenhouse gases emissions scenarios (SSP5-8.5), it will increase to 29.9°C in the 2040s and 31.6°C in the 2090s .




Projection trend of annual average temperature in Hong Kong. (Data source: HKO)

## The Maximum Temperature

Referring to HKO's supplied data, the absolute maximum temperature by the end of this century is predicted to be 41°C under the very high greenhouse gases emissions scenario (RCP8.5).

This is about 5°C higher. This data understanding should be used for all relevant studies regarding the impact of extreme heat on buildings and infrastructure in Hong Kong.

| **Actual observations (1986-2005)** | **36.1** | | | | | |
|---|---|---|---|---|---|---|
| | **RCP4.5** | | | **RCP8.5** | | |
| **Decade** | 5th Prc. | Mean | 95th Prc. | 5th Prc. | Mean | 95th Prc. |
| **2051-2060** | 36.6 | 38.4 | 41.4 | 36.9 | 38.9 | 42.1 |
| **2091-2100** | 36.7 | 38.8 | 42.0 | 38.9 | 41.0 | 45.1 |
| **No. of ensemble members** | 192 | | | 192 | | |
| | **RCP2.6** | | | **RCP6.0** | | |
| **Decade** | 5th Prc. | Mean | 95th Prc. | 5th Prc. | Mean | 95th Prc. |
| **2051-2060** | 36.0 | 37.8 | 40.3 | 35.7 | 37.7 | 40.5 |
| **2091-2100** | 35.7 | 37.3 | 39.5 | 36.4 | 39.0 | 43.1 |
| **No. of ensemble members** | 104 | | | 88 | | |

Absolute maximum temperature in the decade (°C) for baseline period (1986-2005), mid-21st century (2051-2060) and late-21st century (2091-2100) based on the projection of Hong Kong Observatory. (Data source: HKO)

## Hot Nights and Very Hot Days

Referring to HKO's supplied data, both hot nights and very hot days will rapidly increase in the future, however, the increasing trend of hot nights is more severe than that of very hot days. Prolonged hot nights pose greater threat to public health compared to very hot days (Wang et al., 2019).

| **Hot Nights - Actual observations (1986-2005)** | | | | | 18.4 | | | |
|---|---|---|---|---|---|---|---|---|
| | **RCP2.6** | | **RCP4.5** | | **RCP6.0** | | **RCP8.5** | |
| **Decade** | Mean | Likely Range | Mean | Likely Range | Mean | Likely Range | Mean | Likely Range |
| **2051-2060** | 55 | 36-82 | 65 | 43-88 | 49 | 34-73 | 81 | 51-109 |
| **2091-2100** | 50 | 36-65 | 78 | 49-106 | 96 | 67-127 | 149 | 112-183 |

| **Very Hot Days - Actual observations (1986-2005)** | | | | | 9.3 | | | |
|---|---|---|---|---|---|---|---|---|
| | **RCP2.6** | | **RCP4.5** | | **RCP6.0** | | **RCP8.5** | |
| **Decade** | Mean | Likely Range | Mean | Likely Range | Mean | Likely Range | Mean | Likely Range |
| **2051-2060** | 34 | 20-53 | 42 | 27-62 | 28 | 16-47 | 52 | 28-81 |
| **2091-2100** | 24 | 15-40 | 45 | 23-70 | 57 | 32-101 | 112 | 66-159 |

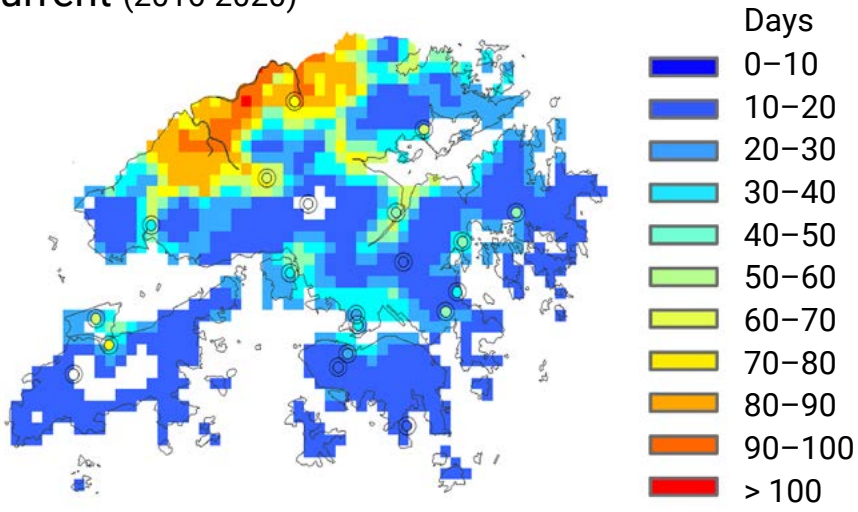
Projected numbers of very hot days and hot nights for baseline period (1986-2005), mid-21st century (2051-2060) and late-21st century (2091-2100) based on the projection of Hong Kong Observatory. (Data source: HKO)

# Higher Frequency of Extreme Heat

## Mean hot days frequency in each summer

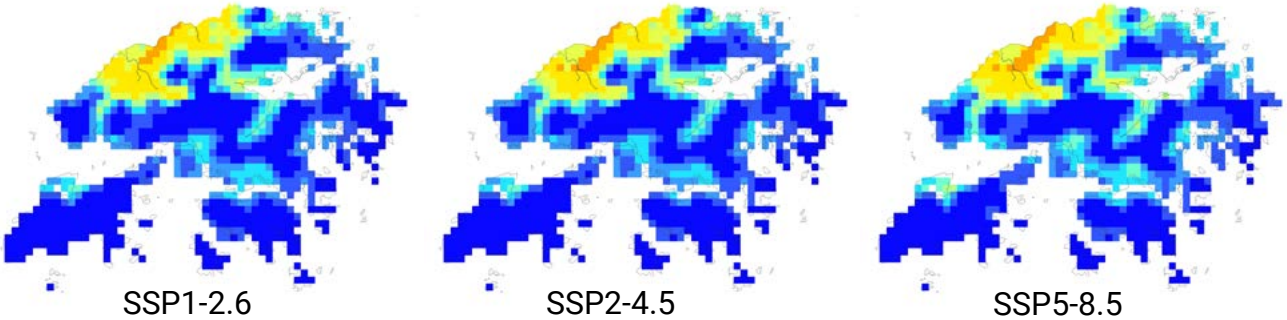
If carbon dioxide emissions remaining around current level, new towns in the northwest such as Tin Shui Wai and Tuen Mun will suffer more hot days than other areas. In the worst case scenario, all urban areas will suffer from extreme heat in the 2090s.

### Current (2016-2020)

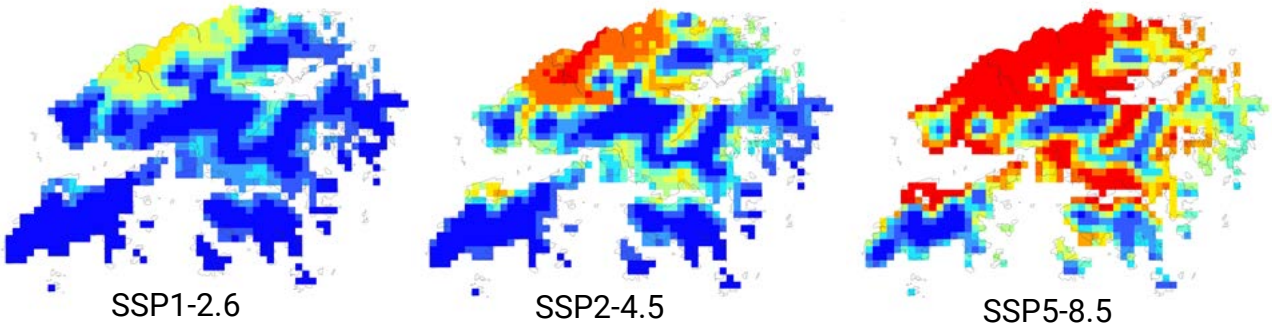



Number of days with daily maximum temperature over ≥33°C. (Source: Professor Jimmy Fung, The Hong Kong University of Science and Technology)

### 2040s




### 2090s



# Understandings of Older Adults

## Daily routines and habits

In general, older adults participating in our study were rather inactive and often stayed at home.

When they stayed at home, their main activities were resting, eating and housework.

There were more reports of feeling uncomfortable at night or when the humidity was higher, even though the same temperature was measured during the day.

The above daily schedules have been considered in the simulations of building performance (See Appendix 3).

## Coping with extreme heat

Most of the older adults were not aware of community heat shelters. Also, the shelters were not attractive enough for them to stay or rest at, as there were no facilities, compared with the elderly community centres and parks nearby.

From a mental well-being perspective, engaging in meaningful activities can buffer against the negative effects of extreme hot weather. This buffering effect is more significant among older adults with lower socio-economic status.

### MAIN ACTIVITIES AT HOME

1 RESTING

2 EATING

3 HOUSEWORK

### TOP 3 INDOOR MEASURES

1 USE A FAN

2 DRINK MORE WATER

3 USE AIR-CON

### TOP 3 OUTDOOR MEASURES

1 DRINK MORE WATER

2 WEAR LOOSE/ LIGHT CLOTHING

3 AVOID DIRECT SUNLIGHT

# Current Situation

## Indoor living environment

If buildings were designed properly, there would be no temperature differences between indoor and outdoor conditions.

Currently, the indoor temperature inside living units is generally 1.5°C higher than outdoor temperature due to human activities and anthropogenic heat generation, depending on the flat size. For units having more poor features including smaller flat size, fully-glazed façades with small openings and west orientation, the indoor temperature can be up to 4°C higher.

With the main building facade facing west, one could expect a 10% decrease in comfort time and a 10% increase in the energy use for air-conditioning.

Fully-glazed façades with minimum openable windows can increase the cooling energy by about 20–30%, depending on flat size and the cooling appliances in use.

Providing few/small openable windows with fully-glazed façades will increase solar radiation and reduce air ventilation inside the living units.

# Current Situation

## Outdoor environment

May and September can be regarded as the shoulder periods of the summer season, with mostly lower temperatures of 28°C or below in these two months.  During the peak period from early-June to mid-August, from daytime until late evening is obviously more uncomfortable.

The following factors are crucial in creating a comfortable outdoor space, taking into account the needs of senior citizens:

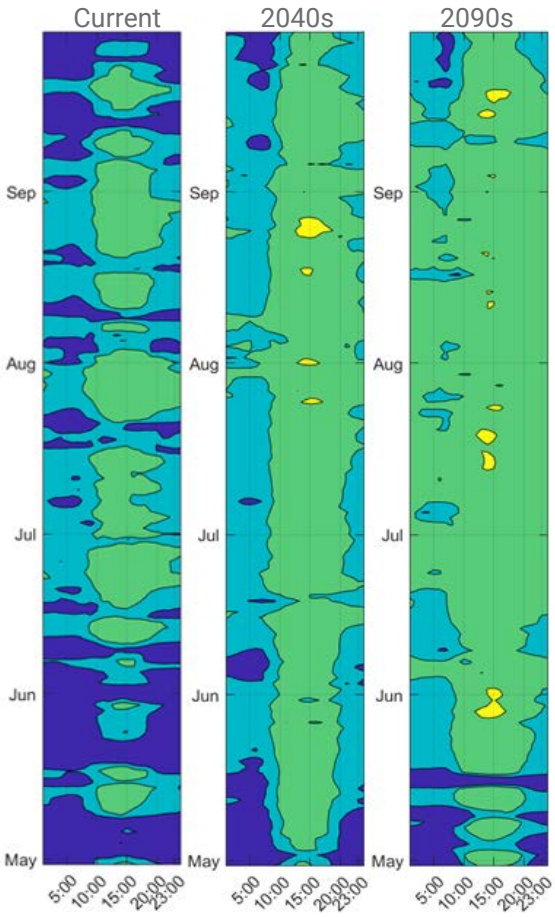
1. Proximity: The walking distance from the entrance of a park or outdoor area.
2. Shaded connectivity: The provisions of artificial and/or tree shades along the route.
3. Availabiity of seating along the route.
4. Engaging activities or plesant views that are appealing to seniors.

In larger parks with various recreational purposes, it is essential to include elderly-friendly spaces in different areas.

Outdoor environment without any tree shades or sun-shading devices increase thermal discomfort and heat risks.

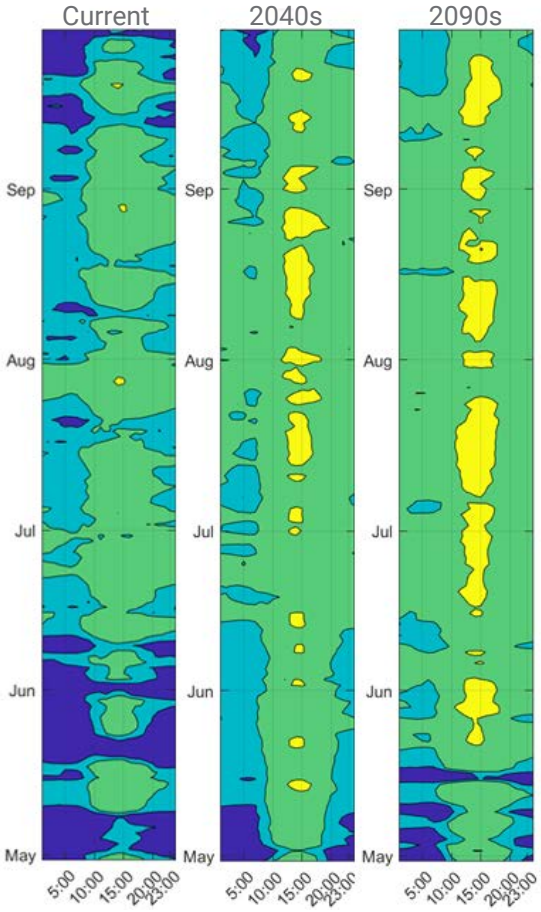
# What If there is No Improvement?

## WELL-DESIGNED CASES
(1.5°C higher than outdoor)



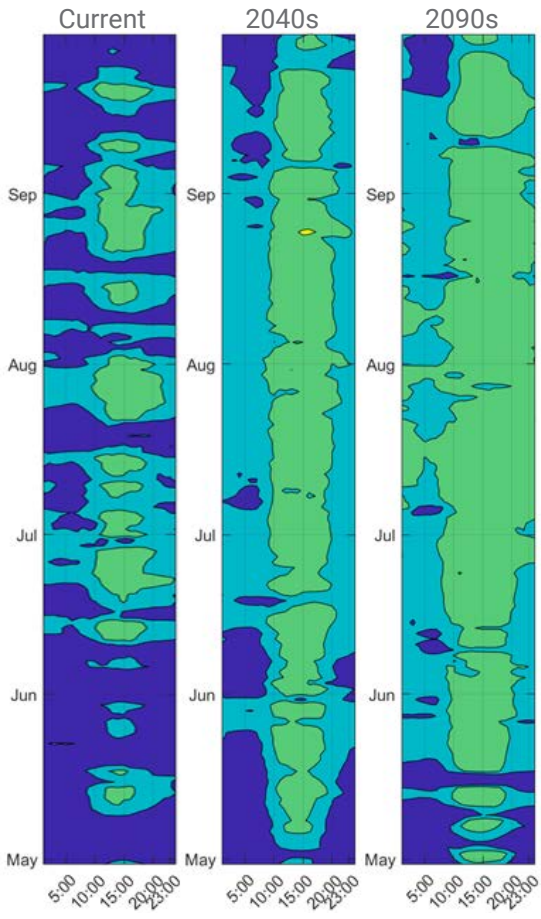

| Period | GOOD | DISCOMFORT | | |
|---|---|---|---|---|
| | ≤28°C | 28–30°C | 30–35°C | ≥35°C |
| Current | 35% | 39% | 26% | 0% |
| 2040s | 9% | 39% | 51% | 1% |
| 2090s | 7% | 21% | 70% | 2% |

## NOT WELL-DESIGNED CASES
(3°C higher than outdoor)



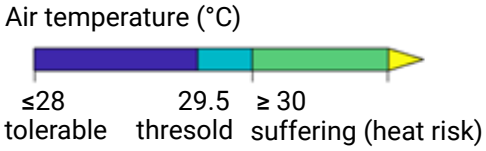

| Period | GOOD | DISCOMFORT | | |
|---|---|---|---|---|
| | ≤28°C | 28–30°C | 30–35°C | ≥35°C |
| Current | 23% | 34% | 42% | 1% |
| 2040s | 4% | 22% | 67% | 7% |
| 2090s | 4% | 12% | 72% | 12% |

## OUTDOOR ENVIRONMENT
(Downtown urban area)




| Period | GOOD | DISCOMFORT | | |
|---|---|---|---|---|
| | ≤28°C | 28–30°C | 30–35°C | ≥35°C |
| Current | 53% | 34% | 13% | 0% |
| 2040s | 19% | 48% | 33% | 0% |
| 2090s | 12% | 36% | 52% | 0% |

Indoor and outdoor air temperature under current situation and future projection scenarios. (Source: CUHK)




## Indoor living environment

Under SSP2-4.5, uncomfortable hours (i.e. air temperature >28°C) will rapidly rise from 65% to about 91% in the 2040s even for well-design cases. For cases that are not well-designed, the discomfort time will even reach 96% in the 2040s. .

## Outdoor weather conditions

With the weather predicted to become increasingly warmer in the coming decades, the comfort time appears to drop sharply in these two decades by 2040.

Under SSP2-4.5, uncomfortable hours may increase from 47% to about 81% in the 2040s and 88% in the 2090s. The projection for nighttime will be even worse, significantly deteriorating from 70% to about 34% in the 2040s and 20% in the 2090s.

# Then, How to Improve?

What can be done?

By Whom?

Where?

To what extent?

What are the benefits?

Any other factors that should be considered?

The following two chapters on indoor and outdoor design strategies will address to the above issues to shed light on the potential improvements that can be achieved through better design and planning.

# INDOOR STRATEGIES

| INDOOR STRATEGIES | SCORING | |
|---|---|---|
| **VENTILATION** | | |
| Cross-ventilation | + ❄❄❄❄ | |
| Increase openable and operable window area | + ❄❄❄❄ | |
| Optimal flat size with at least one bedroom | + ❄❄❄ | |
| More than one window in bedroom and living room | + ❄❄ | |
| Maximise vertical opening distance | + ❄ | |
| Fully glazed facade with small/few openings | | − ❄❄❄ |
| **SHADING & ORIENTATION** | | |
| Shading using balcony | + ❄❄ | |
| Shading using window shading elements | + ❄ | |
| Orientation: Living areas not facing west | + ❄ | |
| Orientation: Living areas facing west | | − ❄ |
| **WINDOW GLAZING** | | |
| Low-E glass / Tinted glass | + ❄ | |
| **OTHERS** | | |
| High floor level and/or unobstructed frontage | + ❄ | |
| Reduce anthropogenic heat | + ❄ | |

| OVERALL SCORE | |
|---|---|
| Outstanding | ❄ × 21 |
| Exceeding Expectations | ❄ × 14 |
| Meeting Expectations | ❄ × 10 |
| Not Meeting Expectations | ❄ × 6 |
| Far Below Expectations | ❄ × 4 |

Since senior citizens often stay indoors, the environmental performance of residential buildings directly influences their living and health conditions. Adopting indoor strategies could help alleviate the impact of extreme heat and associated health problems.

01

“因為我住 Y型大廈嘅尾房，
尾房啲對流風係扯到盡㗎嘛，
所以我間屋呢唔係好熱嘅。
陳婆婆

Grandma Chan
Since I live in the corner flat inside a Y-shaped building, the breeze can reach my flat through convection currents, so it is not very hot. ”

# Cross-ventilation

Air is drawn into a building through a window opening on the high pressure windward side and drawn out of a window opening on the low pressure leeward side.

Cross-ventilation is most desirable, especially for the living/dining room. Incorporating openings in common areas such as corridors and lift lobbies could also help to create cross-ventilation.

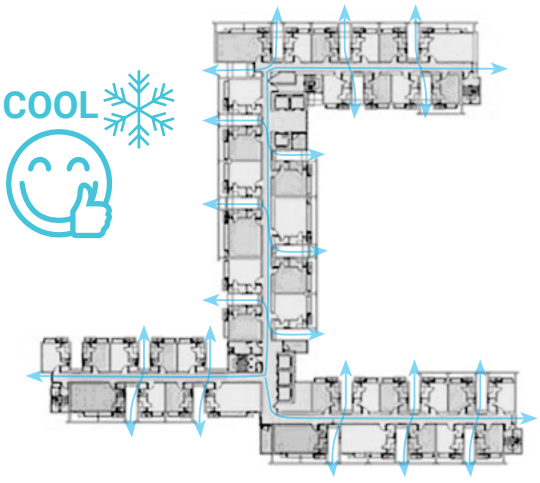
## Caveats

Corridors with cross-ventilation may require enhanced smoke control systems.

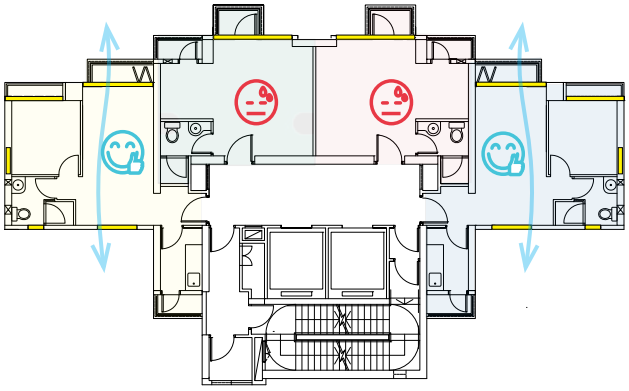
## Practical Considerations

Difficult to achieve due to small flat sizes and restrictions on layout.

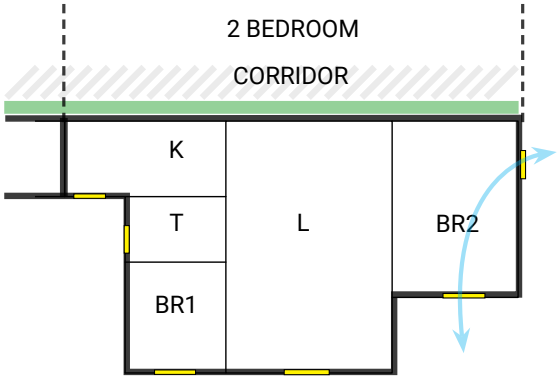
## Cross-ventilation through corridors

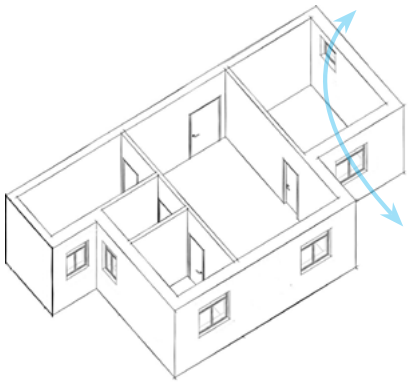



## Cross-ventilation of 4 units per floor benefits half of the units



## Cross-ventilation through windows



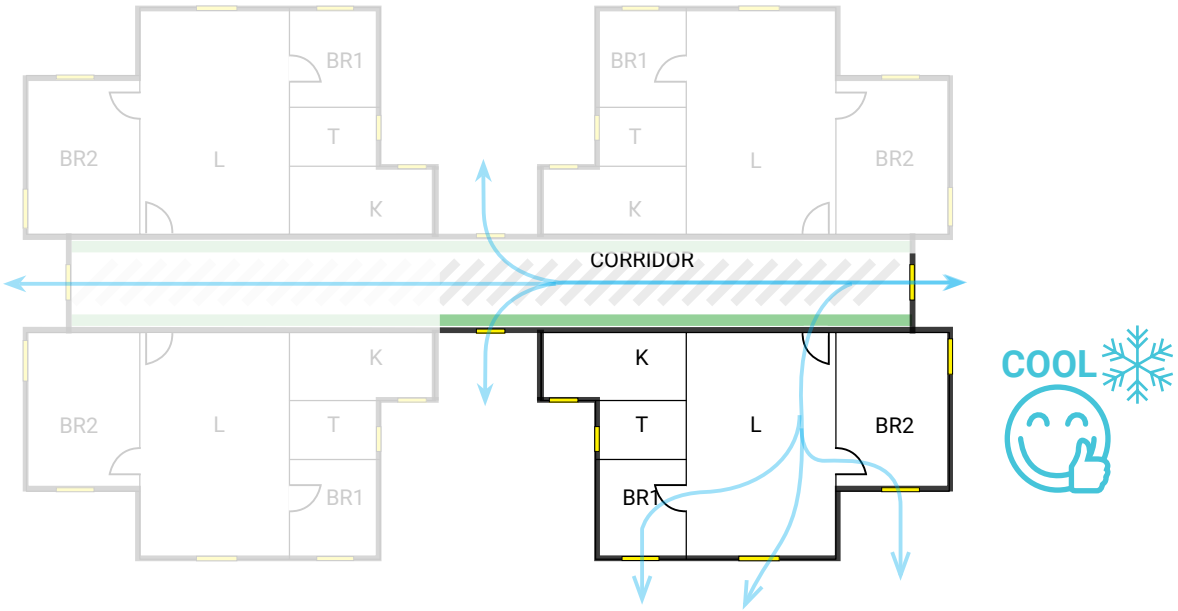



Plan of simulated flat

Windows

Non-heat transfer walls

## Cross-ventilation through corridor and doors



02

“最好開窗門，窗門方便就開多啲窗門，係唔開冷氣，一開窗啲風就係咁扯。
黃氏老夫婦

Grandparents Wong
The best way to do it is to open the windows, not turn on the air conditioner... when the windows are opened, the breeze can come into the apartment by the convection currents. ”

# Increase Openable and Operable Window Area

While current regulation prescribes an openable window-to-floor area ratio of 1/16, the design and installation of more or larger openable windows can maximise natural ventilation indoors.

+ ❄ ❄ ❄ ❄

NOT RECOMMENDED
Fully-glazed façade with minimum openable window area

– ❄ ❄ ❄

## Caveats

Appropriate shading of windows should be considered to minimise solar heat gain (see INDOOR STRATEGY 06 - SHADING USING WINDOW SHADES).

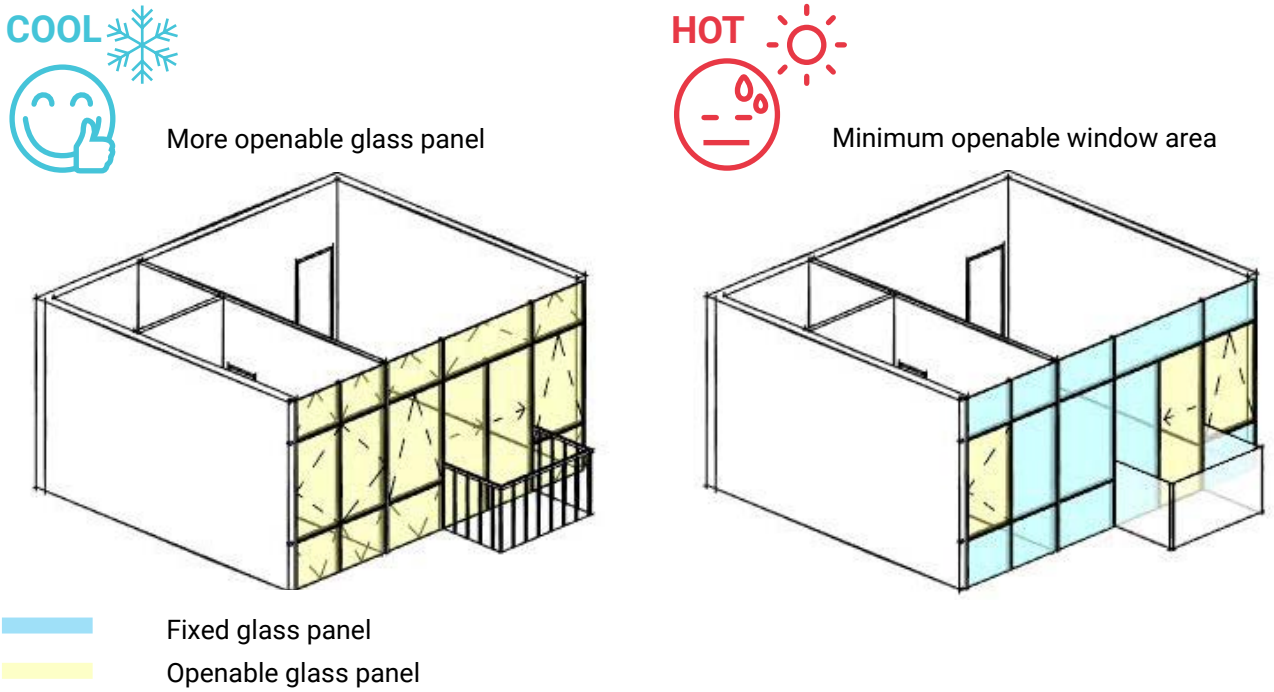
To enable older adults to open the windows independently, window operators could be installed.

