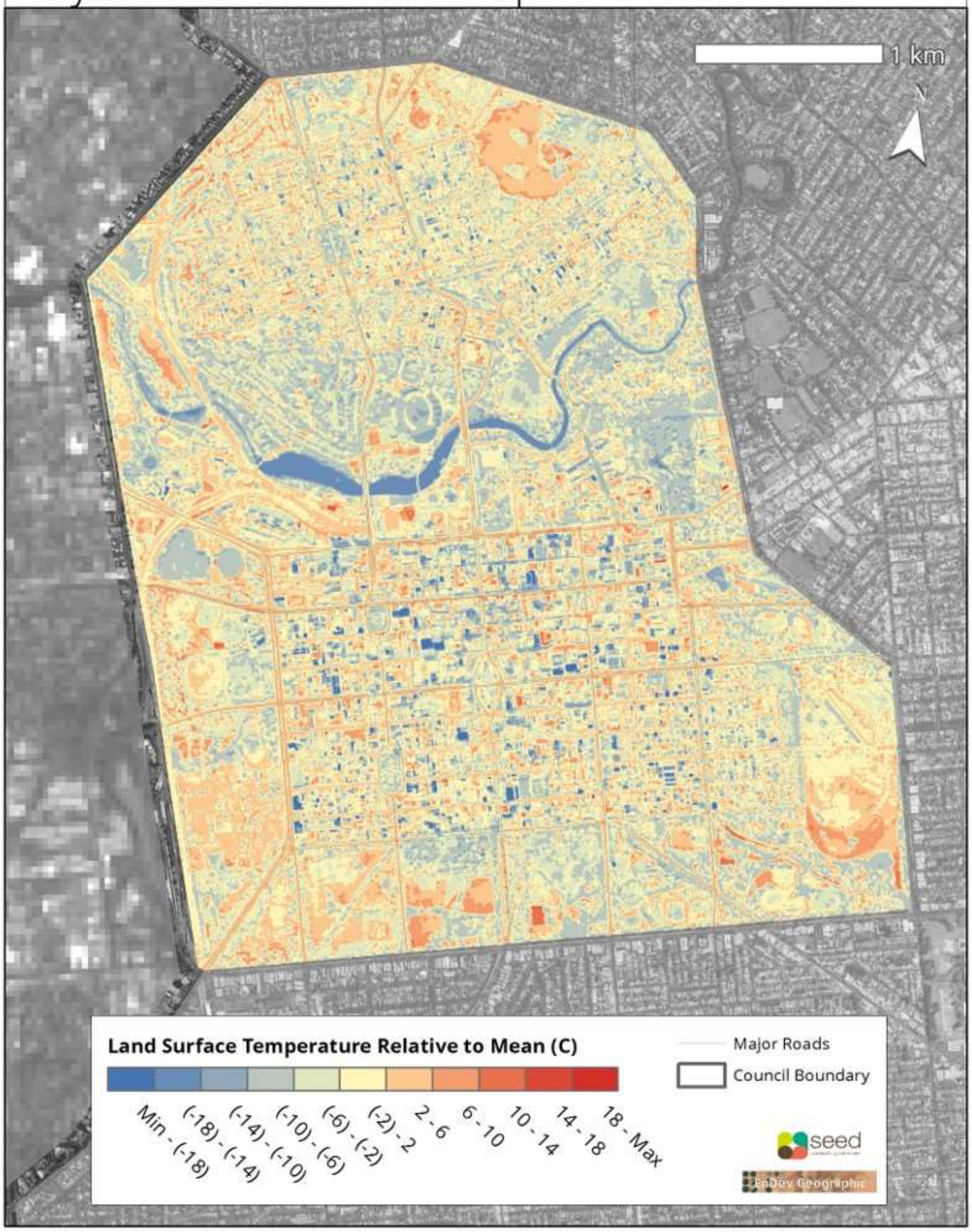
Attachment 1: Council thermal maps

This Attachment provides day and night heat maps for each council.

