A Vertical Approach to Monitoring Microclimates of Urban Street Canyons

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Introduction

The lack of greenery along with high traffic volumes and high density development are some causes of thermal discomfort in urban areas.

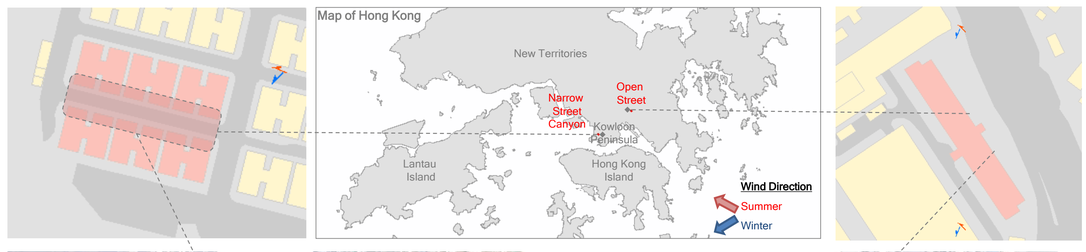
This study utilized a network of small and low-cost logging sensors to measure the vertical temperature variation within a narrow street canyon and at an open street. The logging sensors were installed on every other storey of a building to take temperature measurements in the hot and cold months. The results were visualized and presented using a geographic information system (GIS).

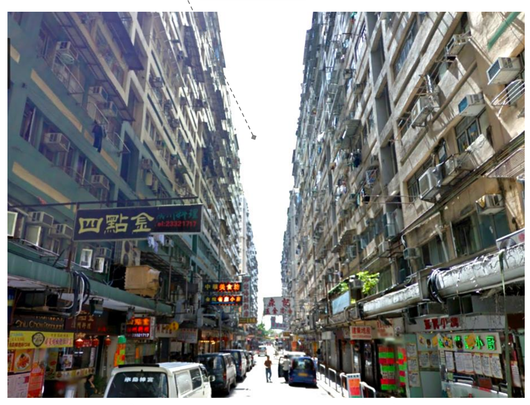
Data and Methods

Study Area

Hong Kong (22°15'N, 114°10'E) has a combination of mountainous terrain and densely built high-rises. It has a monsoon-influenced humid subtropical climate (Köppen classification Cwa) characterized by hot humid summers and mild winters [1]. Most summer days have high humidity with warm air coming from the south, creating local thermal discomfort.

Two typical street configurations, i.e., a narrow street canyon (H/W ratio ≈ 7.3) and an open street, were selected in this study. Both sites are located in urban Kowloon (see map below) with high levels of population and traffic flow. The general wind directions are from the south-east (summer) and north-east (winter).

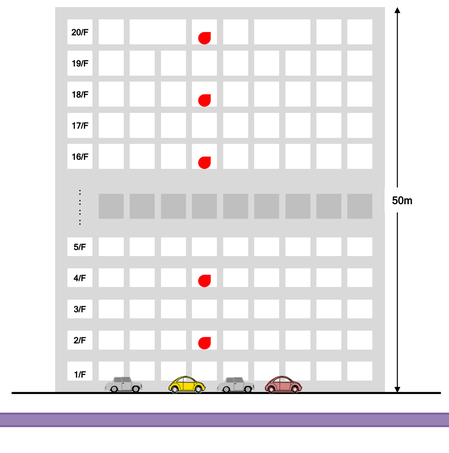



A narrow street canyon - Jordan


An open street - Choi Hung

Microclimate Data Collection

- A set of 20 small logging sensors were deployed to measure vertical air temperature changes at 15-minute interval for 7 consecutive days in both hot and cold months.
- Sensors were all calibrated and mounted on the walls of the buildings at vertical distances of every 2 storeys (5-6m) apart up to 17-20 storeys (≈50 meters) above the street level.



Method of Analysis

- Air temperature measured by sensors in hot and cold months were averaged daily for 6 full days and plotted against the storey level as line graphs to exhibit a vertical profile of temperature behavior.
- Temperature variations for each street configuration (a narrow street canyon and an open street) were compared by graphical means.

