Australia's National
Science Agency

Tangentyere Council Residential Thermal Comfort Project

PHASE ONE: 2021-2022

Tangentyere Council Aboriginal Corporation

July 2024

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Executive summary

Background

This feasibility project, originally funded by a CSIRO Health & Biosecurity (H&B), Indigenous Opportunities ACORN grant, aimed to contribute toward a broader climate change adaption and heat mitigation project in Alice Springs in partnership with Tangentyere Council Aboriginal Corporation (Tangentyere). This project was initiated by Tangentyere in response to energy insecurity and health impacts of climate change and housing suitability being raised as concerns within Tangentyere Council Board of Directors and Town Camp General Meetings. This project therefore sought to provide evidence of feasibility to measure internal climatic conditions of Town Camp residences and compare with outdoor weather conditions and international thermal comfort standards to provide supportive evidence for Tangentyere to advocate for suitable housing stock for Town Camp residents. This study was designed as two Phases. Phase One was designed as feasibility trial to inform the design and implementation of Phase Two. This report pertains to the design, implementation and results of Phase One only.

Methods

A successful scoping phase in 2020 established the feasibility of data upload to cloud storage using local satellite internet or 4G (Phase One). Installation of pared-down Smarter Safer Homes systems with access to real-time Smart Sensor data on temperature and humidity was confirmed, and a feasibility trial commenced in 2021 with ethics approval with CSIRO Health and Medical Human Research Ethics Committee (2020_058_HREC). Site visits to Alice Springs by H&B, Australian eHealth Research Centre Indigenous Health Team personnel enabled research planning, Smart Sensor installation training including trial installations and troubleshooting, focus group discussions and strategic meetings with local service delivery providers. Following recruitment and informed consent procedure, Smart Sensor systems were installed by Tangentyere senior research staff in a total of 20 houses in Town Camp residences for data collection of temperature and humidity over 14 months (May 2021-June 2022). Reference environmental data was sourced from the Bureau of Meteorology station located in Alice Springs ('BOM readings') and used to calculate external climatic conditions per house for the time period each house collected data.

Data were cleaned, visualised and analysed using Python and R software to present graphs and descriptive statistics. International comfort ranges for temperature (18-24°C) and humidity (40-70%) were used as comparators. Notably within this study, internal climatic conditions would have likely been affected by numerous confounding factors including data quality, seasonal differences and the use of active thermoregulatory processes.

Results

Alice Springs is a harsh environment characterised by extreme hot and cold temperature conditions and low to moderate relative humidity.

Overall, average internal house temperature conditions within this study were more likely to reflect outdoor temperature conditions, or warmer (by 0.58°C to 8.54°C). Outdoor temperatures were inside comfort range of 18-24°C less than 50% of the study period (Figure 1A), and indoor temperatures were inside comfort range less than 60% of the study period for 15/18 houses (Figure 1C). However, overall internal temperature ranges were less extreme than those of external temperature ranges. Outdoor temperature readings were outside the comfort range for more than 50% of the study period for each house, with these readings most frequently being above comfort range (Figure 1B). This was reflected by indoor temperatures where 15/18 houses had indoor temperatures outside of the comfort range at least 44% of the time (Figure 1D). These readings were more frequently above comfort range, with indoor temperature rarely below comfort range (Figure 1D).

