WILLINGNESS TO PAY FOR URBAN HEAT ISLAND MITIGATION: A CASE STUDY OF SINGAPORE

(BORZINO, CHNG, MUGHAL AND SCHUBERT, 2020)

SUPPLEMENTARY MATERIAL: SURVEY QUESTIONNAIRE

PART 1 - Demographic variables collected pre-survey

MARITAL STATUS: ● Single ● Married ● Prefer not to say
HIGHEST EDUCATION LEVEL: ● Primary & below ● N/O levels ● Nitec/Higher Nitec ● A levels/Diploma ● Bachelors ● Postgraduate ● Other qualification:_____ ● Prefer not to say
WHAT IS YOUR EMPLOYMENT STATUS? ● Student ● Employed (full/part-time) ● Unemployed (seeking employment) ● Unemployed (not seeking employment) ● Others:_____ ● Prefer not to say
NUMBER OF CHILDREN (UNDER 18) IN YOUR HOUSEHOLD: _____ Prefer not to say
NUMBER OF ADULTS (INCLUDING YOU) IN YOUR HOUSEHOLD: _____ Prefer not to say
FIRST 3 POSTCODE OF RESIDENCE: _____ Prefer not to say
POSTCODE OF WORKPLACE: _____ Prefer not to say

IN A TYPICAL DAY, HOW MANY HOURS DO YOU SPEND OUTDOORS (ie, not in enclosed environments)?

- Less than 2 hours
- 2 to 4 hours
- 4 to 6 hours
- More than 6 hours

The amount of time spent outdoors above is because of…

- Work
- Leisure

TOTAL NUMBER OF YEARS YOU'VE RESIDED IN SINGAPORE:_____

In general, would you say your health is?

- Excellent
- Very good
- Good
- Fair
- Poor
- Prefer not to say

PART 2 - Environmental attitudes and awareness

Words in bold will not be in the survey

ATTITUDE TOWARDS SPENDING TIME OUTDOORS

Q: For me, spending time outdoors (compared to being indoors) is unenjoyable.
Q: For me, spending time outdoors (compared to being indoors) is pleasant during the day.
Q: For me, spending time outdoors (compared to being indoors) is pleasant during the night.

strongly agree	agree	somewhat agree	neutral	somewhat disagree	disagree	strongly disagree

ATTITUDE TOWARDS SUPPORTING MITIGATION STRATEGIES FOR OTC

Q: Improving the thermal comfort of outdoor spaces in Singapore is generally useful.
Q: It is important to ensure that something is done to make outdoor spaces thermally comfortable for outdoor activities.

strongly agree	agree	somewhat agree	neutral	somewhat disagree	disagree	strongly disagree

PERCEIVED FEASIBILITY OF BEING OUTDOORS IN SINGAPORE

Q: For me to spend time doing activities outdoors is very easy.

strongly agree	agree	somewhat agree	neutral	somewhat disagree	disagree	strongly disagree

AWARENESS OF NEED FOR MITIGATION STRATEGIES FOR OTC

Q. The changing climate in Singapore is an urgent problem
Q. Mitigation action needs to be taken for Singapore's changing climate

strongly agree	agree	somewhat agree	neutral	somewhat disagree	disagree	strongly disagree

PERCEPTION OF INDOOR THERMAL COMFORT IN SINGAPORE Q: Often when I'm in an air-conditioned place (e.g., office/shopping centre) I feel that the temperature is						
Much too cold	Too cold	Slightly cold	Just right	Slightly warm	Too warm	Much too warm
Q: What temperature do you usually set your air-conditioner to?						
During the day	___					
During the night	___					

PART 3: Mitigation strategies

Part 3.1: Present information on UHI

The Urban Heat Island Effect is the local temperature increase from human activity. The image shows the Urban Heat Island Effect in Singapore. The brighter areas represent increases in air temperature due to human activity.

