



Data Article

Climate change and indigenous housing performance in Australia: A dataset



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ARTICLE INFO

Article history:

Received 23 August 2022

Revised 25 October 2022

Accepted 9 November 2022

Available online 13 November 2022

Dataset link: [Climate change and Indigenous housing performance in Australia: A dataset \(Original data\)](#)

Keywords:

Heat

Energy efficiency

Building performance

Indigenous housing

Sustainability

Climate change

Thermal comfort

ABSTRACT

A recent paper, entitled “Climate change and Indigenous housing performance in Australia: A modelling study” [1], investigated the impacts of climate change on Australian remote and regional Indigenous housing and it highlighted the significant reform necessary to maintain habitable conditions and improve energy resilience. The associated data is reported in this article. This dataset contains annual energy data and hourly internal temperature of six architectural models under current and future climates. The dataset is provided in this article as supplementary files. This original dataset was generated with a whole building simulation approach and can provide insights on the thermal behaviour of current remote and regional Indigenous building stock in regard to global warming and climate resilience. These insights can be used to improve traditional design, construction and retrofit practices, as well as policies and regulation aimed at ensuring liveable and healthy indoor environments for residents of Indigenous housing. Further, this article includes simulation inputs and assumptions used for the analysis to allow robust expansion of the dataset.

DOI of original article: [10.1016/j.enbuild.2022.112399](https://doi.org/10.1016/j.enbuild.2022.112399)

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<https://doi.org/10.1016/j.dib.2022.108751>

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Specifications Table

Subject	Engineering: Architecture
Specific subject area	Building performance assessment: Indoor thermal comfort and energy efficiency
Type of data	Table Graph
How the data were acquired	The dataset was generated with transient building simulations, using the software DesignBuilder with EnergyPlus simulation engine. The models have been validated with the use of the software TRNSYS and following a comparative approach that evaluates the normalised mean bias error (NMBE), the cumulative variation of root mean square error (CV[RMSE]), and the coefficient of determination (R2).
Data format	Raw Analysed
Description of data collection	The modelling assumptions were based on field studies and supplemented by data from: 1) previous investigation that audited over 7500 Indigenous houses across the different climate zones, 2) interviews with architects involved in the design and construction of Indigenous housing, and 3) standard values indicated by the Nationwide House Energy Rating Scheme (NatHERS) guidelines.
Data source location	The evaluations are performed considering the following data: <ul style="list-style-type: none"> • Moree Country: Australia 29°27'57"S 149°50'02"E • Alice Springs Country: Australia 23°42'00"S 133°52'12"E • Borroloola Country: Australia 16°03'35.64"S136°18'24.48"E
Data accessibility	Results data: Repository name: Mendeley Data Data identification number: Version 1 Direct URL to data: https://data.mendeley.com/datasets/3dv7t7kdcd/1 Simulation code: Repository name: GitHub Data identification number: Version 1 Direct URL to data: https://github.com/aysukuru/climate-change-and-Indigenous-housing-performance-in-Australia Brambilla A., Lea T., Grealy L., Kuru A. <i>Climate change and Indigenous housing performance in Australia: A modelling study</i> . Energy and Buildings, 112399.
Related research article	Brambilla A., Lea T., Grealy L., Kuru A. <i>Climate change and Indigenous housing performance in Australia: A modelling study</i> . Energy and Buildings, 112399.

Value of the Data

- This dataset contains hourly-based predicted data of the thermal performance of Indigenous housing under current and future climate scenarios. A prolonged monitoring campaign within actual Indigenous housing would be unacceptably intrusive for many householders and, without assurance of improvements to follow such data collection, would not comply with the ethic of 'no survey without service'.

- This dataset will benefit researchers investigating energy efficiency, climate resilience and health under warming temperatures in remote or regional vulnerable communities, providing a baseline for modification of assumptions and input parameters.
- This dataset will benefit architects involved in retrofitting Indigenous housing by providing evidence of the performance of current practices, as well as policymakers focused on defining climate resilience strategies for Indigenous communities.
- Different analysis methods can be applied to this dataset to unveil trends and insights not directly available from published studies. This dataset can be further used as a baseline for implementing different assumption variants (or simulation scenarios) and further advance disciplinary knowledge on indoor health and climate resilience of Indigenous housing.