## Practical Considerations

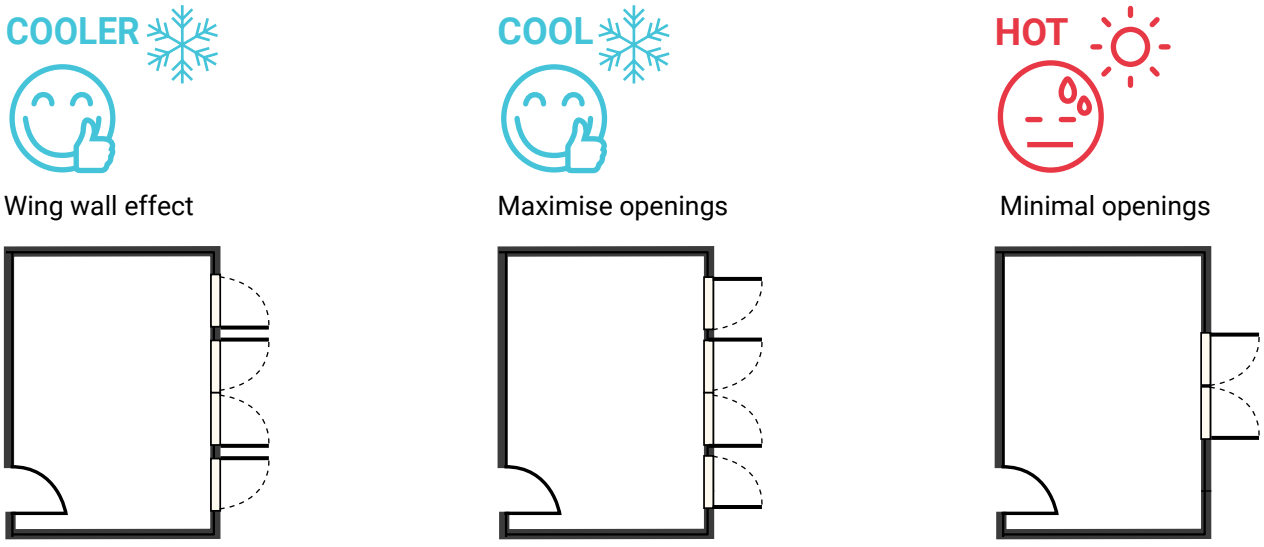
If the size of the operable window is increased, the window joint size needs to be increased accordingly to support the additional weight.

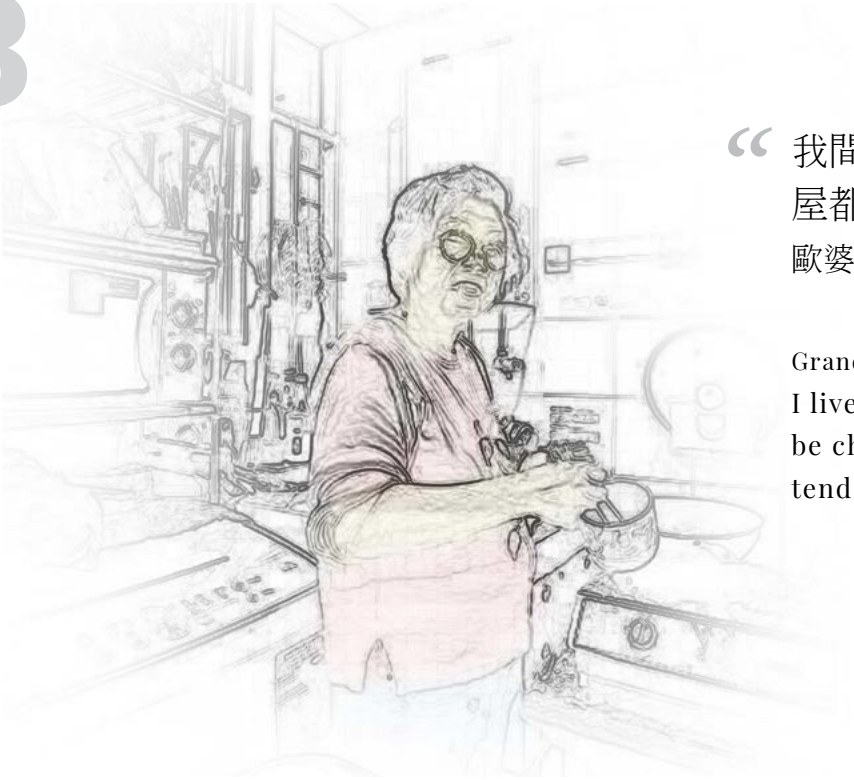
Cost-benefit analysis should be conducted for the cost implication of increasing openable windows to replace fixed windows.

The larger the openable window area,
the greater the natural ventilation potential.




For two openings placed on the same wall,
position the openings on the edges for
better pressure difference.





“我間屋係開放式...仲辛苦，成屋都會變得好熱。
歐婆婆

Grandma Au
I live in a tiny studio flat which can be challenging as the entire space tends to get very hot. ”

# Optimal Flat Size

An optimal flat size with at least 25m$^2$ is desirable to provide the following benefits:

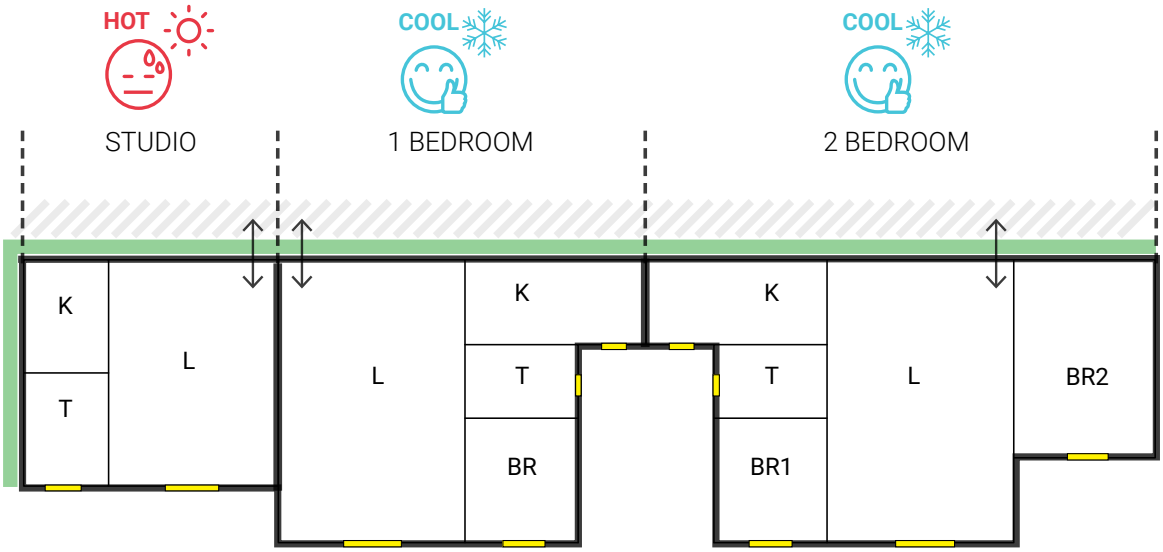
- Reduce the anthorpogenic heat per square metre.
- Possible to provide more window openings.
- At least two rooms can be provided in the unit.
- It is more flexible for the occupant to choose different areas based on their activities, or move to another cooler area considering the orientation of the sun. For example, they can enjoy natural ventilation in the living room in shoulder period; when it is too hot, they can turn on air-conditioning in a smaller room with a lower cost.

The Government has already imposed a new minimum flat size requirement of at least 26 m$^2$ in saleable area on all Government land sale sites.

## Practical Considerations

Flat size imitations imposed by practical, economic and policy constraints need to be reconsidered with respect to environmental performance and quality of living.

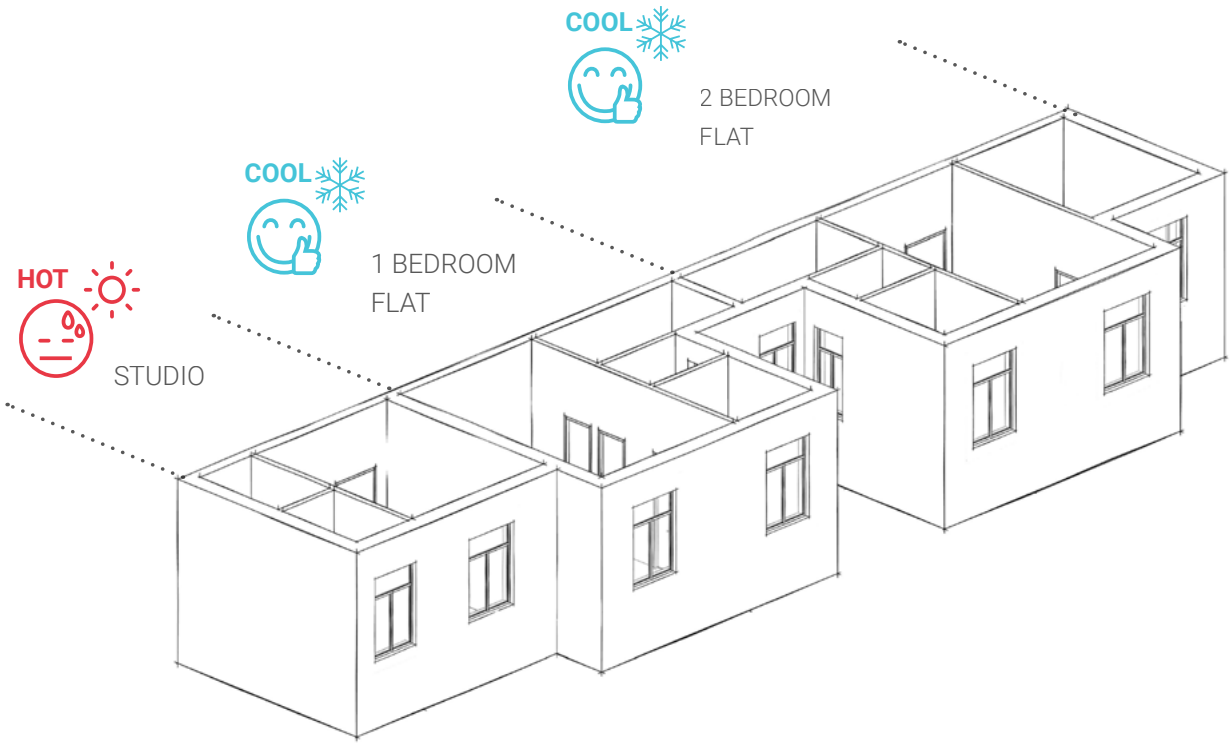
The larger the flat size,
the better the heat dissipation.




Plan of simulated flat

Windows

Non-heat transfer walls



04

“我間房有兩個窗㗎，所以都幾好風㗎，間房幾涼幾舒服。
盧氏夫婦

Grandparents Lo
I have two windows in the bedroom, so the breeze is quite strong. The room is rather cool and comfortable.”

# Provide More Than One Window In Bedroom and Living Room

The pressure difference between two openings can increase ventilation potential as indicated in the Practice Note APP-130 on “Lighting and Ventilation Requirements – Performance-based Approach”.

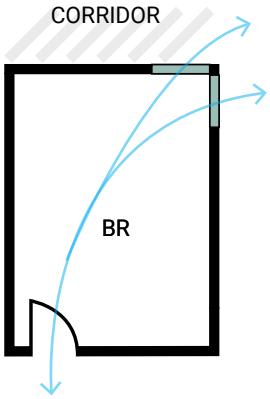
Concerning the increase in the number of hot nights, this measure allows the elderly to maximise the natural ventilation to cool down the bedroom before sleeping.

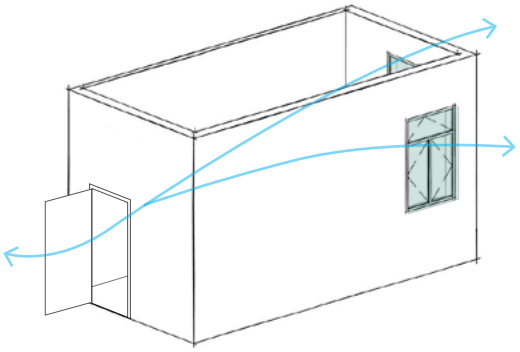
## Caveats

Having more than one window in a small room may affect the placement of furniture.

## Practical Considerations

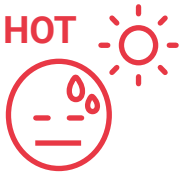
It would be difficult to install more than one openable window on different planes in small bedrooms or small flats.

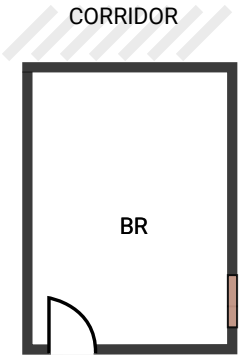



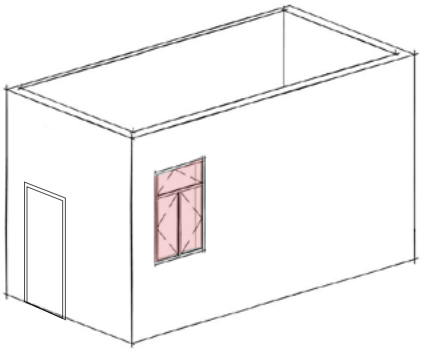



Plan of simulated bedroom

Windows



Plan of simulated bedroom

Window

05

“我屋企裝咗把吊扇。好似通風啲，我都覺得涼爽啲。
陳伯

Grandpa Chan
I have installed ceiling fan at home. The ventilation seems better and I feel cooler.”

# Maximise Vertical Opening Distance

Larger vertical distance between windows enhances air ventilation within a unit through the buoyancy effect. Buoyancy ventilation causes warm air to rise and creates an upward air stream. Enhanced ventilation lowers air temperatures and reduces the need for air-conditioning.

## Caveats

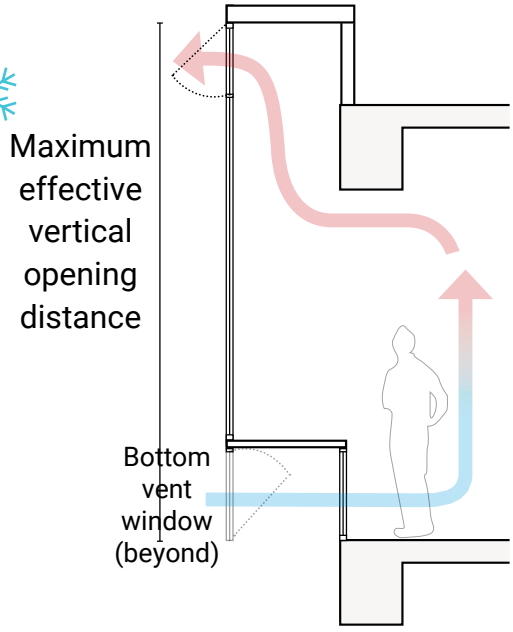
The floor-to-floor height should not exceed 3.5 metres. The edge beam can be offset to allow larger vertical window distance without increasing floor-to-floor height, and without compromising constructability.

## Practical Considerations

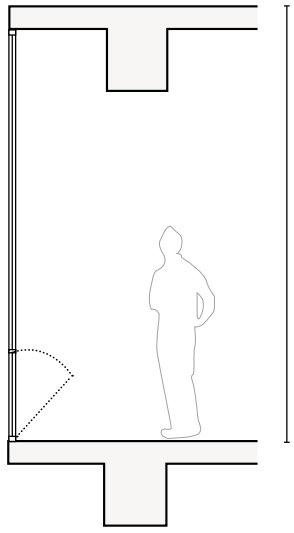
To make the buoyancy effect effective, openings should allow air from outside to be drawn into the unit and vent out at a higher level. The window openings at the lower level should be carefully designed. To enable older adults to open the windows independently, window operators could be installed.

There will be a higher construction cost if floor-to-floor height is increased. Building regulations also need to be considered.

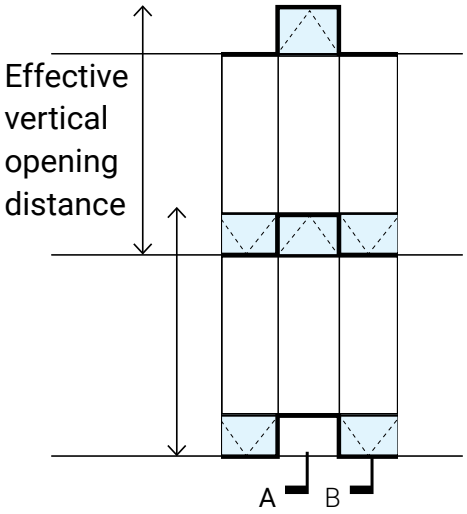
COOLER

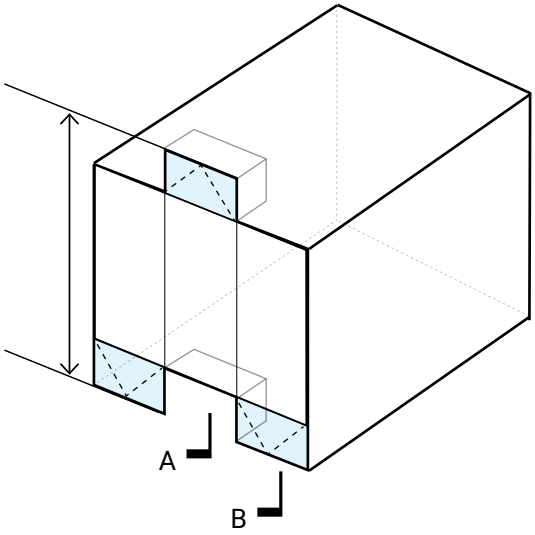



Section A

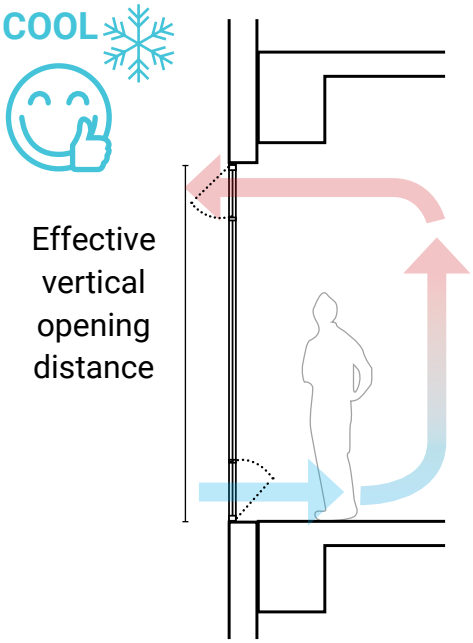



Section B

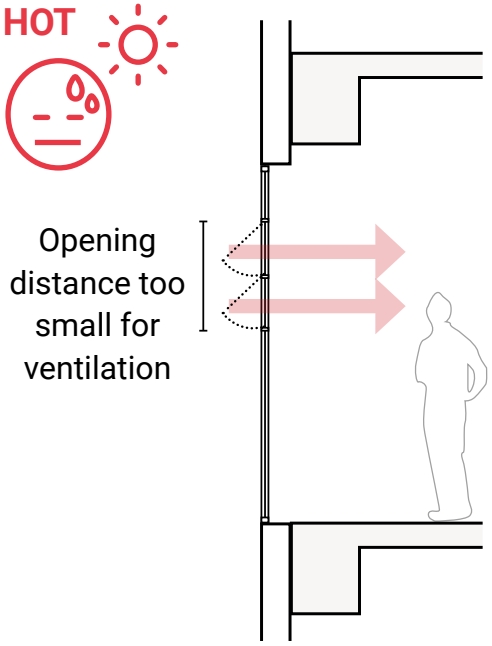



COOL




HOT



06

“我個露台唔係好大，但係都夠遮住下啲太陽，等佢唔好曬到個廳，我又可以喺嗰度晾衫。

郭婆婆

Grandma Kwok

My balcony is not very big, but it is good enough for keeping the sun out of the living room and I can dry my clothes there. ”

# Shading Using Balcony

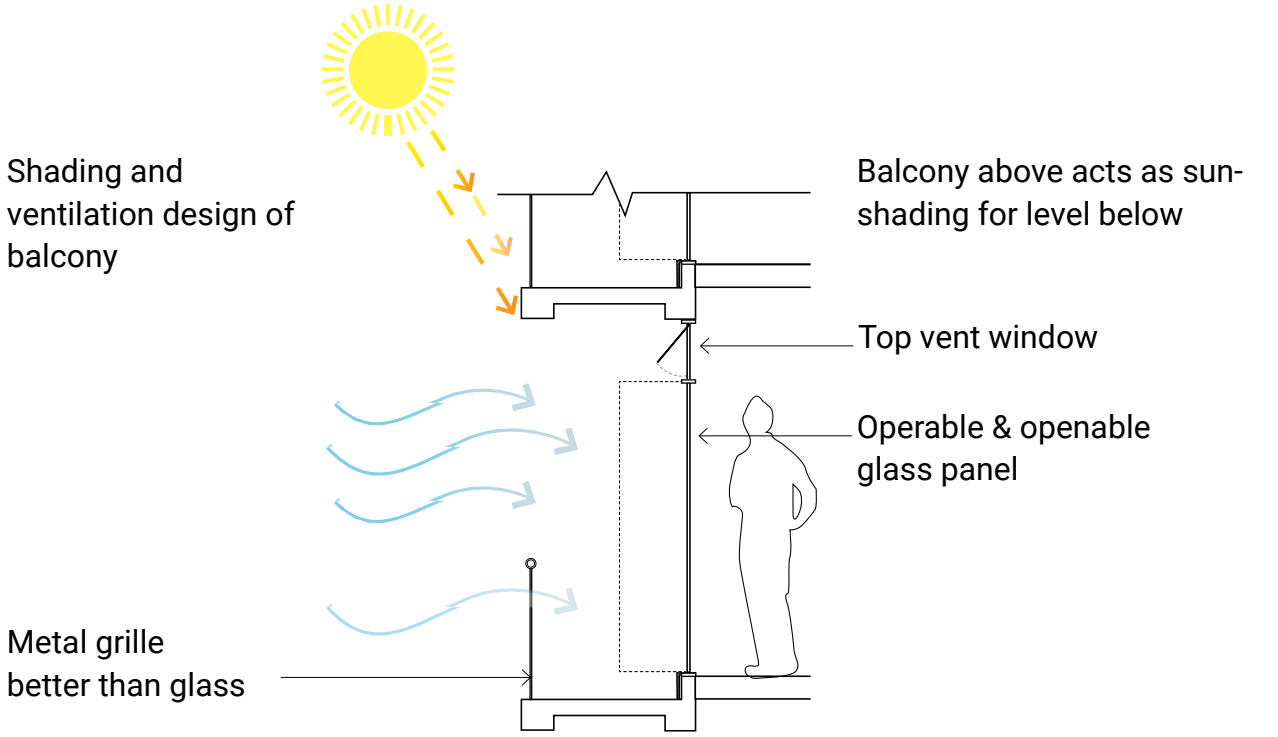
Balconies can provide shading to the simulated flat and the flats below. At the same time, natural ventilation could be enhanced through opening up the doors connecting indoor spaces, such as living and dining rooms, to this outdoor space. This strategy can reduce the use of air-conditioning during shoulder periods (May and September).

## Caveats

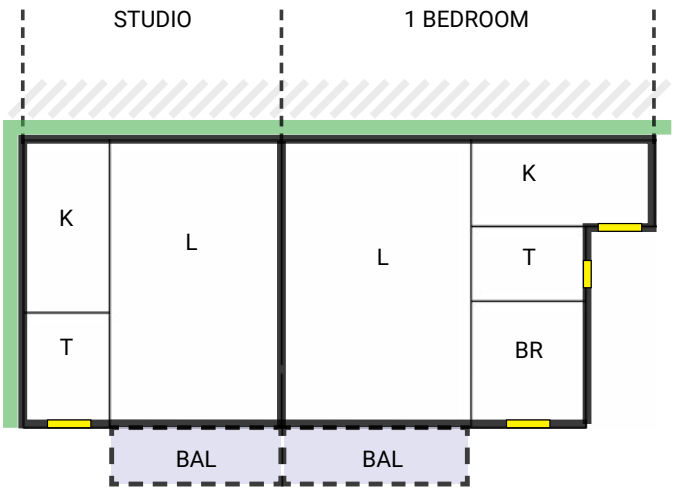
Occupants may have a smaller living area due to the provision of a balcony as the area of balconies is included under saleable area.

## Practical Considerations

The minimum area of balcony which allows it to be usable and effective may exceed the exemption of gross-floor area.  The design of balconies may have safety concerns.




Balcony zone




Plan of simulated flat

- Balcony
- Windows
- Non-heat transfer walls

The design of balcony structures should allow as much air flow as possible.

07

“我哋住向西...我窗口啲太陽曬到入嚟屋企。
蔡婆婆

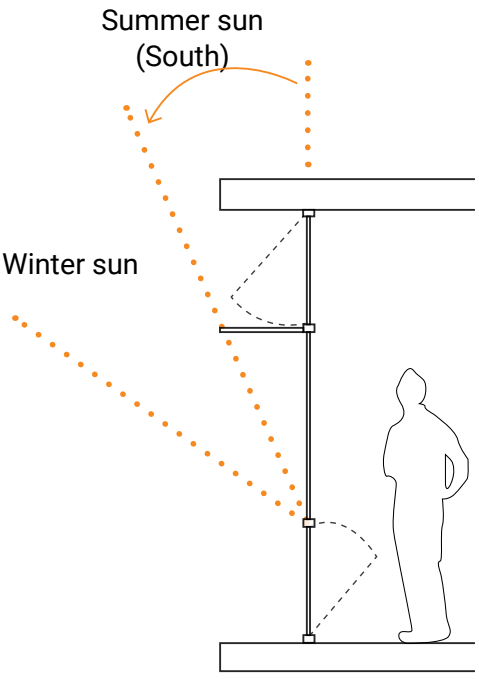
Grandma Choi
Our apartment is facing west....
The sun shines directly through the window. ”

# Shading Using Window Shades

Proper shading devices should be provided according to the orientation of windows to minimise unwanted solar heat gain and glare so that a more comfortable indoor environment can be achieved.

## Caveats

Window shading devices should be designed according to their orientation. As a general rule, it is recommended to install horizontal shades for south-facing windows and vertical shades for east- and west-facing windows.

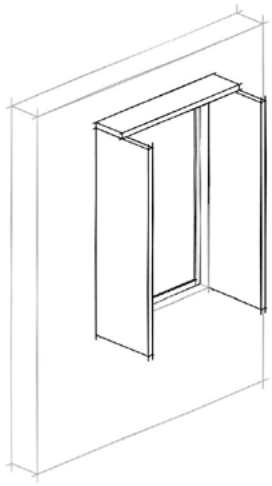



## Practical Considerations

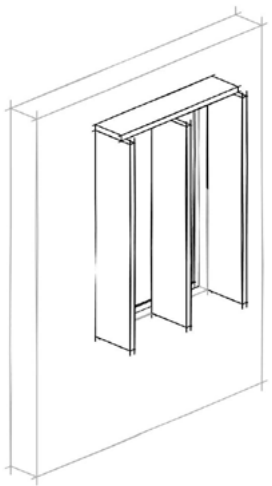
Overhang projection size should comply with building regulations.

Maintenance activities such as cleaning, repairing, or replacing shading devices can pose logistical, safety, and cost challenges that need to be addressed through appropriate planning and coordination among stakeholders.

