

Thermal comfort and adaptation strategies of home occupants in Darwin

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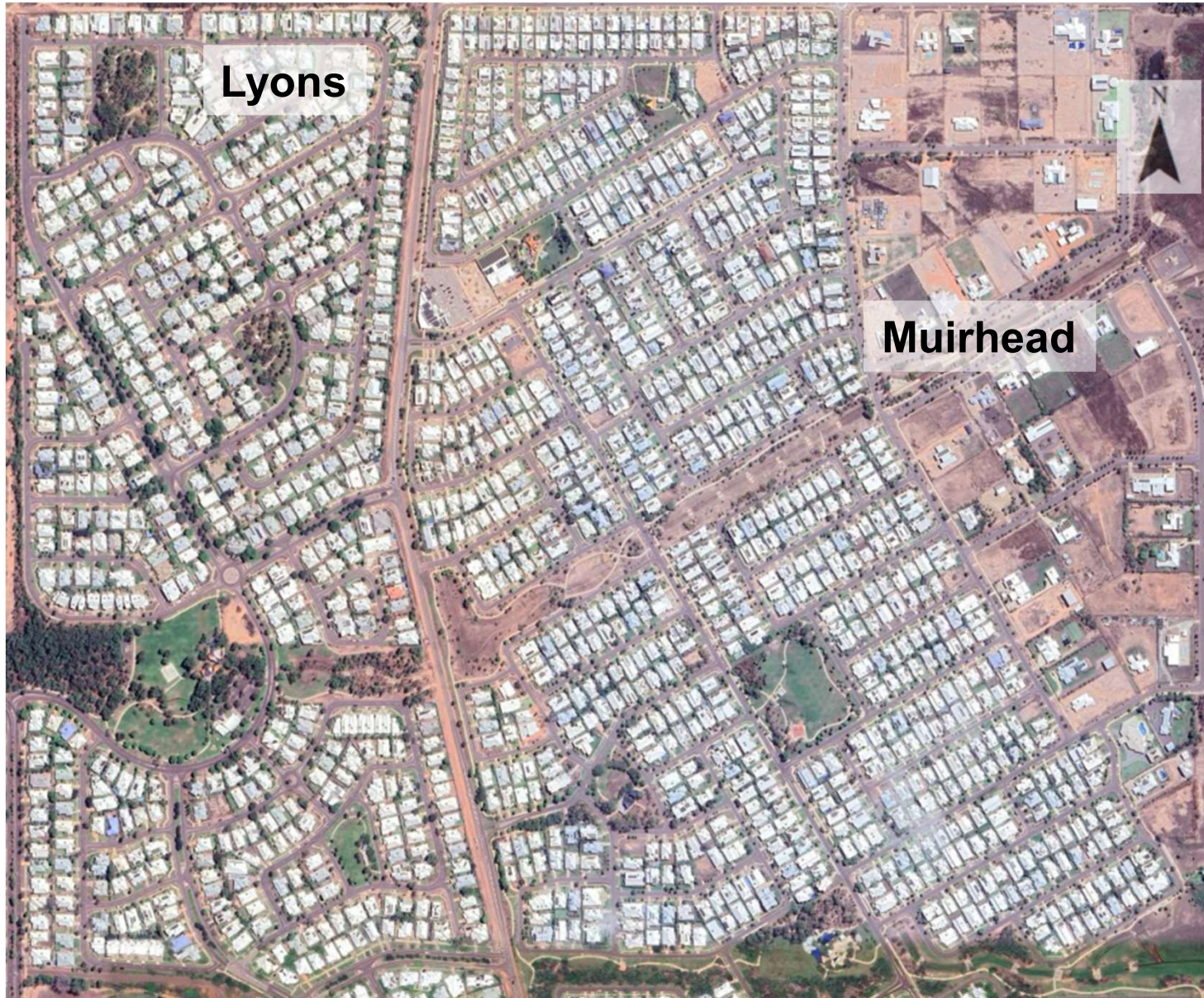
Thermal comfort study

The objectives of this study were to investigate:

- indoor climatic conditions;
- thermal comfort of the occupants;
- the control of indoor environment; and
- adaptation strategies preferred by occupants

in houses designed to meet NatHERS energy efficiency requirements.