1. Data Description

This dataset includes an Excel file for each analysed location (Alice Springs, Moree, Borrooloola), provided as supplementary data. Each file includes results for all the scenarios considered, divided into two spreadsheets: the first contains yearly results, and the second hourly indoor temperatures. Further, an initial table that identifies the scenarios is added.

Table 1 shows an example of how the scenarios are identified and labelled in the dataset. Each column represents a variable that describes the scenario (refer to section “Experimental design, materials and methods”), in particular:

- Scenario refers to the nomenclature used to describe the scenario. As such, the first letter refers to the climate type (T: tropical, A: arid, M: mild), the second item refers to the construction (S: standard or existing, I: improved), the third item refers to the weather file (N: now or current, F: future), the fourth item refers to the occupancy density (4, 7, 11 or 16 occupants), and the fifth item refers to the scenario of the HVAC or natural ventilation system (from S1 to S7, in which S refers to “system”)
- Climate refers to the type of climate that characterises the location
- Construction refers to the building geometry and thermal characteristics of the envelope
- Weather file refers to the current TMY (typical meteorological year) or future climate projection based on IPCC
- Occupancy density is the number of occupants considered
- HVAC or natural ventilation is the type of mechanical system and window opening behaviour

The second page of the Excel file includes a table with the yearly results for each scenario. Table 2 displays a section of this table. From the first column on the left, the information reported includes: name of the scenario, total annual energy needs normalized on the heated area (conditioning, equipment and lighting), total annual conditioning needs normalized on the heated area (heating and cooling), cooling loads, heating loads, maximum registered indoor temperature across all thermal zones, number of hours over one year when this maximum temperature is registered, percentage of time over one year in which the temperature is at its maximum.

Table 1
Scenario identification.

Scenario	Climate	Construction	Weather file	Occupancy density	HVAC or natural ventilation
...
T-S-N-04-S1	Tropical	Existing	Current	4 occupants	No HVAC, windows always open
...
T-I-F-11-S1	Tropical	Improved	Future	11 occupants	No HVAC, windows always open
...

Table 2

Annual energy and temperature results.

Scenario	Total [kWh/m ² y]	Conditioning [kWh/m ² y]	Cooling loads [kWh]	Heating loads [kWh]	Max Indoor temp [°C]	Duration [h]	Duration [%]
...
T-S-N-4-S2	189.33	145.23	13047.42	0	31.2	12	0.14
...

Table 3

Hourly indoor temperatures.

Scenario	...	T-S-N-4-12	...
Time	T [°C]	T [°C]	T [°C]
...
560	...	26.8	...
...

The last page reports the hourly indoor temperatures for each scenario of the selected location. Table 3 shows an extract of this page. The first column displays the hourly step, while the successive columns host the hourly temperatures, expressed in degree Celsius, of each scenario.

2. Experimental Design, Materials and Methods

This section provides a description of the simulation inputs and assumptions as used in the software. A detailed description of the background and rationale underpinning the assumptions are given in [1].

3. Climate

Each location is characterized by two different weather files, representing the current typical meteorological year and the future climate resulting from global warming, defined starting from the IPCC predictions. Climate zones are defined as per the National Construction Code [2]:

- Borroloola, NT, representing a tropical climate (high humidity summer, warm winter)
- Alice Springs, NT, representing an arid climate (hot dry summer, cool dry winter)
- Moree, NSW, representing a hot/mild climate (hot dry summer, cool wetter winter).

4. Building Geometry

Two building geometries have been considered for each location, corresponding to a standard and improved design. The former represents the typical Indigenous housing as designed, and built today, while the latter is representative of current retrofitting approaches. Architectural geometries are derived from fieldwork information (photographs and journal notes), procurement documents for new housing in the NT and NSW, and previous investigations [3][4].