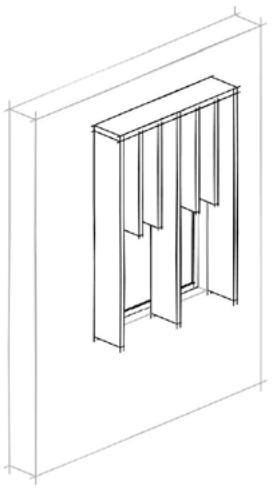
## East and West Orientation: Vertical Shades



Vertical elements to shade from low-angle sun

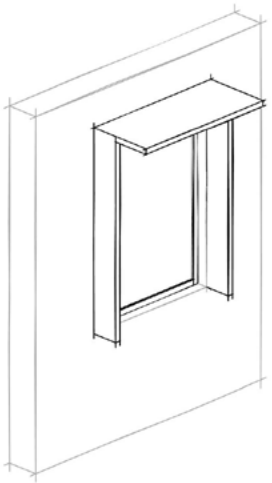


Spacing and depth need to be considered

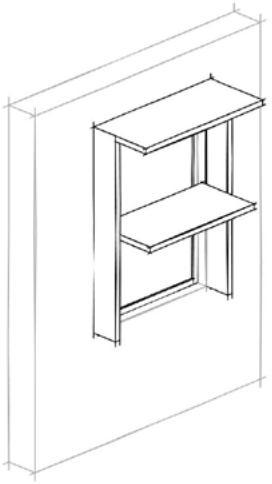


Adjustable vertical fins

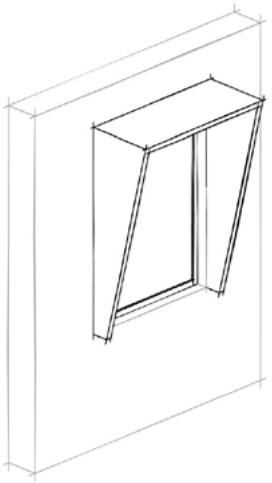
## South Orientation: Horizontal Shades



Horizontal overhang to shade from high-angle sun



Multiple horizontal overhangs to shade large windows

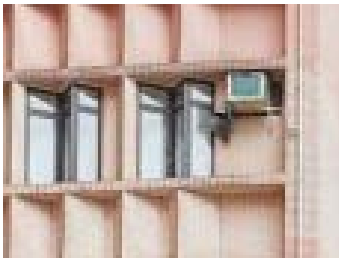


Horizontal & vertical shading for south-east/ south-west orientation

## Examples of Shadings in Hong Kong

Vertical fins

Vertical and horizontal shading



Recess to shield from eastern/weatern sun

08

“我哋個單位向西，十二點開始曬喇，曬到五點幾六點，係好辛苦㗎... 向西呢就曬到暈啊。
李伯伯

Grandpa Li
Our apartment faces to the west. The sun starts to shine into the apartment from 12noon until 5-6pm. It is quite unbearable... It is impossible to avoid the heat from the sun living in an apartment facing west. ”

# Orientation Of Building Block

Building orientation is fundamental to determining the amount of solar heat gain entering a building. West-facing façades are prone to excessive summer heat gain from the late afternoon sun. West-facing living area should be avoided.

The application of properly designed overhangs, external shading or other solar control systems to openings on west-facing façades and south-facing façades can keep the sun's heat from penetrating indoors and keep indoor spaces cooler.

+ ❄

NOT RECOMMENDED
West-facing living area

– ❄

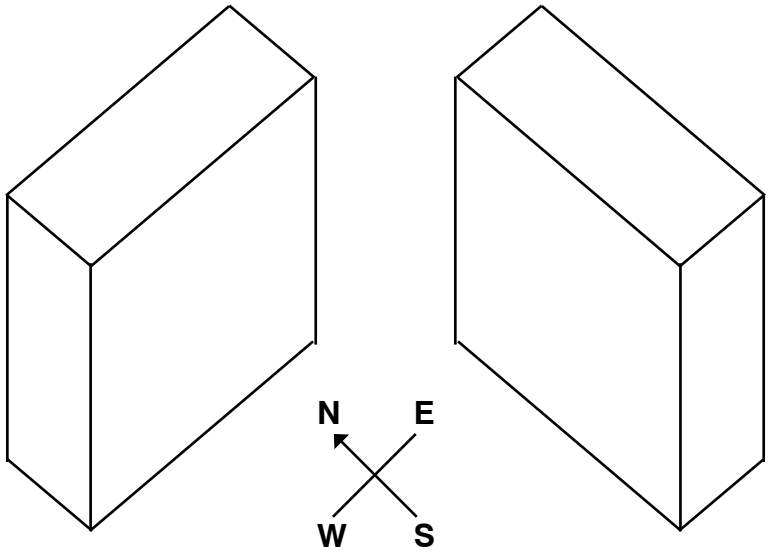
## Caveats

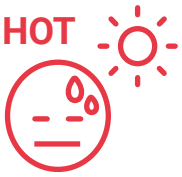
Due to restrictions on spatial arrangement, some flats and regularly inhabited spaces will inevitably face west.

## Practical Considerations

If west orientation cannot be avoided, toilets and kitchens should be placed west-facing instead of living rooms or bedrooms.


Northeast orientation

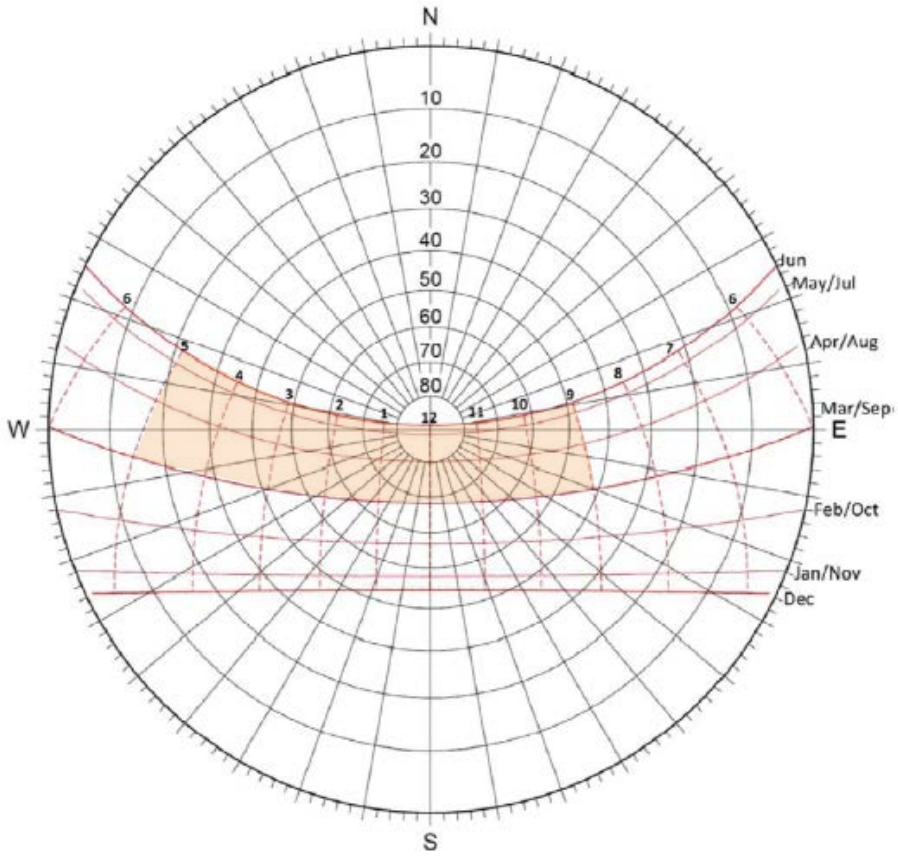



Southwest orientation

North-facing building façades are cooler than those facing south.

Shading or other solar control systems are required for west-facing walls and windows




Avoid façade receiving direct sunlight during these hours

09

“好熱㗎，得一個窗，成日要用檯布遮住。
張婆婆

Grandma Cheung
It’s so hot. I have a window but I have to cover it with a tablecloth most of the time. ”

# Window Glazing

Solar radiation penetrating windows is a main source of heat gain for spaces inside a unit. Applied with a thin and transparent coating, low-E (low-emissivity) glass can reflect solar heat whilst admitting visible light, providing a more comfortable temperature.

## Caveats

Tinted windows may reduce visibility to the outside.

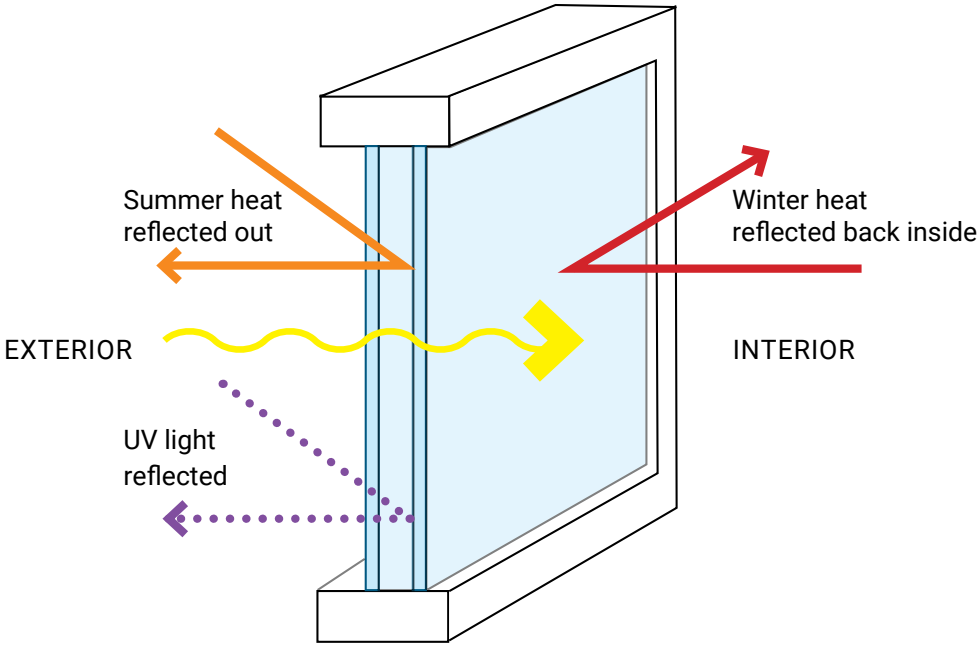
## Practical Considerations

Cost-benefit analysis may be conducted considering low-E glass windows are generally more expensive than uncoated glass units.

COOLER

## Low-emissivity glass windows

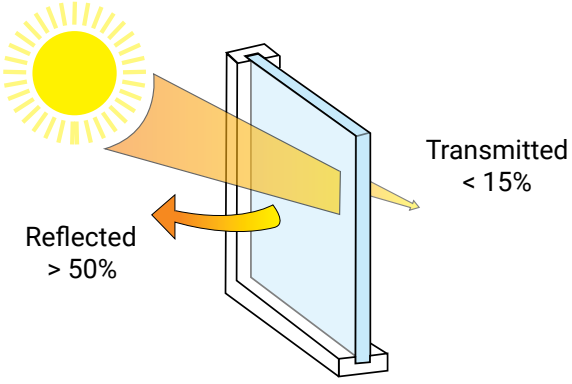
prevent heat from entering the unit in hot weather




COOL

## Tinted glass windows

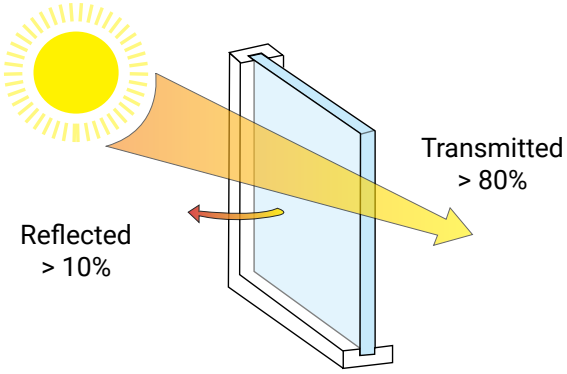
reflect more solar radiation




HOT

## Clear glass windows

transmit more solar radiation into the unit



10

“可能因為我個單位高啲啦，我一開晒啲窗就好扯風㗎喇。所以我坐喺廳度就好舒服。
鄭婆婆

Grandma Cheng
Maybe because my unit is on a higher floor, the wind blows inside once I open all windows. So I feel very comfortable when I sit in the living room.”

# Higher Floor Level and/or Unobstructed Frontage

Higher floor levels of multi-storey, high-rise residential buildings have better natural ventilation than lower floor levels. Air temperature decreases at higher elevations.

If a residential building is higher than the average building height in the surrounding area, it can benefit from the stronger winds at higher elevations.

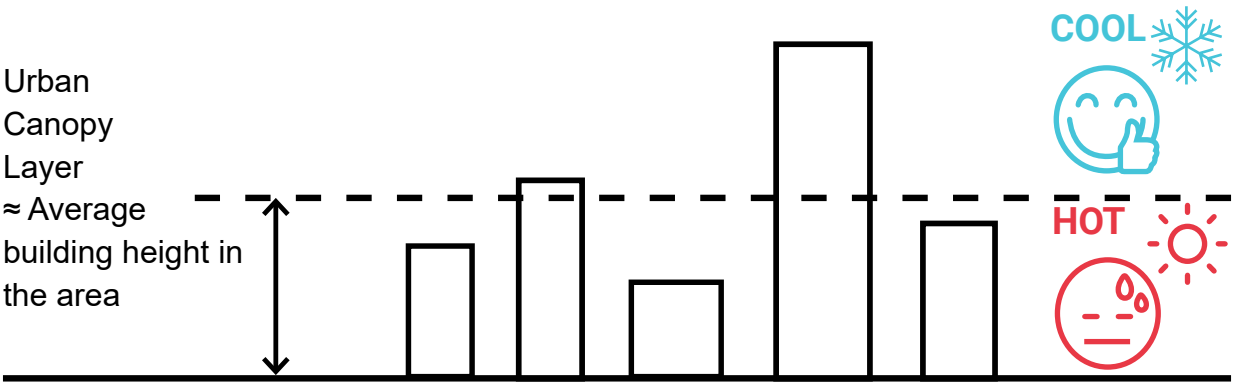
Alternatively, the building having an unobstructed frontage towards seafront or large green open spaces also provide a better natural ventilation.

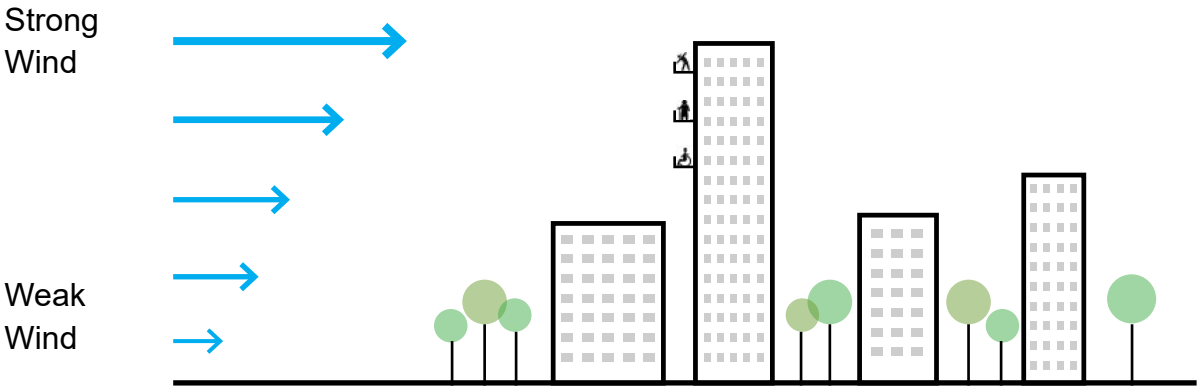
## Caveats

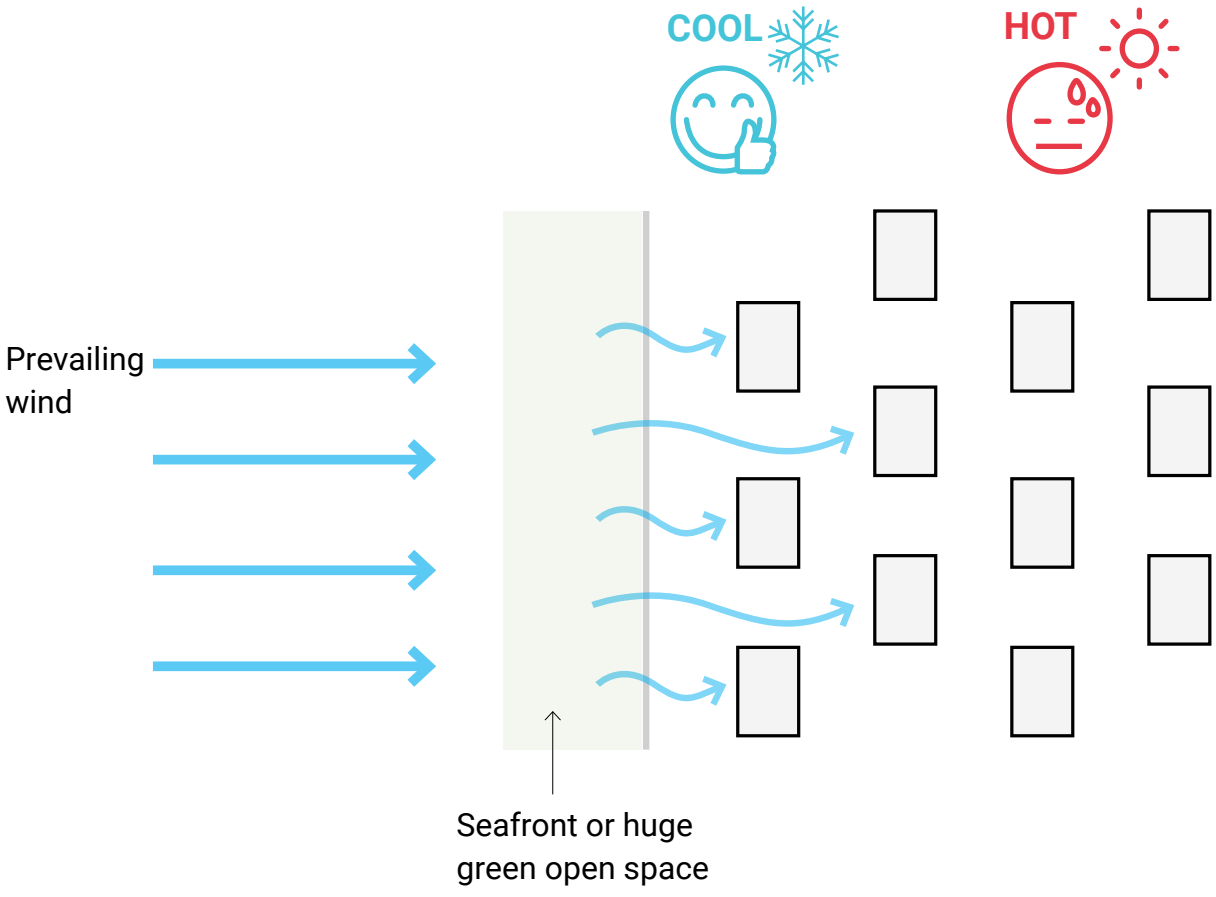
Although higher floors are preferred for better natural ventilation flow, the needs of older adults with limited mobility should be taken into consideration.

## Practical Considerations

If mixed-use building is permitted, consider locating retail and services on lower floors and residential units above podium level.


Urban
Canopy
Layer
≈ Average
building height in
the area
COOL
HOT


Strong
Wind
Weak
Wind


COOL
HOT
Prevailing
wind
Seafront or huge
green open space

11

“廚房就好似焗爐咁。喺廚房做嘢，要開把風扇吹住自己。
陳婆婆

Grandma Chan
The kitchen is just like an oven (during summer). While working in the kitchen, I have to turn on the fan to keep myself cool.”

# Reduce Anthropogenic Heat

Domestic eletrical appliances such as lighting, televisions, refrigerator, cooking stove, water heater, air-conditioners, washing machine, etc. generate heat while running.

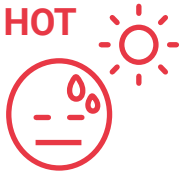
## Caveats

When selecting eletrical appliances it is strongly advised to consider the energy labels and purchase Grade 1 rating.

## Practical Considerations

Existing electrical appliances may not be easily replaced with more energy efficient and therefore less heat generating ones.

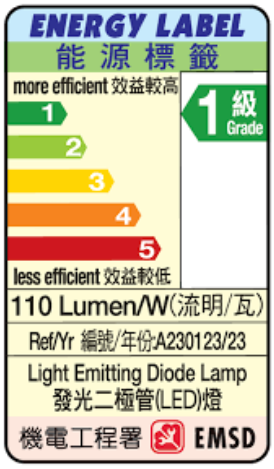
However, it is important to replace gas stove with electric or induction stove as this will greatly reduce heat generation. Furthermore, it is also suggested to use LED light bulbs. Not only do energy efficient appliances generate less heat, but also save energy costs.


HOT


ENERGY LABEL
能 源 標 籤
more efficient 效益較高
1
2
3
4
5
less efficient 效益較低
4級 Grade
53 Lumen/W (流明/瓦)
Ref/Yr 編號/年份:U2-L200123/20
Compact Fluorescent Lamp
緊湊型熒光燈(慳電膽)
機電工程署 EMSD


GAS


COOL


ENERGY LABEL
能 源 標 籤
more efficient 效益較高
1
2
3
4
5
less efficient 效益較低
1級 Grade
110 Lumen/W(流明/瓦)
Ref/Yr 編號/年份:A230123/23
Light Emitting Diode Lamp
發光二極管(LED)燈
機電工程署 EMSD


ELECTRIC
INDUCTION


LED

# OUTDOOR STRATEGIES

| OUTDOOR STRATEGIES | SCORING | |
|---|---|---|
| **SHADING** | | |
| Increase tree shading in open spaces and streets | + ❄❄❄ | |
| Provide sun-shading canopies | + ❄❄ | |
| Glazed canopies | | − ❄ |
| **WIND ENVIRONMENT** | | |
| Improve the wind environment in open spaces | + ❄❄❄ | |
| Appropriate trees in upwind areas | + ❄ | |
| **MATERIALS & SURFACES** | | |
| Provide water features and cool surfaces | + ❄ | |
| Provide green surfaces | + ❄ | |
| **RESTING PLACES** | | |
| Offer furniture with low thermal conductivity | + ❄❄ | |
| Distance and frequency of resting places | + ❄❄❄ | |

| OVERALL SCORE | |
|---|---|
| Outstanding | ❄ × 16 |
| Exceeding Expectations | ❄ × 10 |
| Meeting Expectations | ❄ × 8 |
| Not Meeting Expectations | ❄ × 4 |
| Far Below Expectations | ❄ × 2 |

Outdoor spaces are important for senior citizens as these are where their physical activities and social interactions in the community take place. Not only do they bring benefits to their physical health, but also their psychological well-being by staying socially engaged. Extreme hot weather is an unfavourable condition that may prevent senior citizens from using outdoor spaces or even leaving their homes.

Providing a cool outdoor environment by adopting the outdoor heat mitigation strategies could help maintain their physical health, well-being and quality of life.

01

“我哋唔會行平台㗎，都冇大樹遮蔭，邊涼啫，熱到死 。
陳氏夫婦

Grandparents Chan
We never walk along the exposed podium. There is no tree cover. It is extremely hot.”

# Increase Tree Shading in Open Spaces & Streets

Where senior citizens frequently visited, such as parks, resting areas, fitness corners, etc.

To minimise direct solar gain

## Caveats

The effectiveness of tree shading depends on the crown size and leaf density. Palm trees should be avoided as they do not provide any shading effect. Guidance on the selection of tree species can be found in the Appendix 2.

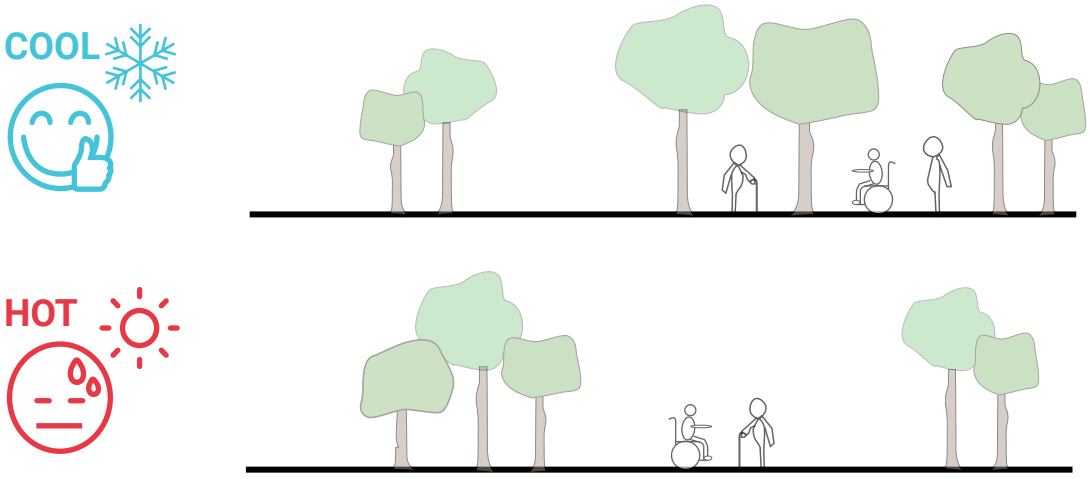
A higher frequency of small rest pockets, equipped with seating that sheltered by trees, is more desirable than having a large park alone.

## Practical Considerations

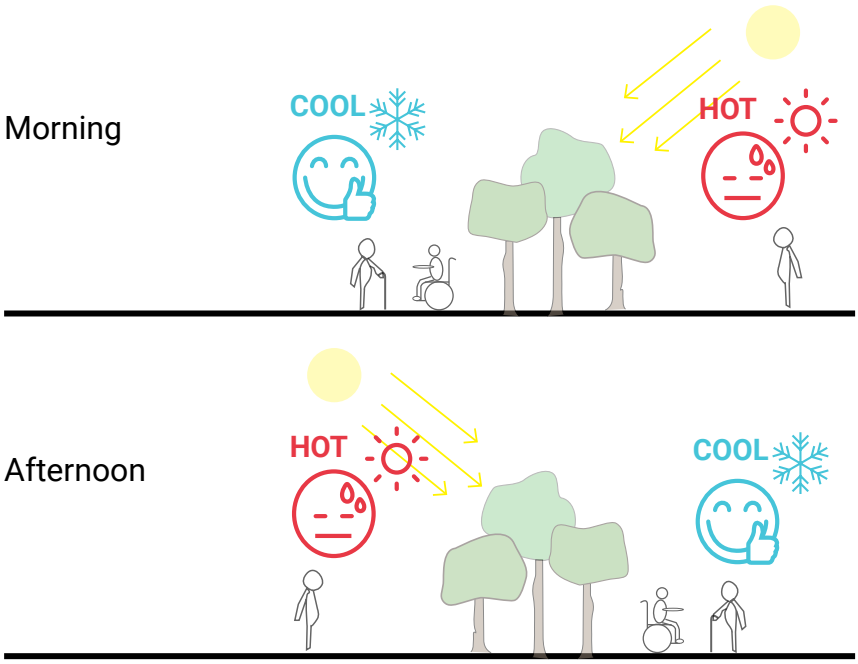
Tree selection may be restricted by budget considerations.

Other than providing tree shading, different factors will affect tree planting in landscape design, such as available space, soil composition, maintenance, biodiversity, aesthetics, land use, etc.