Study area



Study area

- Muirhead



- Lyons



Examples of houses in Muirhead



Single storey, concrete slab on ground, blockwork walls, colourbond roof



Single storey, concrete slab on-ground, fibro clad framed insulated walls

Examples of houses in Lyons

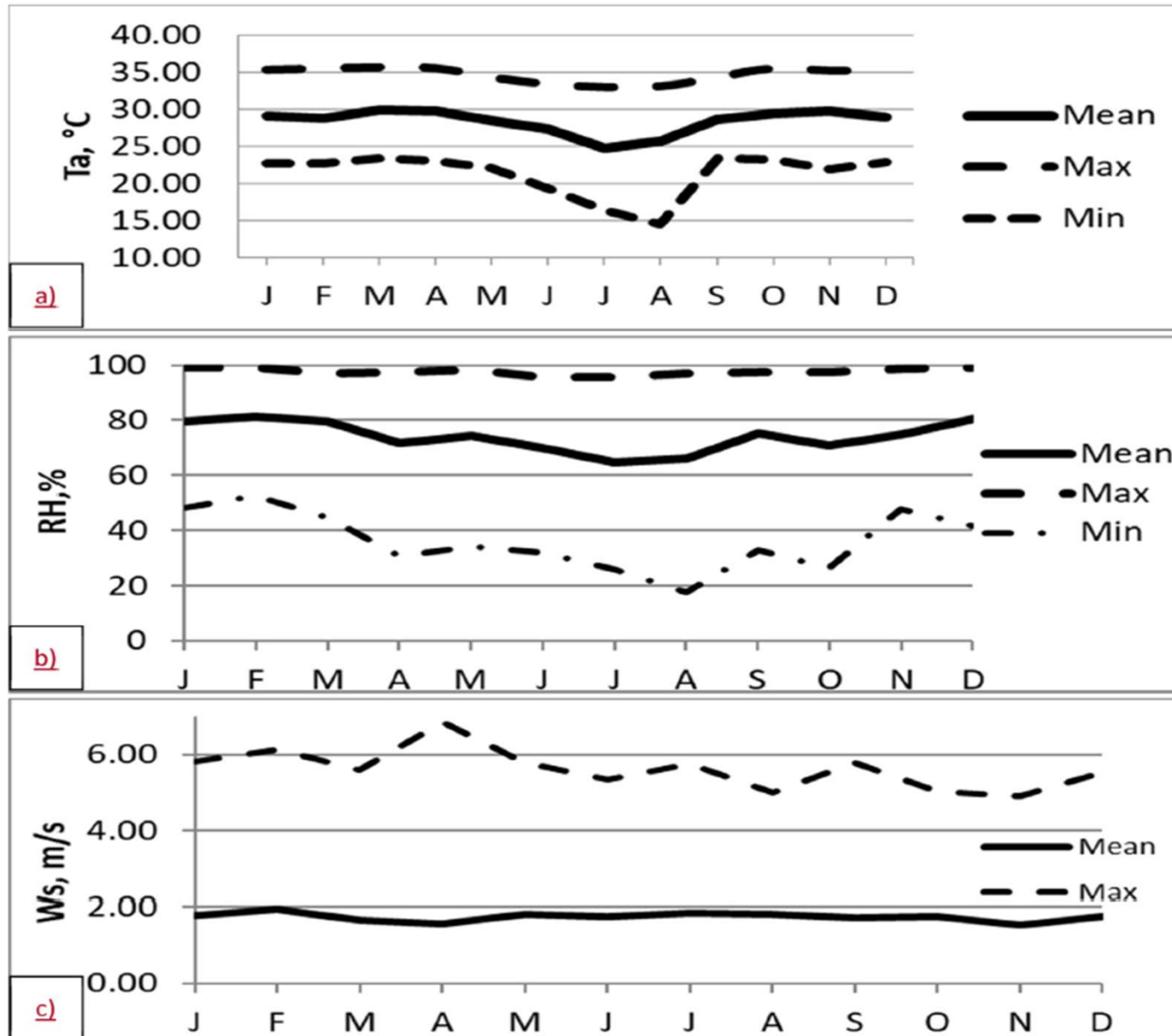


Single storey, concrete slab on ground, blockwork walls, colourbond roof



Elevated house, insulated custom orb metal roof and walls, high ceiling

Local climate



Study participants

	Build-up	Wet	Dry
Number of participants	61	44	36
6 to 7 star	31	24	18
4 to 5 star	30	20	18
Age group			
25-34	18	16	11
35-44	21	16	12
45-54	7	6	6
55-64	10	2	5
65+	5	4	2
Tenure			
Own	25	23	27
Rent	14	9	9

Setup of the data logger



Thermal comfort survey

Scale	Thermal sensation	Air humidity	Air velocity
-3	Cold	Very dry	Completely still
-2	Cool	Dry	Still
-1	Slightly cool	Slightly dry	Slightly still
0	Neither cool nor warm	Neither dry nor humid	Neither still nor breezy
1	Slightly warm	Slightly humid	Slightly breezy
2	Warm	Humid	Breezy
3	Hot	Very humid	Very breezy

Scale	Thermal preference	Air humidity	Air movement
-1	Cooler	Less dry	Less air movement
0	No change	No change	No change
1	Warmer	Less humid	More air movement

Survey results: Build-up

Air-conditioning	On		Off	
Star rating	4 to 5 star	6 to 7 star	4 to 5 star	6 to 7 star
<i>Indoor climatic environment</i>				
T _a (°C)	30.0	28.4	31.9	31.7
RH (%)	51	51	62	64
V _m (m/s)	0.4	0.4	0.3	0.4
<i>Thermal sensation</i>				