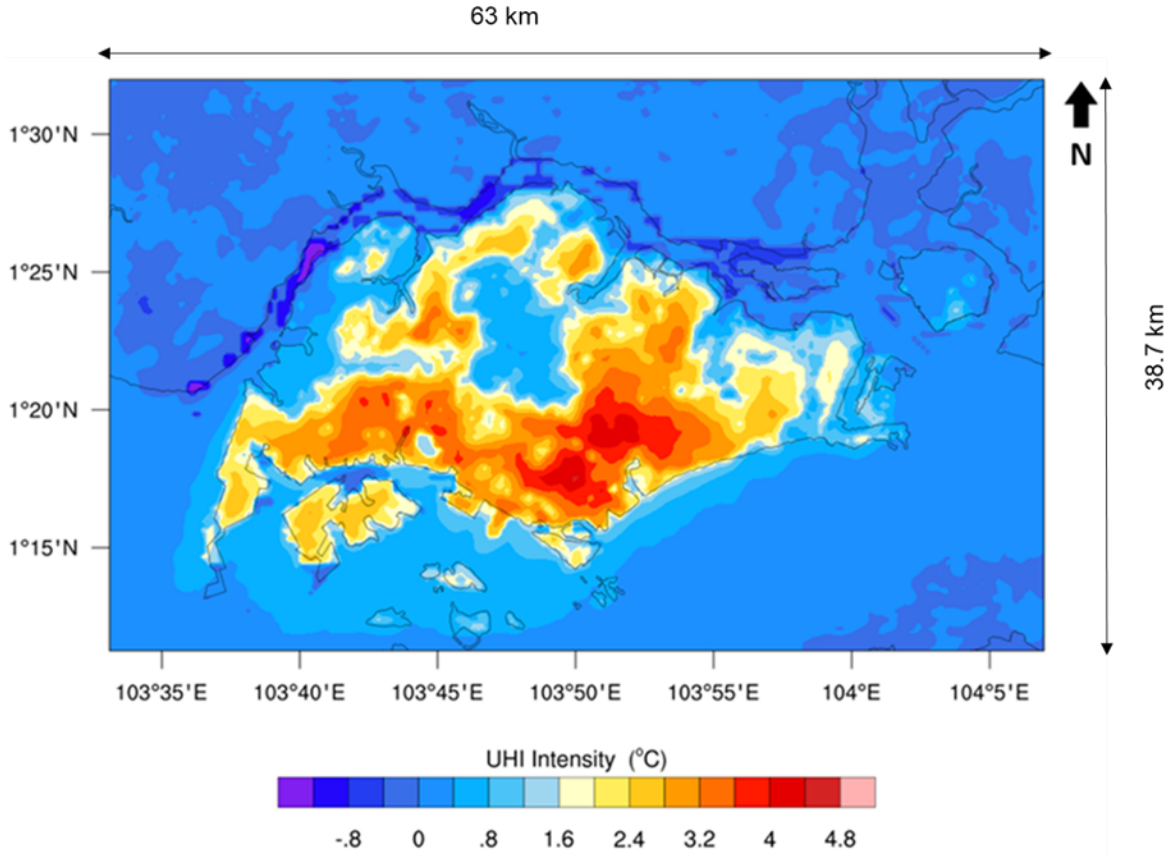


Figure 2: Urban Heat Island = temperature increase from human activity in ºC.
(Source: Omer Muhammad MUGHAL, SMART, Cooling Singapore)

Part 3.2: Present the mitigation strategies, each one separately.

Each mitigation strategy will be presented in an identical form, using photos and short description. Below is 1 example. The other mitigation strategies are presented in Part 2.2.1. The order of the mitigations presented to each participant was randomised.

Each of the mitigation was followed by the questions in Part 2.3.

SHADED WALKWAYS

Shaded walkways are paths covered by fixed structures with fabric or metal covering. These provide shade and shelter from weather conditions, such as sun and rain.

What are the benefits?

Shaded walkways help to reduce the air temperature and surface temperatures. In Singapore, shaded walkways are especially important to protect pedestrians from high sun angles during the afternoon. They also protect urban surfaces of street pavements from overheating. This generates a cooling effect at street level.

Part 3.2.1: Other mitigation strategies, each one separately. Order was randomised for each participant.

Renewable energy

Renewable energy is energy generated from natural sources (like sunlight, wind and water). For example, solar panels generate energy from sunlight.

What are the benefits?

Renewable energy systems release less heat during its entire life cycle (production and operation) compared to conventional fossil fuels. Renewable energy systems, like solar panels, absorb the sunlight and transform it into electricity or heat. This system is viable option for tropical climates with high solar radiation all year long.

Cool bus stations

Cool bus stations are enclosed structures cooled down by air-containing.

What are the benefits?