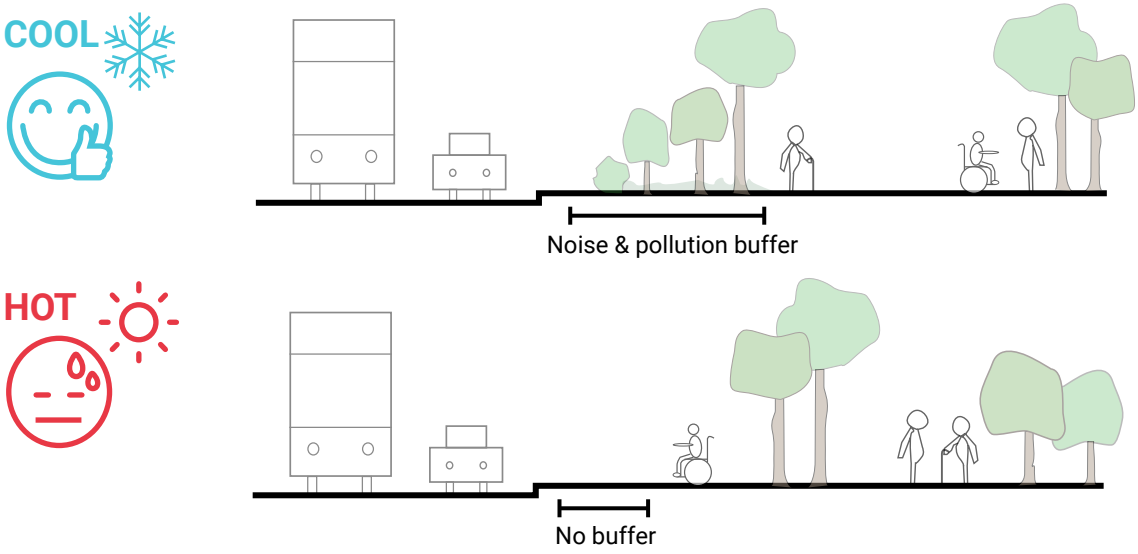
## Plant trees to provide shading along paths




## Solar angle sensitive space design




## Reduce anthropogenic impact



02

“有少少位整個頂呀、篷呀，係底下都唔會直接曬到呀，咁都好缺乏…行過廣福邨河邊，一路都冇架。”

孫伯伯

Grandpa Suen

It should be possible to have some canopies or shelters to avoid direct sunlight. However, such facilities are scarce... Passing by the riverside of Kwong Fuk Estate, there are no shelters along the way.”

# Provide Sun-shading Canopies

Pedestrian pathways, narrow streets, adjacent to buildings, activity areas for seniors

To minimise direct exposure to solar radiation considering local context

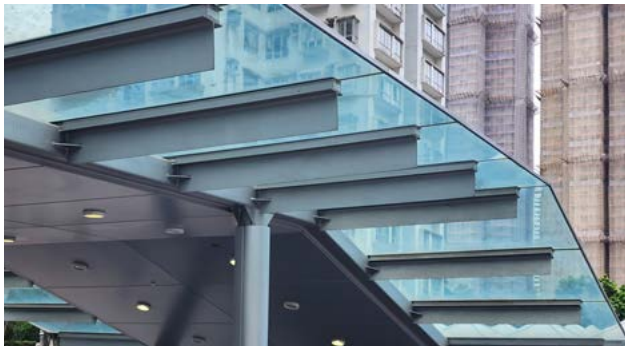
\+ ❄ ❄

NOT RECOMMENDED

Glazed canopies

\- ❄

Large canopy provides shade where trees cannot be planted.



Avoid using a glazed walkway as it does not provide any shade to pedestrians.

Buildings can provide shade through canopies, colonnades, recesses or cantilever structures.

Rather than natural landscaping, using devices such as canopies or louvres to shade outdoor spaces can help to prevent structural damage to buildings and pavements by inappropriate tree species with extensive root networks.

Sufficient head height for shading devices

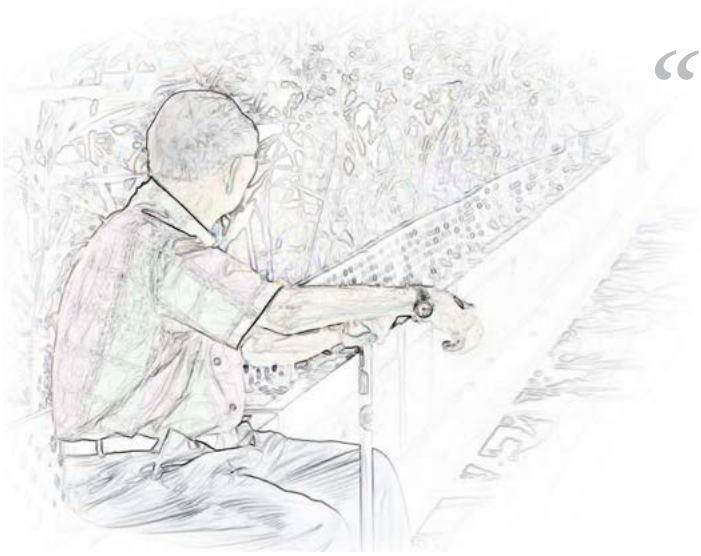
## Caveats

Glass canopy should be avoided as it provides no shading effect.

Shading devices should be placed with adequate distance from head height to allow sufficient ventilation and reduce thermal exposure.

Shading devices for resting areas along jogging trail

03



“我好鍾意坐喺呢個公園㗎。呢度沒咩高樓大廈會擋住啲風，所以啲風吹黎好涼爽架。”
唐伯伯

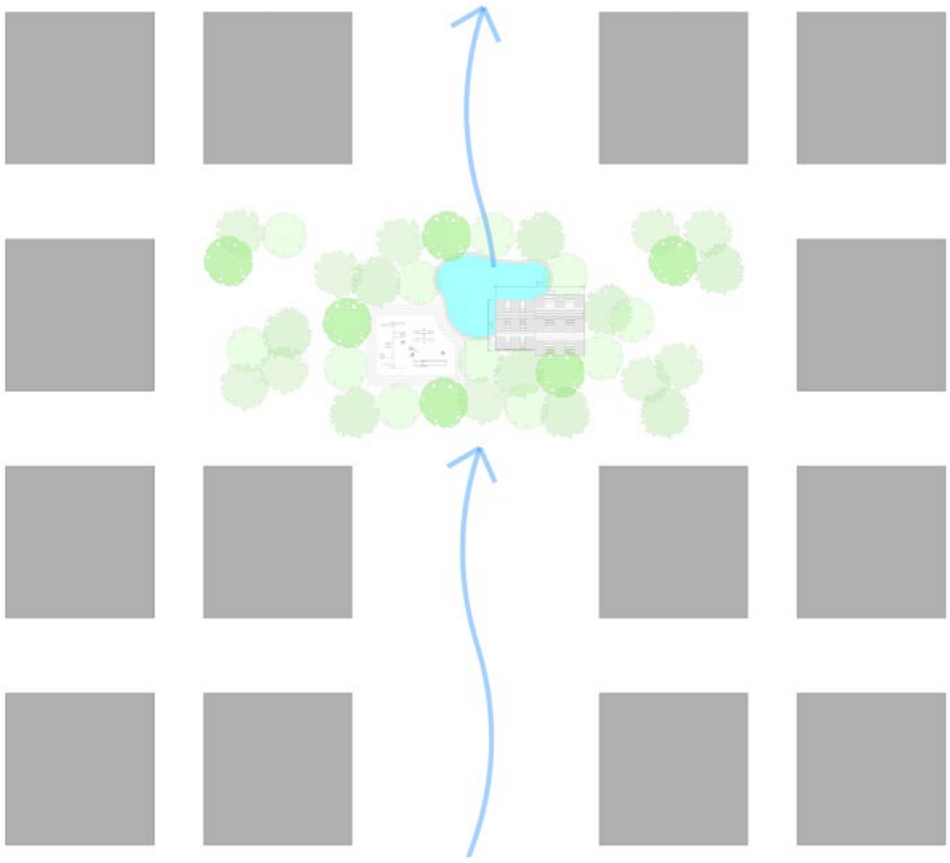
Grandpa Tong
“I really like sitting in this park. There aren’t any tall buildings blocking the wind, so the breeze is refreshing.”

# Improve the Wind Environment

Buildings sited around parks and open spaces

To increase wind flow to reduce heat build-up and reduce air temperature in open spaces and parks

Strategic site planning allows increased ventilation to cool the environment



In a high-density urban environment, air movement or ventilation in open spaces can be enhanced through careful site planning, including:

1. Creating wind corridors to align with the prevailing wind;
2. Building setbacks;
3. Increase permeability of buildings;
4. Proper building massing and arrangement.

## Caveats

Occasional or seasonal strong winds may affect pedestrian comfort in places that are more exposed.

Open spaces shall provide trees or shading devices as wind or rain shelters.

## Practical Considerations

Wind movement needs to be considered early in the pre-design and site planning phase.

Further reading:
Buildings Department. (2016). *Sustainable building design guidelines.* HKSAR Government.

04

“有樹就又遮蔭又涼，微風吹嚟好舒服。我哋好鍾意日日喺度散步。

李氏夫婦

Grandparents Li

The trees not only provide shade, but there are nice cooling breezes here. We enjoy taking walks here every day.”

# Appropriate Trees In Upwind Areas

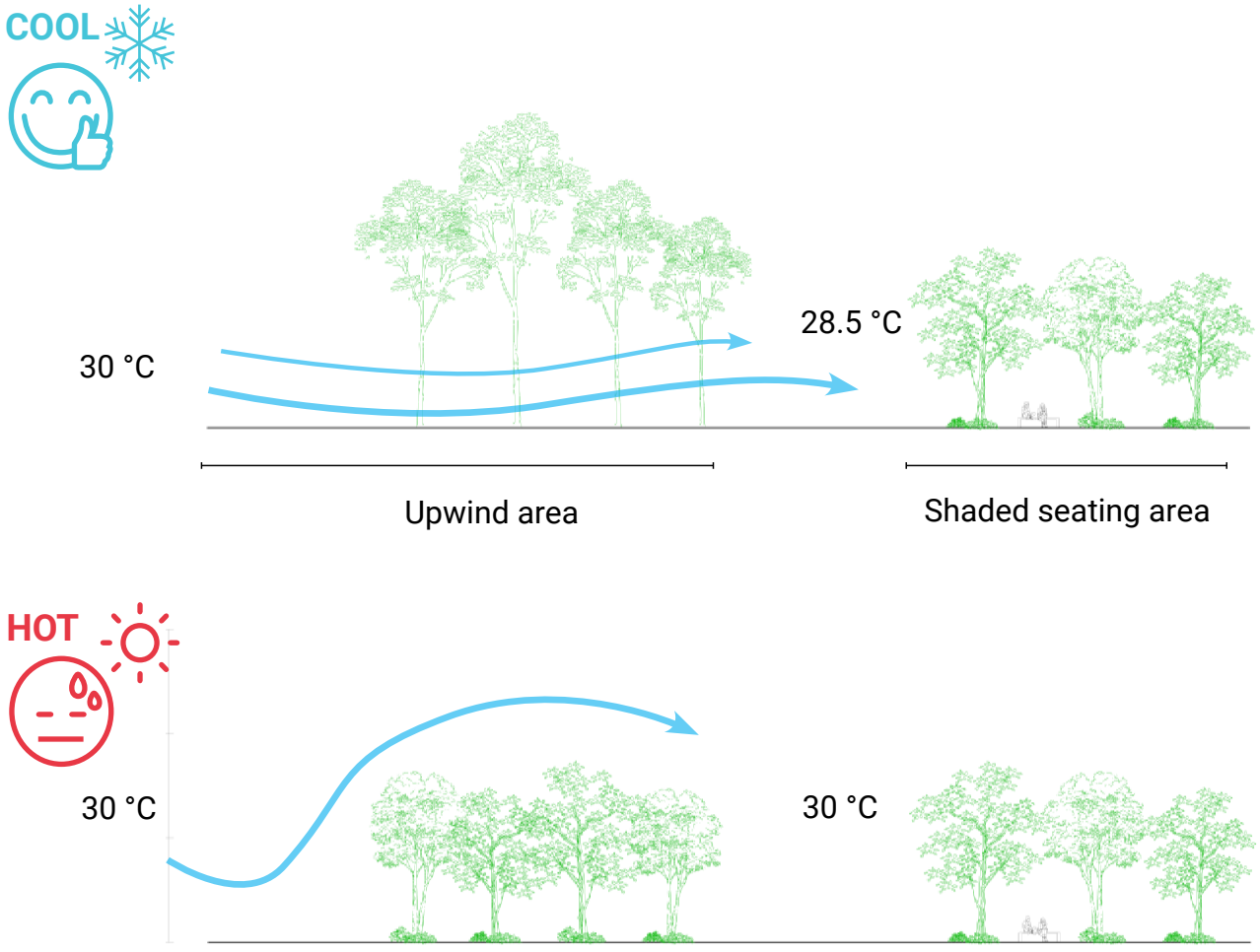
Upwind areas in parks and open spaces

To maximise the cooling effect from tree planting and reduce the ambient temperature

Trees can increase evapotranspiration and reduce the ambient temperature of the surrounding environment.

Planting tall trees with moderately dense tree crowns in upwind areas can maximise the cooling effect in downwind areas.

Cooling effect is amplified when wind speed is higher.




## Caveats

Proper tree species should be carefully evaluated to ensure they are appropriate for the locations in upwind or downwind areas.

## Practical Considerations

Areas under trees should be kept vacant as pedestrian passageways. Obstructions should also be minimised.

Further reading:
Planning Department. (2012). *Urban climatic map and standards for wind environment - feasibility study, executive summary*. HKSAR Government.

05

“河邊好涼爽架..
近河邊就涼啲嘅。
林氏夫婦

Grandparents Lam
It is cooler closer to the river.”

# Provide Water Features and Cool Surfaces

Fountains, waterfalls, misting stations, ponds, permeable paving

To extract heat and cool the surrounding environment

Water evaporation extracts heat from the surrounding environment.


Dynamic water features (mist sprays, fountains, waterfalls) can reduce the ambient air temperature within 3m by 3-5 °C while static water features (ponds, pools) can reduce by 0.2 °C.

## Caveats

The cooling effect of water features will be impaired by humid or cloudy weather conditions.

The effectiveness of water features in cooling depends on their surroundings. Therefore, urban water features should be designed with considerations for shade, green features and ventilation to maximise their cooling potential.

Permeable paving

## Practical Considerations

Safety risk assessments may be required. for communal water features  While the cooling effect of water features is often attributed to the process of evaporation, the surface wetness is more important. Therefore, a shallow water feature is also acceptable.

Permeable pavements have a substantial cost premium over standard pavements. Regular maintenance is needed to retain permeability and should be included in operating budgets.

Further reading:
Hong Kong Green Building Council. (2017). *HKGBC Guidebook on urban microclimate study.* Hong Kong Green Building Council Limited.

06

“我日日喺嗰個公園做運動㗎，有咁多草同樹，涼過我屋企樓下個石屎平台好多囉！
李婆婆

Grandma Li
I excercise in that park every day, because there is so much grass and trees. It is much cooler than the concrete plaza in my housing estate.”

# Provide Green Surfaces

Vertical greening, vegetated ground, grass pavers

To reduce radiation gain and the urban heat island effect

## Caveats

Permeable pavements must be properly installed and maintained to be effective.

## Practical Considerations

Permeable pavements have a substantial cost premium over standard pavements. Regular maintenance is needed to retain permeability and should be included in operating budgets.

The cost of designing, installing and maintaining vertical greening systems may be a concern.

COOL

## Green surfaces

increase heat reflection and evaporative cooling

Vertical greening

Vegetated ground

Grass pavers

Climbing plants

HOT

## Traditional surface materials

absorb and store thermal energy

Light-coloured surfaces radiate more heat than vegetation

Conventional asphalt surfaces

Further reading:
Energy Sector Management Assistance Program. (2020). *Primer for cool cities: Reducing excessive urban heat - With a focus on passive measures.* World Bank.

07

“梅樹坑嗰度有木凳，唔係呢啲鋼凳，個啲木凳坐喺度係舒服㗎。

黃婆婆

Grandma Wong

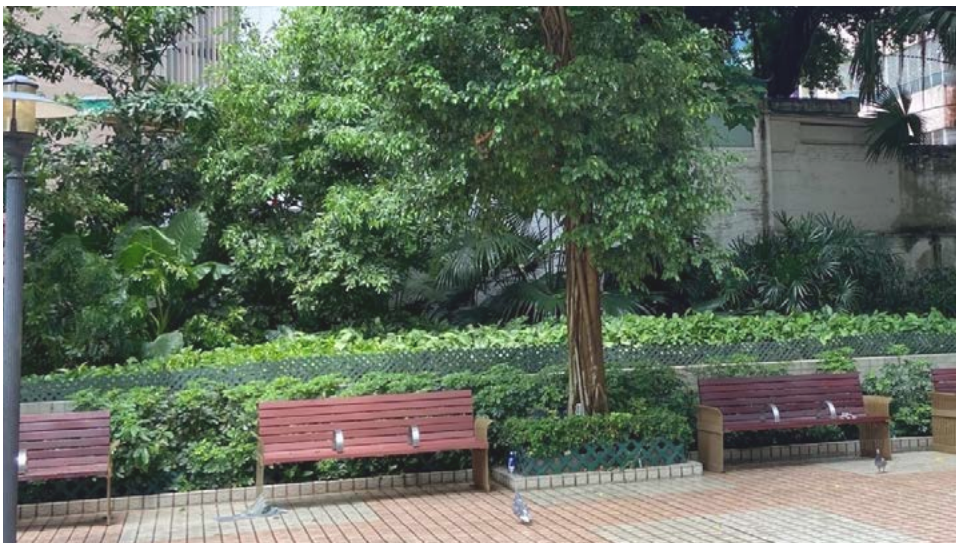
There are wooden benches in Mui Shue Hang playground, not like these metal ones. Those wooden benches are very comfortable.”

# Provide Furniture with Low Thermal Conductivity

Open spaces, parks, street environment

To provide comfortable seating in hot weather

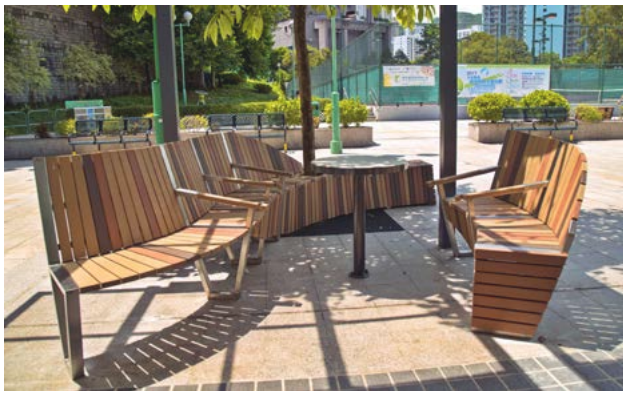
Wooden benches shaded by trees – surface temperature of bench is same as air temperature




## Seating made of natural wood

is thermally comfortable in extreme hot weather (20-30 °C)

Wooden bench



Partially-shaded wooden chairs


## Seating made of metal/stone/synthetic materials

will heat up and become unpleasant under the sun (max. 60 °C)

Stone bench

Metal or synthetic polymer bench

## Caveats

Wooden benches are less durable compared to metal or synthetic polymer benches.

## Practical Considerations

Maintenance would be required for natural wooden benches and should be included in operating budgets.

08

“其實街外嘅樹都比較多，同埋個空氣都比較暢通，好多老人家都會選擇喺樹下面坐。”

高伯伯

Grandpa Ko

Actually, there are many trees outdoors and the air ventilation is better. This is why many older people choose to sit under the trees.”

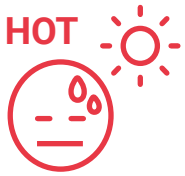
# Provide Frequent Seating and Resting Places

Every 100-150m or 5-10min intervals during walks

To provide resting areas considering the declined mobility of senior citizens

Cool spots providing water features, tree shading and suitable seating are ideal resting places for the elderly under extreme hot weather. The Paley Park in New York City is a good example.


Suggested to increase the number of parks and resting places


Parks in Sheung Wan area - existing resting places are sparse


## Caveats

Proper shading and comfortable outdoor seating facilities should be provided at resting places.

Older adults often enjoy watching others moving around and may even run into friends by chance. Therefore, they are likely to be more satisfied with seating areas that offer a wider view.

Providing armrests can assist seniors getting up from benches independently.

## Practical Considerations

Due to spatial constraints, it may not always be possible to provide resting areas within proximity.

# CASE STUDIES

01 Singapore: Mixed-used development
## Kampung Admiralty

02 Hong Kong: High-rise development
## The Tanner Hill

03 Hong Kong: Residential housing
## North Point Estate (Demolished)

04 Hong Kong: Residential housing
## Verbena Heights

05 Hong Kong: Residential housing
## Sui Wo Court

06 Hong Kong: Outdoor space
## Man Yee Playground

07 Hong Kong: Outdoor space
## Oil Street Art Space

08 Hong Kong: Outdoor space
## Blake Garden

09 Hong Kong: Outdoor space
## Tong Shui Road Garden

01

## Singapore: Mixed-use development

# Kampung Admiralty

Where 676 Woodlands Drive 71, Singapore 730676

What Kampung Admiralty is Singapore's first integrated public development that brings together a mix of public facilities and services under one roof.

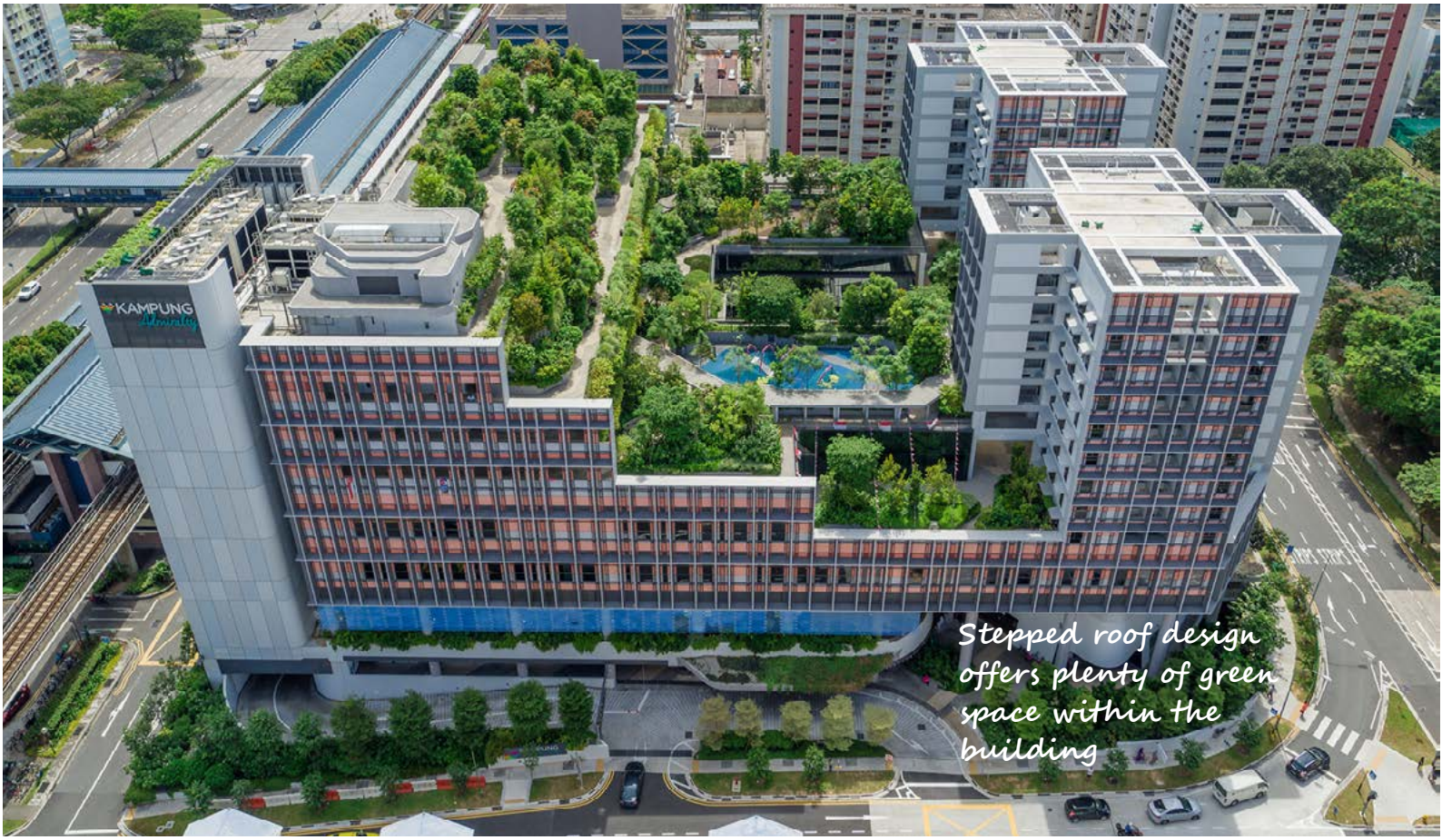
Why This mixed use development maximises land use, and is a prototype for meeting the needs of Singapore's ageing population.

How A "Vertical Kampung (village)" is devised, with a Community Plaza in the lower stratum, a Medical Centre in the mid stratum, and a Community Park with apartments for seniors in the upper stratum.

When 2017

Awards HDB Design Award Winner 2018
World Architecture Festival - World Building of the Year 2018
CTBUH Best Tall Mixed-Use Building - Winner 2019
SGBC-BCA Sustainability Leadership Awards 2019 - Design Award
18th SIA Architectural Design Awards 2019 - Design Award
2019 Green Good Design Award - Winner

Location: Singapore
Site Area: 8,981sqm
GFA: 32,331sqm
No. of Towers: 2
No. of Units: 104
Building Type: Mixed Use



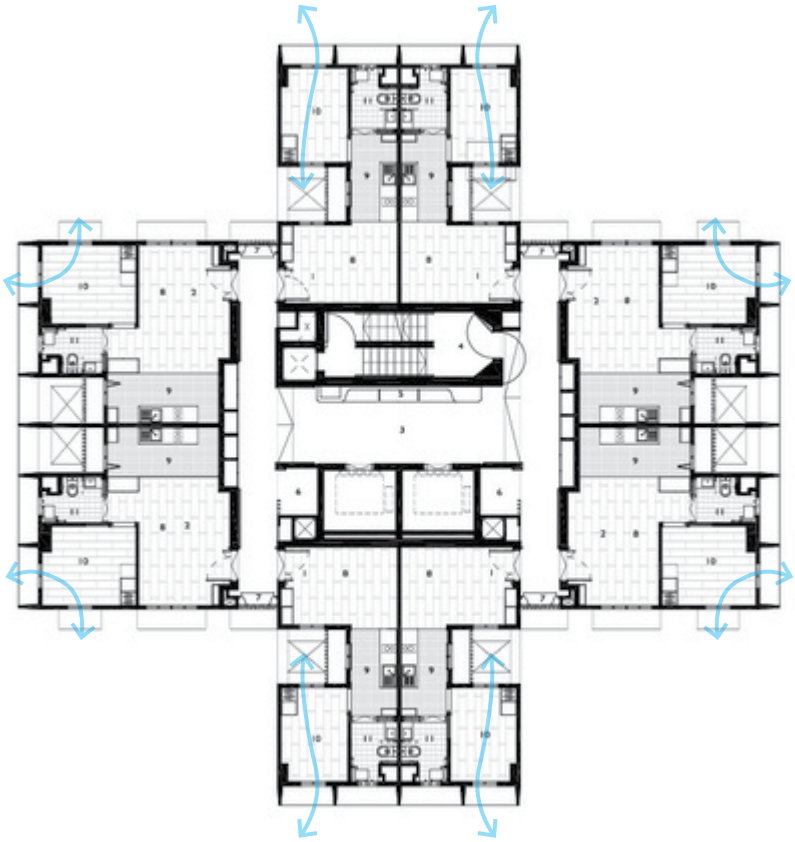

Stepped roof design offers plenty of green space within the building

Porous ground plane with retail facilities on lower levels.