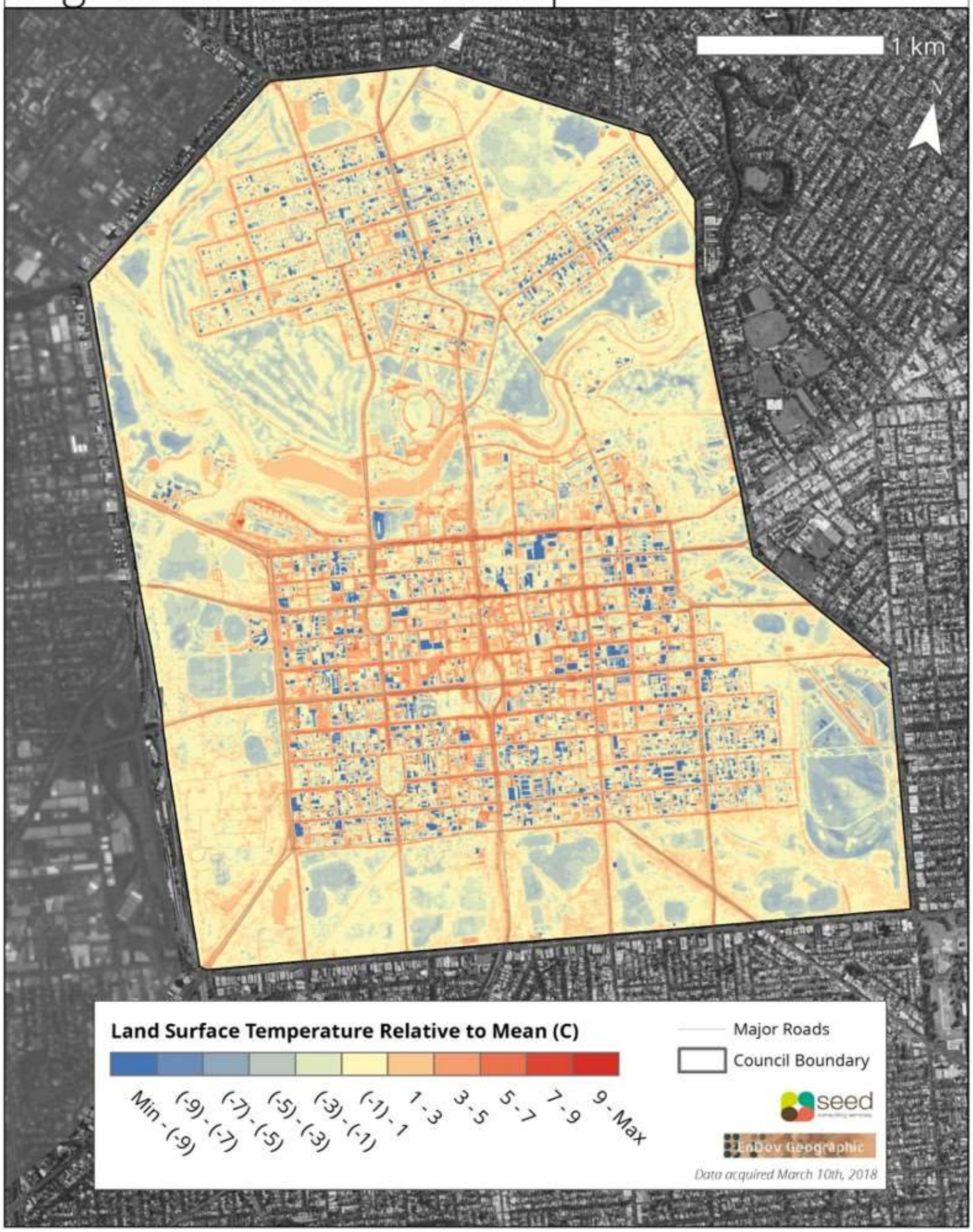
Adelaide City Council

Daytime Urban Heat Map



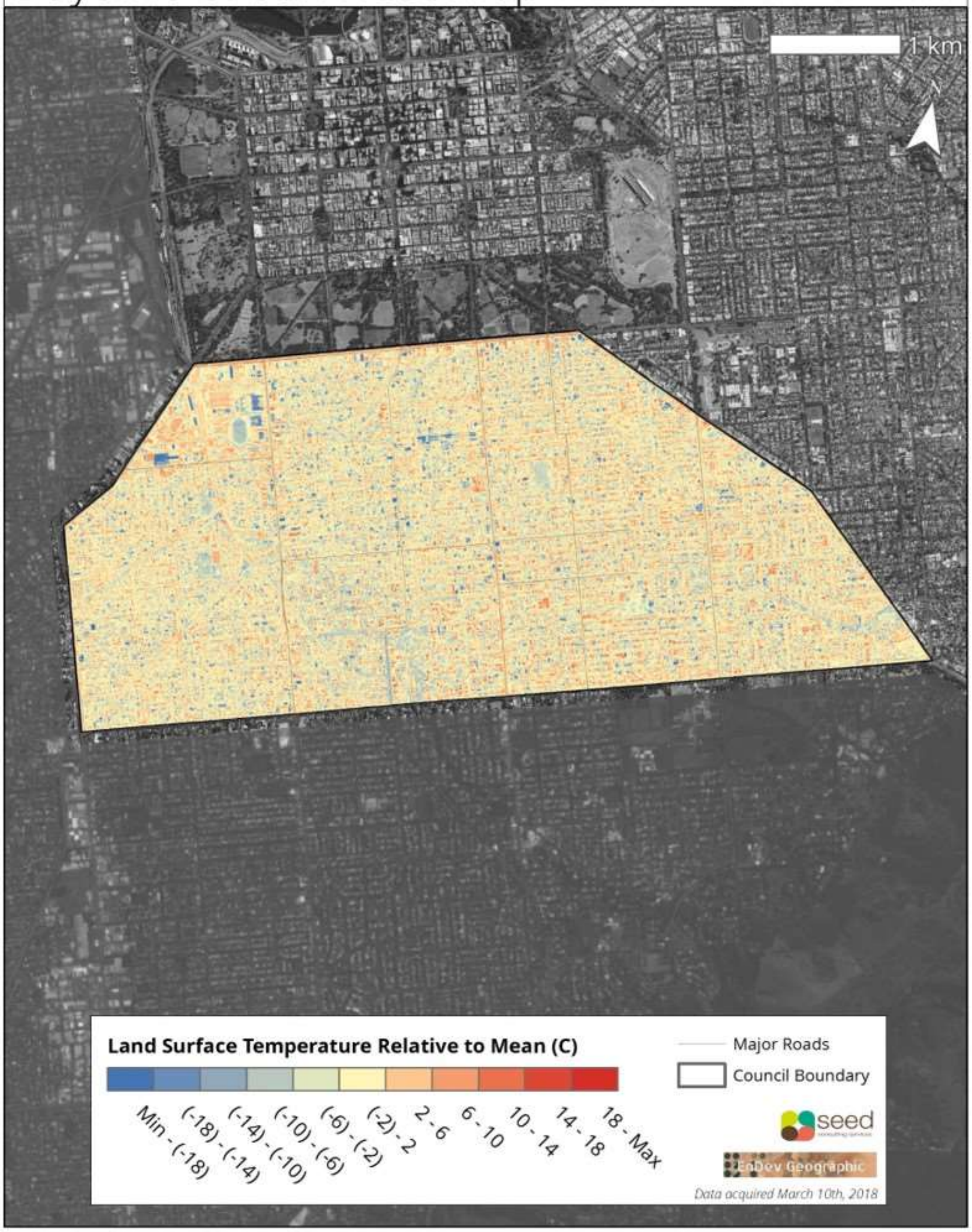
Adelaide City Council

Nighttime Urban Heat Map



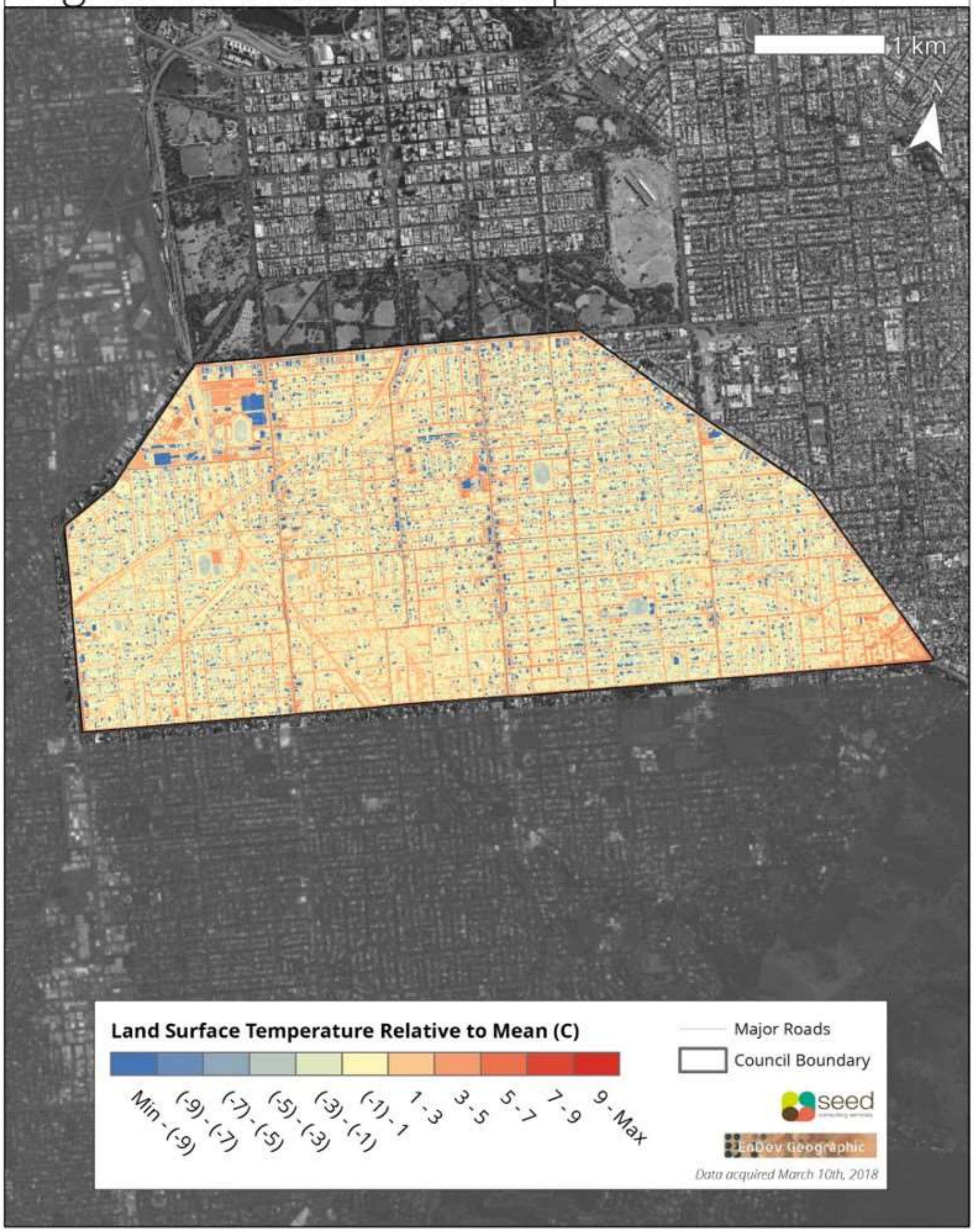
City of Unley

Daytime Urban Heat Map



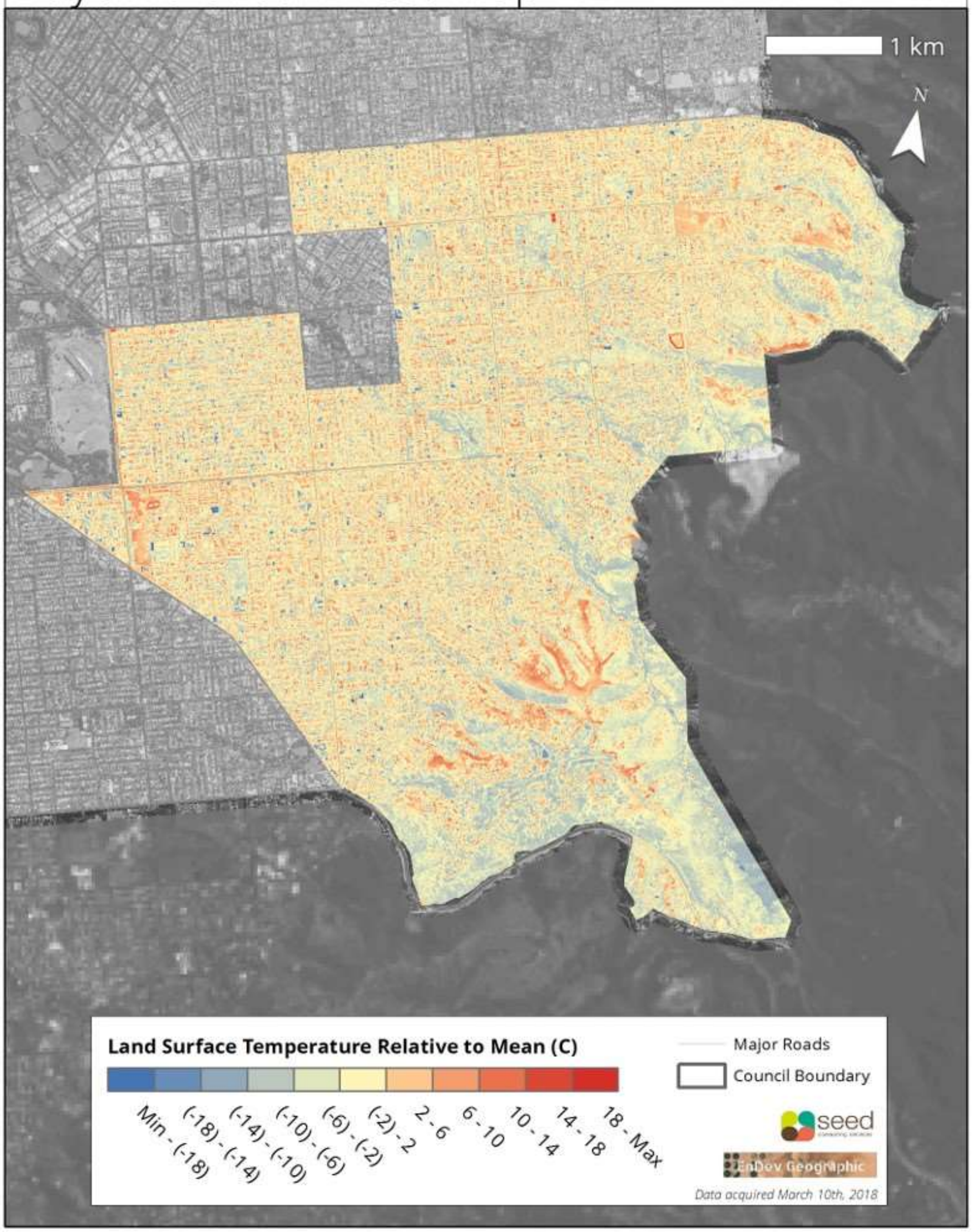
City of Unley

Nighttime Urban Heat Map



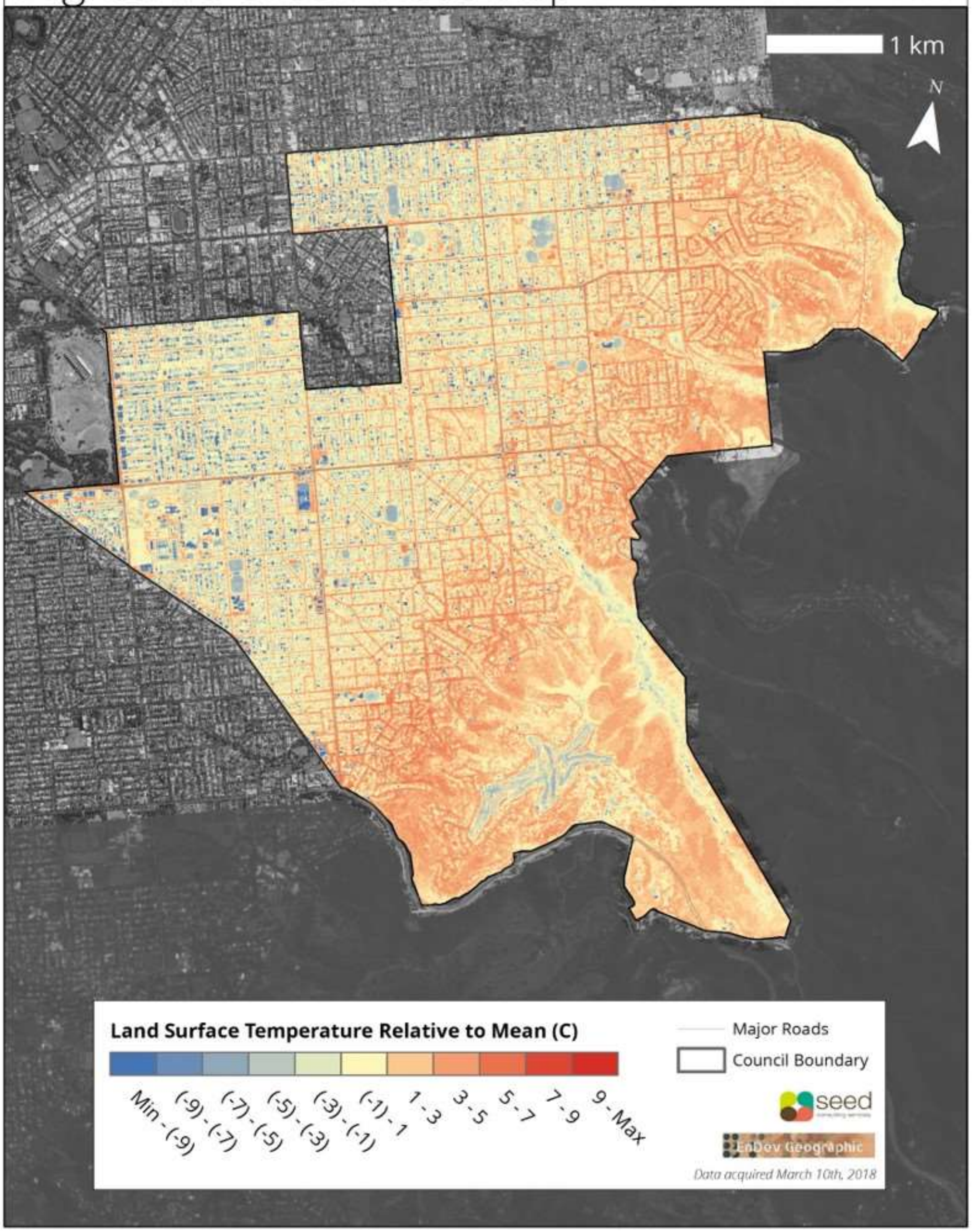
City of Burnside

Daytime Urban Heat Map



City of Burnside

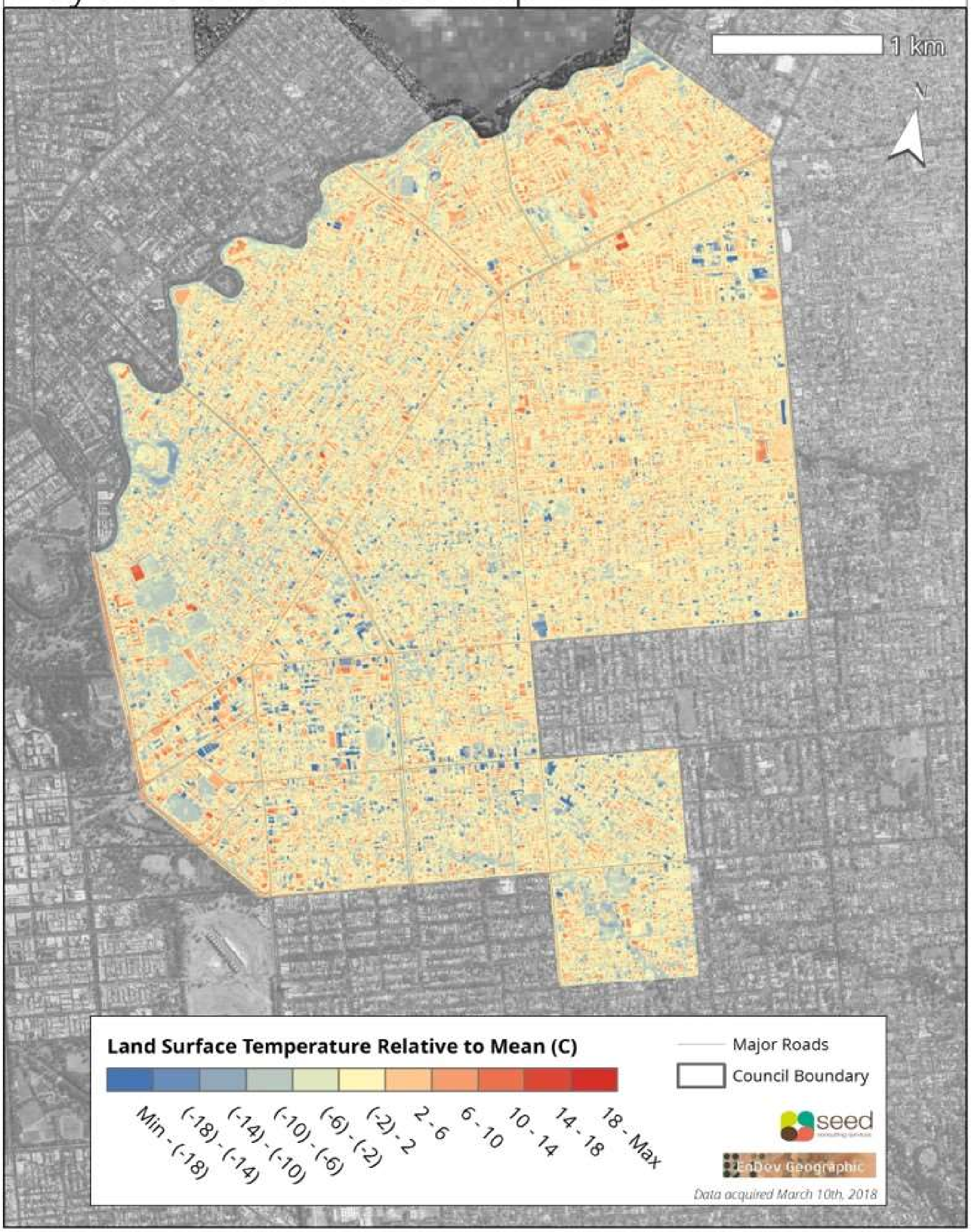
