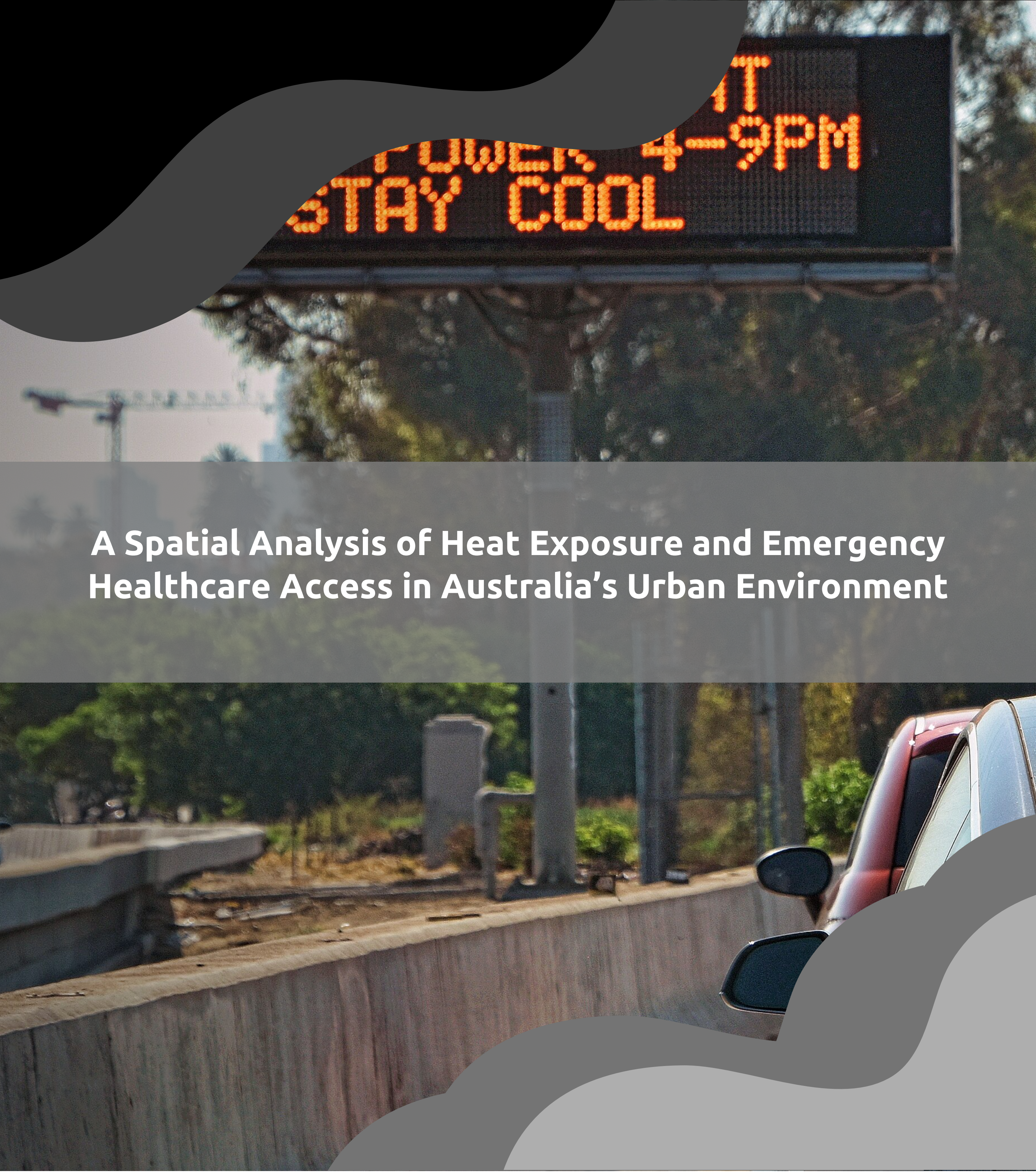

A Spatial Analysis of Heat Exposure and Emergency Healthcare Access in Australia's Urban Environment

the climate centre

A Spatial Analysis of Heat Exposure and Emergency Healthcare Access in Australia's Urban Environment