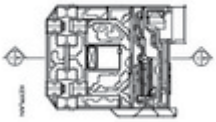
Intergenerational hub with kindergarten and elderly facilities together

Double height open ground plane to foster natural ventilation

Residential flats with ample natural ventilation



1 365QM UNIT
2 455QM UNIT
3 LIFT LOBBY
4 STAIRCASE SHELTER
5 BENCH
6 BIN POINT
7 BUDDY BENCH
8 LIVING ROOM
9 KITCHEN
10 BEDROOM
11 BATHROOM



| INDOOR STRATEGIES | SCORING |
|---|---|
| **VENTILATION** | |
| Cross-ventilation | + ❄❄❄❄ |
| Increase openable window area | + ❄❄❄❄ |
| Optimal flat size with at least one bedroom | + ❄❄❄ |
| More than one window in bedroom and living room | + ❄❄ |
| Maximise vertical opening distance | + ❄ |
| **SHADING & ORIENTATION** | |
| Shading using balcony | + ❄❄ |
| Shading using window shading elements | |
| Orientation: Living areas not facing west | |
| **WINDOW GLAZING** | |
| Low-E glass / Tinted glass | |
| **OTHERS** | |
| High floor level and/or unobstructed frontage | + ❄ |
| Reduce anthropogenic heat | |
| **EXCEEDING EXPECTATIONS** | ❄ × 17 |

02

## Hong Kong: High-rise development

# The Tanner Hill

| | |
|---|---|
| Where | 8 Tanner Road, North Point, Hong Kong |
| What | Comprised of 3 Towers with 588 residential units, Hong Kong's first quality housing for senior citizens aged 60 or above. |
| Why | Envisioned as a hub for elderly living, the podium houses an elderly care home. |
| How | The complex is designed to offer independent living for senior citizens. |
| When | 2015 |
| Awards | HK-BEAM ECO BUILDING Platinum Standard<br><br>4th APAC Eldercare Innovation Awards 2016<br>Winner – Facility of the Year – Independent Seniors Living<br><br>HK Professional Building Inspection Academy:<br>The outstanding Construction and Renovation Award 2016<br>Caring Service of the Year |

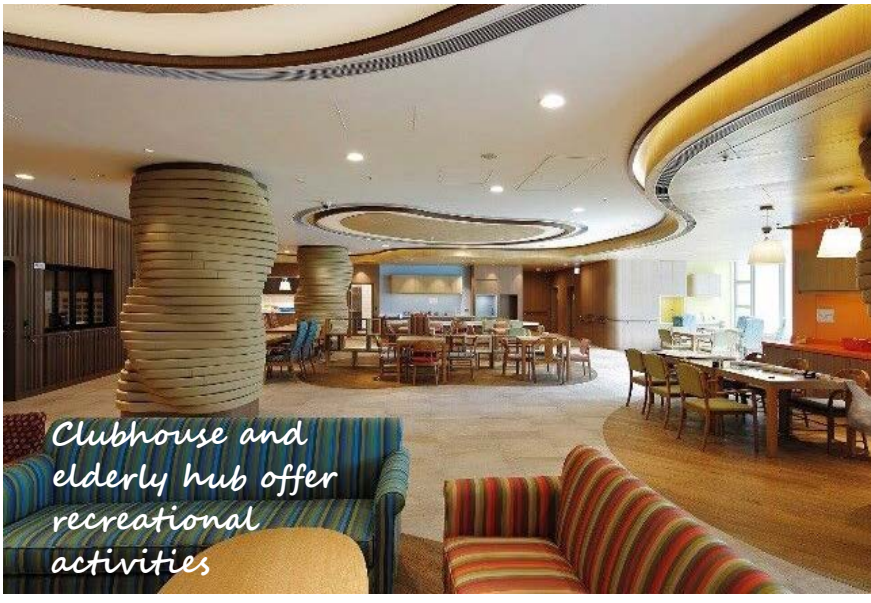
Location: Hong Kong
Site Area: 8,538 sq m
No. of Towers: 3
No. of Units: 588
Building Type: Residential


The 3 towers are laid out to maximise wind for natural ventilation


Various podium gardens are provided for senior citizens


Senior citizens can rest and socialise in these sky gardens


Ergonomic design of the interior space to facilitate independent living

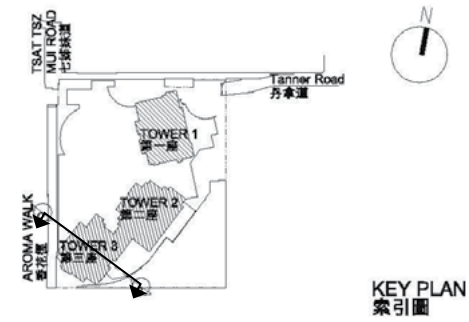

Clubhouse and elderly hub offer recreational activities

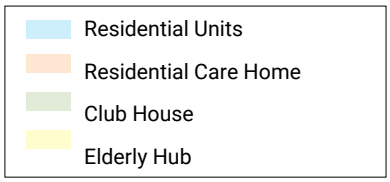
## INFORMATION ON COMMON FACILITIES IN THE DEVELOPMENT
# 發展項目中的公用設施的資料

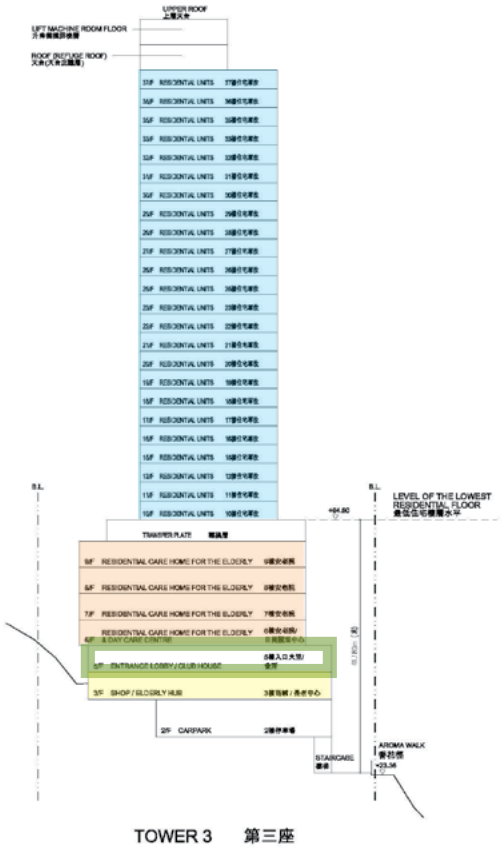
| | | Covered 有上蓋遮蓋 | Uncovered 無上蓋遮蓋 |
|---|---|---|---|
| Residents' Clubhouse (including any recreational facilities for residents' use)<br>住客會所（包括供住客使用的任何康樂設施） | Area 面積 (sq. ft. 平方呎) | 8,524 | - |
| | Area 面積 (sq. m. 平方米) | 791.925 | - |
| Communal garden or play area for residents' use on the roof, or on any floor between the roof and the lowest residential floor, of a building in the Development (whether known as a communal sky garden or otherwise)<br>位於發展項目中的建築物的天台或在天台和最底一層住宅樓層之間的任何一層的、供住客使用的公用花園或遊樂地方（不論是稱為公用空中花園或有其他名稱） | Area 面積 (sq. ft. 平方呎) | 2,851 | 5,997 |
| | Area 面積 (sq. m. 平方米) | 264.843 | 557.18 |
| Communal garden or play area for residents' use below the lowest residential floor of a building in the Development (whether known as a covered and landscaped play area or otherwise)<br>位於發展項目中的建築物的最低一層住宅樓層以下的、供住客使用的公用花園或遊樂地方（不論是稱為有蓋及園景的遊樂場或有其他名稱） | Area 面積 (sq. ft. 平方呎) | 8,963 | 8,975 |
| | Area 面積 (sq. m. 平方米) | 832.669 | 833.764 |

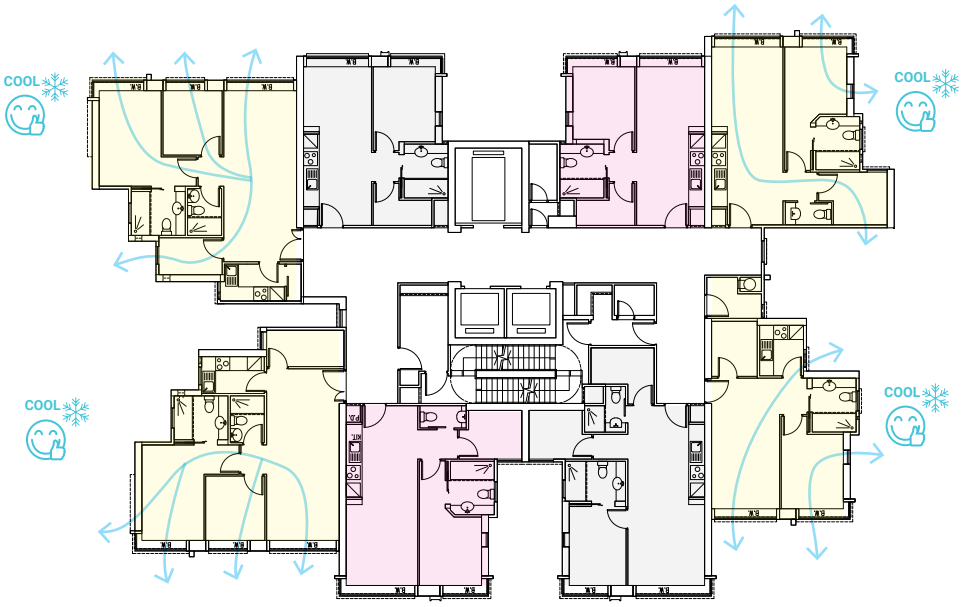
Note:

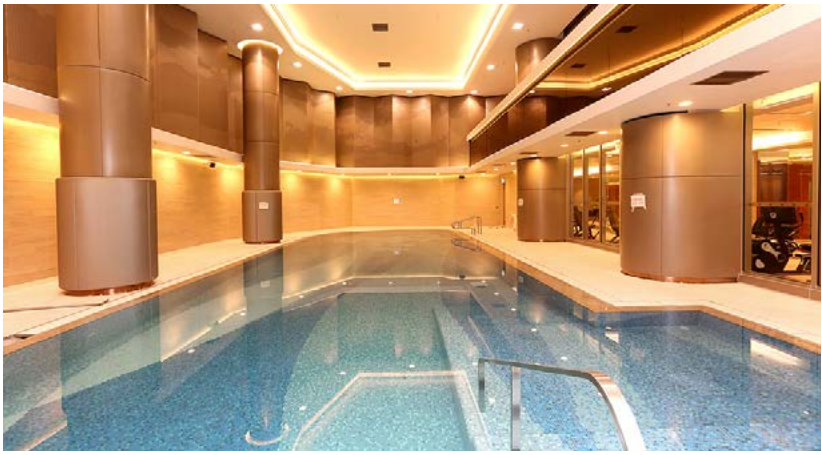
備註：





| INDOOR STRATEGIES | SCORING |
|---|---|
| **VENTILATION** | |
| Cross-ventilation | + ❄❄❄❄ |
| Increase openable window area | + ❄❄❄❄ |
| Optimal flat size with at least one bedroom | + ❄❄❄ |
| More than one window in bedroom and living room | |
| Maximise vertical opening distance | + ❄ |
| **SHADING & ORIENTATION** | |
| Shading using balcony | + ❄❄ |
| Shading using window shading elements | + ❄ |
| Orientation: Living areas not facing west | |
| **WINDOW GLAZING** | |
| Low-E glass / Tinted glass | |
| **OTHERS** | |
| High floor level and/or unobstructed frontage | + ❄ |
| Reduce anthropogenic heat | |
| **EXCEEDING EXPECTATIONS** | ❄ × 16 |

# 03

## Hong Kong: Residential housing

# North Point Estate (Demolished)

Where 202 Java Road, North Point, Hong Kong

What The estate enjoyed a reputation as one of the most impressive construction schemes in Asia and as a public housing estate in one of the most “luxurious” areas on Hong Kong Island.

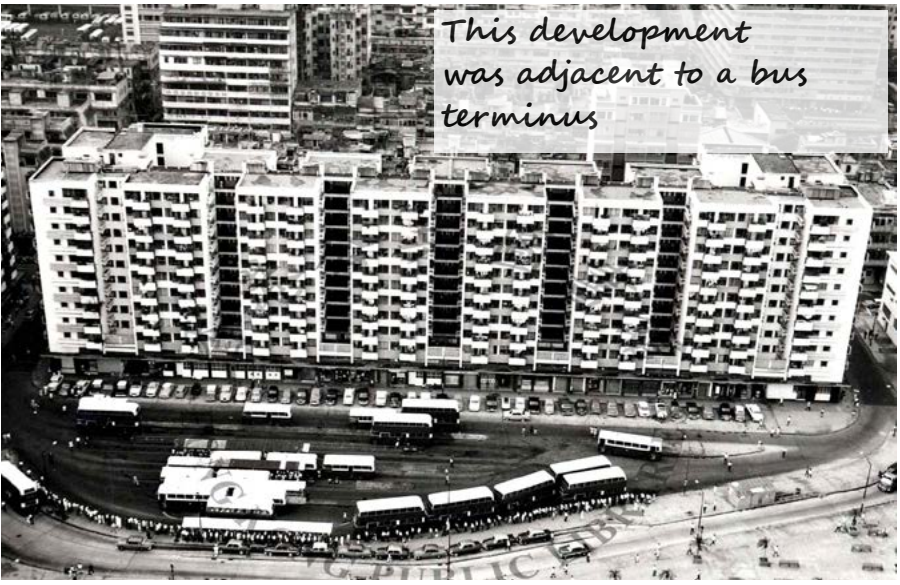
Why Passive design strategies such as solar control and ventilation are simple yet effective. There were small plazas between the blocks
The design enhanced social interaction and enhances neighbourly feelings.

How Each flat was attached to a balcony that provides solar shading. A central corridor with staggered flats on both sides allowed for enhanced ventilation and maximum daylight penetration.

When 1957-2003

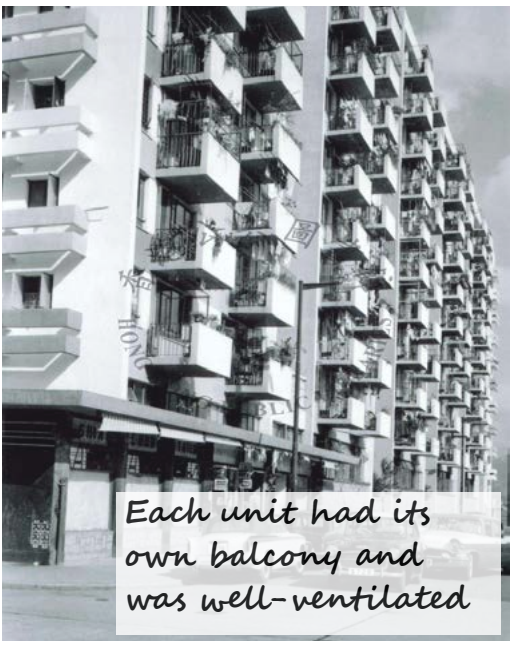
Location: Hong Kong
Site Area: 6.5 acre
GFA: 27,900 sq m
No. of Towers: 7
No. of Units: 1,956
Building Type: Residential

Located on a prime site facing the harbour



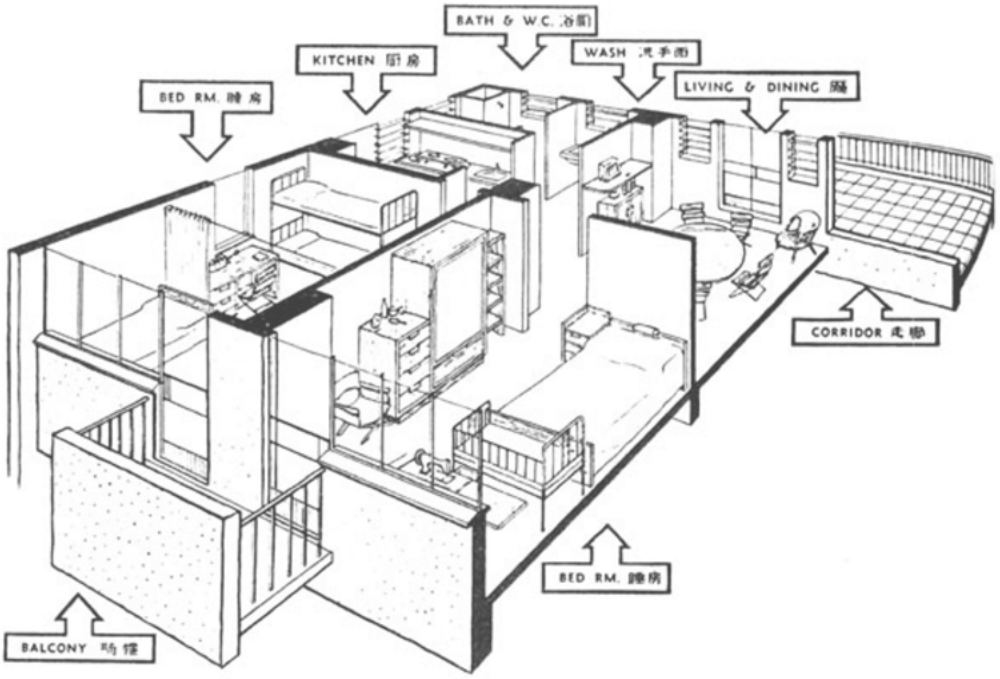
This development was adjacent to a bus terminus

Optimally-sized flats each with their own balcony

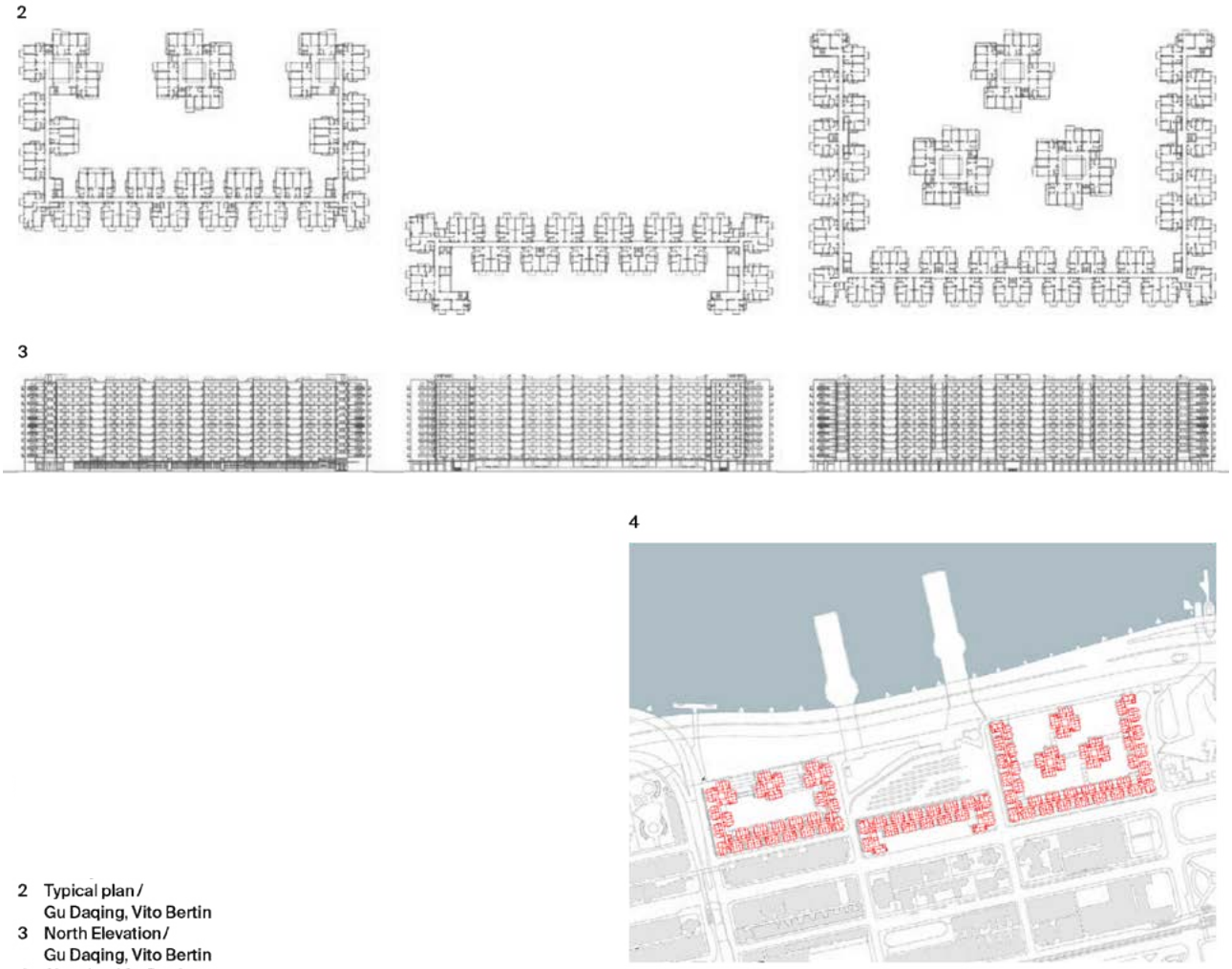


Each unit had its own balcony and was well-ventilated

Plaza between the blocks provided leisure space and social interaction

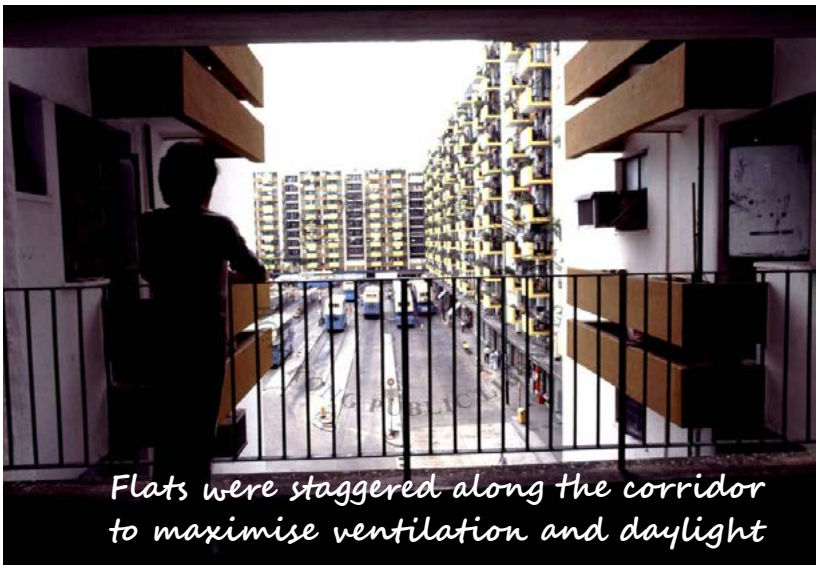



Perspective view of a typical flat with balcony (Source: Hong Kong Housing Authority, 1955)

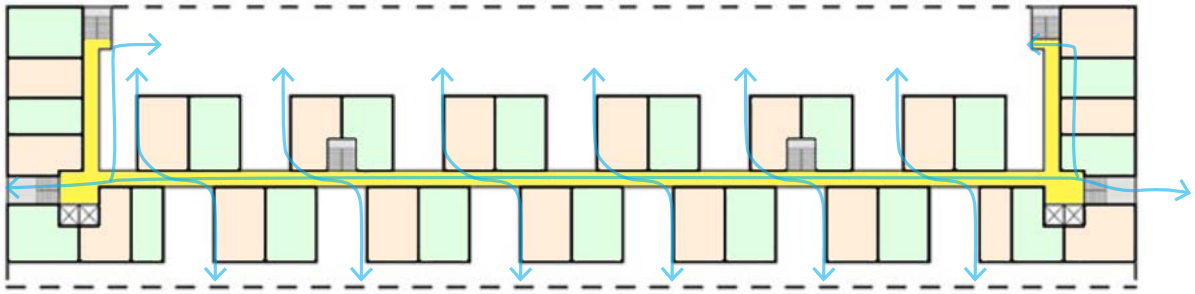



2 Typical plan / Gu Daqing, Vito Bertin
3 North Elevation / Gu Daqing, Vito Bertin
4 Site plan / Gu Daqing, Vito Bertin

Typical plan, north elevation and site plan (Source: Adapted from HKIA, 2016)


Flats were staggered along the corridor to maximise ventilation and daylight


Low plot ratio and low site coverage allowed ventilation and prevented overshadowing



Typical plan: flat arrangement allows for cross ventilation through corridor and enhanced daylight penetration

| INDOOR STRATEGIES | SCORING |
|---|---|
| **VENTILATION** | |
| Cross-ventilation | + ❄❄❄❄ |
| Increase openable window area | + ❄❄❄❄ |
| Optimal flat size with at least one bedroom | + ❄❄❄ |
| More than one window in bedroom and living room | + ❄❄ |
| Maximise vertical opening distance | |
| **SHADING & ORIENTATION** | |
| Shading using balcony | + ❄❄ |
| Sahding using window shading elements | + ❄ |
| Orientation: Living areas not facing west | |
| **WINDOW GLAZING** | |
| Low-E glass / Tinted glass | |
| **OTHERS** | |
| High floor level and/or unobstructed frontage | |
| Reduce anthropogenic heat | |
| **EXCEEDING EXPECTATIONS** | ❄ × 16 |

04

## Hong Kong: Residential housing

# Verbena Heights

Where 8 Mau Tai Rd, Tseung Kwan O, Hong Kong

What The design showcases an environmentally responsible development in a high density city.

Why It was highly innovative, especially with respect to its sustainable passive design features including solar shading, daylight harnessing, natural ventilation, material conservation, low embodied energy, green sanitation and waste recovery.

How The estate was designed with environmental features, including wind-channeling canopies, sun canopies and sky garden while inside the flats there are minimal-flush toilet systems and large windows for better air circulation.

When 1996/97

Awards Hong Kong Institute of Architects Silver Medal 1999

Location: Hong Kong
Site Area: 21, 218 sq m
No. of Towers: 7
No. of Rental Units: 971
No. of Sale Units: 1,894
Building Type: Residential


Stepped tower design for maximum daylight, solar access and ventilation

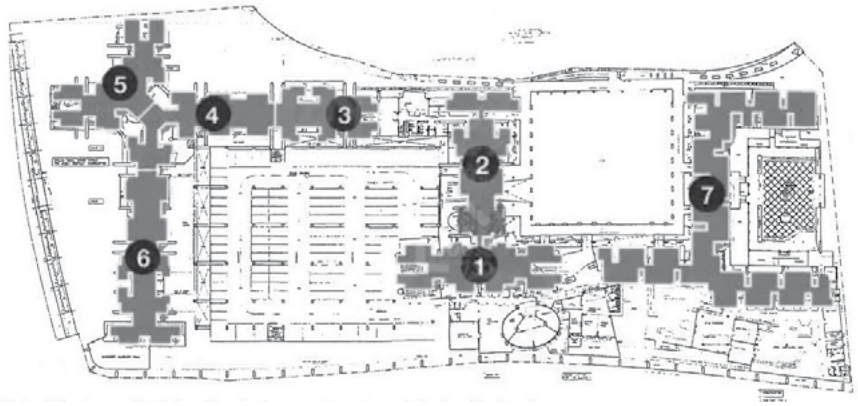

Integrated facade design with shading and noise mitigation


Placement of trees and use of acoustic panels can mitigate noise pollution

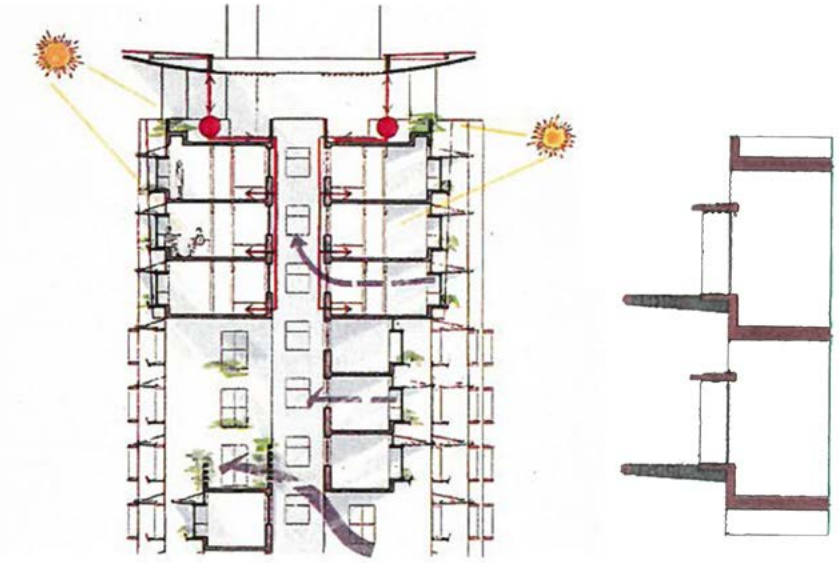

Maximise ventilation and minimise strong wind


Central garden for residents to rest and socialise

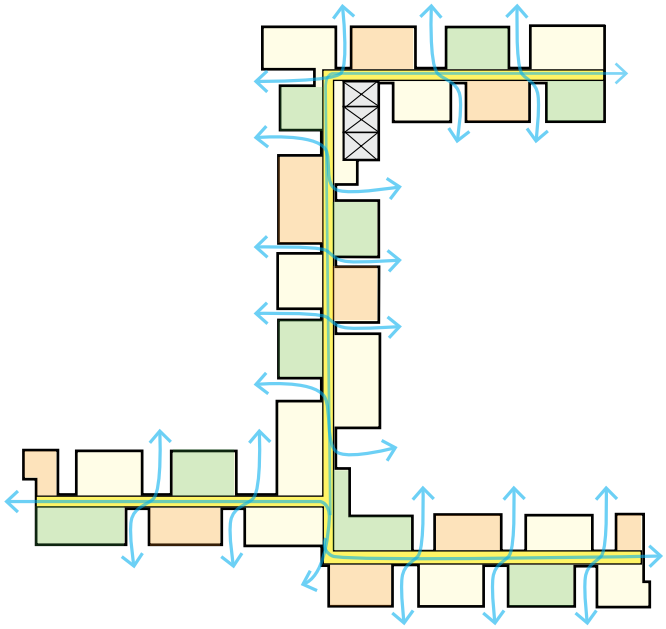
Site plan of the development showing the arrangement of the seven blocks with communal plazas in between




Various passive design strategies are employed including solar shading, planter area, cross ventilation, stack ventilation, waste recovery, materials with low embodied energy, etc.