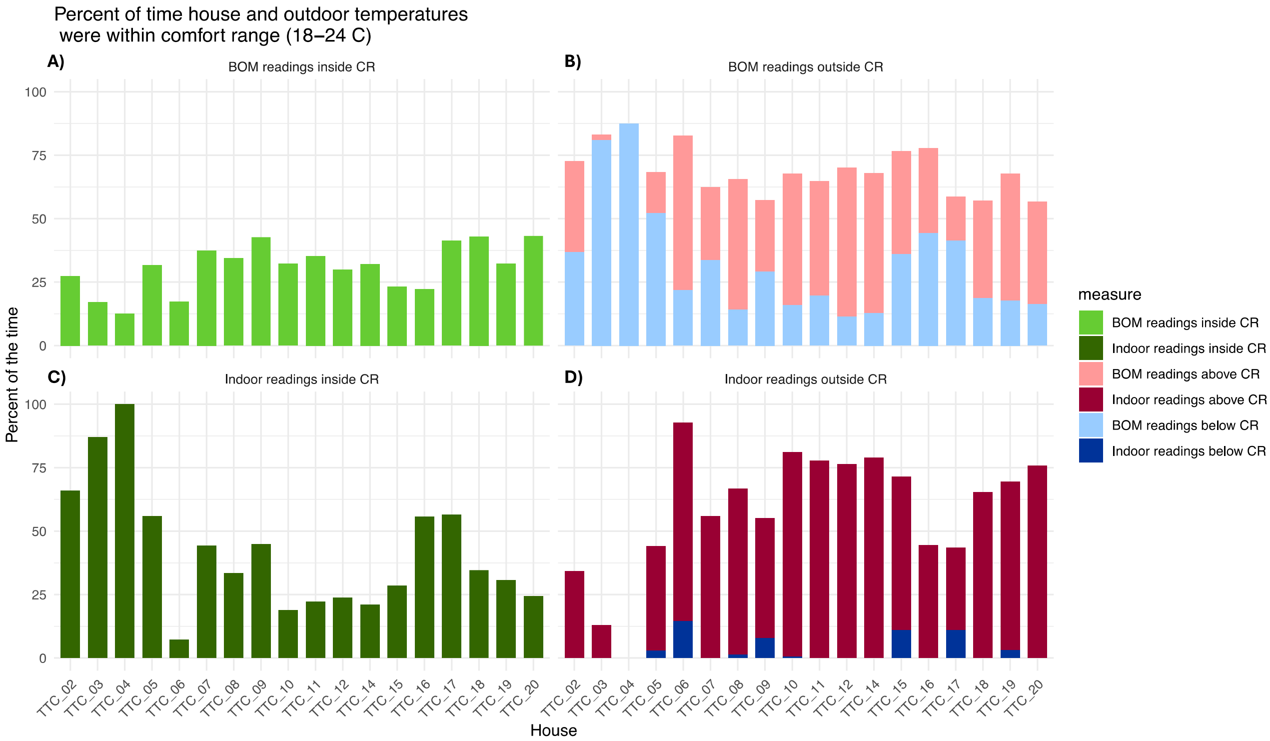

Figure 1: Percent of time house and outdoor (BOM) temperatures were within comfort range (18-24°C)
BOM readings are calculated per house from data sourced from the BOM weather station at Alice Springs airport for the time period each house collected data. Both indoor and BOM readings are displayed as a proportion of the time that each house collected data.

Overall, internal and outdoor relative humidity was most frequently outside the comfort range of 40% to 70% and rarely inside comfort range. All houses, excluding House 14 had humidity readings outside of the comfort range for more than 33% of the study period (Figure 2D). When humidity readings were outside of the comfort range, they were more frequently below the comfort range (Figure 2B and D), meaning that outdoor conditions and houses typically exhibited low humidity. Indoor humidity was within the comfort range between 20.5% and 66.4% of the time, with 15/18 houses exhibiting comfortable humidity less than 50% of the time (Figure 2C).