Nighttime Urban Heat Map



City of Norwood Payneham & St Peters

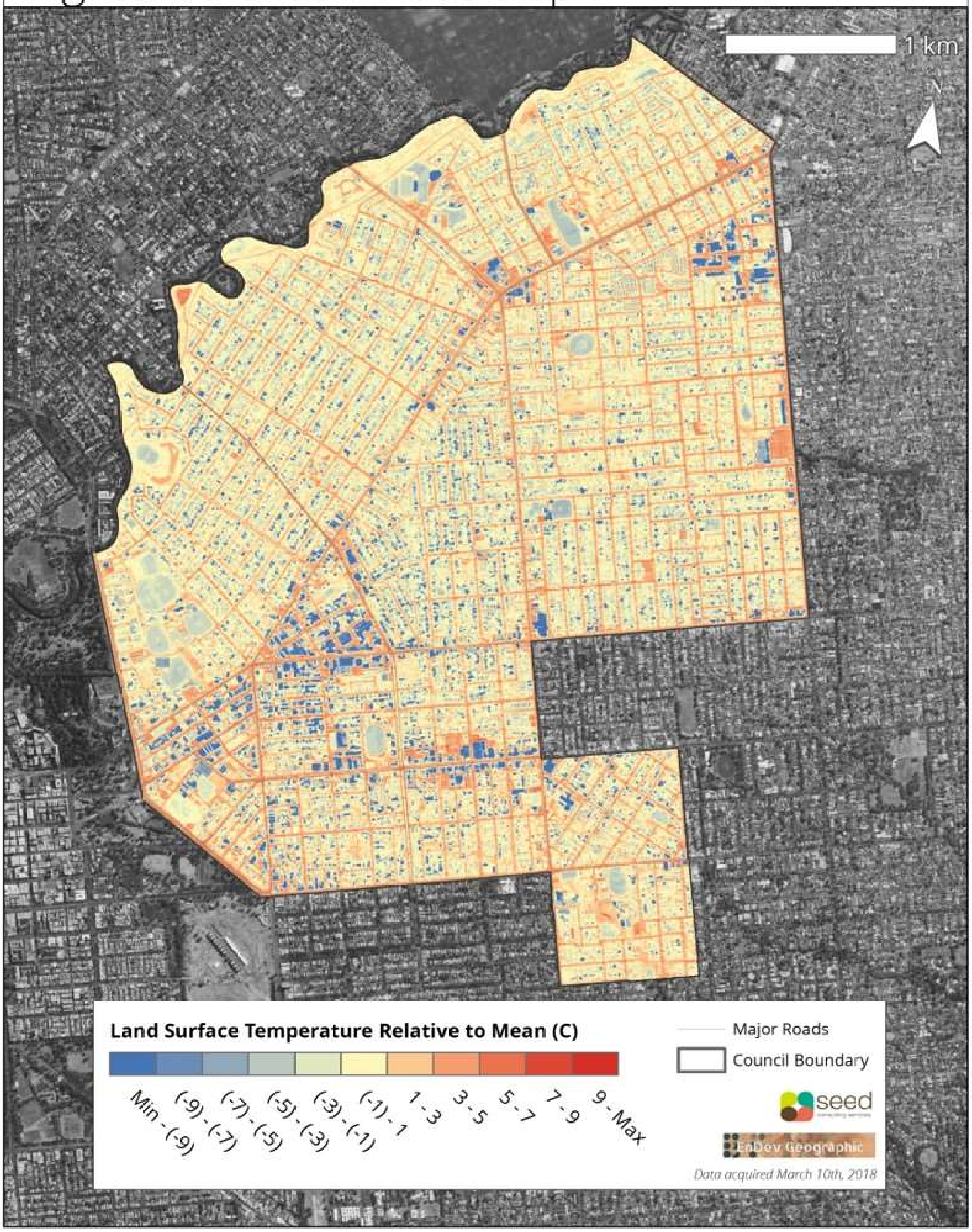
Daytime Urban Heat Map

EAST HEAT



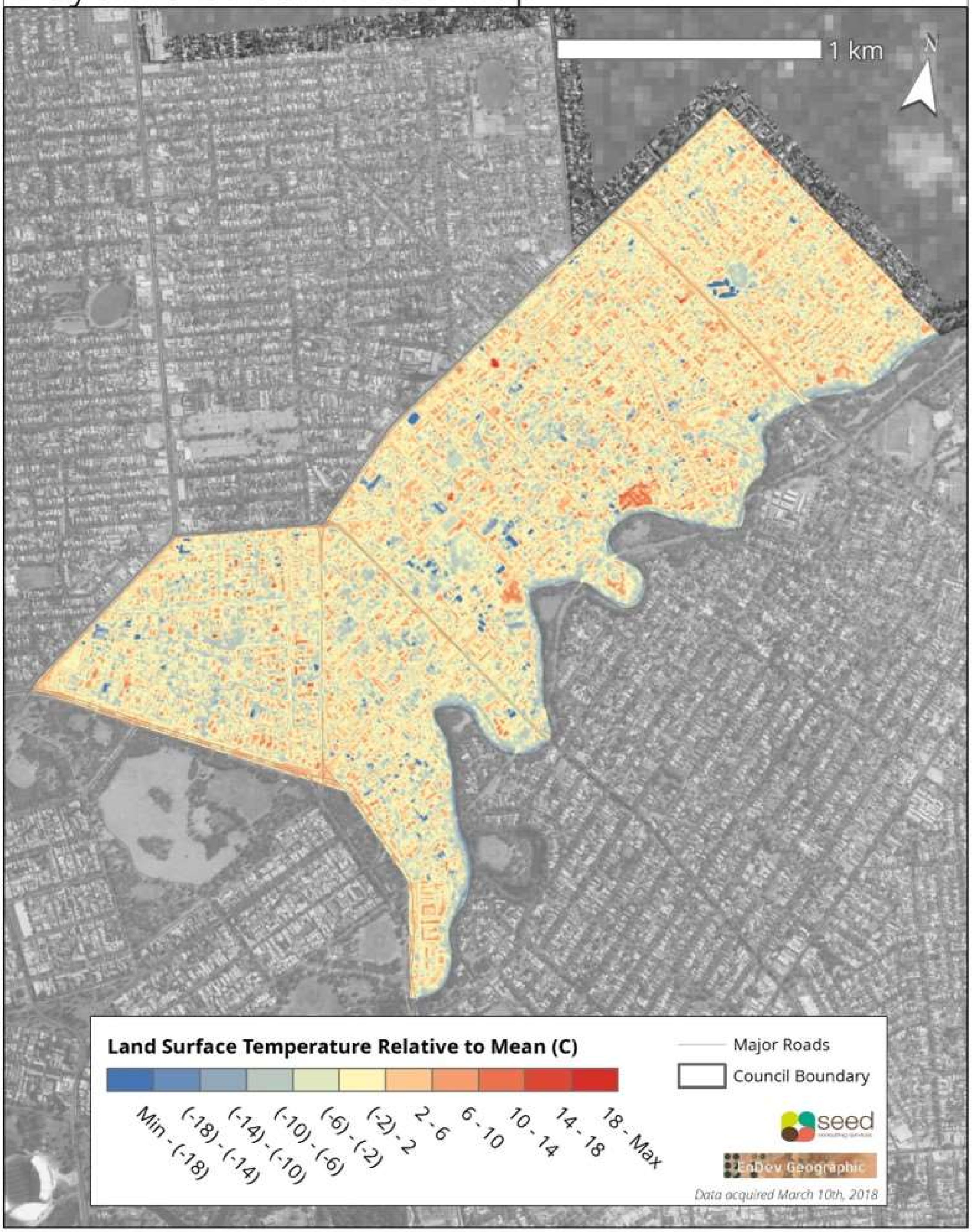
City of Norwood Payneham & St Peters

Nighttime Urban Heat Map



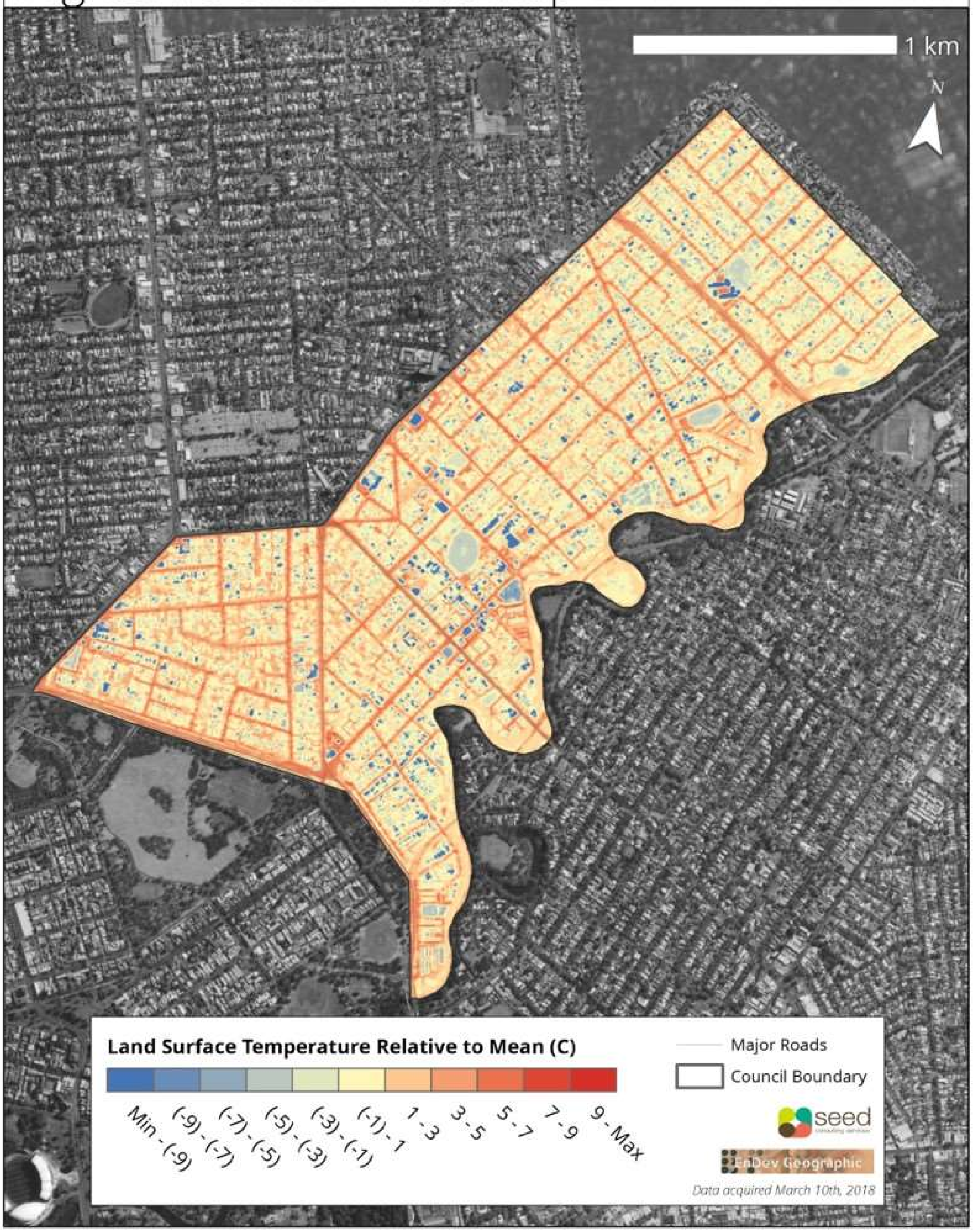
Town of Walkerville

Daytime Urban Heat Map



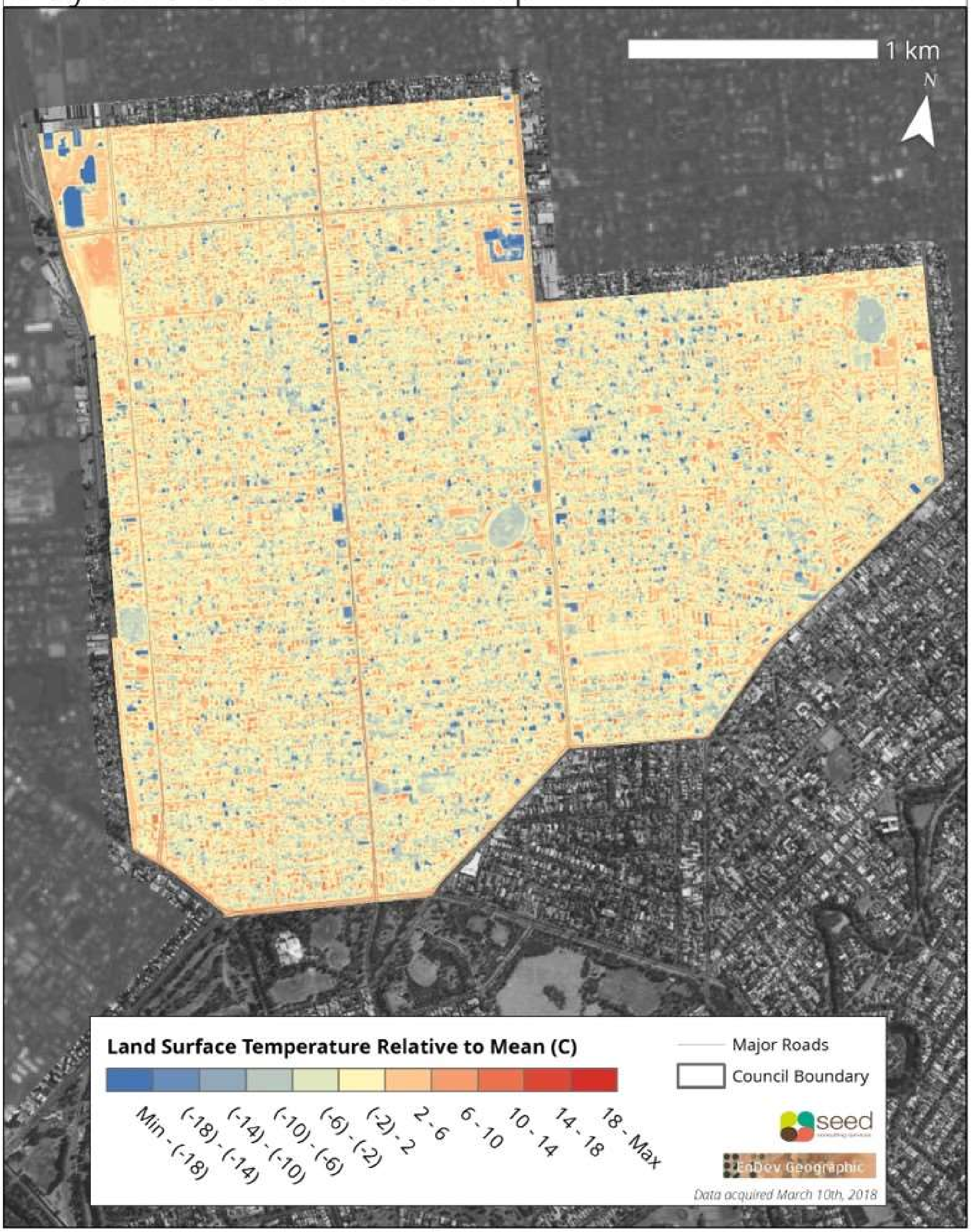
Town of Walkerville

Nighttime Urban Heat Map



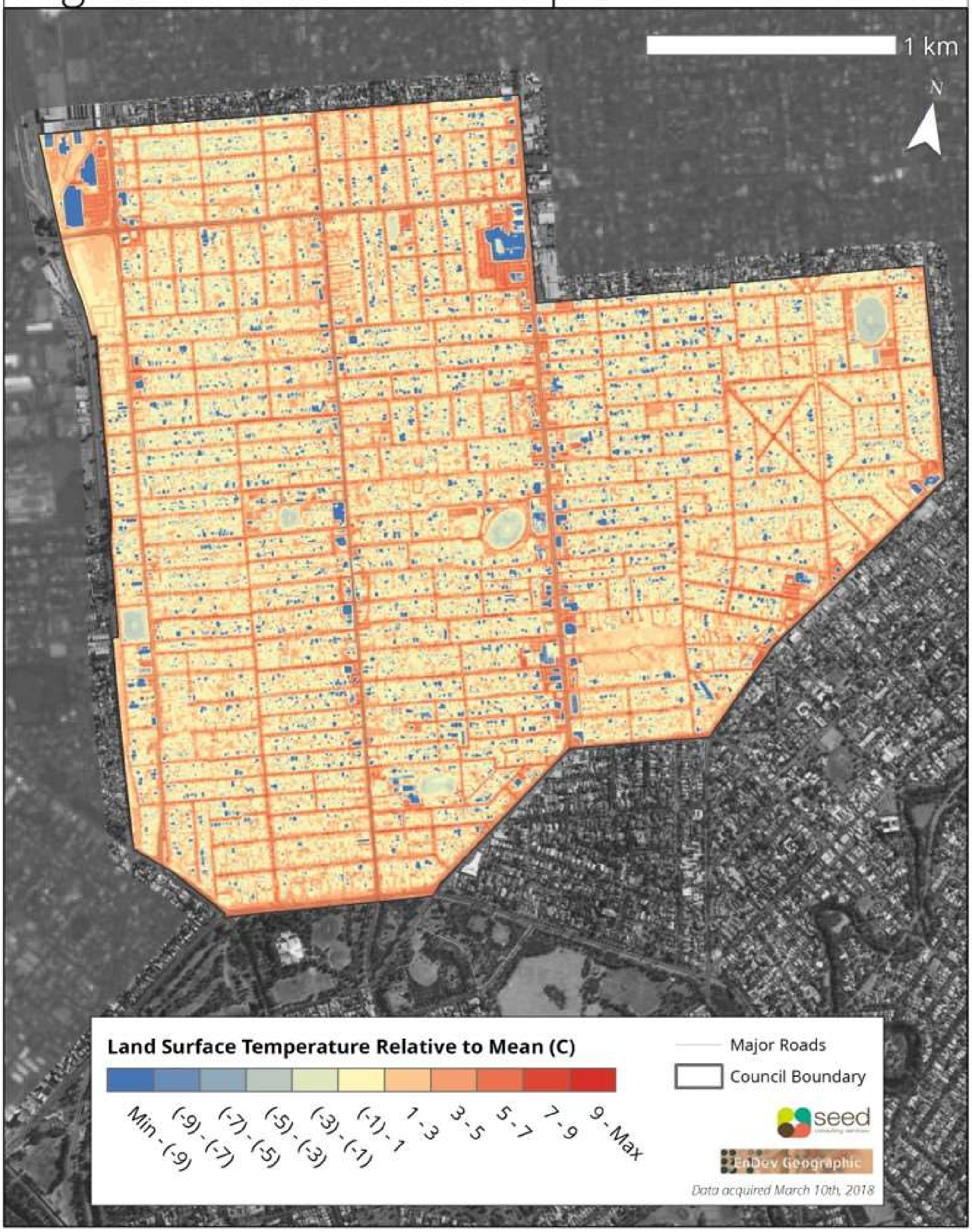
City of Prospect