Block 7 floor plan: flat arrangement allows for cross ventilation through corridor and enhanced daylight penetration







| INDOOR STRATEGIES | SCORING |
|---|---|
| **VENTILATION** | |
| Cross-ventilation | + ❄❄❄❄❄ |
| Increase openable window area | + ❄❄❄❄❄ |
| Optimal flat size with at least one bedroom | + ❄❄❄❄ |
| More than one window in bedroom and living room | + ❄❄❄ |
| Maximise vertical opening distance | + ❄ |
| **SHADING & ORIENTATION** | |
| Shading using balcony | + ❄❄❄ |
| Shading using window shading elements | + ❄ |
| Orientation: Living areas not facing west | |
| **WINDOW GLAZING** | |
| Low-E glass / Tinted glass | |
| **OTHERS** | |
| High floor level and/or unobstructed frontage | + ❄ |
| Reduce anthropogenic heat | |
| **EXCEEDING EXPECTATIONS** | ❄ × 18 |

05

## Hong Kong: Residential housing

# Sui Wo Court

Where 13 Sui Wo Road, Fo Tan, Hong Kong

What The development is one of the first estates under the government's Home Ownership Scheme.

Why The design was considered to be highly innovative, especially with respect to its "pinwheel" apartment plan.

How Corridor blocks enhance cross ventilation for flats and common lobby spaces and enhanced use of common lobby spaces for social interaction and activities. There are three landscaped areas that contain water features and resting places which are connected through shaded covered walkways and tree canopies. The management fee is only around $1 per square foot.

When 1981

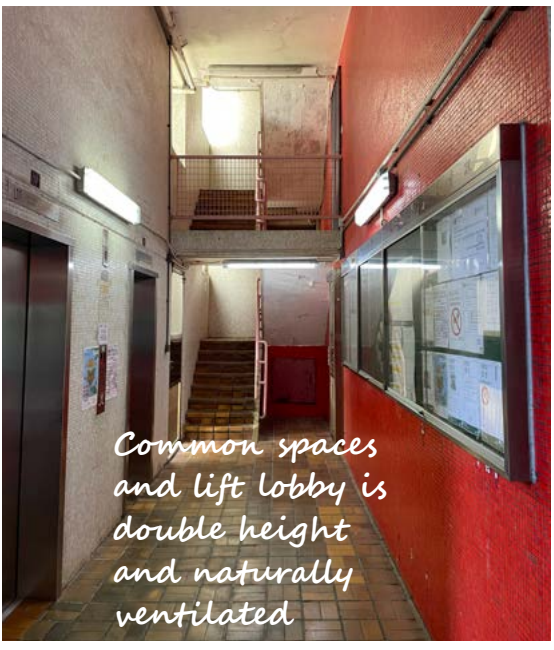
Awards Hong Kong Institute of Architects Silver Medal 1981

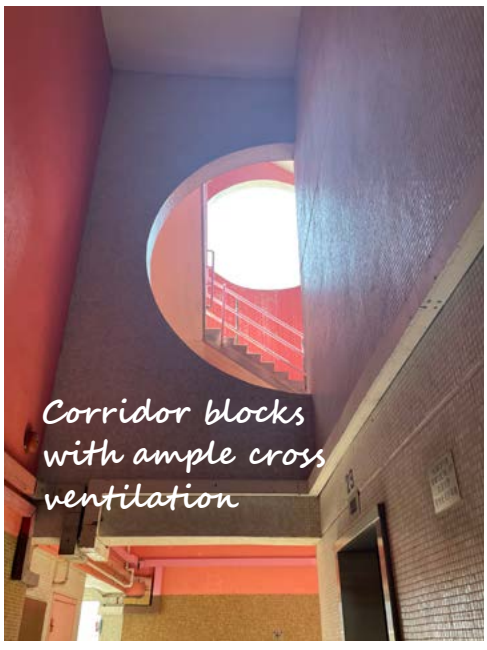
Location: Hong Kong
No. of Towers: 9
No. of Units: 3,501
Building Type: Residential


Located on a mountain
and facing the river

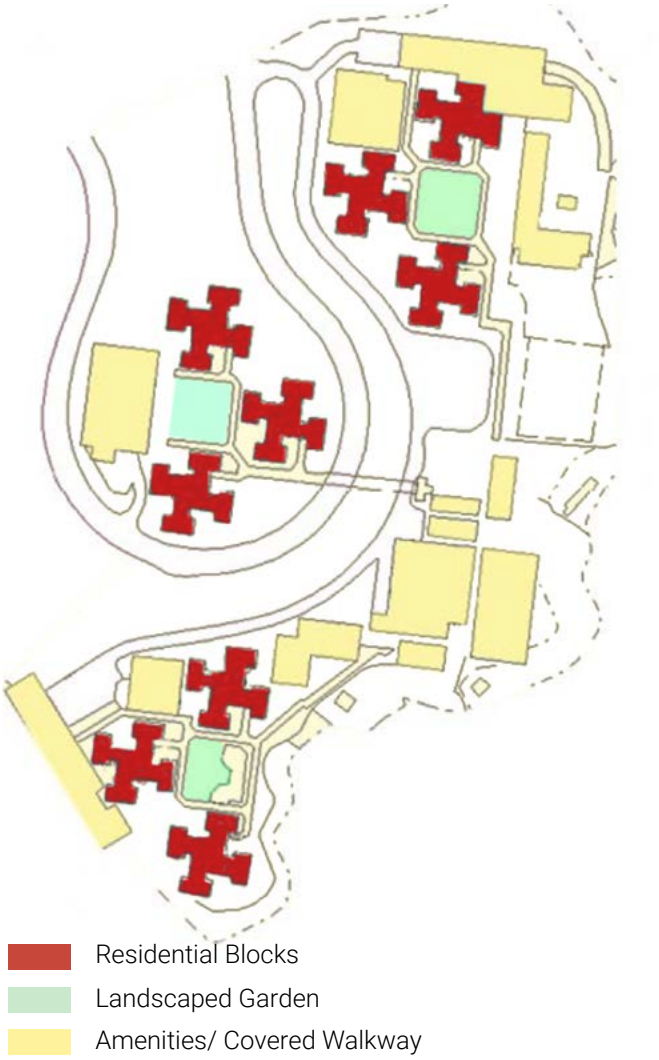

Stepped roof heights to
prevent overshadowing of
adjacent flats

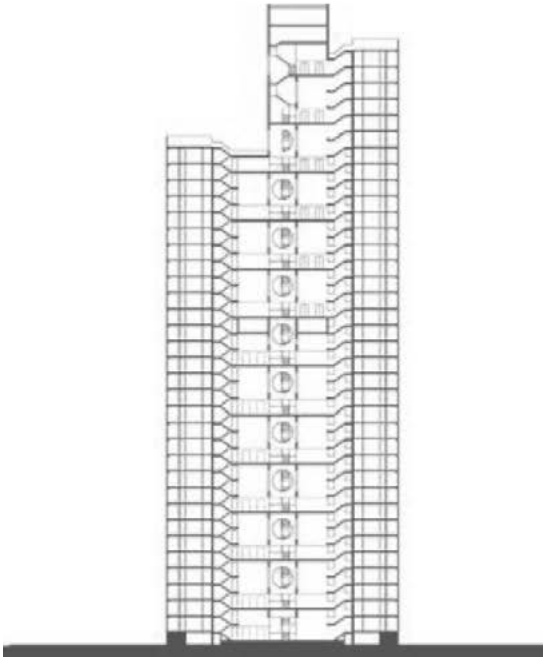

Strategically-
placed openings
in the double
height corridors
enhance
ventilation


Common spaces
and lift lobby is
double height
and naturally
ventilated

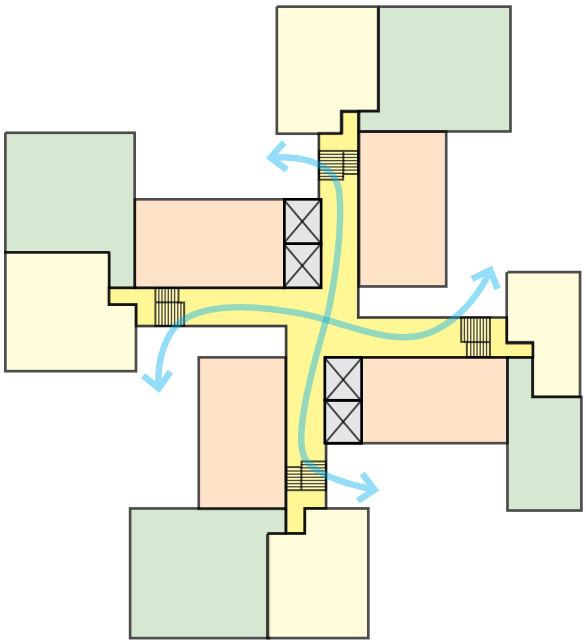

Corridor blocks
with ample cross
ventilation


12-flats per floor
in groups of 3
units, each with
its own stair

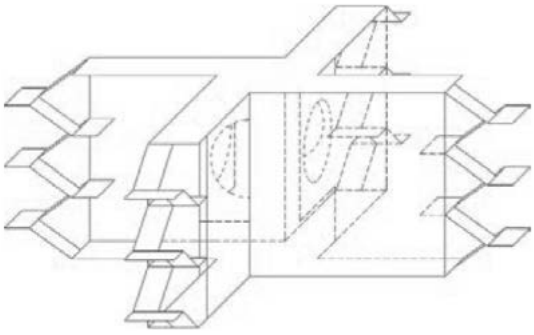


Residential Tower Cross Section
(Source: HKIA, 2016)

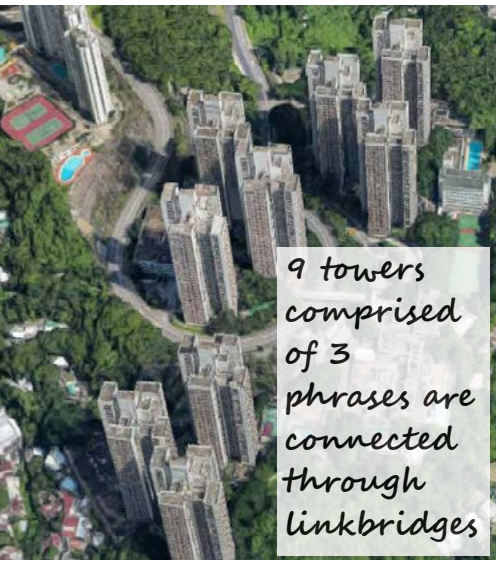


Typical floor plan:
12-flats per floor in groups of 3 units, each with its own stair. Double height corridor spaces allow for enhanced cross ventilation.

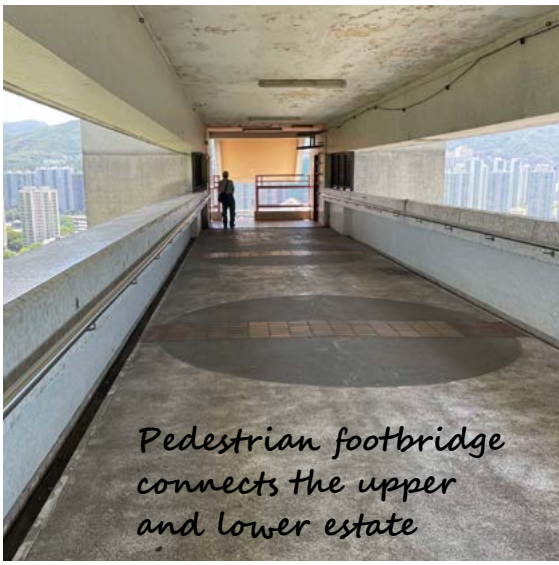


Circulation Diagram
(Source: HKIA, 2016)


This estate contains a shopping mall with a carpark. The whole development considers the microclimatic conditions of the site.


9 towers comprised of 3 phrases are connected through linkbridges


Situated next to a highway; the estate contains a bus terminus


Pedestrian footbridge connects the upper and lower estate


Well-shaded areas for physical exercise


Public areas with tree shade for social interaction and leisurely activities


Self-sufficient estate with shopping mall Roof design for natural ventilation


Each phase consists of 3 towers with a central garden


Plenty of wooden benches covered by tree shade


Water feature keeps the environment cooler


Extensive covered walkways to shelter from sun and rain


Large open spaces for residents to exercise in groups


Shaded areas for different physical activities including ball exercise

| INDOOR STRATEGIES | SCORING |
|---|---|
| **VENTILATION** | |
| Cross-ventilation | + ❄❄❄❄ |
| Increase openable and operable window area | + ❄❄❄❄ |
| Optimal flat size with at least one bedroom | + ❄❄❄ |
| More than one window in bedroom and living room | |
| Maximise vertical opening distance | + ❄ |
| **SHADING & ORIENTATION** | |
| Shading using balcony | + ❄❄ |
| Shading using window shading elements | + ❄ |
| Orientation: Living areas not facing west | |
| **WINDOW GLAZING** | |
| Low-E glass / Tinted glass | |
| **OTHERS** | |
| High floor level and/or unobstructed frontage | + ❄ |
| Reduce anthropogenic heat | |
| **EXCEEDING EXPECTATIONS** | ❄ × 16 |

| OUTDOOR STRATEGIES | SCORING |
|---|---|
| **SHADING** | |
| Increase tree shading in open spaces and streets | + ❄❄❄ |
| Provide sun-shading canopies | + ❄❄ |
| **WIND ENVIRONMENT** | |
| Improve the wind environment in open spaces | + ❄❄ |
| Appropriate trees in upwind areas | + ❄ |
| **MATERIALS & SURFACES** | |
| Provide water features and cool surfaces | + ❄ |
| Provide green features | + ❄ |
| **RESTING PLACES** | |
| Provide furniture with low thermal conductivity | + ❄❄ |
| Distance and frequency of resting places | + ❄❄ |
| **OUTSTANDING** | ❄ × 14 |

06

## Hong Kong: Outdoor space

# Man Yee Playground

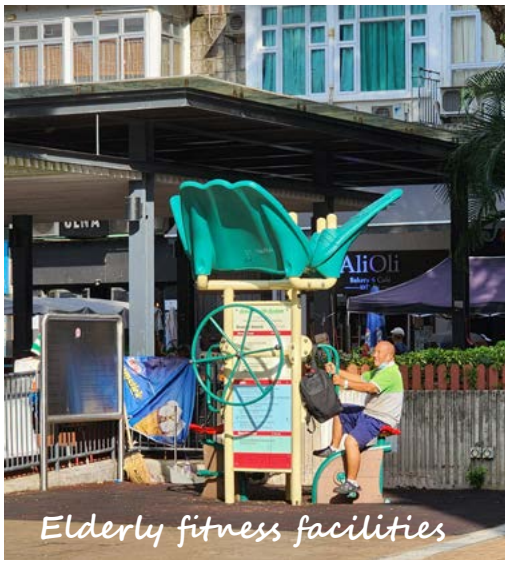
| | |
|---|---|
| Where | Man Nin Street, Sai Kung, Hong Kong |
| What | Comprised of two pavilions, a children's playground, basketball court and elderly fitness equipment. |
| Why | This public space allows people to gather, socialise, play and relax. |
| How | The playground was designed to offer shade, seating areas and facilities for senior citizens and children.<br>Trees provide shade, cooling effect and visual aesthetic.<br>Sea breezes are able to penetrate into the playground. |

Location: Hong Kong

Type: Open space

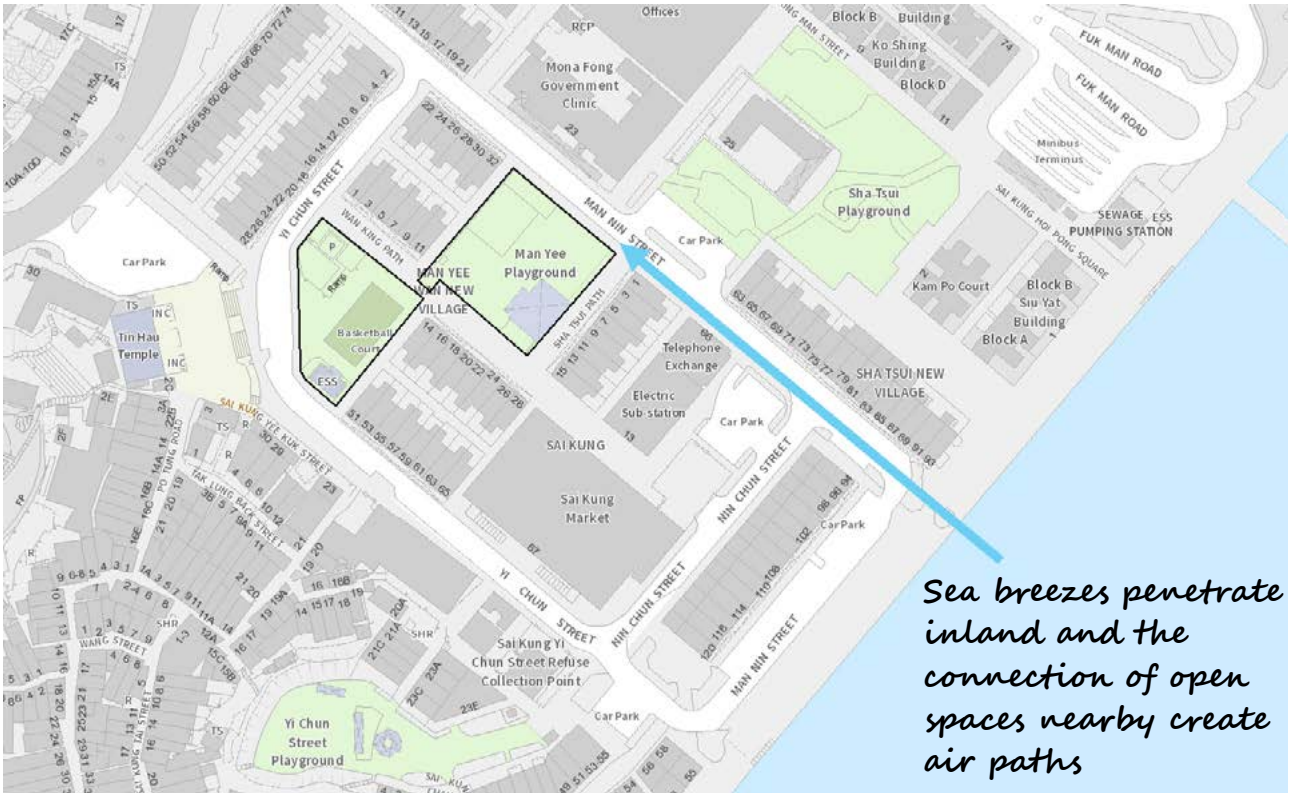
Trees scattered around the square provide shade for the public travelling through

Large shaded area with seats allow people to rest and socialise




Elderly fitness facilities


Openings on all sides facilitate better wind flow
Access points with handrails welcome senior citizens


Sea breezes penetrate inland and the connection of open spaces nearby create air paths
Mona Fong Government Clinic
Block B Building
Ko Shing Building
Block D
FUK MAN ROAD
Minibus Terminus
Sha Tsui Playground
SEWAGE PUMPING STATION
MAN NIN STREET
Car Park
Man Yee Playground
MAN YEE NEW VILLAGE
YI CHUN STREET
WAN KING PATH
Kam Po Court
Block B Siu Yat Building
Block A
Tin Hau Temple
Basketball Court
Telephone Exchange
Electric Sub-station
SHA TSUI NEW VILLAGE
SAI KUNG
Sai Kung Market
NIN CHUN STREET
Sai Kung Yi Chun Street Refuse Collection Point
Yi Chun Street Playground


Pedestrians can freely access the playground from different directions and paths


Basketball court provides spaces for group activities and excercise


Shaded seating area facing the children's playground provides opportunity for senior citizens to rest and observe children playing


*In comparison, this pavilion at the corner is not so attractive as it is isolated and much smaller.*

| OUTDOOR STRATEGIES | SCORING |
|---|---|
| **SHADING** | |
| Increase tree shading in open spaces and streets | + ❄❄❄ |
| Provide sun-shading canopies | + ❄❄ |
| **WIND ENVIRONMENT** | |
| Improve the wind environment in open spaces | + ❄❄ |
| Appropriate tree planting in upwind areas | |
| **MATERIALS & SURFACES** | |
| Provide water features and cool surfaces | |
| Provide green features | |
| **RESTING PLACES** | |
| Provide furniture with low thermal conductivity | + ❄❄ |
| Distance and frequency of resting places | + ❄❄ |
| **EXCEEDING EXPECTATIONS** | ❄ × 11 |

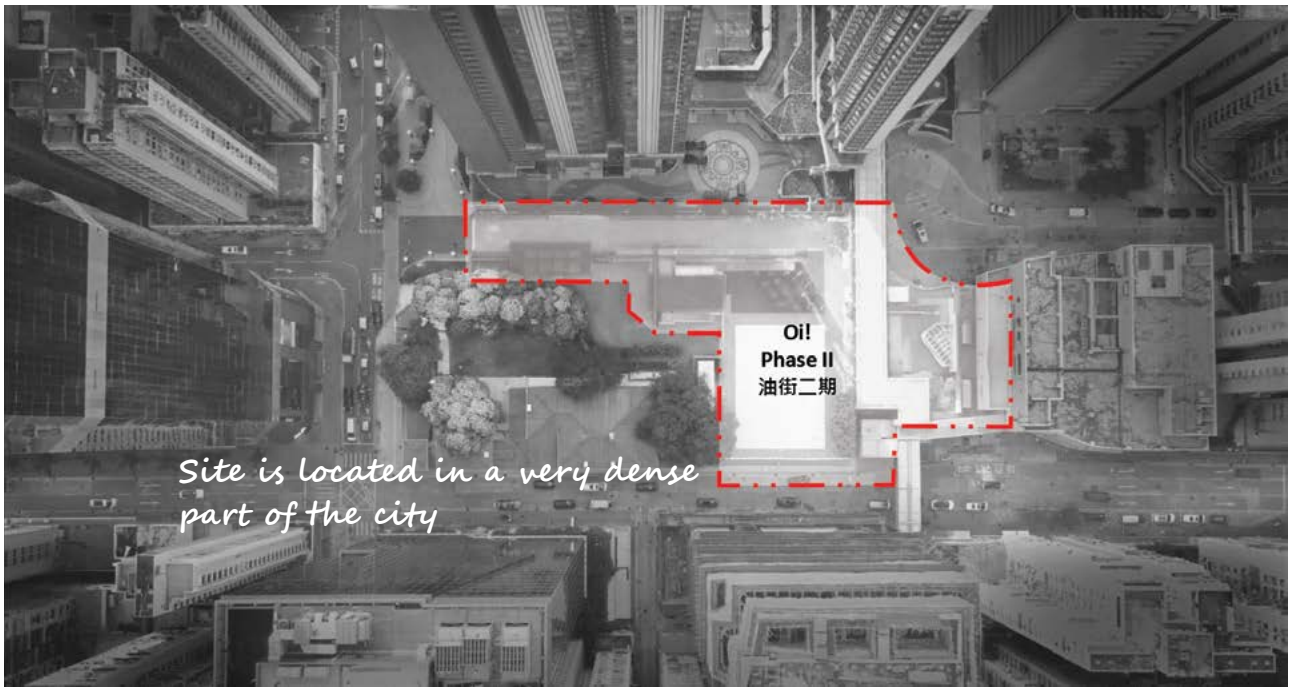
07

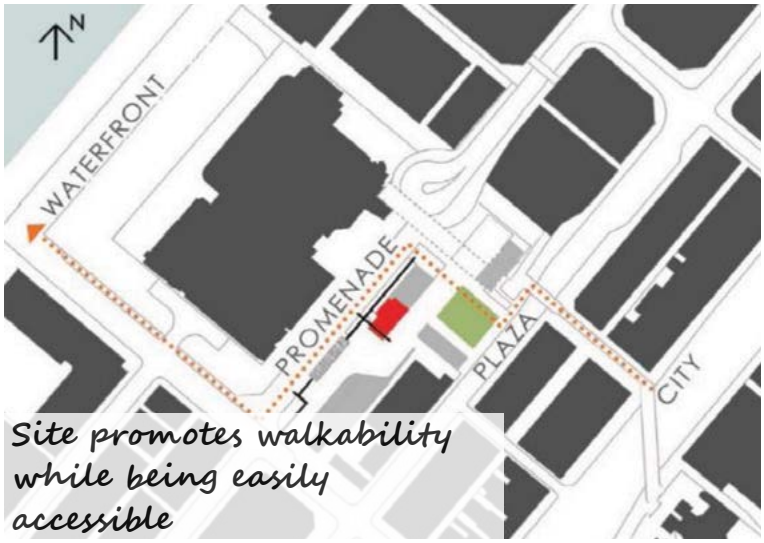
## Hong Kong: Outdoor space

# Oil Street Art Space

| | |
|---|---|
| Where | Oil Street, Fortress Hill, Hong Kong |
| What | The site contains outdoor activity spaces next to an open-air museum which is a Grade 2 historic building |
| Why | It is situated in a highly dense residential and commerical area, and provides a breathing space for the neighbourhood. |
| How | The park offers a tranquil space in bustling city, provides new spaces for art display while offering outdoor activities and interventions. The site has an open perimetier, and widened the existing footpath to encourage safety, walkability and offers wheelchair access. The old trees on the site have been presevered and offer extensive shading for areas with outdoor activities and seating. |

Location: Hong Kong
Type: Open space with historic building


Oi!
Phase II
油街二期
Site is located in a very dense part of the city


N
WATERFRONT
PROMENADE
PLAZA
CITY
Site promotes walkability while being easily accessible