Sensation (% score –1,0,1)	75	79	55	88
Satisfied (%)	88	79	64	88
Preference (% no change)	50	57	32	25
<i>Humidity</i>				
Sensation (% score –1,0,1)	100	86	42	60
Satisfied (%)	83	86	47	53
Preference (%no change)	67	64	16	13
<i>Air movement</i>				
Sensation (% score –1,0,1)	88	100	78	100
Satisfied (%)	88	100	65	94
Preference (% no change)	75	79	43	71

Survey results: Wet season

Air-conditioning	On		Off	
	4 to 5 star	6 to 7 star	4 to 5 star	6 to 7 star
Star rating				
<i>Indoor climatic environment</i>				
T _a (°C)	29.4	29.7	31.6	30.7
RH (%)	57	50	70	73
V _m (m/s)	0.3	0.2	0.4	0.3
<i>Thermal sensation</i>				
Sensation (% score –1,0,1)	86	81	50	100
Satisfied (%)	100	69	67	88
Preference (% no change)	57	50	25	25
<i>Humidity</i>				
Sensation (% score –1,0,1)	83	76	30	43
Satisfied (%)	67	53	30	29
Preference (%no change)	50	53	10	14
<i>Air movement</i>				
Sensation (% score –1,0,1)	100	81	92	63
Satisfied (%)	75	88	92	75
Preference (% no change)	50	56	58	63

Survey results: Dry season

Air-conditioning	Off	
	4 to 5 star	6 to 7 star
Star rating		
<i>Indoor climatic environment</i>		
T _a (°C)	28.3	28.5
RH (%)	50	54
V _m (m/s)	0.2	0.3
<i>Thermal sensation</i>		
Sensation (% score –1,0,1)	78	72
Satisfied (%)	94	94
Preference (% no change)	72	78
<i>Humidity</i>		
Sensation (% score –1,0,1)	71	57
Satisfied (%)	71	74
Preference (%no change)	79	87
<i>Air movement</i>		
Sensation (% score –1,0,1)	81	94
Satisfied (%)	67	94
Preference (% no change)	48	78