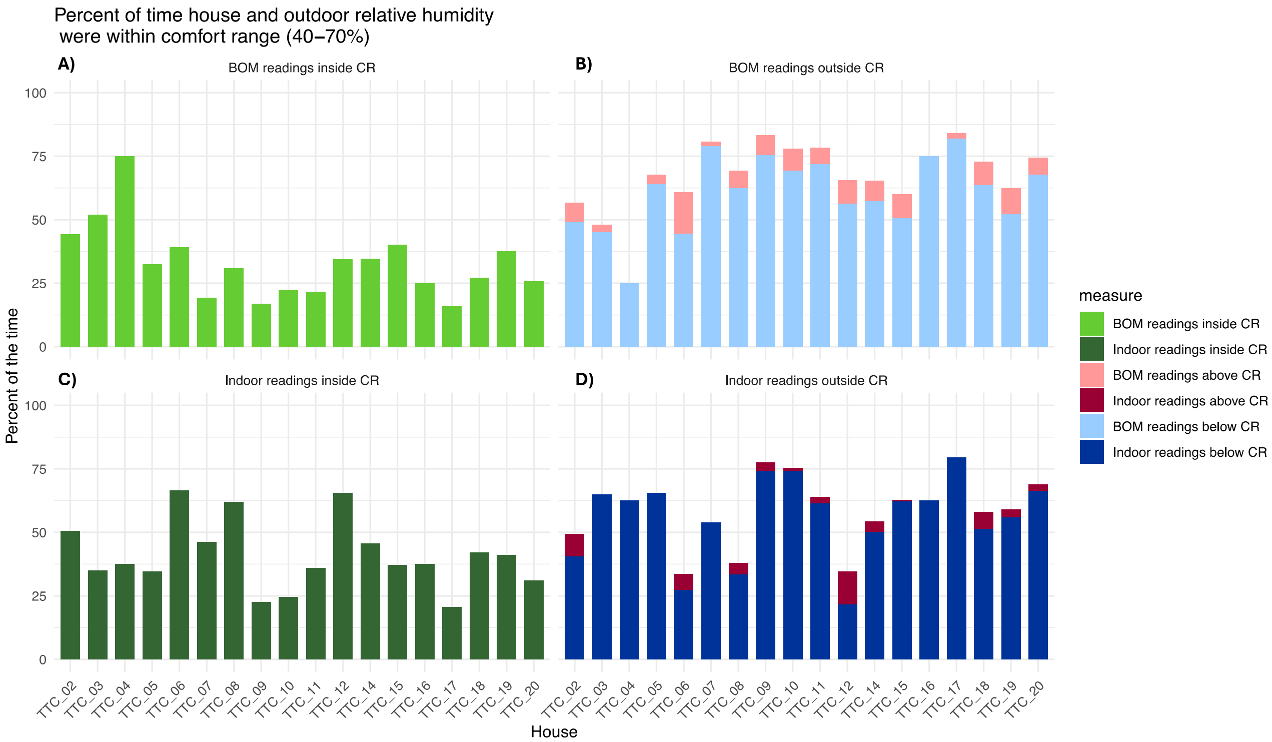

Figure 2: Percent of time house and outdoor (BOM) relative humidity were within comfort range (40-70%)
BOM readings are calculated per house from data sourced from the BOM weather station at Alice Springs airport for the time period each house collected data. Both indoor and BOM readings are displayed as a proportion of the time that each house collected data.

Differences across the entire data collection timeframe between internal and external relative humidity ranged from -6.18% to 12.30% on average with considerable differences between maximum (-6.98% to -52.83%) and minimum (6.74% to 48.47%). However, from the combined overall data set it is difficult to attribute this to passive or active thermoregulation.

Temperature

Mean outdoor temperatures (BOM) were always warmer than indoor temperatures, evident by the positive difference between mean outdoor and mean indoor temperatures (Figure 3A). Nearly all houses were within the range of outdoor temperatures. The mean minimum indoor temperature was higher than the mean minimum outdoor temperature for all houses (Figure 3B), indicating houses did not get as cold as outdoors. The mean maximum indoor temperature was lower than the mean maximum outdoor temperature for 16/18 houses (Figure 3C), indicating most houses did not get as hot as outdoors.

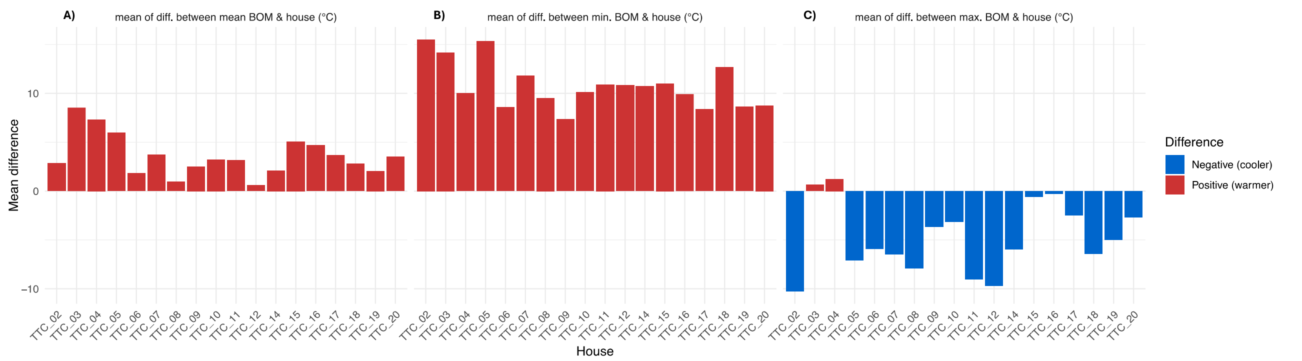

Figure 3: Difference between mean, minimum and maximum outdoor (BOM) and indoor temperatures

Humidity

Mean outdoor humidity was typically higher than indoor humidity, evident by the positive difference between mean outdoor and mean indoor relative humidity readings (Figure 4A). All houses were within the range of outdoor humidity levels. The mean minimum indoor humidity was higher than the mean minimum outdoor humidity (Figure 4B), indicating houses did not get as dry as outdoors. The mean maximum indoor humidity was lower than the mean maximum outdoor humidity for all houses (Figure 4C), indicating houses did not get as humid as outdoors.