Introduction

- Perth, Western Australia, is a low-population-density metropolitan area characterised by a Mediterranean climate, making it increasingly vulnerable to heatwaves and associated public health impacts under climate change. As one of Australia's most isolated major cities, equitable access to emergency medical services during extreme heat events is a pressing urban planning challenge.
- Heatwaves are Australia's deadliest natural hazard, causing more deaths than all other natural hazards combined (Coates et al., 2021; AIHW, 2023). The health burden includes increases in emergency department presentations, ambulance callouts, and excess mortality during heat events (Amoatey et al., 2025).
- Rapid urban sprawl in Perth has produced a city that is among the spatially largest in the world yet also among the lowest population densities of any major city globally (Cox, 2025). Research shows that access to essential social and health services in Perth is adequate only in the CBD, with outer metropolitan areas experiencing uniformly limited service accessibility (AIHW, 2025).
- Under a high-emissions scenario, Western Australia can expect an average annual temperature increase of 1.1–2.7°C in a medium-emission scenario, and 2.6–5.1°C in a high-emission scenario by the end of the century, with Perth projected to face up to twice as many days over 35°C by 2050 (DPIRD WA, 2021; Climate Council, 2023).
- This study investigates the intersection of public health, urban land planning, and transport planning, focusing on the spatial co-occurrence of high heat exposure and poor emergency healthcare access across Perth's metropolitan area.

Methods

- This study uses data spanning 1889 to 2025 to provide a long-term assessment of maximum daily surface air temperatures and spatial access to emergency healthcare, identifying suburbs at greatest combined risk.
- Two primary datasets were used: the SILO project (Queensland Government, 2026), a Queensland Government database providing spatially interpolated daily climate data for Australia from 1889 to present based on data from the Bureau of Meteorology (BOM).
- The 419 suburb centroids within the Greater Perth metropolitan area were derived from Australian Bureau of Statistics (ABS) geographical boundary data (ABS, 2021). 11 suburbs were excluded due to various reasons, for example Rottnest Island is a tourism destination not connected to the mainland, Garden Island is primarily a military facility, and Avon Valley National Park is primarily a recreational area.
- Daily maximum temperature data were aggregated to annual averages, and calculated for each suburb centroid, then averaged across the 1941–1970 baseline period and the most recent decade (2016–2025) to compute temperature anomalies. The annual average number of days exceeding

30°C was also calculated for each suburb centroid over those same two periods.

- Emergency room locations were sourced for each non-specialised Western Australian metropolitan hospital. Travel times were calculated from these locations to each suburb centroid using the OpenRouteService API (Heidelberg Institute for Geoinformation Technology, 2025), which computes road-network drive times between origin and destination points.
- A combined risk index was constructed with the formula: travel time × temperature anomaly × additional days over 30°C / 10,000 to identify areas of compounding vulnerability.

Results

Temperature anomalies

- SILO data from 1889 to 2025 showed a metropolitan-wide increase in annual maximum daily temperatures consistent with global warming trends. The northwestern coastal corridor showed the most pronounced and consistent warming signal.
- This included Pinjar, which recorded the highest anomaly (+2.0°C), followed by Alkimos, Carabooda, Craigie, Eglinton, Hillarys, Kallaroo, Mullaloo, Padbury (all +1.96°C). The lowest anomalies were in southern inland areas such as Fairbridge (+0.54°C) and North Dandalup (+0.56°C).

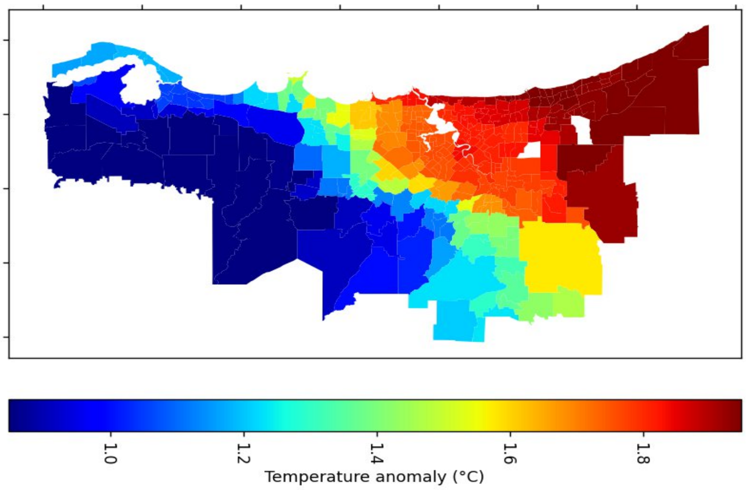

Fig. 1 Annual average temperature anomaly for suburbs within the Perth metropolitan area for the period 2016 to 2025 compared to the period 1941 to 1970. Oriented with west up, north right.