Daytime Urban Heat Map



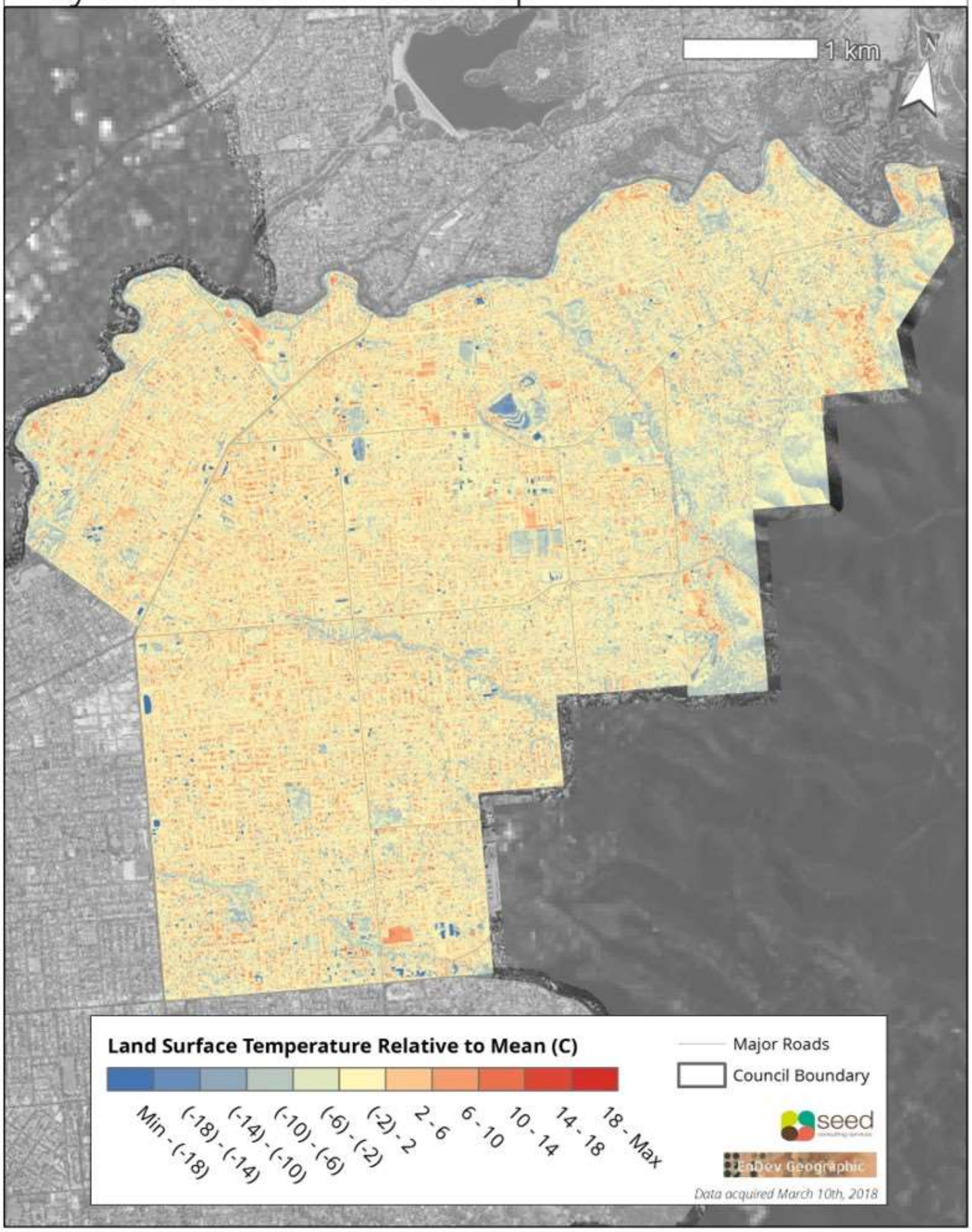
City of Prospect

Nighttime Urban Heat Map



Campbelltown City Council

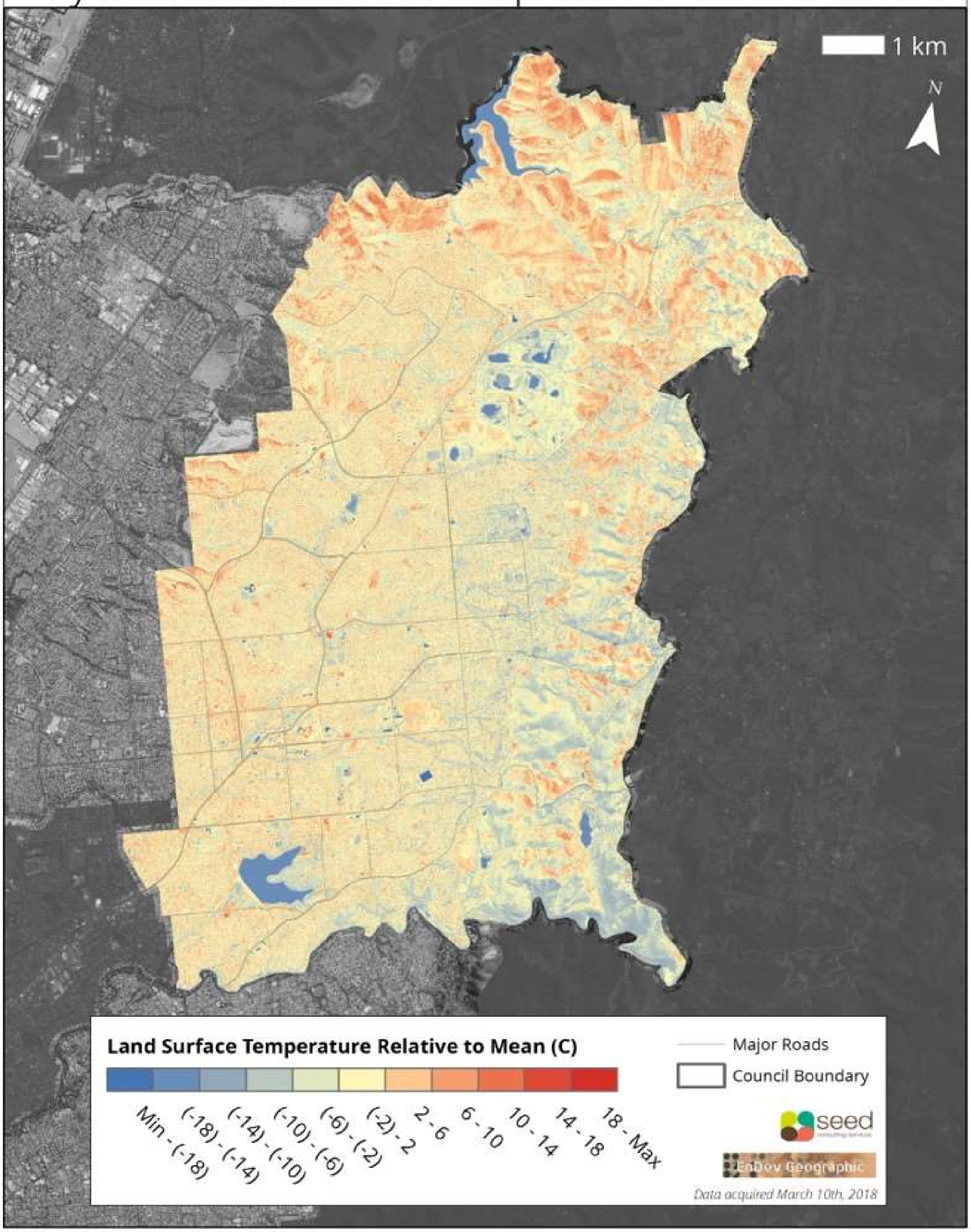
Daytime Urban Heat Map




Campbelltown City Council
Nighttime Urban Heat Map
1 km
Land Surface Temperature Relative to Mean (C)
Min - (-9)
(-9) - (-7)
(-7) - (-5)
(-5) - (-3)
(-3) - (-1)
(-1) - 1
1 - 3
3 - 5
5 - 7
7 - 9
9 - Max
Major Roads
Council Boundary
seed
EnDev Geographic
Data acquired March 10th, 2018