Thermal Comfort Survey

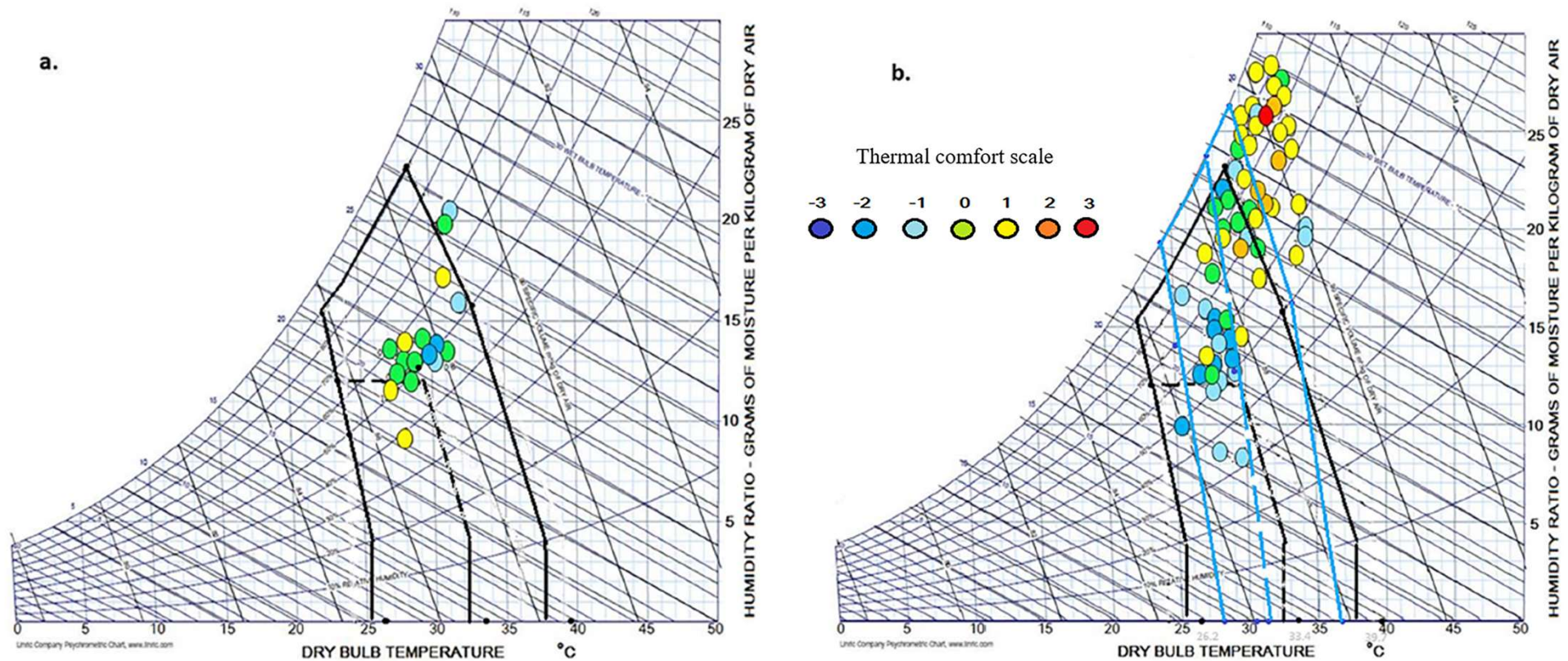