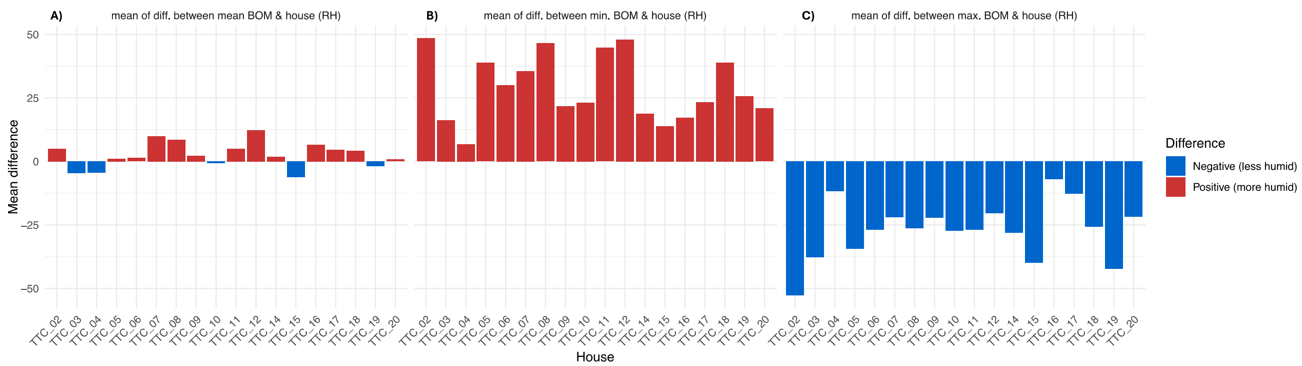

Figure 4: Difference between mean, minimum and maximum outdoor (BOM) and indoor relative humidity

Examination of extremely hot periods found that when outdoor temperatures were above the comfort range, most houses also experienced indoor temperatures that exceeded the comfort range. Exceptions to this were most likely due to the use of active cooling methods, specifically evaporative cooling. During extremely cold periods temperatures were below the comfort range 58% to 66% of the time, indicating greater thermoregulatory capacity compared to extremely hot periods. Again, when considering humidity data, exceptions to this were most likely due to the presence of active heating. During climate shoulder seasons, indoor temperature ranges and humidity levels were not as extreme as external conditions. This may indicate a blend of active heating and cooling being employed by houses, although not to the same extent as in extreme hot and cold periods.

Conclusions

Overall, this data indicates that unless active heating and cooling practices are being implemented, indoor temperature and relative humidity closely reflects outdoor weather conditions. Therefore, houses in this feasibility trial were unable to passively regulate temperature and humidity levels effectively. One limitation of this feasibility trial was the reliance on stable power for data collection that was impacted by factors including involuntary self-disconnection of prepayment meters, resulting in incomplete datasets. However, it is evident that the incapability of the housing stock in this trial to effectively provide adequate thermoregulation for their tenants is exacerbated during periods of extreme heat and cold, both of which are experienced throughout the year in Central Australia where Alice Springs is situated.

Recommendations

Without adequate and substantial investment into the development of suitable housing, both climatically and culturally, for Alice Springs Town Camps and residents, inequitable living standards and subsequent disparate financial, health and mortality outcomes will continue to be witnessed. Although there is unquestionable evidence of the ongoing resilience and adaptability of Alice Springs Town Camp residents who have little choice but to reside in the available housing stock, progress towards achieving the National Closing the Gap targets are unlikely to be seen unless there is systemic change.

The learnings gained from Phase One of this study have been integrated into the design of Phase Two which will see the utilisation of fit-for-purpose sensors deployed into more Alice Springs Town Camp housing stock. These sensors do not require power or internet connection, therefore addressing issues associated with involuntary self-disconnection from power. Phase Two will aim to further explore thermal comfort levels of Town Camp residences and its correlation with health and wellbeing of residents to support Tangentyere to advocate for suitable housing stock.

Full Report

The published full report documenting the complete and comprehensive results from the study can be found at this DOI: https://doi.org/10.25919/x1nh-ck44

Citation: Chelberg, Georgina; Wright-Pedersen, Sophie; Law, Hannah; Klerck, Michael; Davis, Vanessa; Foster, Denise; Smallbon, Vanessa; Lu, Wei; Mahoney, Ray. Tangentyere Council Residential Thermal Comfort Project. Phase One: 2021-2022. Herston, Brisbane, Queensland: CSIRO; 2024. csiro:EP2024-3700. https://doi.org/10.25919/x1nh-ck44

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