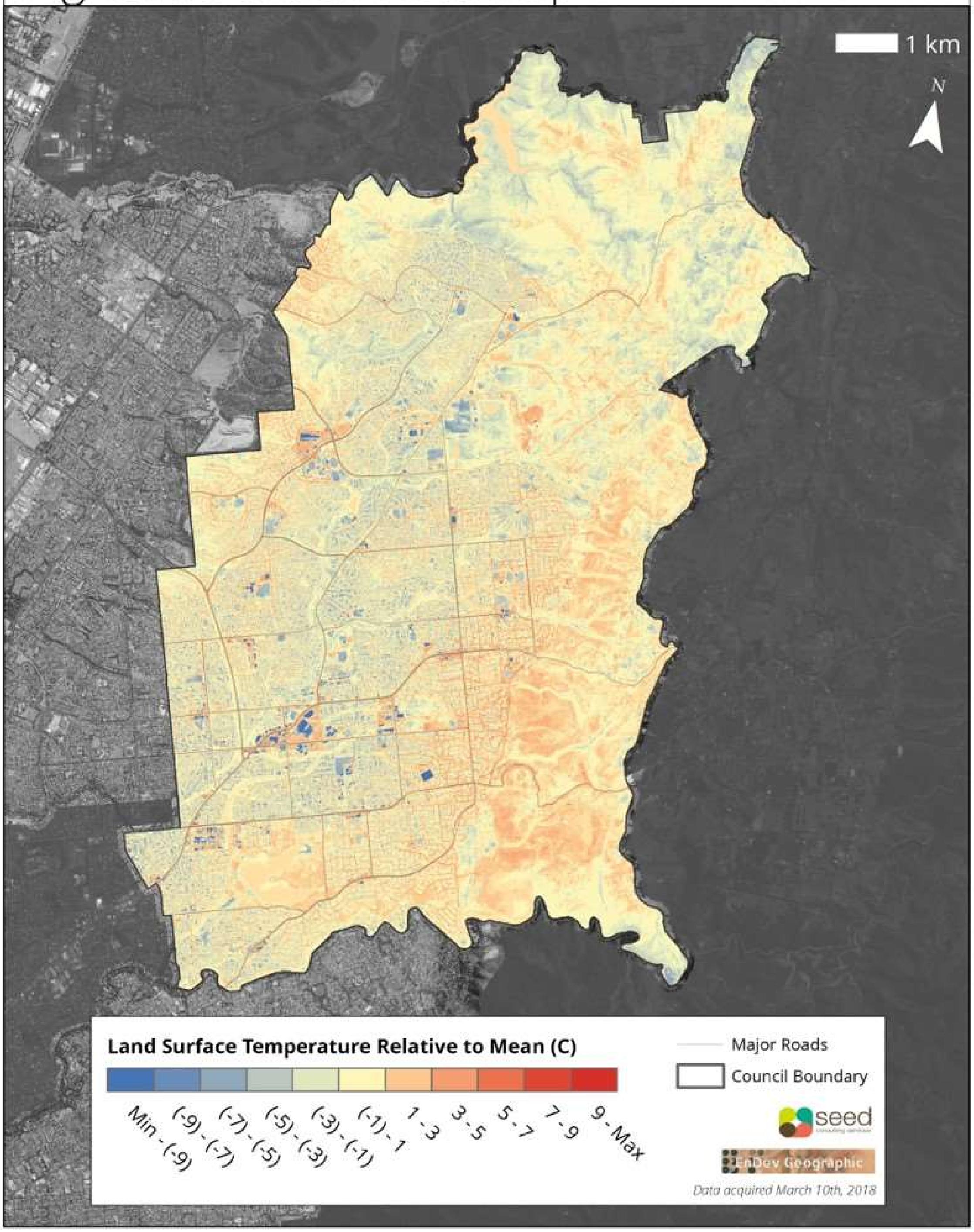
City of Tea Tree Gully

Daytime Urban Heat Map

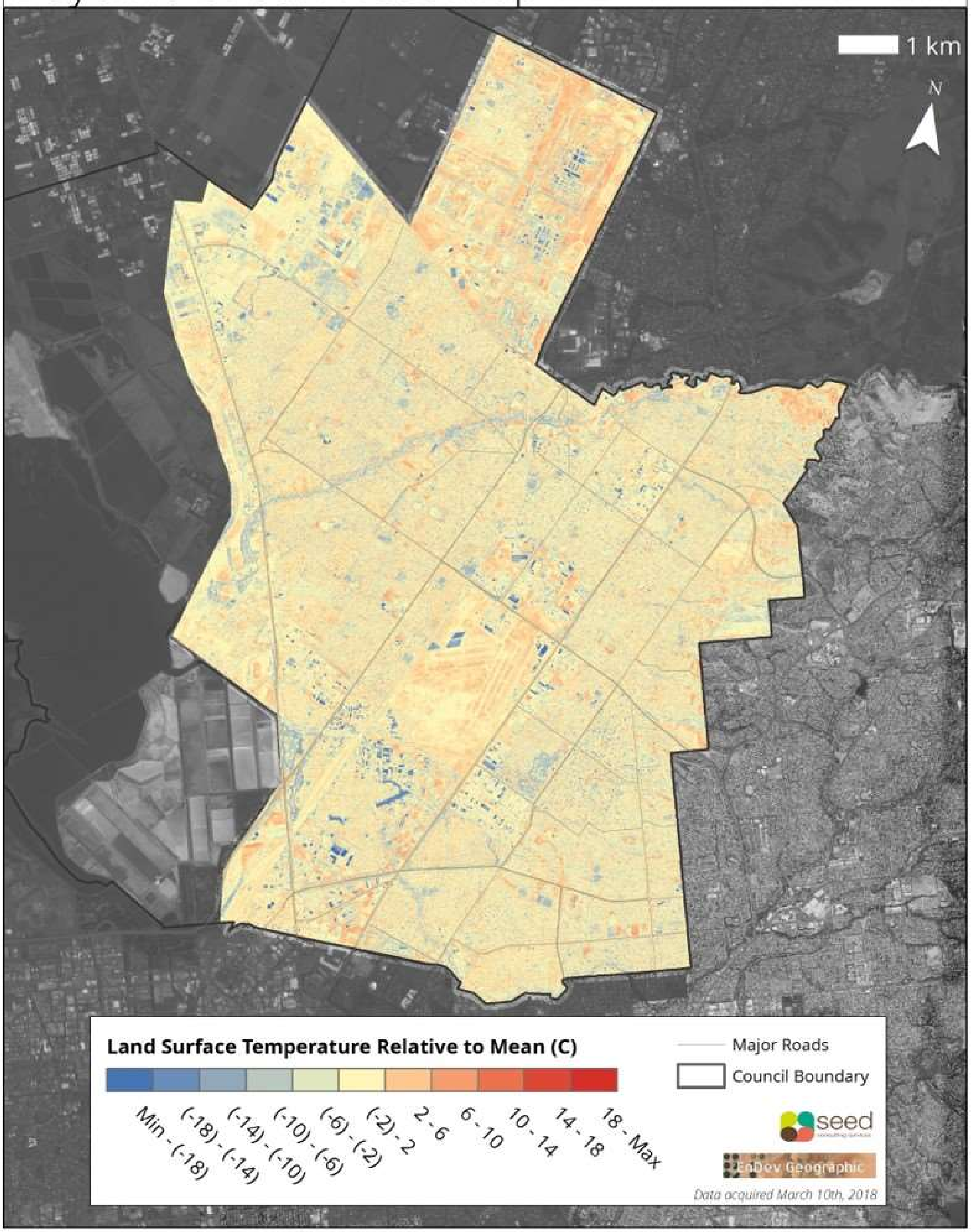


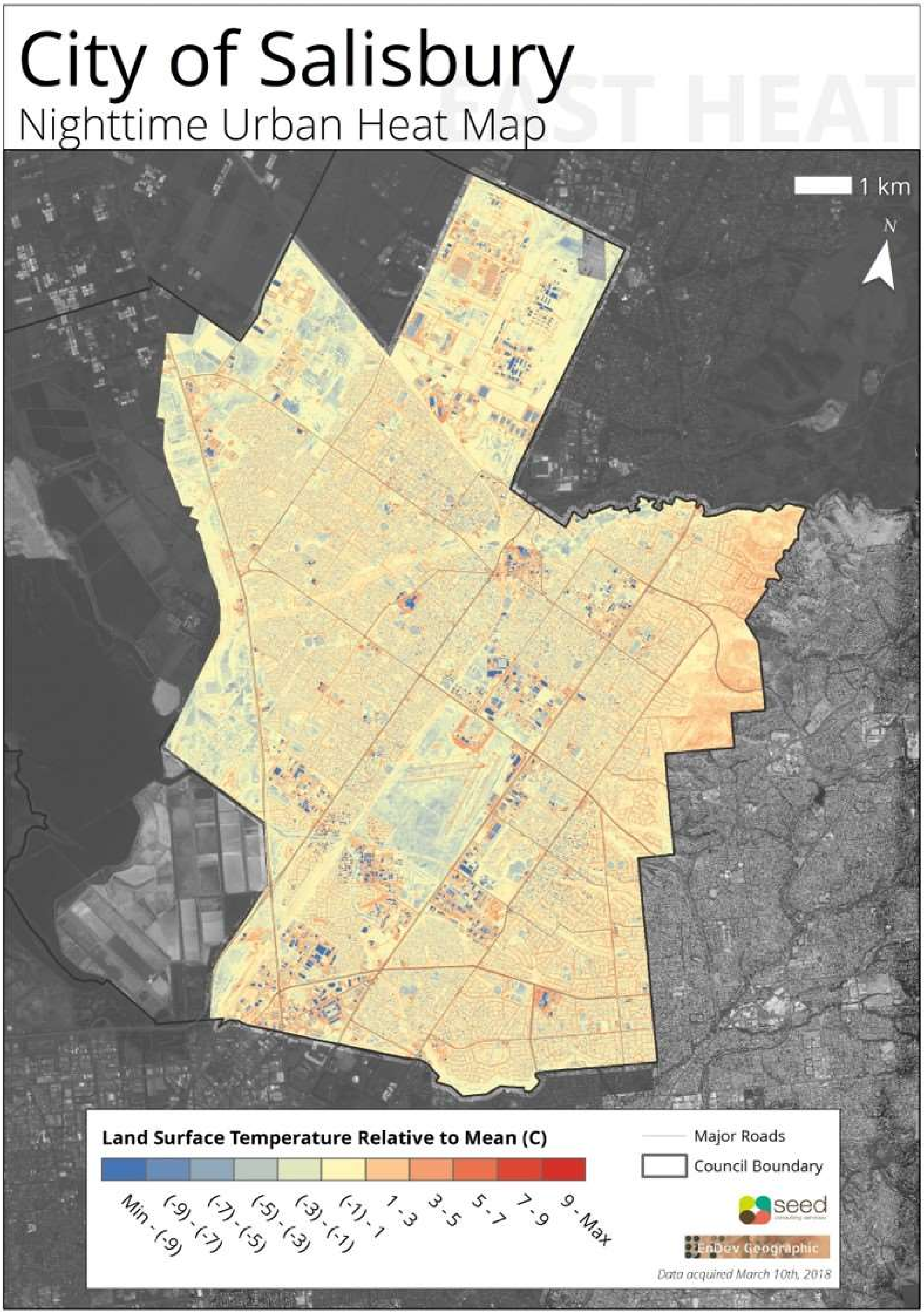
City of Tea Tree Gully

Nighttime Urban Heat Map



City of Salisbury
Daytime Urban Heat Map





City of Salisbury
Nighttime Urban Heat Map
FAST HEAT
1 km
N
Land Surface Temperature Relative to Mean (C)
Min - (-9)
(-9) - (-7)
(-7) - (-5)
(-5) - (-3)
(-3) - (-1)
(-1) - 1
1 - 3
3 - 5
5 - 7
7 - 9
9 - Max
Major Roads
Council Boundary
seed
EnDev Geographic
Data acquired March 10th, 2018

Attachment 2: Hottest suburbs by council

Attachment 2 provides tables listing the ten hottest suburbs within each council with those that are in the top 10% for the whole region listed in red. Note: not all suburbs are listed as some councils have more than ten.