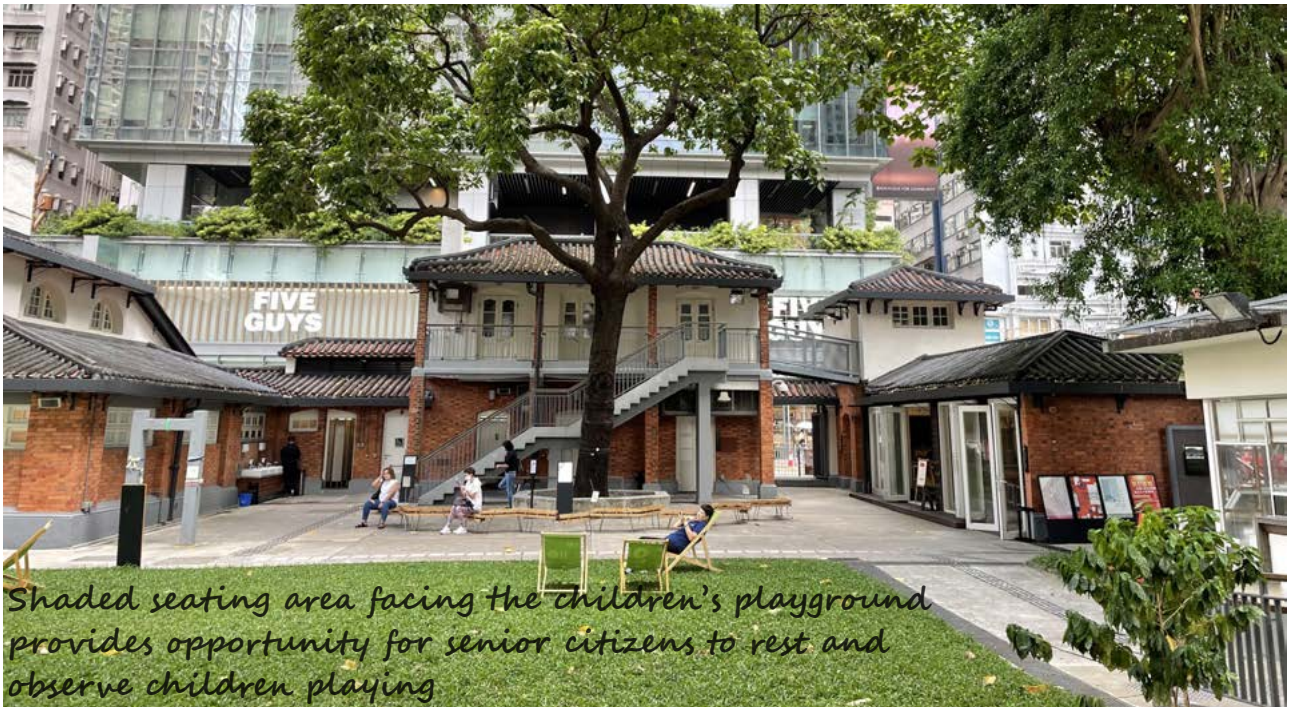

Senior in shade


Old trees are preserved, and seating is placed under tree shade

The site promotes natural ventilation and offers saded outdoor spaces

Green installations

Voids enhance natual ventilation




Shaded seating area facing the children's playground provides opportunity for senior citizens to rest and observe children playing




| OUTDOOR STRATEGIES | SCORING |
|---|---|
| **SHADING** | |
| Increase tree shading in open spaces and streets | + ❄❄❄ |
| Provide sun-shading canopies | + ❄ |
| **WIND ENVIRONMENT** | |
| Improve the wind environment in open spaces | + ❄❄ |
| Appropriate tree planting in upwind areas | + ❄❄❄ |
| **MATERIALS & SURFACES** | |
| Provide water features and cool surfaces | |
| Provide green features | + ❄ |
| **RESTING PLACES** | |
| Provide furniture with low thermal conductivity | + ❄ |
| Distance and frequency of resting places | + ❄❄ |
| **EXCEEDING EXPECTATIONS** | ❄ × 11 |

08

## Hong Kong: Outdoor space

# Blake Garden

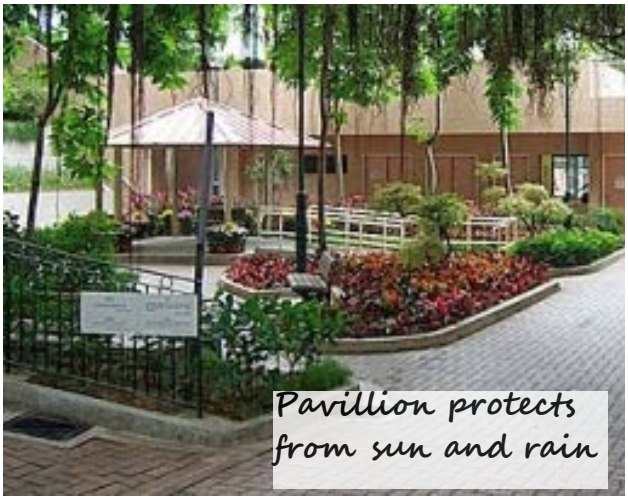
| | |
|---|---|
| Where | Kui In Fong, Sheung Wan, Hong Kong |
| What | The site contains outdoor activity spaces next to an open-air museum which is a Grade 2 historic building |
| Why | The park is located in a dense residential area, and offers valuable outdoor space for the neighbourhood. |
| How | The park provides a quiet environment in bustling city, with courts for basketball and football. There are ample and spacious resting areas that are extensively shaded by large trees. Several pavillia offer protection from the sun and rain. |

Location: Hong Kong

Type: Public Park

Resting area has many seatings and is covered by tree shade

Site promotes walkability while being easily accessible



Pavillion protects from sun and rain

Old trees are preserved, and seating is placed under tree shade

Senior citizens conduct group exercise

Tall trees in upward wind area

Shaded path with seating


Fitness stations

Shaded path

Multiple outdoor courts and children playground

| OUTDOOR STRATEGIES | SCORING |
|---|---|
| **SHADING** | |
| Increase tree shading in open spaces and streets | + ❄❄❄ |
| Provide sun-shading canopies | + ❄ |
| **WIND ENVIRONMENT** | |
| Improve the wind environment in open spaces | + ❄❄ |
| Appropriate tree planting in upwind areas | + ❄❄❄ |
| **MATERIALS & SURFACES** | |
| Provide water features and cool surfaces | |
| Provide green features | + ❄ |
| **RESTING PLACES** | |
| Provide furniture with low thermal conductivity | + ❄ |
| Distance and frequency of resting places | + ❄❄ |
| **EXCEEDING EXPECTATIONS** | ❄ × 11 |

08

## Hong Kong: Outdoor space

# Tong Shui Road Garden

Where — Tong Shui Road, North Point, Hong Kong

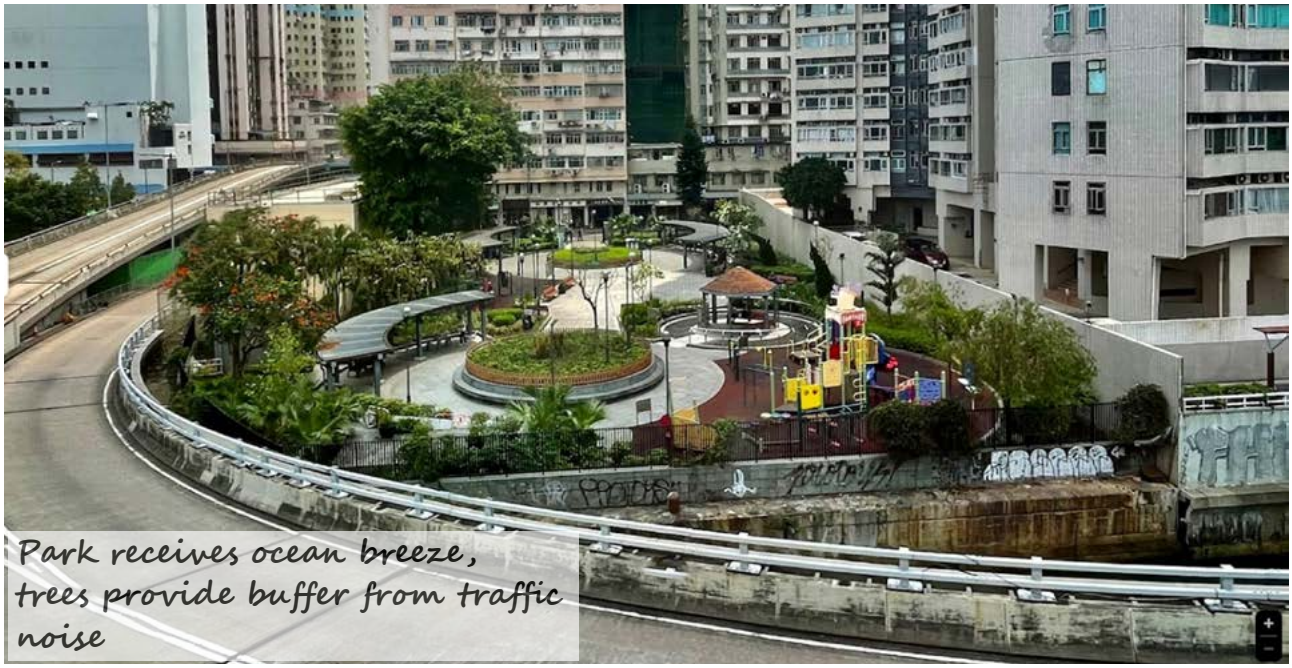
What — The park is adjacent to the harbour and receives plenty of natural ventilation. The park is surrounded by tall buildings on either side providing shading for most of time.

Why — The park is located in a dense residential area, and offers valuable outdoor space for the neighbourhood. Seating areas are covered by trellis canopies which offer protection from direct sun and rain.

How — The park provides a cooler environment due to breezes received from the harbour. It is also adjacent to a larger park, the North Point promenade. The short distance and frequency of parks promotes walkability for older citizens.

Location: Hong Kong

Type: Public Park

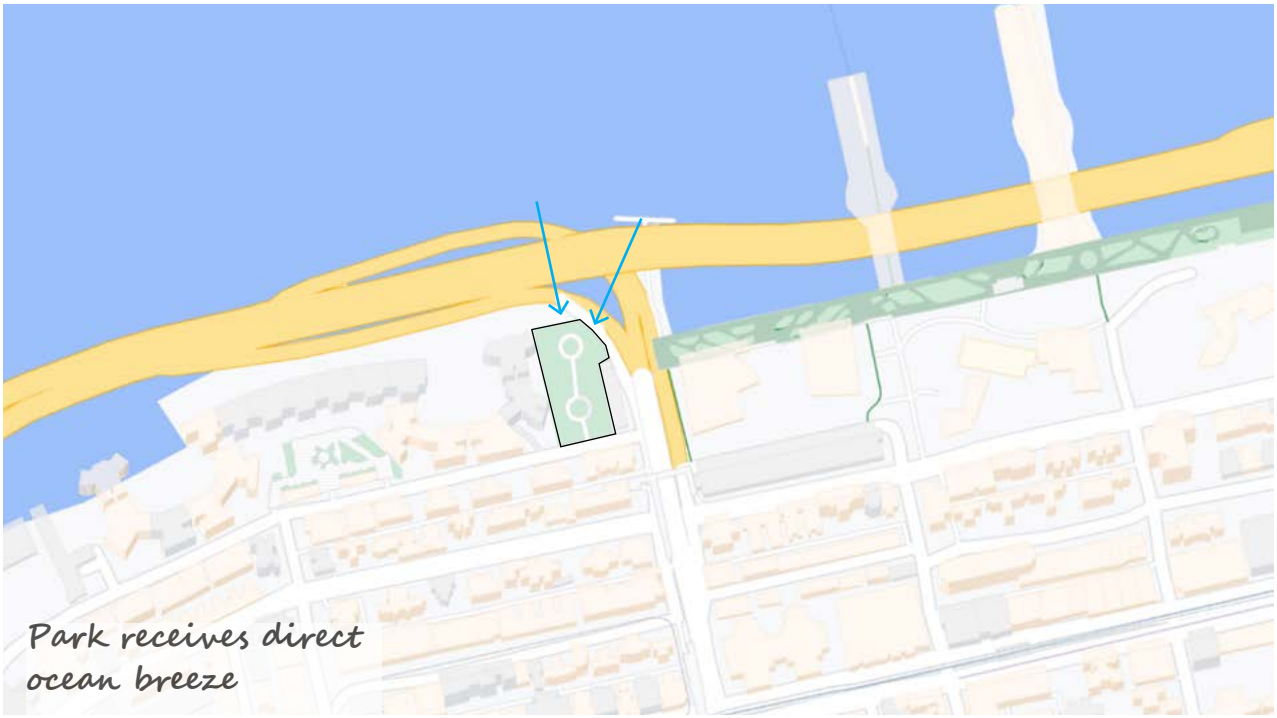


Park receives ocean breeze, trees provide buffer from traffic noise

Surrounding buildings provide ample shading

Pavillion protects from sun and rain

Senior citizens can play board games under canopy trellis


Park receives direct
ocean breeze


Buildings shade
from western sun


Shaded path
with seating


Fitness stations


Shaded
resting area

Tall trees allow upwind through park

Senior citizens rest under trellis

| OUTDOOR STRATEGIES | SCORING |
|---|---|
| **SHADING** | |
| Increase tree shading in open spaces and streets | + ❄❄ |
| Provide sun-shading canopies | + ❄❄❄ |
| **VENTILATION** | |
| Improve the wind environment in open spaces | + ❄❄❄ |
| Appropriate tree planting in upwind areas | + ❄❄ |
| **MATERIALS & SURFACES** | |
| Provide water features and cool surfaces | |
| Provide green features | + ❄ |
| **RESTING PLACES** | |
| Provide furniture with low thermal conductivity | + ❄ |
| Distance and frequency of resting places | + ❄❄ |
| **EXCEEDING EXPECTATIONS** | ❄ × 11 |

# COOL SPOTS

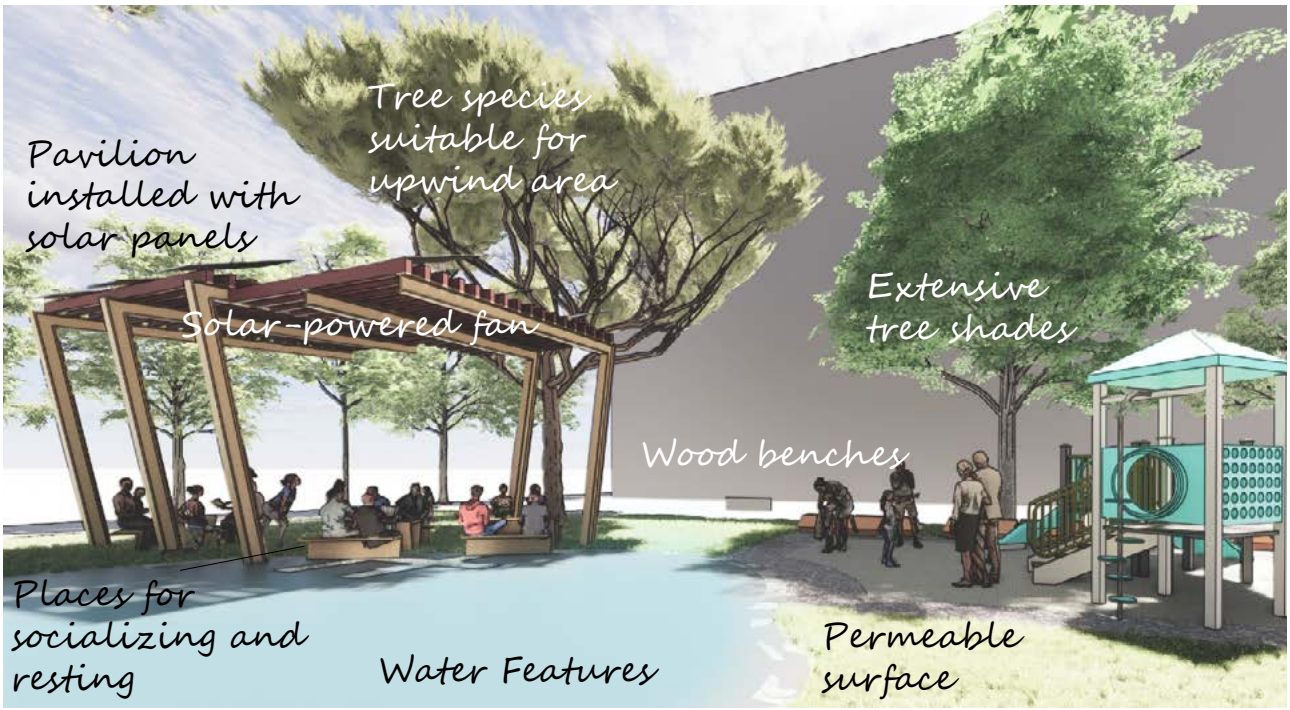
# Definition of cool spots

Parks / open spaces / squares / sitting-out areas at neighbourhoods, surrounded by buildings or roads

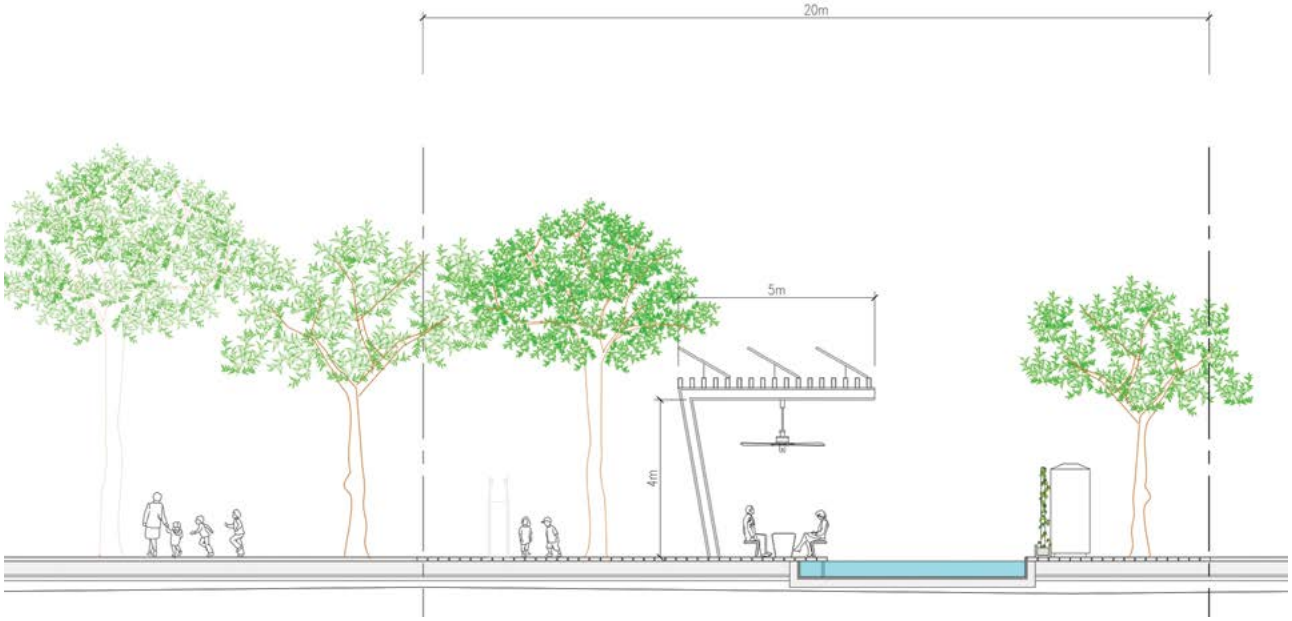
To provide comfortable environment for senior citizens at outdoors

DESIGN ELEMENTS
A combination of extensive tree planting, water features, cool surfaces and solar-powered cooling system are desired.

ACTIVITIES FOR MENTAL WELL-BEING
Providing activities for senior citizens in cool spots can make them feel engaged and stimulated, which could in turn reduce the probability of feeling depressed and irritable during the hot weather, and help support mental well-being.



# An illustration of cool spot

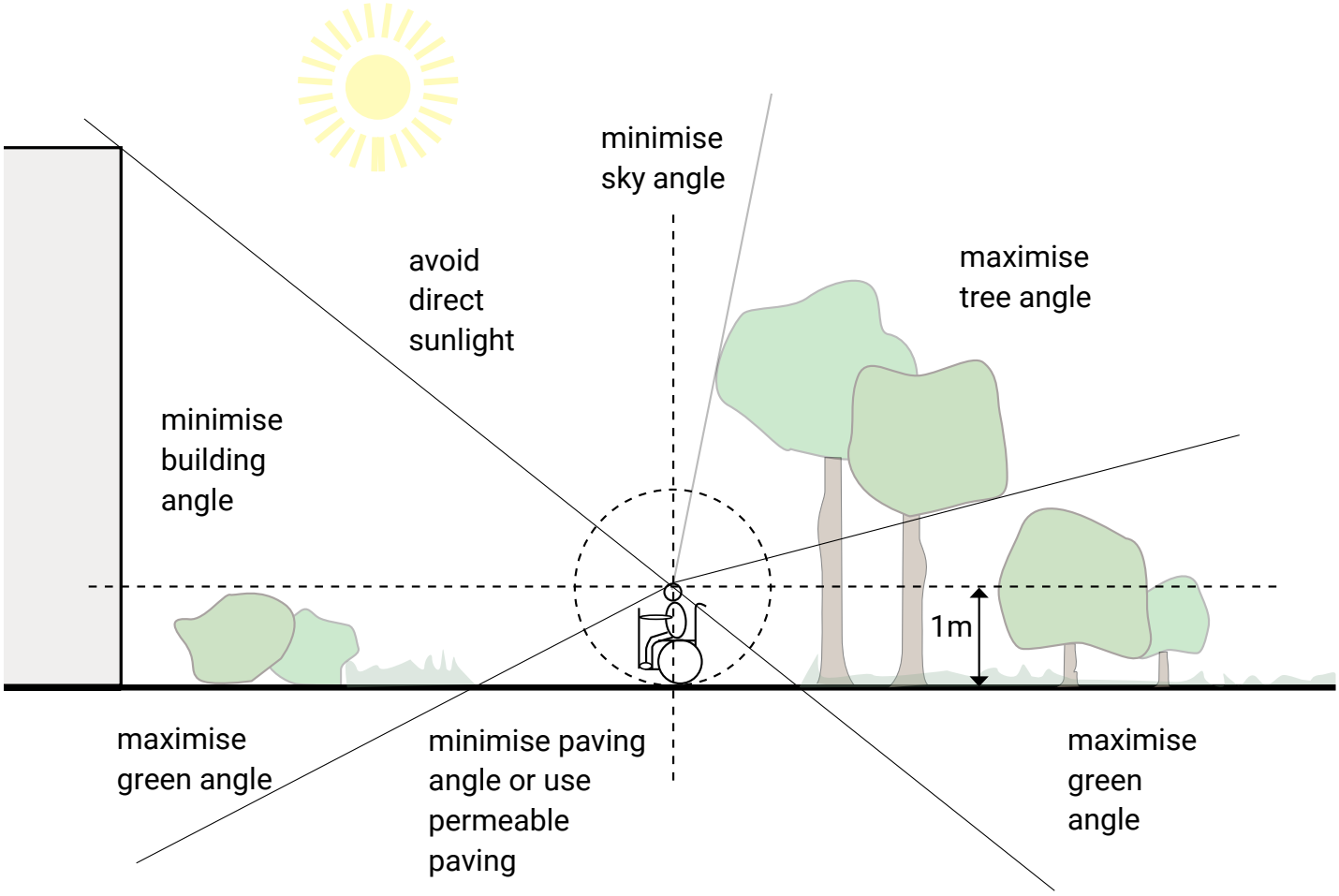
# Way Forward

This design guidebook is being developed to introduce various indoor and outdoor heat mitigation strategies for urban planners, architects, developers, and other professionals in the building industry. The guidebook emphasizes the urgency for concrete improvements to the urban environment and highlights the health impacts of extremely hot weather, providing clarity on these important issues.

Given that the research team is now conducting research for an annual understanding of future climate trends, the official release of the Guidebook will be timed to coincide with the completion of the annual climate trend analysis, ensuring the final document provides a holistic and up-to-date set of recommendations.

# Appendix 1:
# How to Understand the Urban (Thermal-radiative) Environment Using View Angles

For the sake of simplicity, a 2D view angle is illustrated below. However, it is important that architects and designers should employ a 3D view angle in their actual practice.



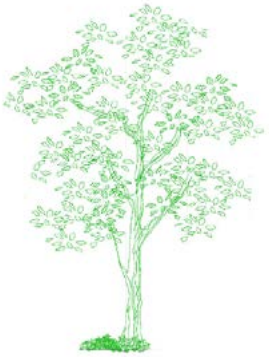
Appendix 2:

# Tree Species

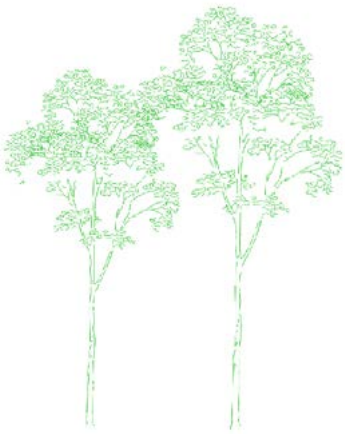
Three different conditions will be considered for tree planting in terms of tree species.

1. Extensive tree shade to provide shading for human activities in open spaces.
2. Trees with tall trunks and moderately dense tree crowns in upwind areas.
3. Tree species that are not recommended due to limited environmental benefits.

01



02



03

## Examples: The top 20 common urban trees

The tree species listed on the top 20 urban common trees in the “Street Tree Selection Guide” have been categorised into three aforementioned conditions for reference. Among these, tree species with a fast-growing rate are preferred, whereas invasive alien species and palm trees should be avoided.

However, as this list only provides limited information, it is highly recommended to consult with landscape architects to identify suitable tree species as they will consider other site-specific considerations in addition to thermal comfort issues.