Days Exceeding 30°C

- North-eastern suburbs experienced the highest number of days over 30°C as calculated as an annual average of the period 2016-2025. This included Brigadoon, Upper Swan, Ellenbrook, The Vines, Bullsbrook, Baskerville, Millendon, Aveley, Belhus, and Henley Brook, all with more than 100 days per year over 30°C during this period.

- However, it was central, centre-east and centre-north suburbs that recorded the highest increase to the number days exceeding 30°C compared to the 1941-1970 average. High Wycombe and Maida Vale recorded the greatest absolute increase (28.1 additional days per year), followed by Ashfield, Bassendean, Eden Hill, Guildford, Kiara, and Lockridge (all ~28.0 days).
- Southern and coastal areas showed the least change, with Peron and Shoalwater gaining fewer than 10 additional days per year, compared to the ~28 days gained in the highest-impact central suburbs.

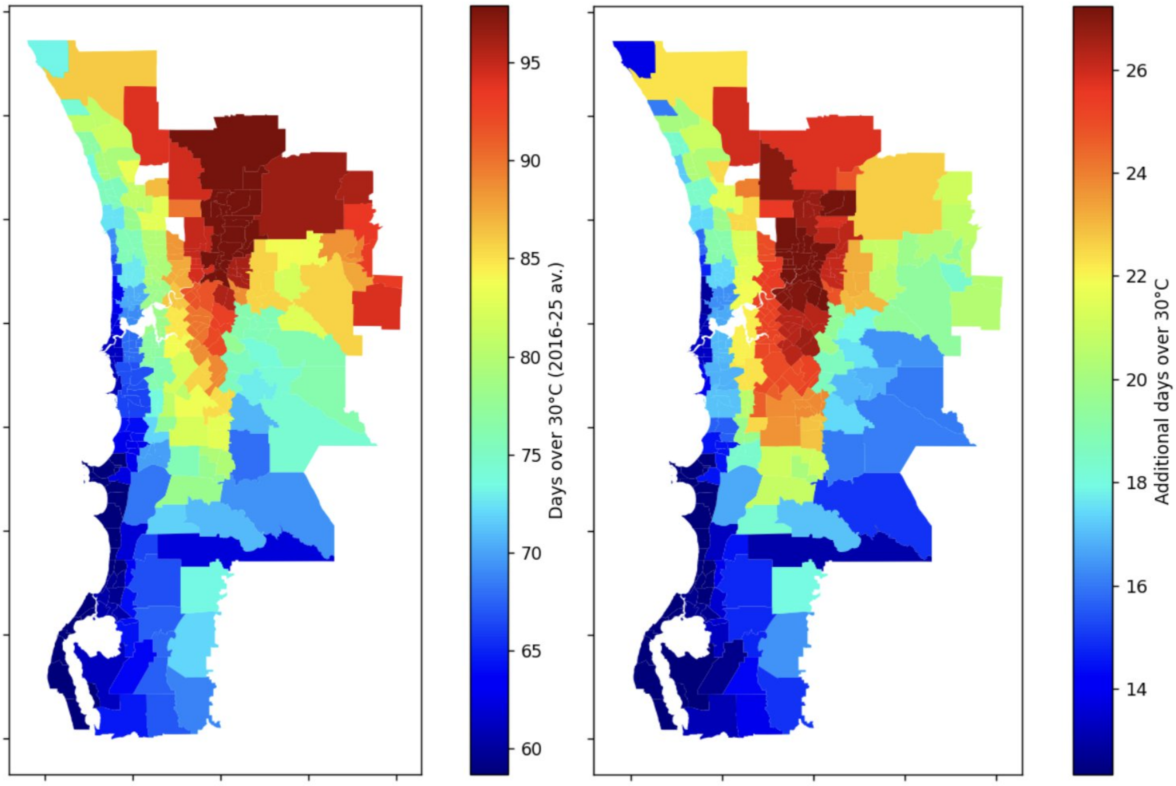

Fig. 2 Suburbs within the Perth metropolitan area by the average number of days over 30°C per year for the period 2016 to 2025 (left) and the average number of additional days over 30°C per year for the period 2016 to 2025 compared to the period 1941 to 1970 (right). Oriented with north up.