General architectural and construction input details of the different architectural models, as adopted in the software, are reported in Table 4.

Table 5 reports the architectural improvements considered to generate the *improved* models, while Table 6 displays the architectural and construction input details of the different improved architectural models.

Table 4

Model input data summary for the standard (base case) scenario.

Climate and its zone	Warm/mild Climate Zone 5**	Hot arid Climate Zone 3**	Tropical Climate Zone 1**
Location	Moree, NSW	Alice Springs, NT	Borroloola, NT
Construction type	Fibro	Concrete	Concrete
U-value [W/m ² K]	External walls: 0.35 Partitions: 2.13 Slab on ground: 0.23 Ceiling: 0.25 Roof: 2.56 Windows: 5.8	External walls: 0.35 Partitions: 2.13 Slab on ground: 0.23 Ceiling: 0.25 Roof: 2.56 Windows: 5.8	External walls: 0.35 Partitions: 2.13 Slab on ground: 0.23 Ceiling: 0.25 Roof: 2.56 Windows: 5.8
Glazing type	Standard single clear float glass panel	Standard single clear float glass panel	Standard single clear float glass panel
Glazing SHGC	0.8	0.8	0.8
Glazing thermal transmittance	5.8	5.8	5.8
Frame type	Aluminium frame without thermal brake	Aluminium frame without thermal brake	Aluminium frame without thermal brake
Frame thermal transmittance	12	12	12
Infiltration rate (ac/h)	0.7	0.7	0.7
Ventilation mode	Natural ventilation	Natural ventilation	Natural ventilation
Wall minimum total thermal resistance	2†	2†	2†
Roof maximum solar absorptance	0.7†	0.7†	0.7†
Equipment load (W/m ²)	3.9	3.9	3.9
Lighting load (W/m ²)	5	5	5
Domestic hot water consumption (lt/person)	4	4	4

* [3][4]; **[2]; †Archival drawings

Table 5

Key design and construction improvements considered in the improved design models for each climate zone.

Climate	Design strategies
Tropical	Awnings to shade windows and prevent solar radiation entering the building Awnings to shade walls to prevent solar radiation overheating surfaces and to increase the heat transmitted indoors through conduction Additional wall insulation Verandas or pergolas to create buffer zones and shading Maximisation of cross ventilation Increased window performance (glass Solar Heat Gain Coefficient and frame R-value)
Arid	Awnings to shade windows and prevent solar radiation entering the building Awnings to shade walls to prevent solar radiation overheating surfaces and increase the heat transmitted indoor through conduction Additional roof insulation Roof vents to increase hot air exhaustion Increased window performance (glass Solar Heat Gain Coefficient and frame R-value)
Hot/mild	Awnings to shade windows and prevent solar radiation entering the building Additional wall and roof insulation Maximisation of cross ventilation Increased window performance (glass Solar Heat Gain Coefficient and frame R-value)

Table 6
Model input data summary for the improved scenario.

Climate type and its NCC zone	Warm/mild Climate Zone 5**	Hot arid Climate Zone 3**	Tropical Climate Zone 1**
Location	Moree NSW	Alice Springs NT	Borroloola NT
Construction type	Increased insulation	Increased insulation*	Increased insulation
Glazing type	Standard single clear float glass panel	Standard single clear float glass panel	Standard single clear float glass panel
Glazing Solar Heat Gain Coefficient	0.8	0.8	0.8
Glazing thermal transmittance	5.8	5.8	5.8
Frame type	Aluminium frame with thermal brake	Aluminium frame without thermal brake	Aluminium frame with thermal brake
Frame thermal transmittance	8	8	8
Infiltration rate (ac/h)	0.7	0.7	0.7
Ventilation mode	Natural ventilation	Natural ventilation	Natural ventilation
Wall minimum total thermal resistance	3.7	3.7	3.7
Roof maximum solar absorptance	0.45	0.45	0.45
Equipment load (W/m ²)	3.9	3.9	3.9
Lighting load (W/m ²)	5	5	5
Domestic hot water consumption (lt/person)	4	4	4

* [3][4]; **[2]; †Archival drawings

5. Occupancy Density

Four different scenarios regarding occupancy have been considered. These scenarios are characterized by standard moisture and heat generation rates as indicated by the Nationwide House Energy Rating Scheme (NatHERS) guidelines, the Australian reference document used to predict the energy performance of new residential buildings, based on their design [5]. Table 7 shows the scenarios and the inputs used in the simulation software.

