



Overheating adaptations in acclimatised Singaporeans: Do spatial adaptation options matter? A pilot study Tanjong Pagar CBD case study

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52. Overheating adaptations in acclimatised Singaporeans: Do spatial adaptation options matter? A pilot study

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Background and Purposes

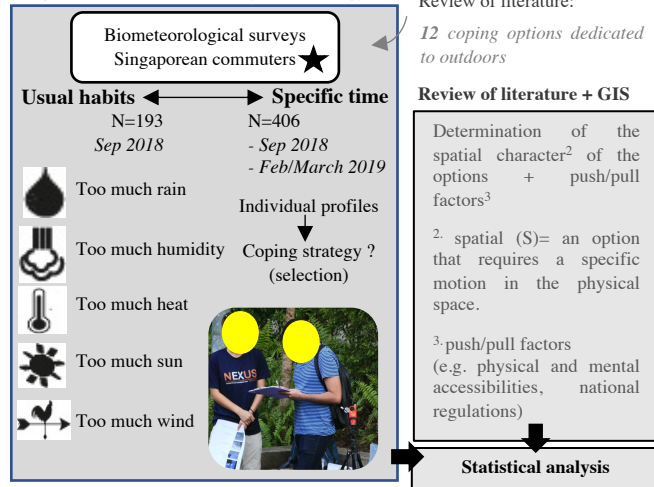
Singapore experiences high humidity and high air temperature throughout the year. It challenges human thermal comfort in the outdoors. To reduce the extreme heat exposure, implementations of cool amenities and climate-responsive designs that consciously integrate climate principles in urban architecture are envisioned in the densely built island (e.g. tree-shaded streets or continuously roofed streets, urban pocket parks). Yet, little is known on Singaporeans' behavioural overheating¹ adaptation strategies in the outdoors. As a first approach of Singaporean's overheating adaptation strategies, this pilot study aims to determine:

- the nature of the overheating coping actions
- the contribution of space in the Singaporean's overheating adaptation strategies

¹ Overheating as defined in Nazarian *et al.*, 2022 Integrated assessment of urban overheating impacts on human life, Earth Future, 10(8).

Methods

Fig. 1. Flowchart of the study methodology



Overheating coping options:

- Air conditioned indoors:** stay in A/C indoors; enjoy the entrance of a MRT or a A/C indoor public place (e.g. shopping mall)
- Human body:** use of protecting devices (e.g. fan, umbrella,...); change clothes (body insulation); postpone the planned activity (metabolic heat)
- Artificial water infrastructure:** look for mist or fountain (S); look for pools (S).
- Blue and Green infrastructures:** visit large water reserves or sea facades (S); visit parks and other types of greeneries (S)
- Transport:** take public transport (with A/C, incl. taxis); use naturally covered routes (trees shade, S); use artificially covered routes (S)

Tanjong Pagar CBD case study

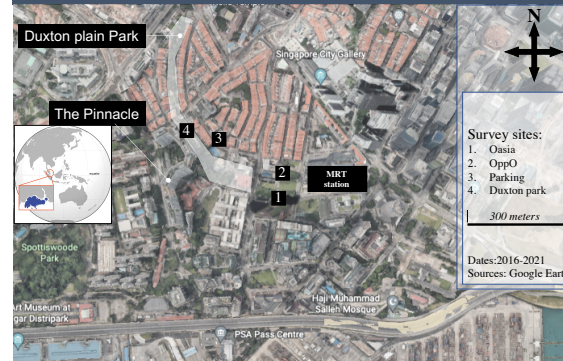


Fig. 2. Localization of the survey sites

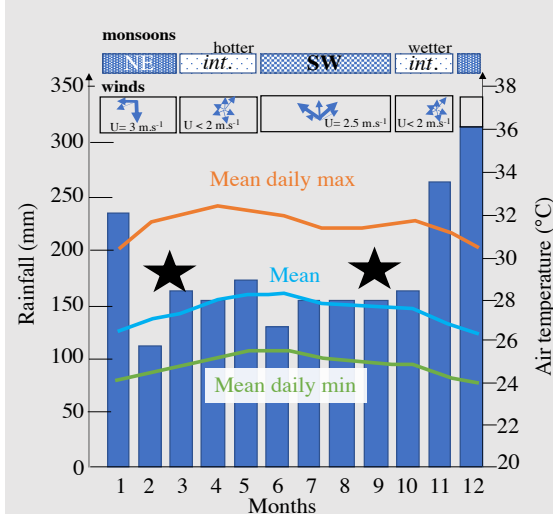


Fig. 3. Usual Singaporean climate (Changi airport station, source MSS) and the survey periods (stars)

Observations @1.1 m a.g.l. at the survey sites:

- Air temperature: 27.3 to 37.8 °C, (avg.: 30.8 °C),
- Air humidity: 25.6 to 38.1 hPa (avg. 29.8 hPa),
- Wind speed: 0 to 6 m.s⁻¹ (avg.: 1.1 m.s⁻¹),
- Mean radiant temperature: 27.6 to 82.9 °C (avg.: 35.8 °C)

Preliminary exploratory results

Overheating coping (habits)