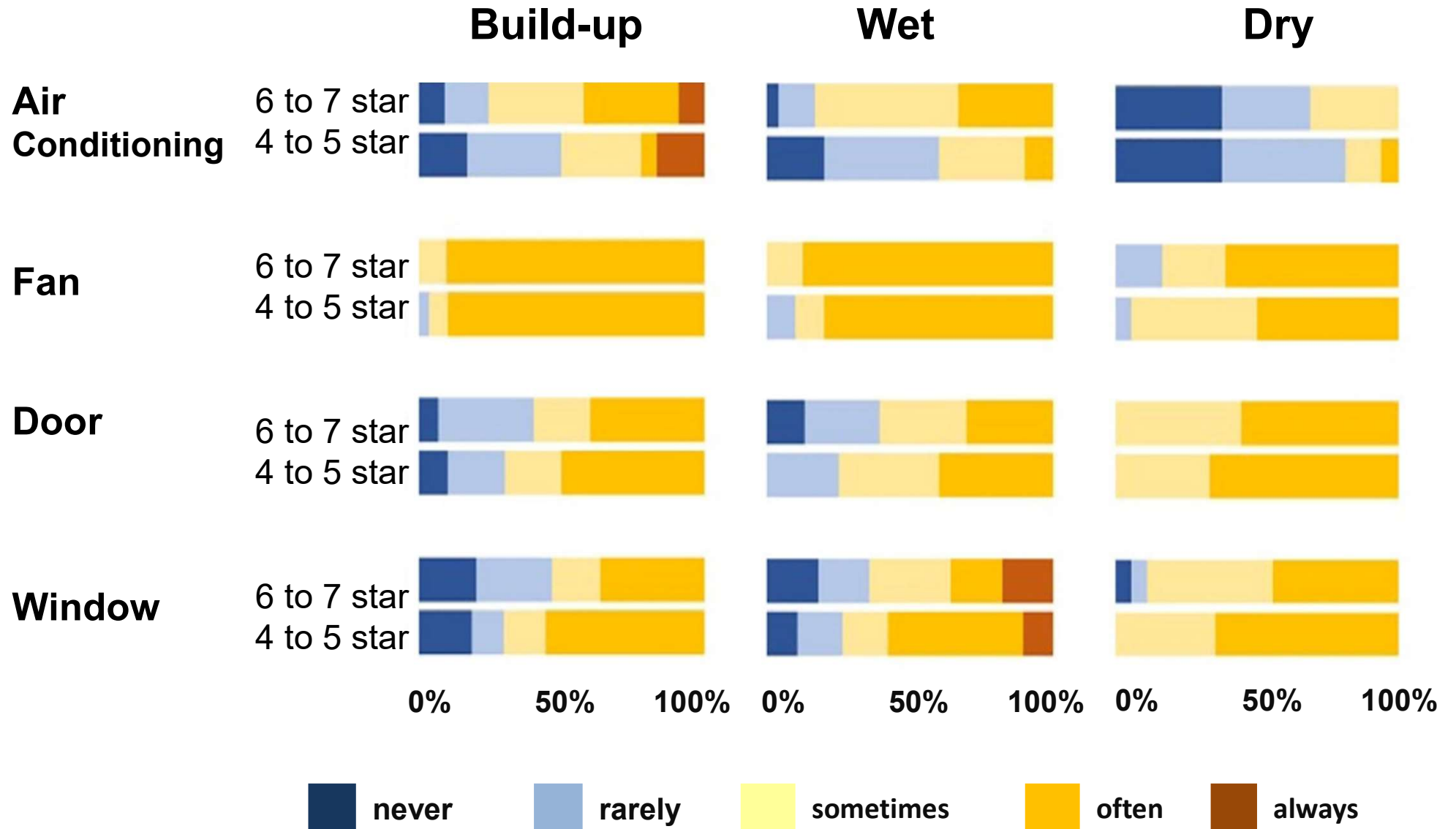
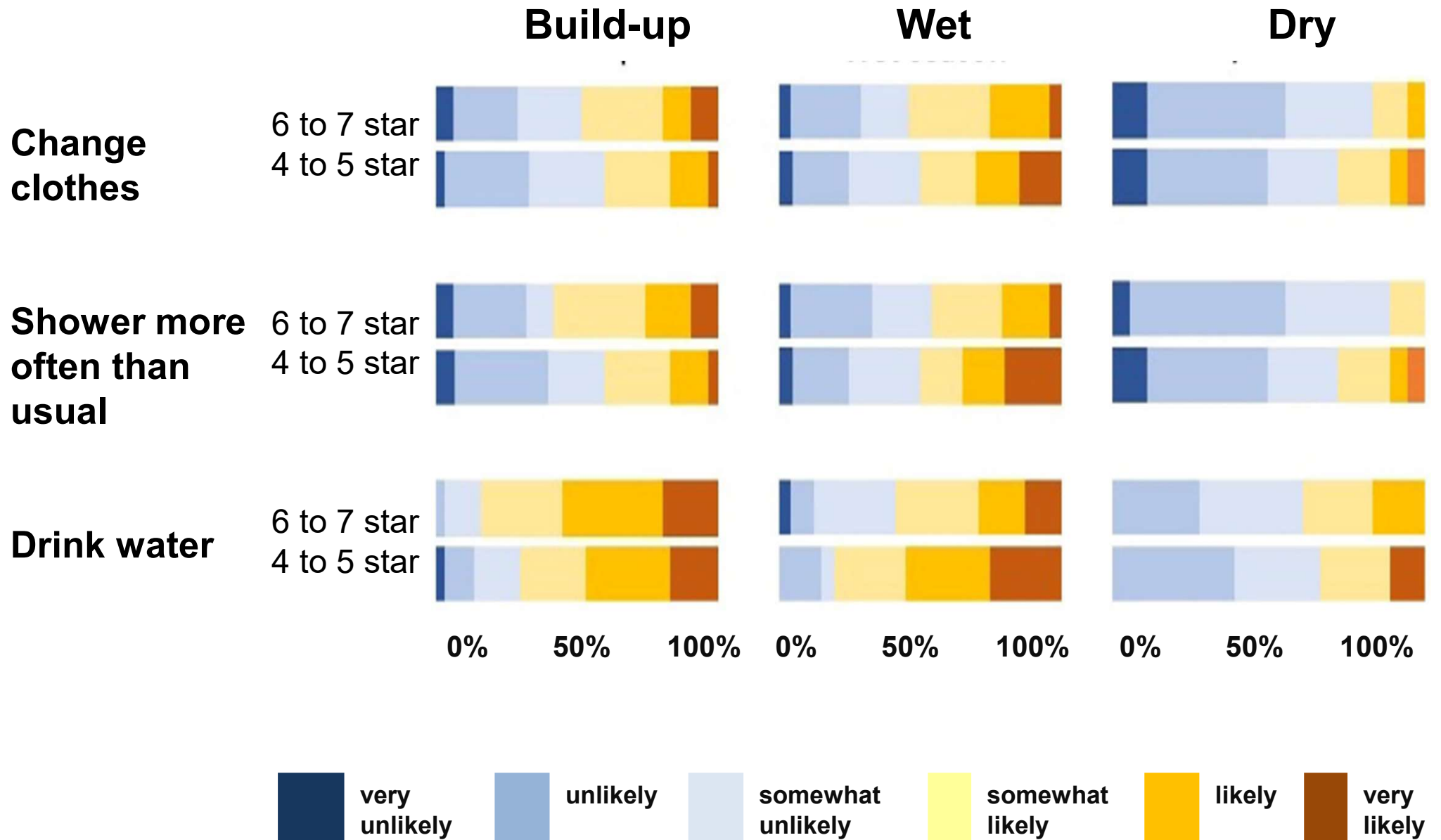