Table 7
Occupancy density data.

Scenario	Number of occupants	Climate	Occupancy density (people/m ²)					
			Bedroom1	Bedroom 2	Bedroom 3	Living room	Wet areas	Other
O4	4	Moree NSW	0.1406	0.0728	0.0781	0	0.0692	0.1156
		Alice Springs NT	0.128	0.0688	0.0699	0	0.0524	0.0973
		Borroloola NT	0.1555	0.0854	0.1289	0	0.129	0.1308
O7	7	Moree NSW	0.1406	0.2183	0.1562	0	0.0692	0.2023
		Alice Springs NT	0.128	0.2063	0.1398	0	0.0524	0.1704
		Borroloola NT	0.1555	0.2562	0.2577	0	0.129	0.229
O11	11	Moree NSW	0.3516	0.2911	0.1562	0	0.0692	0.3179
		Alice Springs NT	0.3199	0.2751	0.1398	0	0.0524	0.2677
		Borroloola NT	0.3888	0.3416	0.2577	0	0.129	0.3598
O16	16	Moree NSW	0.3516	0.2911	0.3125	0.2032	0.0692	0.8064
		Alice Springs NT	0.3199	0.2754	0.2795	0.0897	0.0524	2.0942
		Borroloola NT	0.3888	0.3416	0.5155	0.132	0.129	2.0382

6. Air Conditioning and Windows Opening

Different combination of active mechanical services for conditioning and windows opening behaviour have been considered. Based on field studies, four possibilities of active systems installed are assumed:

- No active cooling system is installed. This is a worst-case scenario for cooling, where either no mechanical system is available, or major faults prevent any use.
- A non-ducted cooling system is available in the living area and main bedroom.
- A ducted cooling system is installed where occupants can control the temperature in each room of the house separately.
- A split system air conditioning plus heating system is installed. Cooling is separately available in all rooms, while heating is centralised and controlled in the living room.

Further, starting from the baseline schedules for use of the systems and windows opening behaviour [5], a set of different options has been identified as representative of current practices in Indigenous housing (additional and detailed explanation of the background can be found in [1]):

- windows always open
- window always closed
- windows open when the indoor temperature is above 24°C and outdoor temperature is above 16°C (hereafter called 'natural ventilation')
- windows open during the night ('night purging').

These two sets have been merged to create seven different scenarios, as reported in Table 8. Two main types of systems have been considered, e.g., split system (active) and natural ventilation (passive). Possible combinations of these systems are determined according to Health Habitat [4], which provides empirical evidence for the types of ventilation systems used in Indigenous housing in Australia. It is assumed that when active systems are in use, the occupants will not operate the windows for natural ventilation.

Table 8

Active and passive systems scenario matrix.

Scenario	Description
1	No active systems + windows always open
2	No active systems + windows always closed
3	No active systems + natural ventilation when indoor $T > 24^{\circ}\text{C}$ and outdoor $T > 16^{\circ}\text{C}$
4	No active systems + Windows open during night
5	Split system in living area and main bedroom (activated when $T > 26^{\circ}\text{C}$) + natural ventilation when the system is switched off
6	Split system all room (activated when $T > 26^{\circ}\text{C}$) + natural ventilation when system off
7	Split system (activated when $T > 26^{\circ}\text{C}$) + heating (when temperature drop below 18) + natural ventilation when the system is switched off

Table 9 displays the opening schedules associated to the different scenarios and used in the software.

Table 9
Openings control schedules.