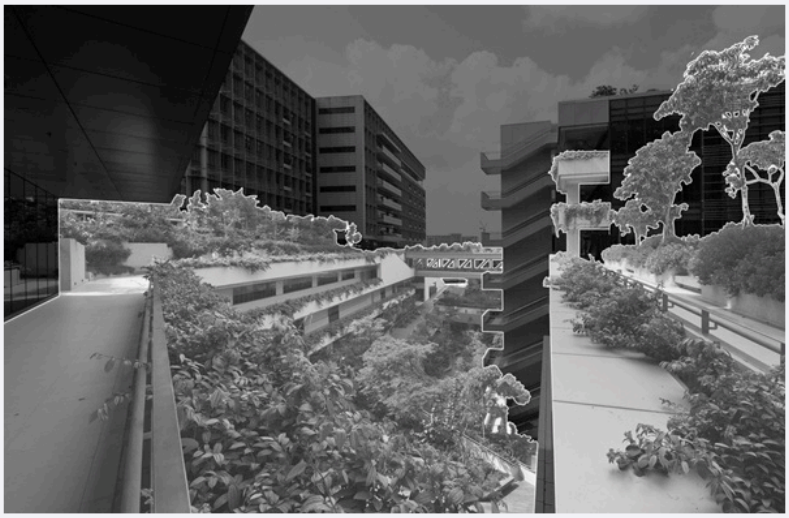
Cool bus stations can help to ensure a comfortable temperature while waiting for the bus. It can also support the temperature transition from stations to buses, and vice versa. This can reduce the thermal shock for pedestrians moving in and out.

Shaded neighborhoods

Shaded neighborhoods are multiple urban areas surrounded by buildings, covered by fixed or moveable structures. These large-scale structures can have fabric or metal covering.

What are the benefits?

Shaded neighborhoods help to block solar radiation and thus reduce the surface temperatures. The large-scale shading structures protect outdoor surfaces of streets, plazas and also building facades from overheating. This makes outdoor spaces thermally more comfortable.



Green terraces

Green terraces are layers of vegetation (like plants, grass, shrubs or moss) growing on multiple building floors (from ground floor to roof). These provide shade from the sun and drain rainwater.

What are the benefits?

Green terraces help to reduce the overheating of building surfaces in horizontal (terraces and roofs) and vertical (facades) direction. The benefit of tropical climates (like Singapore) is that the vegetation grows very fast due to the high humidity levels.

Green façades

Green façades are layers of vegetation (like plants, grass and moss) attached to external building envelope. These provide shade from the sun.

What are the benefits?

Green façades help to reduce the surface temperatures of building materials in the exterior. They protect building façades from direct sunlight. They protect indoor areas from overheating and thus reduce the energy consumption require for space cooling.

Green streetscapes

Green streetscapes are ground surfaces around buildings covered by vegetation (like plants, shrubs, grass and trees). These provide shade from the sun and drain rainwater.

What are the benefits?

Green streetscapes help to reduce the surface temperate of ground pavements. The effect can vary depending on the size, orientation and species of vegetation. Specially trees with big crowns can protect pedestrian from direct sunlight.

Cross-ventilation

Cross-ventilation is achieved by placing openings and gaps on opposite sides of the buildings. It optimizes the pathway of air flows through the buildings. They can be located on ground floor, like void decks.

What are the benefits?

Cross-ventilation helps to increase the natural ventilation of spaces. On the ground floor, it can also remove heat and pollutants. The effect can vary depending on the wind direction and wind speed. it can generate a cooling effect to pedestrians.

Part 3.3: Set of questions for <u>each</u> mitigation strategy

PERCEIVED POTENTIAL USE Q. I will be more inclined to spend time outdoors if [mitigation strategy was implemented]						
strongly agree	agree	somewhat agree	neutral	somewhat disagree	disagree	strongly disagree
PERCEIVED BENEFIT TO SELF Q. With my current lifestyle, I will directly benefit from [the implementation of this mitigation strategy].						
strongly agree	agree	somewhat agree	neutral	somewhat disagree	disagree	strongly disagree
PERCEIVED BENEFIT TO SINGAPORE'S UHI CHALLENGE Q. [Mitigation strategy] will improve the outdoor thermal comfort in Singapore.						
strongly agree	agree	somewhat agree	neutral	somewhat disagree	disagree	strongly disagree
PERCEIVED BEHAVIOURAL CONTROL Q: It is possible for me to contribute to this mitigation strategy.						
strongly agree	agree	somewhat agree	neutral	somewhat disagree	disagree	strongly disagree

PERCEIVED EFFECTIVENESS Q. [Mitigation strategy] will improve my comfort when outdoors.						
strongly agree	agree	somewhat agree	neutral	somewhat disagree	disagree	strongly disagree
IMPLEMENTATION PREFERENCE Q. I would like to see this [Mitigation strategy] implemented.						
strongly agree	agree	somewhat agree	neutral	somewhat disagree	disagree	strongly disagree

PART 4: Economic evaluation

Part 4.1: Willingness to pay (contribution) for mitigation strategies