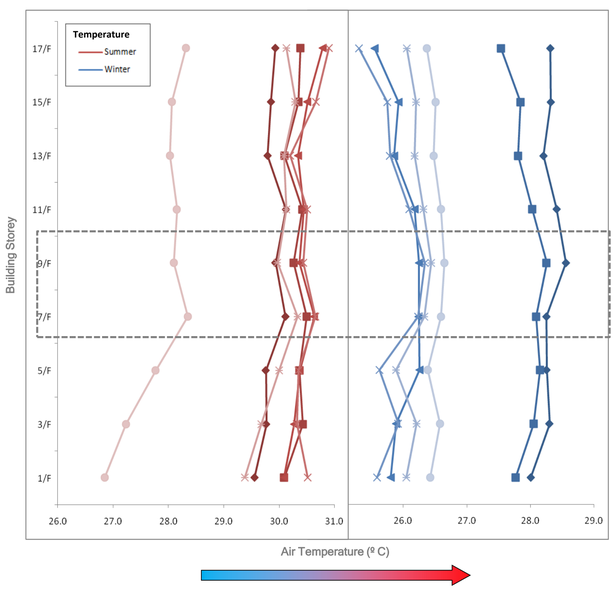
Results and Discussion

Average values in both hot and cold months indicated dissimilar vertical temperature distribution for the two street configurations; likely caused by microclimate differences (e.g., wind directions) and neighborhood morphology.

References:

[1] Siu, L. & Hart, M. (2013) Quantifying urban heat island intensity in Hong Kong SAR, China. Environmental Monitoring and Assessment, 1-16.

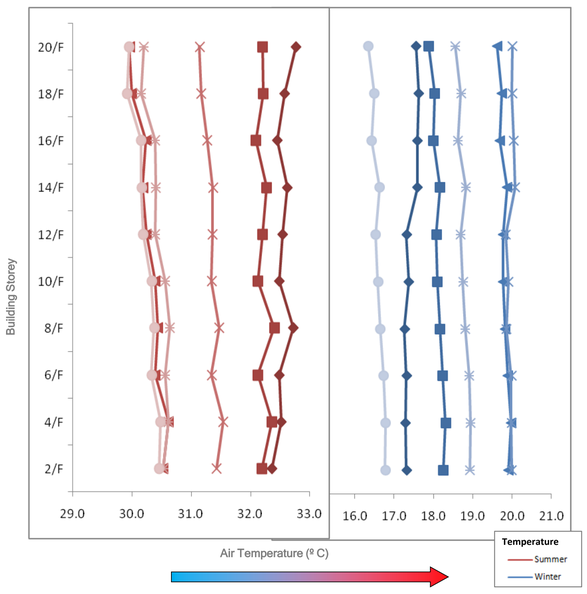
[2] Chan, LY. & Kwok, WS. (2000) Vertical Dispersion of suspended particulates in urban area of Hong Kong, Atmospheric Environment, 34, 4403-4412.



Narrow Street Canyon

The narrow street canyon registered warmer temperature trend towards higher floors up to about 7-9 storeys in both seasons. Shadings from adjacent buildings could explain lower temperature values near ground level.

High temperature values persisted from 9/F to 17/F in the summer (red lines) where heat was trapped within the narrow street canyon. A decreasing trend above 9/F was observed in the winter (blue lines) due to potential air movement cooling effect on the windward side.



Open Street

Vertical temperatures did not appear affected by height for the open street configuration. The pattern of temperature variation remained consistent in both hot and cold months, with higher readings for the former.

The results echoed findings similar to an earlier research [2] reporting that the open street setting of Hong Kong did not show specific pattern in the vertical dispersion of suspended particulates.

Conclusion

- This observational study may not be precise but it furnishes interesting findings about vertical microclimate variation even though more refined measurements (including wind speeds and directions) are necessary to explain factors contributing to the variation.
- Given that modern cities have mixed land uses and are increasingly vertical, this kind of microclimate study can better inform best practice on street designs and building forms.

Acknowledgements
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