Windows always open	Windows always closed	Windows open during night
Schedule: Compact, windows always open, Fraction, Through: 31 Dec, For: All days, Until: 24:00, 1;	Schedule: Compact, windows always closed, Fraction, Through: 31 Dec, For: All days, Until: 24:00, 0;	Schedule: Compact, windows open during night, Fraction, Through: 31 Dec, For: All days, Until: 06:00, 1, Until: 18:00, 0, Until: 24:00, 1;

General schedules

Table 10 reports the general schedule used in the software as modelling assumptions.

Table 10
General control schedules.

Lighting	Ventilation	Equipment	Occupancy
Schedule: Compact, lighting schedule, Fraction, Through: 31 Dec, For: All days, Until: 05:00, 0.05, Until: 06:00, 0.25, Until: 08:00, 0.8, Until: 09:00, 0.5, Until: 17:00, 0.2, Until: 24:00, 0.5;	Schedule: Compact, hvac schedule, Fraction, Through: 31 Dec, For: All days, Until: 10:00, 1, Until: 16:00, 0, Until: 24:00, 1;	Schedule: Compact, equipment schedule, Fraction, Through: 31 Dec, For: All days,3, Until: 02:00, 0.2, Until: 06:00, 0.15, Until: 07:00, 0.4, Until: 08:00, 0.8, Until: 09:00, 0.5, Until: 10:00, 0.3, Until: 17:00, 0.5, Until: 19:00, 0.4, Until: 20:00, 0.5, Until: 22:00, 0.6, Until: 23:00, 0.4, Until: 24:00, 0.2;	Schedule: Compact, occupancy schedule, Fraction, Through: 31 Dec, For: All days, Until: 05:00, 0.9, Until: 06:00, 0.8, Until: 07:00, 0.7, Until: 09:00, 0.6, Until: 10:00, 0.3, Until: 16:00, 0.1, Until: 17:00, 0.2, Until: 18:00, 0.3, Until: 19:00, 0.4, Until: 20:00, 0.5, Until: 21:00, 0.6, Until: 23:00, 0.7, Until: 24:00, 0.9;

Ethics Statements

None

CRedit Author Statement

Arrianna Brambilla: Conceptualization, Methodology, Validation, Investigation, Writing – Original draft preparation; **Aysu Kuru:** Conceptualization, Software, Methodology, Data curation, Visualization, Writing – review & editing; **Tess Lea:** Conceptualization, Writing – review & editing, Project administration, Funding acquisition; **Liam Grealy:** Writing – review & editing, Project administration, Resources.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Data Availability

[Climate change and Indigenous housing performance in Australia: A dataset \(Original Data\)](#) (Data in Brief).

[A dataset for climate change and Indigenous housing performance in Australia \(Original Data\)](#) (Mendeley Data).

Acknowledgments

This work was supported by the [Australian Housing and Urban Research Institute](#) (AHURI; Grant No [20/PRO/73237](#)). AHURI played no role in the study design; in the collection, analysis, and interpretation of data; or in the decision to submit this article for publication.

References

- [1] Brambilla A., Lea T., Grealy L., Kuru A. Climate change and Indigenous housing performance in Australia: a modelling study. *Energy Build.*, 112399.
- [2] Australian Building Codes Board (2019). National construction code: Australia climate zone map. <https://www.abcb.gov.au/Resources/Tools-Calculators/Climate-Zone-Map-Australia-Wide>, ABCB.
- [3] Healthabitat. Temperature control inside the house – warm. Available at: <https://www.healthabitat.com/research-development/temperature-control-inside-the-house-warm-houses-in-cold-climates/>
- [4] Healthabitat. Temperature control inside the house – cold. Available at: <https://www.healthabitat.com/research-development/temperature-control-inside-the-house-warm-houses-in-cold-climates/>
- [5] DISERNationwide House Energy Rating Scheme (NatHERS) Software Accreditation Protocol, S. Department of Industry, Energy and Resources, Canberra, 2019 <https://www.nathers.gov.au/nathers-accredited-software>.