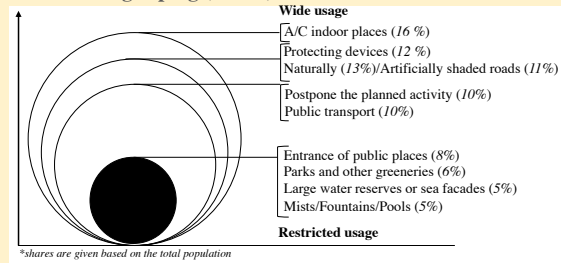


Fig. 4. Share of the coping options in all the usually taken options

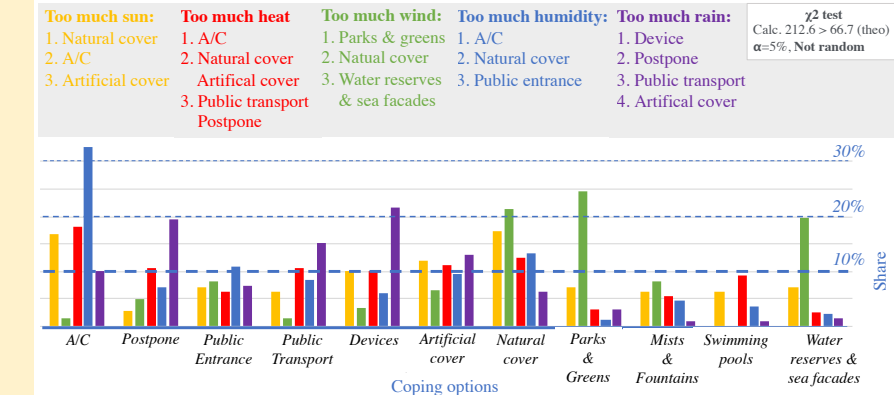


Fig. 5. Distribution of the coping options in dependence with the extreme weather

Overheating coping actions

(specific time)
→ daily commute

Inertia: 49.2 %

Contribution Dim 1:

- Tree shade
- Roof shade
- Indoor shortcut
- Parks

Contribution Dim 2:

- Devices
- Clothes
- Postpone

Supplementary variables:

Age & sex (no impact), trip motives, job status, weather awareness & proactivity, thermal sensations (air temperature, wind, humidity, sun)

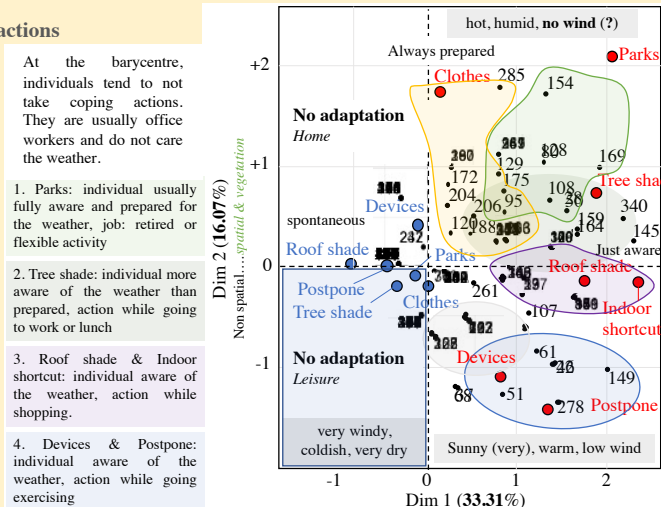


Fig. 6. Multiple Correspondence Analysis factor map

⇒ Adaptation strategies mostly target **extreme rain & sun** (each representing 30 % of the total adaptative actions), then **extreme heat** (23%).

⇒ **A/C option dominates** (4) as in Canada where it ranked first in the individual heat coping strategies (5 cities, N=1141 ind., Alberini *et al.*, 2011).

⇒ **A/C indoors, protecting devices** (umbrella), **naturally or artificially covered roads** are used in **different extremes**. In contrast, **natural settings** (parks, water bodies) are quasi uniquely dedicated to cope with **extreme winds**.

⇒ **Water bodies rarely used** ⇒ Strict national policies on fresh water, difficult access to the coast (harbours, military lands), loss of most of the district iconic fountains. For the **swimming pools** (uniformly distributed over the island but usually outdoors) ⇒ mental and time barriers? Hazardous weather?

⇒ **Poor use of parks & forests**, which is surprising considering the Singapore motto ("a city in a garden") ⇒ less accessible than aligned tree-streets (extreme wind, sun, humidity, heat), which are preferred to artificially covered streets (extreme rain).

⇒ **Poor adjustment of the activity schedule with weather** (3rd on 12 heat coping options in the 10 biggest cities of Québec, OQACC, 2018) + **poor use of public transport**. These are mainly chosen in case of **extreme rain or heat** ⇒ difficulties to change daily schedule, different judgment of extreme conditions in Canada and Singapore.

Take away

- Not a unique overheating strategy. In Singapore, natural settings are less used than artificial ones, and local solutions preferred (in long and short term adaptation).
- Rain = aspatial strategies; extreme sun = local spatial strategies, extreme heat & humidity = mix local spatial & aspatial strategies, extreme wind = non local spatial strategies.
- Based on ACM analysis ⇒ possible to highlight some individual adaptation profiles even if most of the commuters (about 60 % of the respondents) declared not to care the weather.

Acknowledgment: The study data were recorded during the Cooling Singapore 1.0 project (Singapore National Research Foundation grant). Ethics approval number of the National University of Singapore Institutional Review Board committee: S-18-058).