Fig. 2. Distribution of indoor climatic measurements in air-conditioned rooms (a) and in naturally ventilated rooms (b) overlaid on the psychrometric chart for Darwin at 101 hPa: the black dashed line boundary is for comfort zone 1 at < 0.2 m/s air movement, and unbroken line boundary is for comfort zone 2 (1 m/s air movement). Each point represents multiple votes collected in the same room. The blue lines identify the comfort zone at air velocities between 0.2 m/s and 1 m/s, 0.35 clo and 1 met. The blue broken line identifies a boundary between comfort zone for 0.2 m/s and 1 m/s in accordance with ASHRAE Standard 55-2020 based on the CBE Thermal Comfort Tool [58], it is accepted that mean radiant temperature is equal to dry bulb temperature.

Control strategies



Adaptation strategies



References

- S. Safarova, E. Halawa, A. Campbell, L. Law, J. van Hoof, Pathways for optimal provision of thermal comfort and sustainability of residential housing in hot and humid tropics of Australia – A critical review, *Indoor Built Environ.* 27 (8) (2018) 1022–1040, <https://doi.org/10.1177/1420326X17701805>.
- Safarova S, van Hoof J, Law L, Zander KK, Garnett ST. Thermal comfort in a tropical savanna climate: The case of home occupants in Darwin, Australia. *Energy and Buildings.* 2022 Jul 1;266:112074.