# 01 Extensive tree shading to provide shading for human activities in open spaces

## *Acacia confusa*
TAIWAN ACACIA

| | |
|---|---|
| HEIGHT | 6-15 m |
| CROWN SPREAD | UP TO 10 m |
| GROWING HABIT | EVERGREEN |
| DISTRIBUTION | EXOTIC |
| RECOMMENDATION | ❄❄❄ |

## *Aleurites moluccana*
CANDLENUT TREE

| | |
|---|---|
| HEIGHT | UP TO 18 m |
| CROWN SPREAD | UP TO 8 m |
| GROWING HABIT | EVERGREEN |
| DISTRIBUTION | EXOTIC |
| RECOMMENDATION | ❄❄❄ |

## *Bauhinia variegata*
CAMEL'S FOOT TREE

| | |
|---|---|
| HEIGHT | UP TO 15 m |
| CROWN SPREAD | UP TO 7 m |
| GROWING HABIT | SEMI-DECIDUOUS |
| DISTRIBUTION | EXOTIC |
| RECOMMENDATION | ❄❄❄ |

## *Bauhinia x blakeana*
HONG KONG ORCHID TREE

| | |
|---|---|
| HEIGHT | 8-10 m |
| CROWN SPREAD | UP TO 15 m |
| GROWING HABIT | EVERGREEN |
| DISTRIBUTION | NATIVE |
| RECOMMENDATION | ❄❄❄ |

## *Celtis sinensis*
CHINESE HACKBERRY

| | |
|---|---|
| HEIGHT | UP TO 10 m |
| CROWN SPREAD | UP TO 15 m |
| GROWING HABIT | DECIDUOUS |
| DISTRIBUTION | NATIVE |
| RECOMMENDATION | ❄❄❄ |

## *Cinnamomum camphora*
CAMPHOR TREE

| | |
|---|---|
| HEIGHT | UP TO 30 m |
| CROWN SPREAD | UP TO 20 m |
| GROWING HABIT | DECIDUOUS |
| DISTRIBUTION | NATIVE |
| RECOMMENDATION | ❄❄❄ |

## *Delonix regia*
FLAME OF THE FOREST

| | |
|---|---|
| HEIGHT | UP TO 20 m |
| CROWN SPREAD | UP TO 25 m |
| GROWING HABIT | DECIDUOUS |
| DISTRIBUTION | EXOTIC |
| RECOMMENDATION | ❄❄❄ |

## *Ficus microcarpa*
CHINESE BANYAN

| | |
|---|---|
| HEIGHT | UP TO 25 m |
| CROWN SPREAD | UP TO 15 m |
| GROWING HABIT | EVERGREEN |
| DISTRIBUTION | NATIVE |
| RECOMMENDATION | ❄❄❄ |

## *Hibiscus tiliaceus*
SEA HIBISCUS

| | |
|---|---|
| HEIGHT | 3-7 m |
| CROWN SPREAD | UP TO 8 m |
| GROWING HABIT | EVERGREEN |
| DISTRIBUTION | NATIVE |
| RECOMMENDATION | ❄❄❄ |

## *Lagerstroemia speciosa*
QUEEN CRAPE MYRTLE

| | |
|---|---|
| HEIGHT | UP TO 8 m |
| CROWN SPREAD | UP TO 6 m |
| GROWING HABIT | DECIDUOUS |
| DISTRIBUTION | EXOTIC |
| RECOMMENDATION | ❄❄❄ |

## *Lophostemon confertus*

BRISBANE BOX

| | |
|---|---|
| HEIGHT | UP TO 20 m |
| CROWN SPREAD | 10-15 m |
| GROWING HABIT | EVERGREEN |
| DISTRIBUTION | EXOTIC |
| RECOMMENDATION | ❄❄ |

## *Macaranga tanarius var. tomentosa*

ELEPHANT'S EAR

| | |
|---|---|
| HEIGHT | 5-10 m |
| CROWN SPREAD | UP TO 5 m |
| GROWING HABIT | EVERGREEN |
| DISTRIBUTION | NATIVE |
| RECOMMENDATION | ❄❄❄ |

## *Spathodea campanulata*

AFRICAN TULIP TREE

| | |
|---|---|
| HEIGHT | 10-15 m |
| CROWN SPREAD | 10-15 m |
| GROWING HABIT | EVERGREEN |
| DISTRIBUTION | EXOTIC |
| RECOMMENDATION | ❄ |

## *Sterculia lanceolata*

LANCE-LEAVED STERCULIA

| | |
|---|---|
| HEIGHT | 6-15 m |
| CROWN SPREAD | UP TO 8 m |
| GROWING HABIT | EVERGREEN |
| DISTRIBUTION | NATIVE |
| RECOMMENDATION | ❄❄❄ |

# 02 Tree species with tall trunks and moderately tree crowns in upwind areas

## *Casuarina equisetifolia*
HORSETAIL TREE

| | |
|---|---|
| HEIGHT | 15-25 m |
| CROWN SPREAD | UP TO 8 m |
| GROWING HABIT | EVERGREEN |
| DISTRIBUTION | EXOTIC |
| RECOMMENDATION | ❄❄❄ |

## *Eucalyptus spp.*

| | |
|---|---|
| HEIGHT | 18-28 m |
| CROWN SPREAD | VARIES |
| GROWING HABIT | EVERGREEN |
| DISTRIBUTION | EXOTIC |
| RECOMMENDATION | ❄❄❄ |

## *Mallotus paniculatus*
TURN-IN-THE-WIND

| | |
|---|---|
| HEIGHT | 3-15 m |
| CROWN SPREAD | UP TO 4 m |
| GROWING HABIT | DECIDUOUS |
| DISTRIBUTION | NATIVE |
| RECOMMENDATION | ❄❄❄ |

## *Melaleuca quinquenervia*
PAPER-BARK TREE

| | |
|---|---|
| HEIGHT | 18 m |
| CROWN SPREAD | UP TO 8 m |
| GROWING HABIT | EVERGREEN |
| DISTRIBUTION | NATIVE |
| RECOMMENDATION | ❄❄❄ |

## *Heptapleurum heptaphyllum*
IVY TREE

| | |
|---|---|
| HEIGHT | UP TO 10 m |
| CROWN SPREAD | 5-10 m |
| GROWING HABIT | EVERGREEN |
| DISTRIBUTION | NATIVE |
| RECOMMENDATION | ❄❄❄ |

# 03 Tree species that are not recommended due to limited environmental benefits

## *Livistona chinensis*

CHINESE FAN PALM

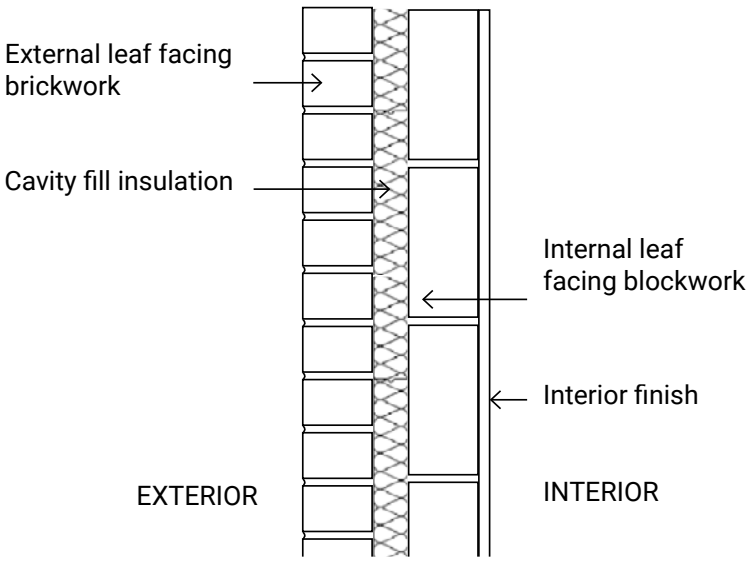
| | |
|---|---|
| HEIGHT | 10 m |
| CROWN SPREAD | 8 m |
| GROWING HABIT | EVERGREEN |
| DISTRIBUTION | EXOTIC |
| RECOMMENDATION | ❄ |

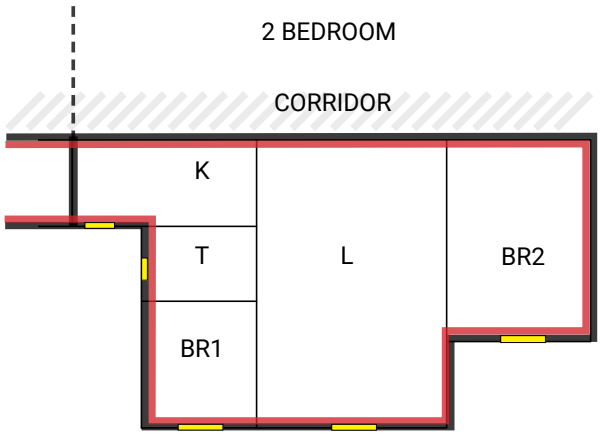
Appendix 3:

# Thermal Insulation

Although thermal insulation is commonly adopted in Hong Kong, as Hong Kong's climate is sub-tropical with modest temperature difference, this strategy has negligible impact on reducing energy required for heating and cooling.

## Wall insulation

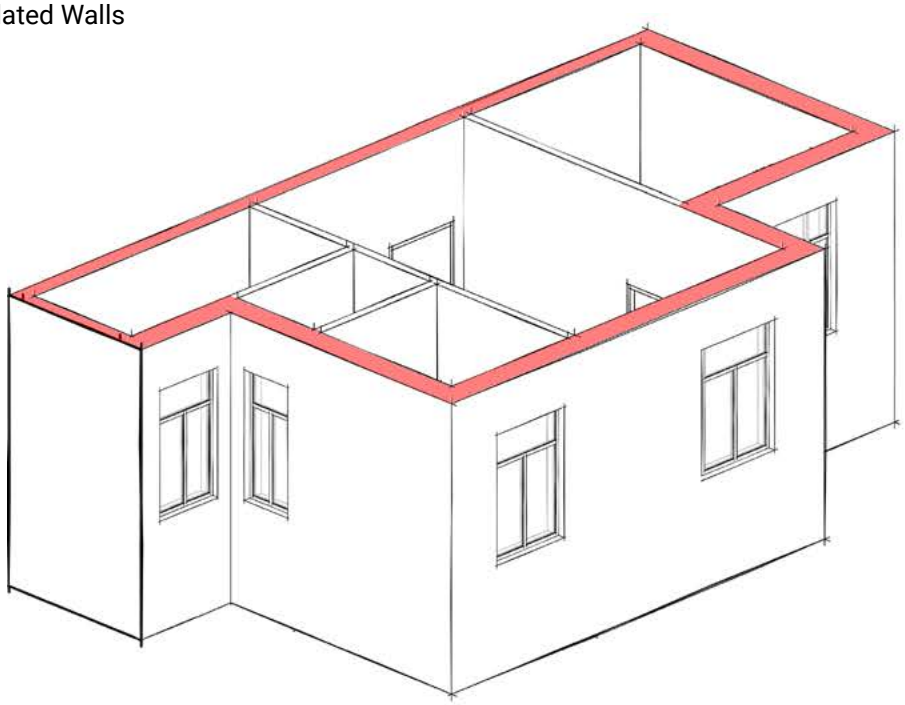





Plan of simulated flat

Windows

Thermally Insulated Walls



Appendix 4:

# Simulation Settings

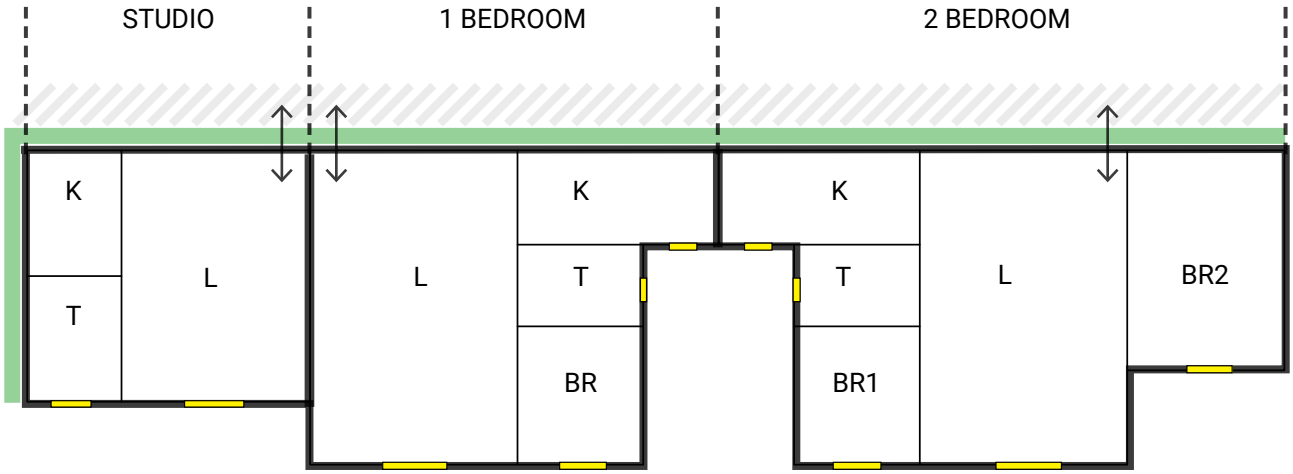
The outdoor strategies introduced in this guidebook are based on simulations conducted recently on the environmental performance of a high-rise residential building in Hong Kong. The simulation was carried out using Energy Plus (version 9.4) and the dataset of extreme weather conditions (i.e. near-extreme summer meteorological dataset generated by the Summer Reference Year approach). Wind direction is based on the measured wind data of Hong Kong Observatory Headquarters.

The simulation model is built on the layout of a typical high-rise residential buildings. Simulations were conducted for three flat types including 1-person without bedroom (studio), 2-persons with one bedroom (1 bedroom) and 4-persons with two bedrooms (2 bedroom).

The strategies have been examined to evaluate their effects on two different criteria: whether air-conditioning is required or not.

1. **Shoulder periods in May and September:**
Whether the elderly are able to maintain a comfortable indoor environment without air-conditioning but instead turn on ventilation fans whenever necessary, i.e. the increase in comfort time.

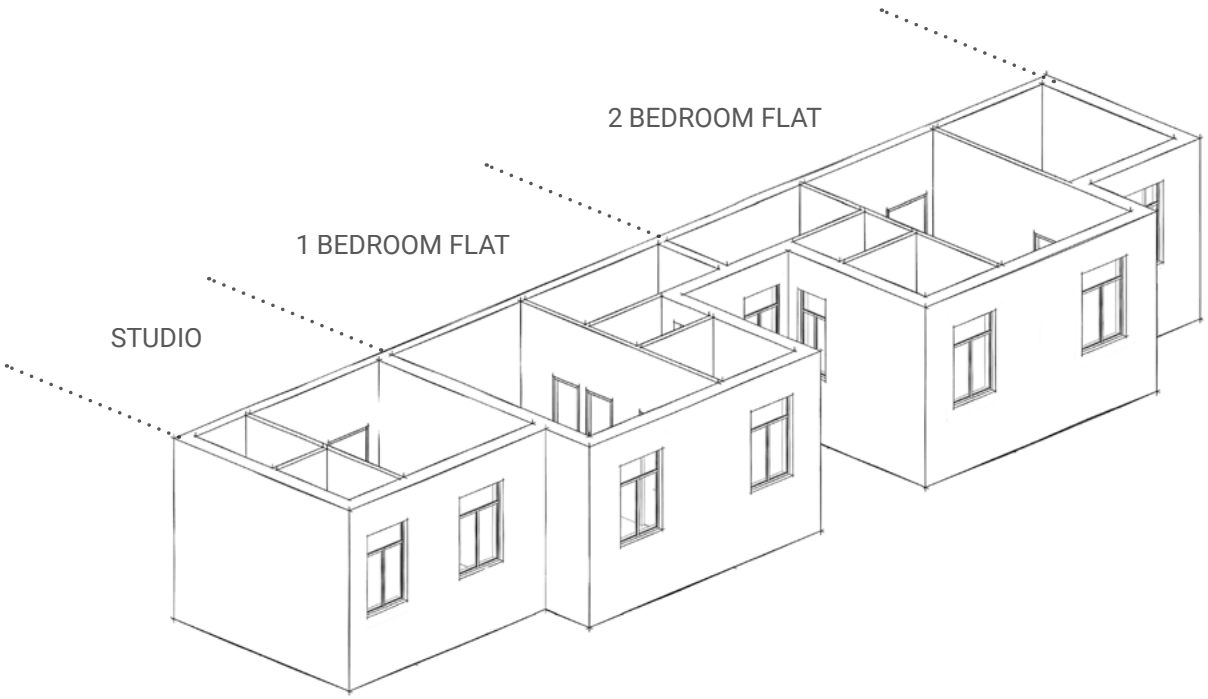
2. **Peak-load period from June to August:**
The potential to save energy in space cooling when the control set point for air conditioning is set to 25-26 °C whilst maintaining the thermal comfort of occupants (i.e. below 29°C for the elderly staying indoors).



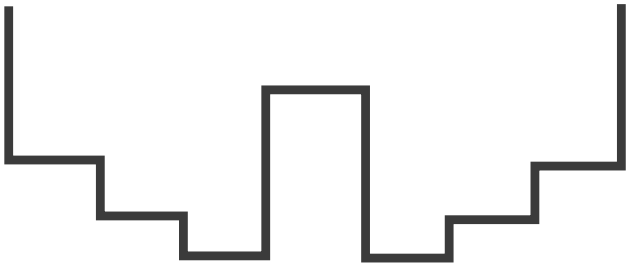

Plan of simulated flat

Windows

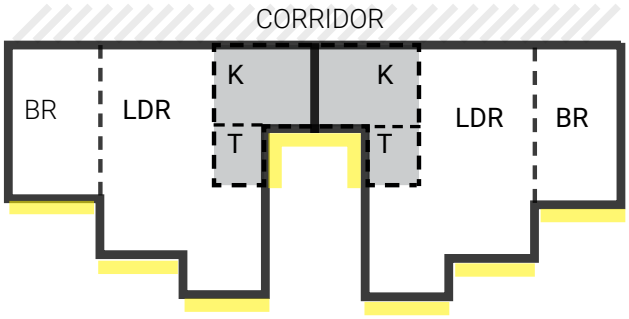
Non-heat transfer walls



# 1. Traditional Housing Block

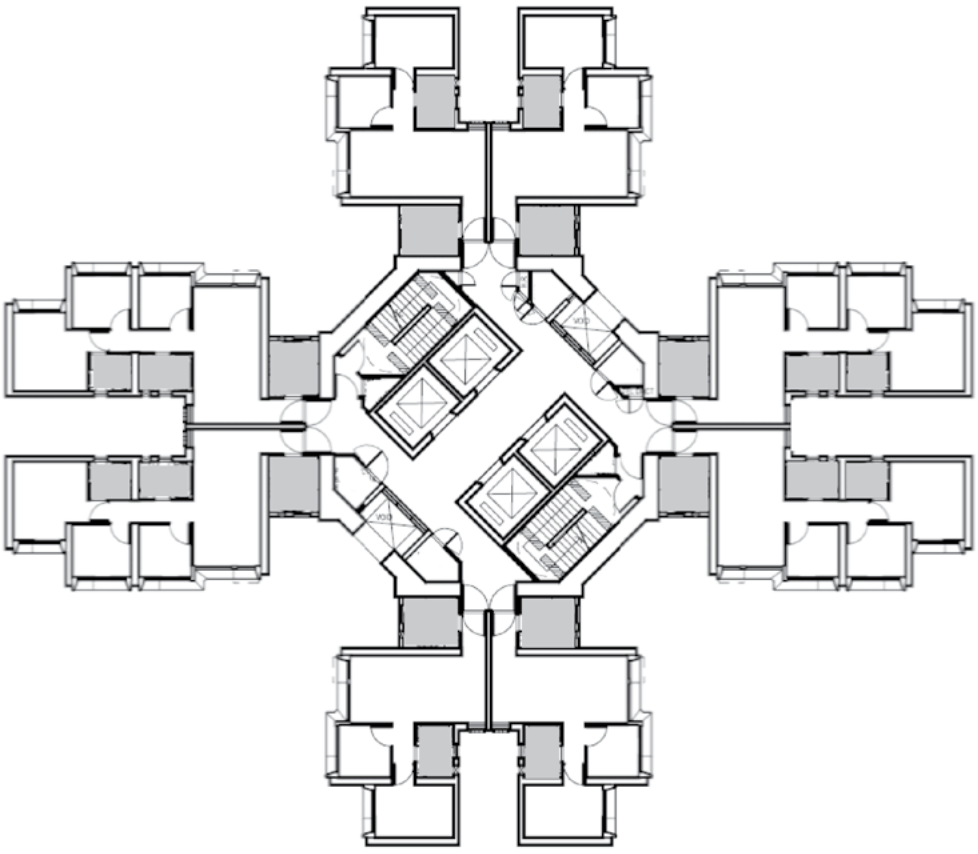


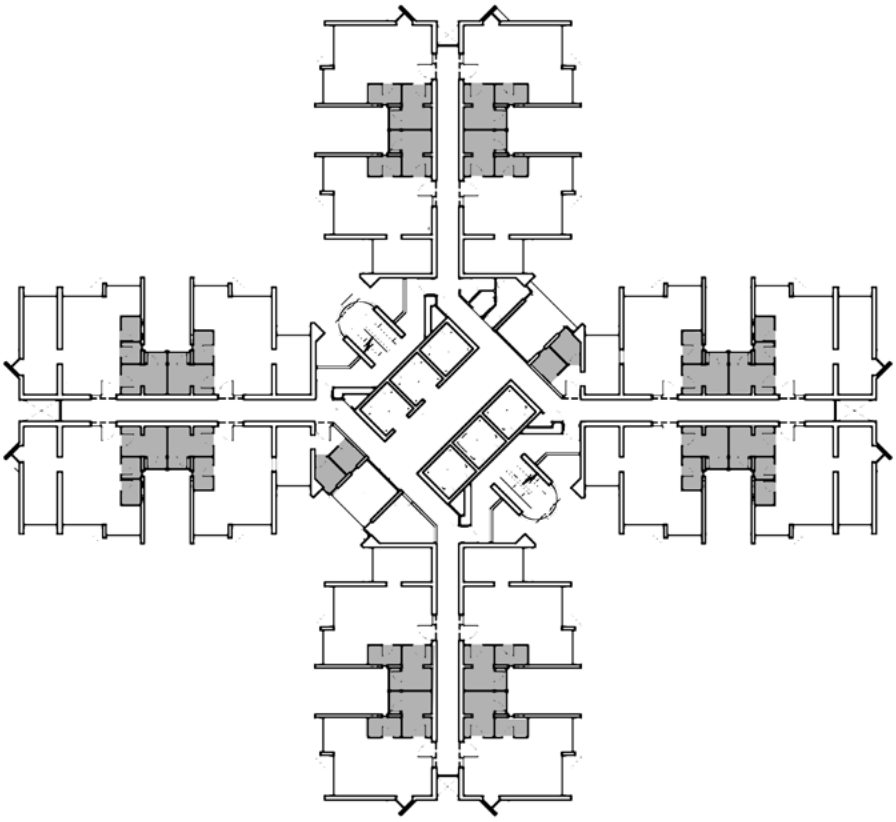
Undulating form allows increased ventilation area and access to natural light

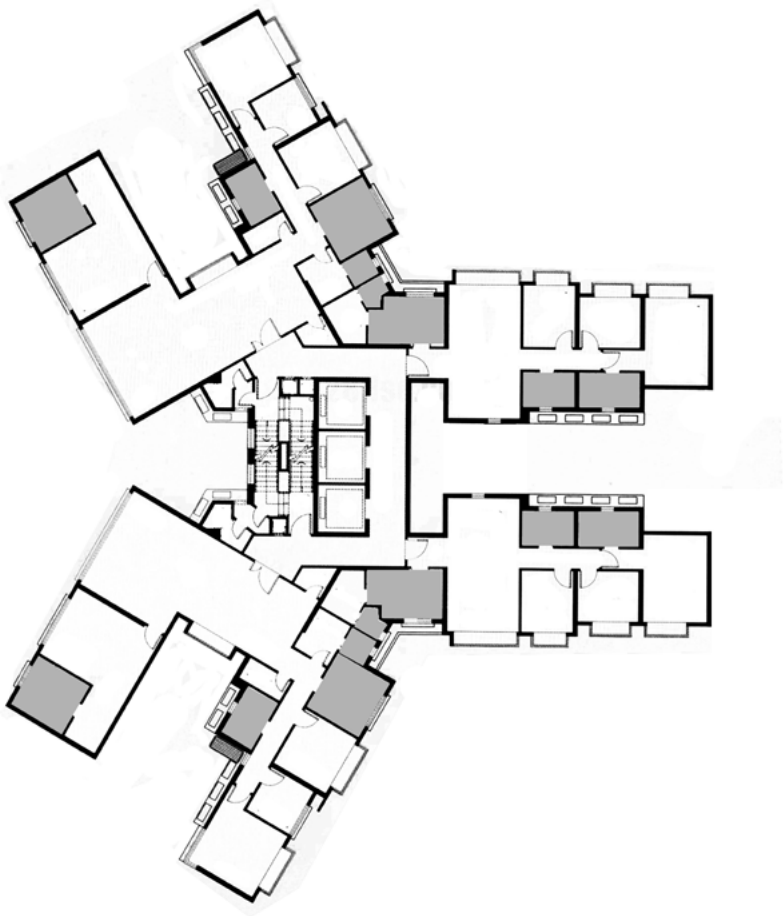



Toilet and kitchen have access to natural light.

Windows

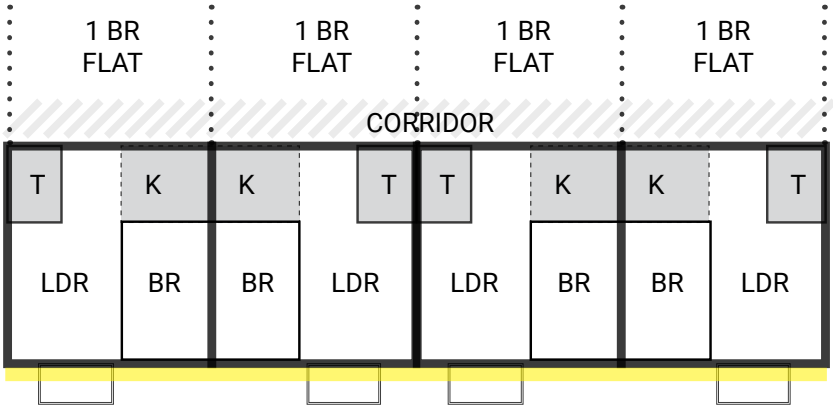






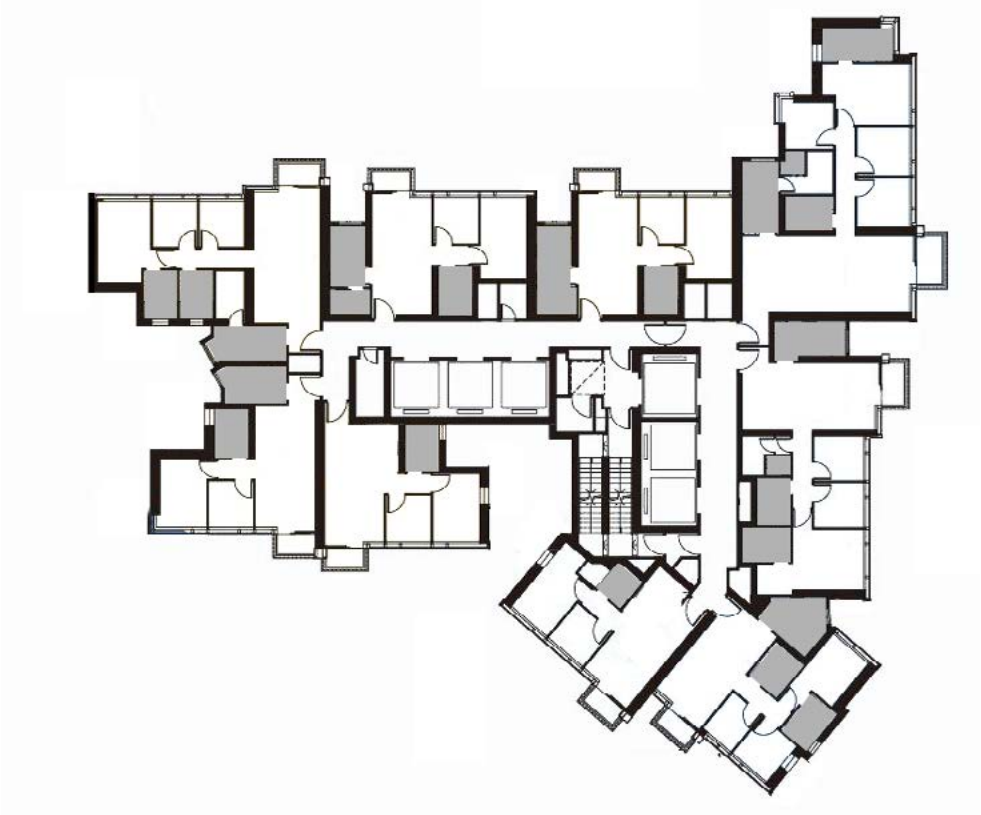
# 2. Curtain Wall Housing Blocks

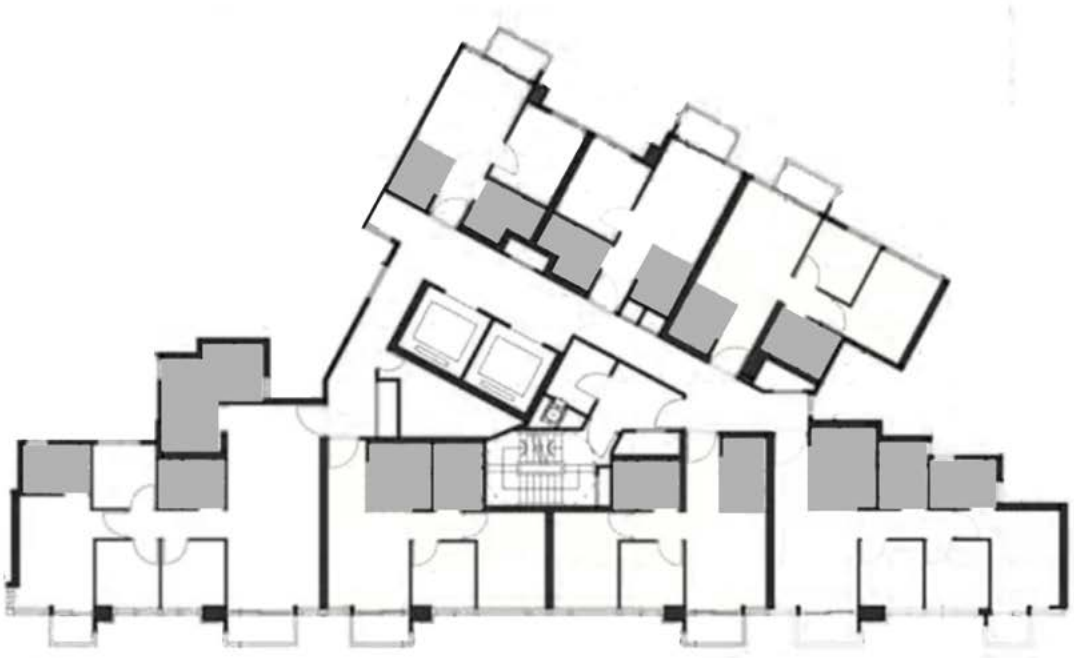
Flat curtain wall with no shading and limited ventilation/ access to natural light




Kitchen and toilet are arranged away from curtain wall, thus receive no sunlight & natural ventilation.

Windows





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# Project Team

The Chinese University of Hong Kong

City University of Hong Kong

The University of Science and Technology

University of Hong Kong

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