Hottest Suburbs - Adelaide City Council			
Rank	Suburb	Mean Daytime Temperature (C°)	Mean Nighttime Temperature (C°)
1.	ADELAIDE	37.38	18.43
2.	NORTH ADELAIDE	36.85	18.12
Council Average		**37.25**	**18.33**

Hottest Suburbs - City of Unley			
Rank	Suburb	Mean Daytime	Mean Nighttime
1	KESWICK	38.67	19.20
2	EVERARD PARK	37.43	18.03
3	MALVERN	37.28	18.03
4	FULLARTON	37.21	17.78
5	KINGS PARK	37.15	18.93
6	HIGHGATE	37.10	17.34
7	PARKSIDE	37.04	17.47
8	MYRTLE BANK	36.87	18.67
9	CLARENCE PARK	36.84	18.13
10	BLACK FOREST	36.76	17.91
Council Average		**36.88**	**18.07**

Hottest Suburbs - City of Burnside			
Rank	Suburb	Mean Daytime Temperature (C°)	Mean Nighttime Temperature (C°)
1	GLENSIDE	37.99	17.95
2	ROSSLYN PARK	37.74	20.24 (11th)
3	FREWVILLE	37.57	17.81
4	LINDEN PARK	37.49	18.50
5	MAGILL	37.47	19.16
6	KENSINGTON GARDENS	37.34	18.69
7	AULDANA	37.29	20.85 (3rd)
8	ST GEORGES	37.21	19.67
9	BEAUMONT	37.20	20.60 (6th)
10	EASTWOOD	37.17	17.60
Council Average		**36.46**	**19.54**

Hottest Suburbs - Norwood Payhenham and St. Peters			
Rank	Suburb	Mean Daytime	Mean Nighttime
1	PAYNEHAM SOUTH	38.56	17.81
2	FIRLE	38.50	18.15
3	FELIXSTOW	38.36	17.96
4	GLYNDE	38.21	17.69
5	PAYNEHAM	38.18	17.91
6	MARDEN	38.02	17.93
7	ROYSTON PARK	37.71	17.61
8	ST MORRIS	37.66	17.76
9	TRINITY GARDENS	37.57	17.50
10	JOSLIN	37.44	17.51
Council Average		**37.32**	**17.65**

Hottest Suburbs - Town of Walkerville			
Rank	Suburb	Mean Daytime	Mean Nighttime
1	VALE PARK	38.07	17.74
2	WALKERVILLE	37.43	17.93
3	MEDINDIE	36.94	18.46
4	GILBERTON	36.73	18.02
Council Average		**37.44**	**18.02**

Hottest Suburbs - City of Prospect			
Rank	Suburb	Mean Daytime	Mean Nighttime
1	BROADVIEW	38.03	17.90
2	FITZROY	37.75	18.46
3	PROSPECT	37.54	17.82
4	COLLINSWOOD	37.44	18.11
5	MEDINDIE GARDENS	37.14	18.07
6	NAILSWORTH	37.13	17.64
7	SEFTON PARK	36.80	17.70
Council Average		**37.4**	**17.96**

Hottest Suburbs - City of Campbelltown			
Rank	Suburb	Mean Daytime	Mean Nighttime
1	HECTORVILLE	38.45	18.16
2	CAMPBELLTOWN	38.19	18.13
3	TRANMERE	37.89	18.33
4	NEWTON	37.79	18.27
5	MAGILL	37.47	19.16
6	PARADISE	37.33	18.29
7	ROSTREVOR	37.10	19.90
8	ATHELSTONE	36.53	19.78
Council Average		**37.39**	**18.95**

Hottest Suburbs - City of Tea Tree Gully			
Rank	Suburb	Mean Daytime	Mean Nighttime
1	SALISBURY EAST	38.96 (11th)	18.75
2	GILLES PLAINS	38.47	17.85
3	GREENWITH	38.28	18.40
4	VALLEY VIEW	38.06	18.14
5	MODBURY HEIGHTS	37.97	18.54
6	HOLDEN HILL	37.97	18.58
7	MODBURY NORTH	37.86	18.32
8	GOULD CREEK	37.81	18.35
9	WYNN VALE	37.79	18.84
10	DERNANCOURT	37.28	18.46
Council Average		**36.61**	**18.88**

Hottest Suburbs - City of Salisbury			
Rank	Suburb	Mean Daytime	Mean Nighttime
1	PARAFIELD	40.55 (1st)	16.83
2	EDINBURGH	39.95 (2nd)	17.80
3	DRY CREEK	39.75 (3rd)	17.95
4	WALKLEY HEIGHTS	39.43 (4th)	18.22
5	SALISBURY HEIGHTS	39.22 (5th)	19.32
6	PARAFIELD GARDENS	39.16 (6th)	17.85
7	GULFVIEW HEIGHTS	39.01 (7th)	19.08
8	BOLIVAR	38.98 (8th)	17.52
9	PARALOWIE	38.97 (9th)	17.97
10	SALISBURY EAST	38.96 (10th)	18.75
Council Average		**38.77**	**17.86**

Attachment 3: Normalized Difference Vegetation Index (NDVI) Map

As part of the deliverables, each council will be provided with a very high resolution (0.45 m) NDVI dataset. The NDVI was calculated using the red and near-infrared bands of the 4-band imagery collected as part of this project. The full NDVI map is provided here.

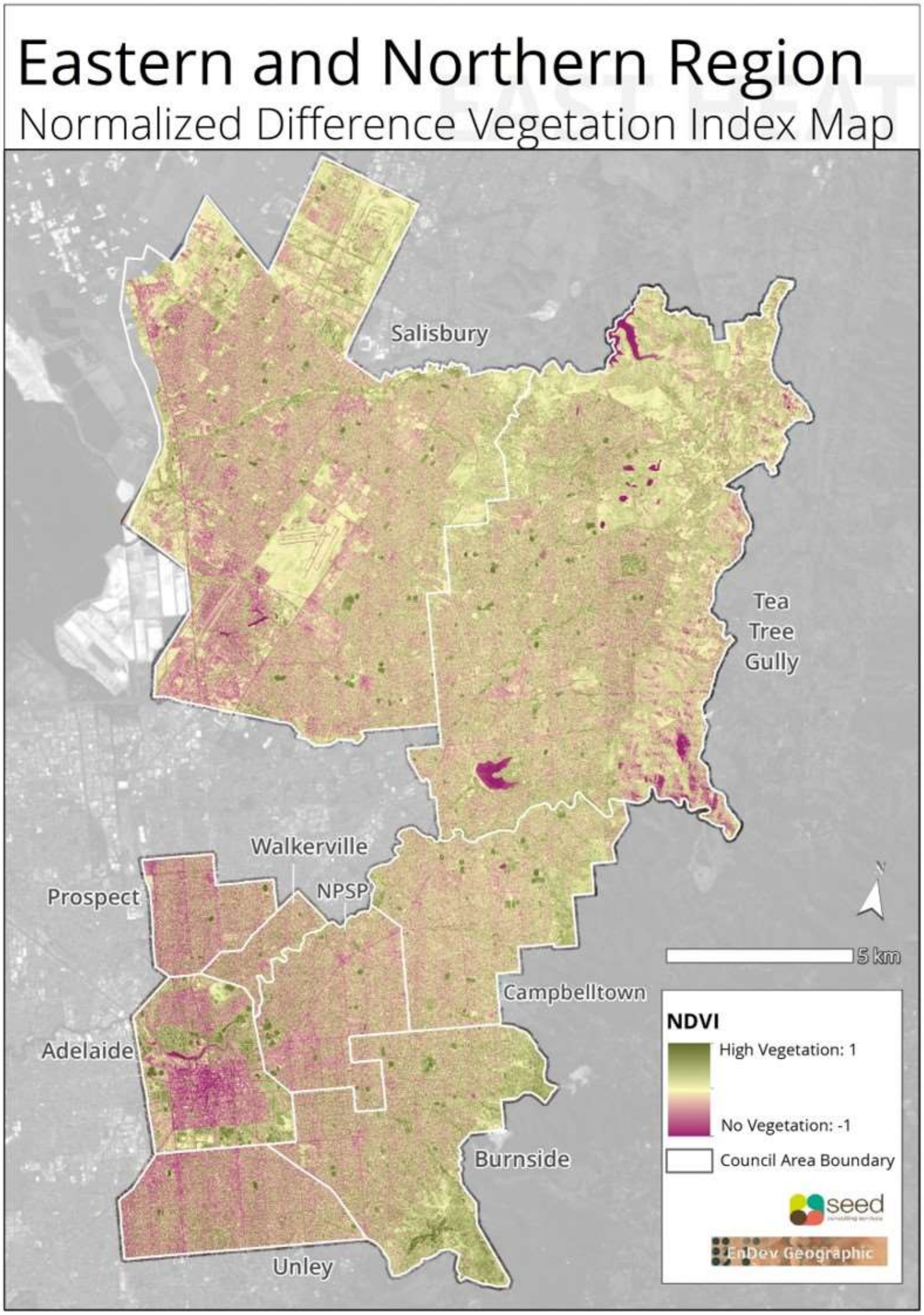


Figure 1. NDVI Map

Attachment 4: Tree canopy map

As part of the deliverables, each council will be provided with a very high resolution (0.30 m) canopy map dataset showing the presence of trees derived using an object-oriented spectral classification scheme. The dataset achieves 96.6% accuracy in identifying the location of tree features, though the areal measure is not accurate enough to give a robust measure of total canopy fraction at large scales. Significant errors were driven primarily by over-counting shrubs other vegetation as trees, and under-counting shadowed sides of tree as non-tree features. The full canopy map is provided here. The resultant map and data are highly useful for exploring the location of trees across properties, suburbs, and councils.

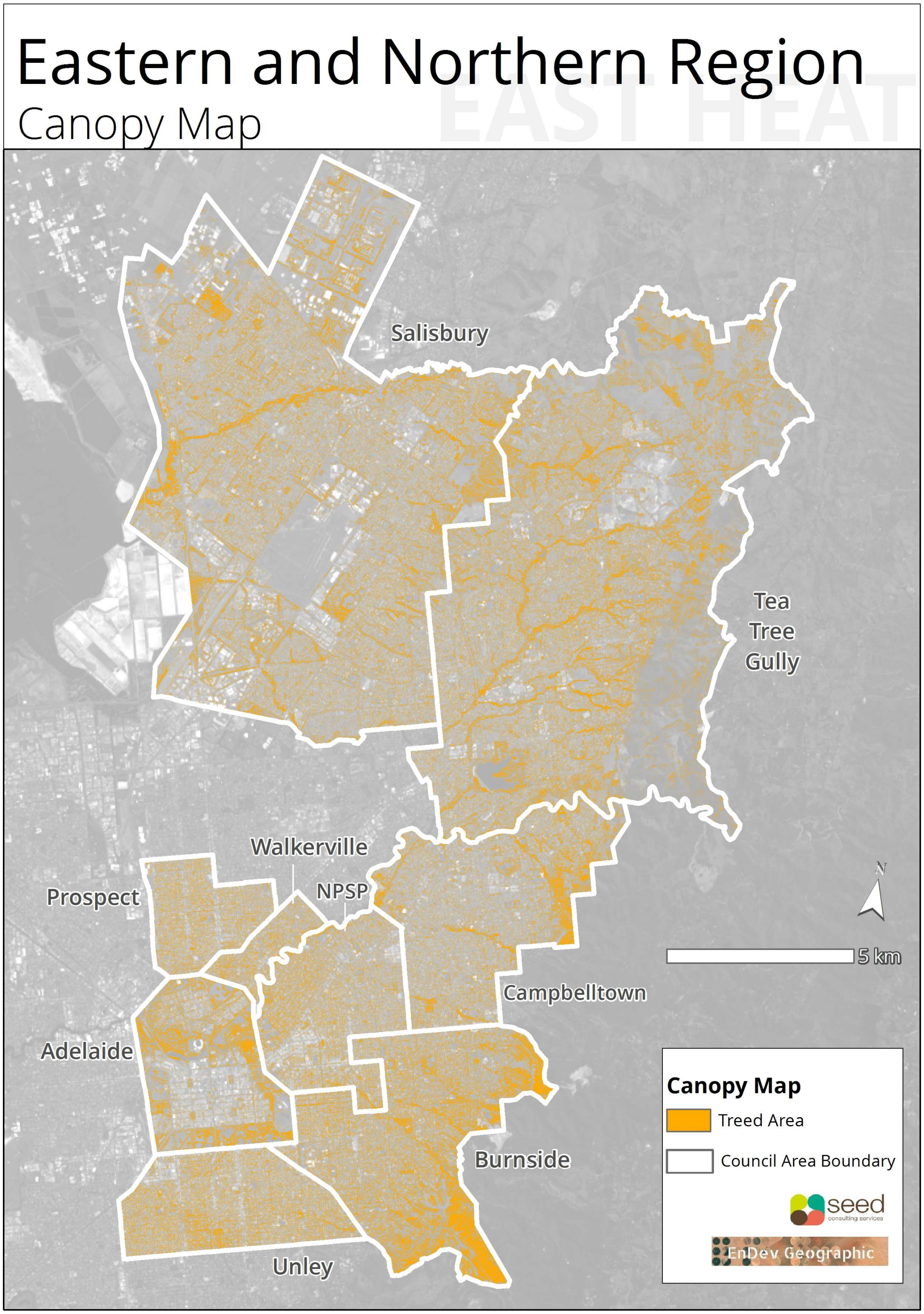


Figure 2. Tree canopy map.

Attachment 5: Instrumentation, data collection and analysis

Instrumentation

Instrumentation specifications are provided here for the thermal camera, precision navigation units and aircraft.