Travel Times to Emergency Rooms

- Travel times from suburb centroids to the nearest public emergency room ranged from 1.2 minutes (Cooloongup) to 89.0 minutes (Flynn), with a metropolitan mean of 18.7 minutes and median of 16.5 minutes.
- Outer fringe suburbs recorded the longest travel times: Flynn (89.0 min), Malmalling (72.0 min), Nanga Brook (62.7 min), Morangup (61.7 min), and Gorrie (58.6 min). Of the 408 suburbs assessed, 52 (12.7%) had travel times exceeding 30 minutes, and 121 (29.7%) exceeded 20 minutes. Inner suburbs near existing hospitals had the shortest times, with 71 suburbs (17.4%) accessible within 10 minutes.

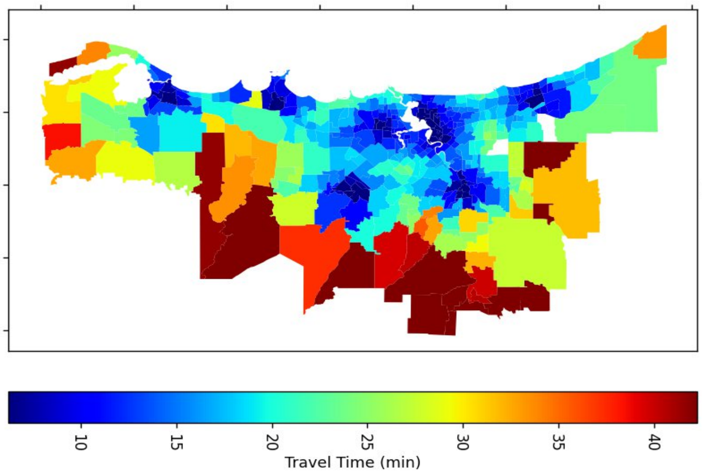

Fig. 3 Travel times from suburb centroids to the nearest public emergency room department in minutes. Oriented with west up, north right.

Combined Heat and Access Risk

- The combined index highlights that northern and northeastern outer suburbs face a compound disadvantage of high travel times and rising heat. Central and inner-east suburbs face a distinct but equally important risk: a disproportionate and accelerating increase in extreme heat days relative to baseline conditions.

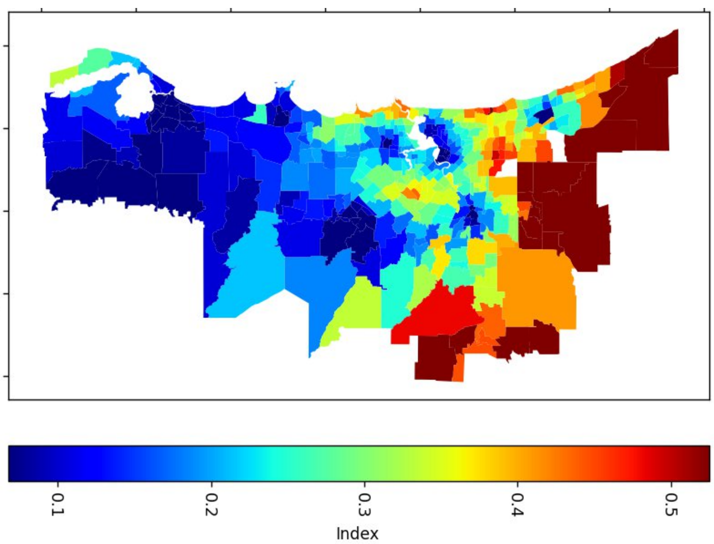

Fig. 4 Combined heat and access index values for suburbs in the Perth metropolitan area. Oriented with west up, north right.

Discussion

- These findings indicate an urgent need for the construction of additional emergency rooms, cooling shelters and accessible public spaces in the northern areas of Perth, where the combined burden of high heat and poor emergency access is greatest.
- Perth's low-population-density urban form structurally disadvantages outer suburban residents, who face longer travel times to emergency care.

Research has consistently shown that heatwaves significantly increase emergency department presentations (Toloo et al., 2014; Amoatey et al., 2025), meaning that longer travel times during heat events directly translate to worse health outcomes for outer suburban populations.

- The disproportionate increase in days exceeding 30°C in certain central, centre-north and centre-east suburbs compared to coastal and southern areas highlights that heat risk is not uniform across the city and requires spatially targeted planning responses.
- These outcomes highlight the necessity for adaptive measures in urban planning to enhance public health resiliency. Future research should incorporate population vulnerability indicators (such as age, socioeconomic status, and housing type) alongside heat and access metrics, and extend the analysis to other Australian cities facing similar climate trajectories.

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