- Piper PA28-161 aircraft
- FLIR model A615 thermal imaging sensor
- Hasselblad A6D medium format camera
- Nikon D800E NIR camera
- award-winning Aviatrix flight management system

Flight specifications:

Element	**Description**
Operator	AeroScientific operating from the South Coast Air Centre.
Chief Pilot	Paul Dare
Reserve Pilot (nighttime only)	Jack Madeley
Aircraft	Piper PA28-161
Instruments	• FLIR model A615 thermal imaging sensor • Hasselblad A6D medium format camera • Nikon D800E NIR camera
Flight Planning System	Aviatrix flight management system
Flight description	Data collection will consist of three overflights: one daytime thermal flight, one daytime four-band flight, and one nighttime thermal flight, to collect data over the study area. Each daytime flight will originate from and finish at Aldinga Airfield. The nighttime flight will originate from and finish at Adelaide Airport.
Flight plan	Anticipated flight plan attached.
Data Collection Parameters (Daytime thermal)	Altitude: 9500ft above sea level Take-off time and location: 1130, Aldinga Airfield Data collection start time: 1200 Data collection completion time: 1600 Landing time and location: 1630, Aldinga Airfield Total flight time: 5.0 hours (approximate) Number of flight runs: 25 runs, aligned NNE – SSW

Element	Description
Data Collection Parameters (Nighttime thermal – flight 1)	Altitude: 9500ft above sea level Take-off time and location: 2230, Adelaide Airport Data collection start time: 2300 Data collection completion time: 0130 Landing time and location: 0200, Adelaide Airport Total flight time: 3.5 hours (approximate) Number of flight runs: 19 runs, aligned NE - SW
Data Collection Parameters (Nighttime thermal – flight 2)	Altitude: 9500ft above sea level Take-off time and location: 0230, Adelaide Airport Data collection start time: 0300 Data collection completion time: 0430 Landing time and location: 0500, Adelaide Airport Total flight time: 2.5 hours (approximate) Number of flight runs: 15 runs, aligned north - south
Data Collection Parameters (daytime four-band – flight 1)	Altitude: 8500ft above sea level Take-off time and location: 1000, Aldinga Airfield Data collection start time: 1030 Data collection completion time: 1230 Landing time and location: 1300, Aldinga Airfield Total flight time: 3.0 hours (approximate) Number of flight runs: 15, aligned north-south (*to be collected at future date, tbd*)
Data Collection Parameters (daytime four-band – flight 2)	Altitude: 8500ft above sea level Take-off time and location: 1330, Aldinga Airfield Data collection start time: 1400 Data collection completion time: 1600 Landing time and location: 1630, Aldinga Airfield Total flight time: 3.0 hours (approximate) Number of flight runs: 15, aligned north-south (*to be collected at future date, tbd*)
Flight communications	All flights will take place in controlled airspace. The pilots will maintain continuous communication with Adelaide air traffic controllers. All necessary information and flight plans will be provided to air traffic control prior to the flight being undertaken.
Protocols around excluded locations	Airspace restrictions surrounding RAAF Base Edinburgh are only in effect during weekdays and are not expected to interfere with the anticipated day of collection. RAAF Base Edinburgh is not part of the study area and hence any collected data will be excluded during data processing. No other restricted areas will be covered during this data collection.
Relevant statutory authorities and licences required – to be forwarded	AeroScientific is licensed to operate under the South Coast Air Centre Operators Certificate (attached). Pilot Paul Dare is authorized under license number 569657.
Risk assessment / SWMS for flights	Weather conditions will be monitored continuously before and during flight. Night time flying will occur with two pilots to increase visual awareness. All other standard flight safety protocols will be followed.

Flight plan

Figure 3. Approximated flight path undertaken during daytime thermal data capture.

Urban heat island and hot spot identification

Underlying each heat island is a mixture of landscapes, land-uses, and land-covers resulting in different characteristics of each heat island. Analysing social vulnerability within heat islands reveals who lives within these areas, identifies social groups that are disproportionately affected by heat, and helps prioritise which areas of heat are most in need of remediation. How to cool heat islands depends on what lies within heat islands. Landscape analysis investigates various land cover types to identify their impact as a basis for developing heat reduction strategies for effective land use planning.

Urban heat islands and hot spots occur at any location where the built environment causes the temperature to be warmer than it would have been in its natural state. With no way of knowing the natural temperature of an area without the built environment, baseline temperatures are taken as the average temperature of the local area and hot spots are identified as exceedingly warm areas compared to this baseline. Urban heat islands and hot spots are defined for this project as any location where the temperature exceeds 2°C above the mean temperature of the local area. To account for surface warming during the data collection process, a moving average threshold was used to establish the expected mean temperature for seven zones. Areas of built-up heat were identified as exhibiting a temperature greater than 2°C or 4°C above the local mean temperature at the time of measurement.

As urban heat islands typically have larger diffuse effects, the analysis aggregated thermal data from 2 m to 125 m resolution to identify general areas of built up heat and to understand how they relate to the people who live in those areas. Hot spot analyses use 2 m resolution thermal data to explore thermal impacts of specific land-uses.

Land use analysis

To explore the relationship between land use and heat, ten predominant land surface types were chosen across four categories: impervious surfaces, green infrastructure, buildings, and water. For each of the seventeen surface types, 30 to 85 points were selected (depending on prominence of each surface in the landscape) that represented clear examples of each surface type. Day temperature, night temperature, and NDVI values were calculated for each point.

An average of 61 points were analysed for each land-surface category to understand the mean temperatures of surface over the whole of the study area, providing broader, more robust results to supplement and contextualize the individual case studies. The combined land use-case study investigations illustrate local examples with robust analysis to reveal patterns of urban heat, quantify the magnitude of those patterns, and highlight effective lessons for urban heat management.

Social vulnerability analysis

The tools for mitigating urban heat (proximity to water, green infrastructure, white roofing) generally come at additional costs, which tends to result in heat islands having a more pronounced effect upon residents of lesser means. To assess whether heat disproportionately affects any particular groups within the Eastern and Northern Adelaide Region, social vulnerability data was acquired from the 2016 census. Building upon the Resilient East Adaptation Plan, key social vulnerability indicators were identified as:

- elderly population (>65 years old);
- young children (<15 years old)
- people who need assistance due to disabilities;
- people of culturally and linguistically diverse backgrounds; and
- low income households.

Data were acquired from the 2016 Census at the Statistical Area Level 1 (SA1). These data were used to create a simple Social Vulnerability Index (SVI), normalizing each dataset from 0 to 1 and summing the results to give an index value of 0 to 5 representing low to high vulnerability. The SVI was calculated for each urban heat island informing where heat and vulnerability co-exist.

Limitations

Limitations of this analysis that should be noted when interpreting the results are as follows:

- While the urban heat island is a large-scale phenomenon, the effects of the heat island manifest in highly localised temperature variation. The scale of urban heat islands in this analysis (125 m x 125 m) intentionally overlooks highly localised detail. This scale especially affects night urban heat island mapping as important linear features such as roads exist below this resolution, suggesting that hot spot analysis is a vital supplement.

- Social vulnerability data were downscaled to spatially represent each indicator. These values were then re-summed to calculate the social vulnerability for each urban heat island. The method has a 3.5% margin of error between actual and estimate values. More accurate approximations could be provided with more detailed data.

Attachment 6: Microclimate assessment

Measurements and locations

On the day/night of the aircraft thermal overflights (10-11 March, 2018), three Kestrel 4400 Heat Stress Tracker weather stations were established across three different local microclimatic environments adjacent to the Tea Tree Gully Council Offices in northeast Adelaide. These locations, representing a typical range of local environments, included a grassed, irrigated open area, a sealed carpark and a heavily tree-shaded grassed environment (Figure 4). The Kestrel 4400 instruments measure the normal range of meteorological data at a height of 1.2 m, but also incorporate black bulb thermometry allowing calculation of mean radiant temperature (MRT) and later computation of a number of human thermal indices, including the most comprehensive index available, the Universal Thermal Climate Index (UTCI).

Manual measurements of surface temperature were also made at each site every 30 minutes, using a precision infra-red (IR) thermometer (Omega OS425-LS). Measurements were made from late morning until late evening on the day of the flight, capturing surface thermal and human thermal comfort data, including for the specific times of flights. A key objective was to compare the microclimatic environments of the three sites. Unfortunately, the 10-11 March data were lost for the open grass site because of instrument malfunction, so the microclimate measurements were repeated (without thermal overflights) on 23 March.

A number of standard thermal comfort indices are available directly from Kestrel 4400 output. More complex and comprehensive thermal comfort indices including Apparent Temperature (AT), Predicted Mean Vote and Percentage People Dissatisfied (PMV/PPD) and the Universal Thermal Climate Index (UTCI) were derived from the Kestrel observations, along with calculations of MRT.

Figure 4. Equipment setup at Tea Tree Gully Council Offices, northeast Adelaide, March 2018; (a) locations in relation to the Council Offices; (b), (c) and (d) Kestrel 4400 setup over irrigated open grass, carpark pavement and tree-shaded grass. (Images: Google Maps, Justin VanderBerg).

Comparison and validation of surface temperature measurements

Table 1 and Figure 5 compare aircraft observations of land surface temperature (LST) with the local measurements of LST (hand held IR thermometer) and air temperature at 1.2 m (Ta). No Kestrel observations are available for the grassed site in Table 6.

Time	Aircraft LST (°C)			Omega LST (°C)			Kestrel Ta (°C)		
	Grass (Open)	Car Park (Sealed)	Tree (Shaded)	Grass (Open)	Car Park (Sealed)	Tree (Shaded)	Grass (Open)	Car Park (Sealed)	Tree (Shaded)
01:27pm	32.6	41.8	31.6	37.8	49.4	26.4	-	35.2	32.5
01:15am	14.2	22.3	16.8	12.3	27.9	16.2	-	21.6	21.1

Table 1. Comparison of aircraft and hand-held IR thermometer LST, along with air temperature for times of aircraft overflights, 10-11 March, 2018.

The aircraft observations show a daytime (01:27 pm) underestimation of open grass LST (by 5.2°C) and carpark LST (by 7.6°C) and an overestimation of tree-shaded LST (by 5.2°C). At night (01:15am) there is more convergence of aircraft LST with open grass and tree-shaded LST (overestimation of 1.9°C and 0.6°C respectively) and a larger underestimation of carpark LST (by 5.6°C). Kestrel air temperatures also differ considerably from the LST measured by handheld IR thermometer and aircraft, as is to be expected.

These results confirm that caution must be applied when considering the broad LST patterns derived from aircraft or satellite remote sensing and applying them at the microscale, or to air temperatures. The reasons for differences in LST most likely relate to the relative resolution of the observations (aircraft pixel resolution is ~5 m at the surface, while the hand-held observations "see" ~0.5-1 m^2), the emissivity corrections applied to the aircraft observations (handheld emissivity is set at 0.95), and exactly what the aircraft is "seeing". For example, the aircraft cannot "see" beneath the tree canopy so is likely overestimating the daytime LST at that location. There will also be some local microclimatic/topographic variability that the aircraft cannot detect. There are similar complications relating Ta to LST, with shading and wind effects likely to be very important. It is not within the scope of this analysis to resolve these differences.

Figure 5 shows that the spot measurements of LST (aircraft) are against a backdrop of generally rising daytime surface temperatures. The suppression of LST increase between 2-3 pm is likely due to an increase in local wind speed at this time. Of interest is the high nocturnal and steadily decreasing temperature of the carpark compared to the relatively lower but more stable surface temperatures beneath the tree. This is related to the large storage of heat in the carpark surface during the day, followed by the steady release of this heat at night.

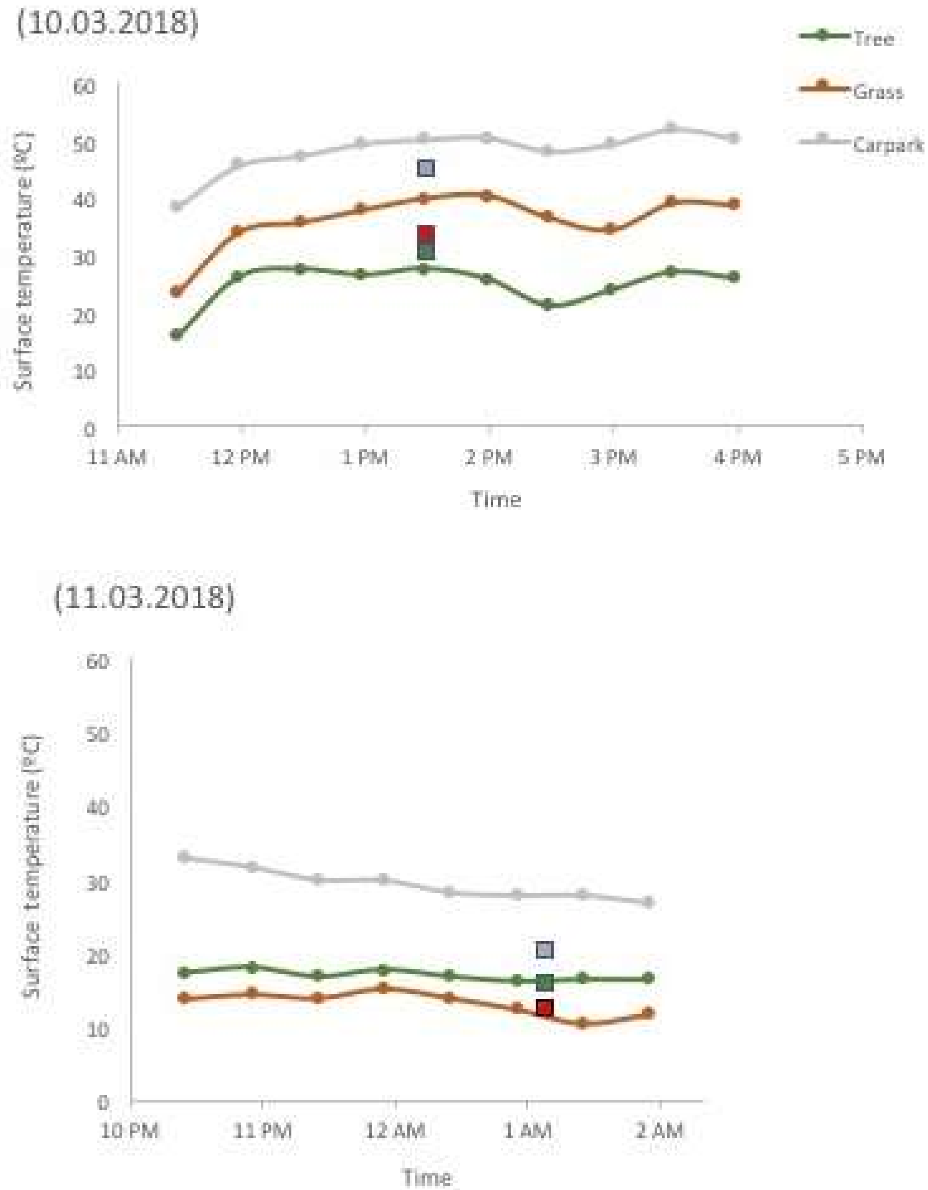


Figure 5. Spot measurements of aircraft-derived LST (coloured rectangles) for 1:27pm and 01:15am plotted against the time series of handheld LST measurements.

Local microclimate variation shown by meteorological data

Local differences in surface types, water availability and short and long wave radiation exposure, among other factors, give rise to strong microclimate variability, even within distance scales of 10 m – 100 m. Such is the case in the vicinity of Tea Tree Gully Council

Offices. Figure 6 and Figure 7 show local meteorological data for 10-11 March and 23

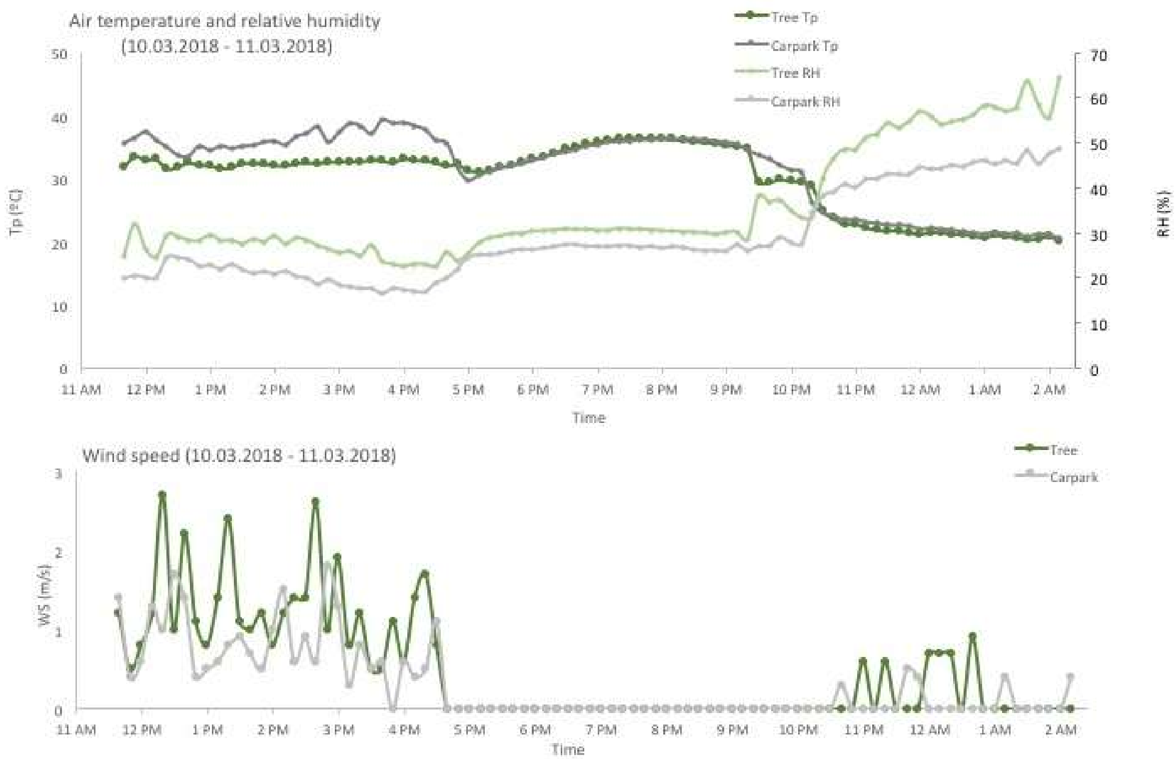


Figure 6. Meteorological data for the treed (shaded) and carpark (sealed) sites for 10-11 March, 2018. Note – no data are available for the grassed (open) site on these days.

March respectively, for the microclimate sites adjacent to the council offices.These measurements reveal considerable local climate differences, even though the sites are within 200 m of one another. In Figure 6, air temperatures are 3-5°C warmer during most of the afternoon at 1.2 m above the sealed carpark surface compared to temperatures above the tree-shaded grass location. This clearly reflects the greater amount of net radiation in the carpark that is being partitioned into sensibly heating the air. For the treed site, lower solar exposure and the moist grass surface reduces net radiation and partitions more available energy into evaporation, this cooling and moistening the air overlying the surface. This is also reflected in the higher relative humidity for much of the day and night.

After sunset, the temperature differences between locations substantially disappears, but the humidity difference remains, showing the importance of continued evaporation from the moist grass surface under the tree canopy. Winds drop in the late afternoon and commence again during the late evening. The low wind speeds coincide with the equalisation of temperatures at the treed and carpark site. Winds at the treed site are generally higher than in the carpark, probably illustrating channeled airflow at that location, because winds would normally be expected to be higher in an exposed carpark.

Figure 6 also shows temperatures at 1.2 m above the carpark surface to be 3-5°C warmer than at the tree-shaded location for much of the late morning and afternoon of 23 March, 2018. For much of this period temperatures at 1.2 m above the open grass remain between the shaded and sealed carpark surface, but later in the afternoon the differences disappear, possibly because of drying of the open grass surface. Relative humidity shows the reverse relationship during this time as would be expected, with carpark humidity lowest and tree-shaded humidity highest, reflecting the temperature and water availability of the different sites. Winds are light to moderate at all sites until late afternoon when they drop to zero. From mid-afternoon, there is clear advection of dry, very warm air to all sites with thermal and humidity differences disappearing. Interestingly irrigation appears to have started at the open grass site at ~3:30pm, leading to a localised rapid cooling and moistening of air.

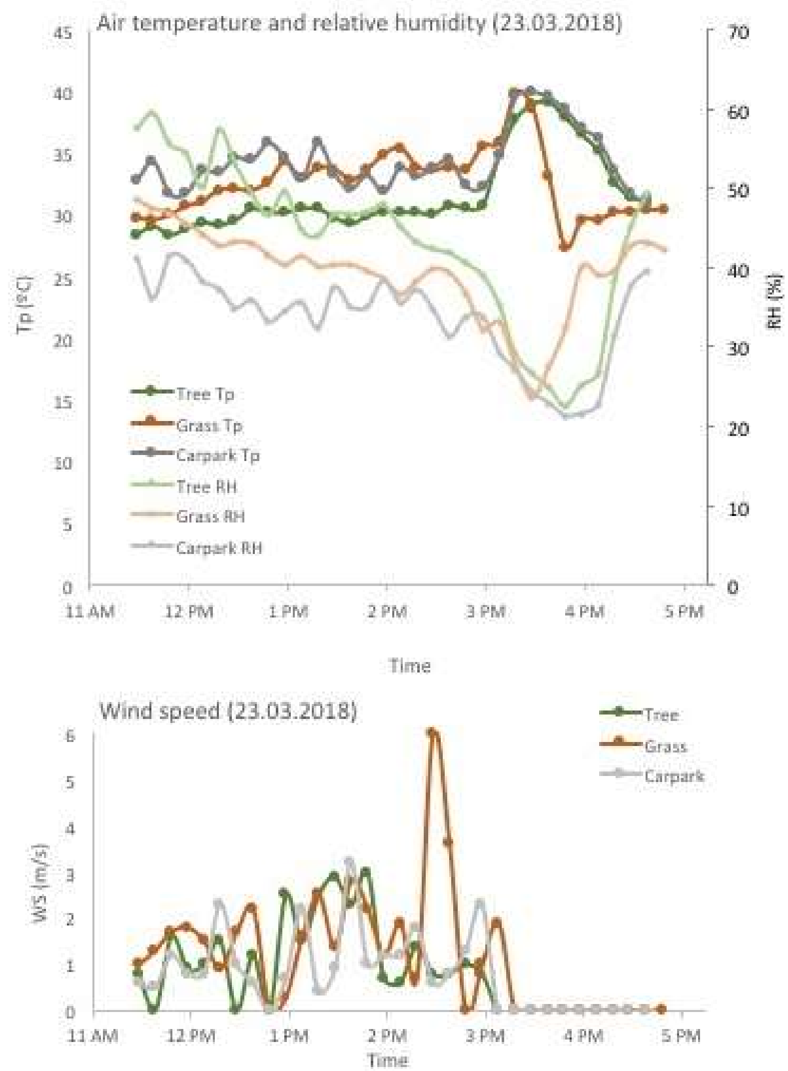


Figure 7. Meteorological data for the treed (shaded), open grassed, and carpark (sealed) sites for 23 March, 2018.

Local thermal comfort variation calculated from meteorological data

Given the considerable microclimate variations between sites shown above, it would be expected that this would be reflected in human thermal comfort. A simple Heat Stress Index (HI), provided as direct output from the Kestrel 4400, is shown in Figure 8. HI is calculated from both environmental temperature and humidity.

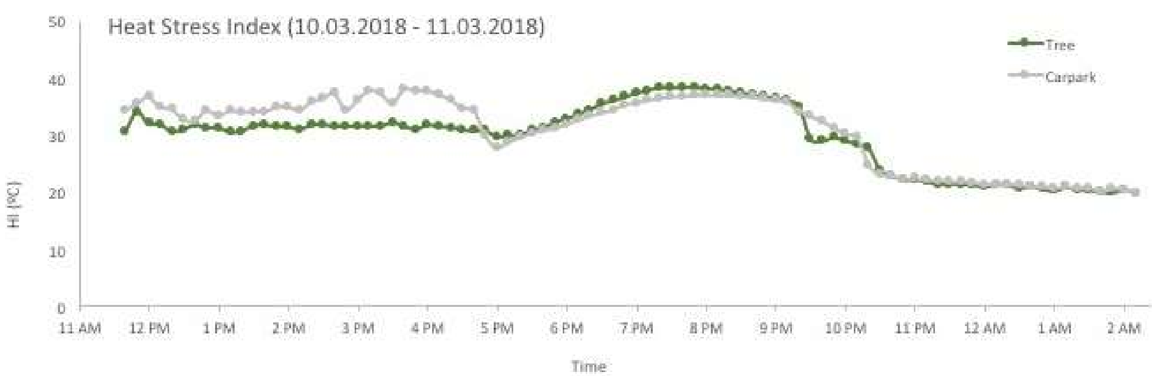


Figure 8. The Heat Stress Index (HI) for the treed (shaded) and carpark (sealed) sites on 10-11 March 2018 and for the treed (shaded), open grassed, and carpark (sealed) sites on 23 March 2018.

Since it is derived directly from the temperature and humidity measurements, the HI follows the trends in Figure 6 and Figure 7, with the highest HI at the carpark site through much of the afternoon on both 10 and 23 March. Again, HI for the open grassed site (23 March) tends to be intermediate between the carpark and treed sites early in the day, but equals and exceeds that of the carpark by mid-afternoon, until cooling (likely associated with irrigation) drops the HI at the grassed site in the late afternoon.

More robust measures of human thermal comfort include Apparent Temperature (AT), Predicted Mean Vote and Percentage People Dissatisfied (PMV/PPD) and Universal Thermal Climate Index (UTCI). AT is the index favoured by the Australian Bureau of Meteorology and extends the meteorological considerations to include the effects of wind speed. PMV, PPD and UTCI are more comprehensive measures again of thermal comfort, including effects of clothing and the local radiative environment. Table 2 shows these indices calculated for times when measurements of mean radiant temperature were available.

	AT (°C)			PMV			PPD (%)			UTCI (°C)			UTCI Category		
Day/Time	Car Park (Sealed)	Tree (Shaded)	Grass (Open)	Car Park (Sealed)	Tree (Shaded)	Grass (Open)	Car Park (Sealed)	Tree (Shaded)	Grass (Open)	Car Park (Sealed)	Tree (Shaded)	Grass (Open)	Car Park (Sealed)	Tree (Shaded)	Grass (Open)
10 March 2:40pm	37.4	31.7	-	5.01	2.18	-	100.0	84.3	-	37.7	31.9	-	Very Strong	Moderate	-
11 March 1:15am	21.2	21.7	-	-0.59	-0.64	-	12.3	13.6	-	20.8	21.0	-	Comfortable	Comfortable	-
23 March 11:30am	34.9	30.6	31.5	3.32	0.7	1.73	99.9	15.4	63.4	35.7	30.6	32.5	Strong	Moderate	Strong

Table 2. Measures of human thermal comfort calculated for various times on March 10, 11 and 23, 2018. Clothing is assumed to be shorts and t-shirt during the day, and long trousers, shirt and pullover at night.

AT is much higher at the carpark site by day than at either the treed site or the open grassed site, but the difference is negligible at night. PMV is neutral (close to zero) when people are comfortable, is strongly positive when they are uncomfortably hot, and strongly negative when they are uncomfortably cool. PMV for this study therefore suggests people would be uncomfortably hot in the carpark during daytime on March 10 and 11, and less so at the grassed and especially the treed site. Nighttime PMV suggests that people would be slightly uncomfortably cool at either the carpark or treed site.

The PMV results are confirmed by the PPD results that suggest that 100% and 99.9% of people would be uncomfortably hot during the day at the carpark site on 10 and 23 March respectively. Conversely 12.3% and 13.6% of people would be uncomfortably cool at the carpark and treed sites respectively, in the early hours of the morning on March 23. UTCI temperatures can be classified into various heat stress classes, from Comfortable (no heat stress) to Moderate, Strong, Very Strong and Extreme. As can be seen in Table 2, heat stress at the carpark site during the day on both March 10 and 23 ranges from Strong to Very Strong, and at the open grass site on 23 March is also Strong. However, UTCI in the early hours of the morning on 11 March at both the treed and carpark sites is categorized as being Comfortable.