Heat Risk in Mississauga

Using GIS to identify priority areas for community heat response

CODG 127 Final Project

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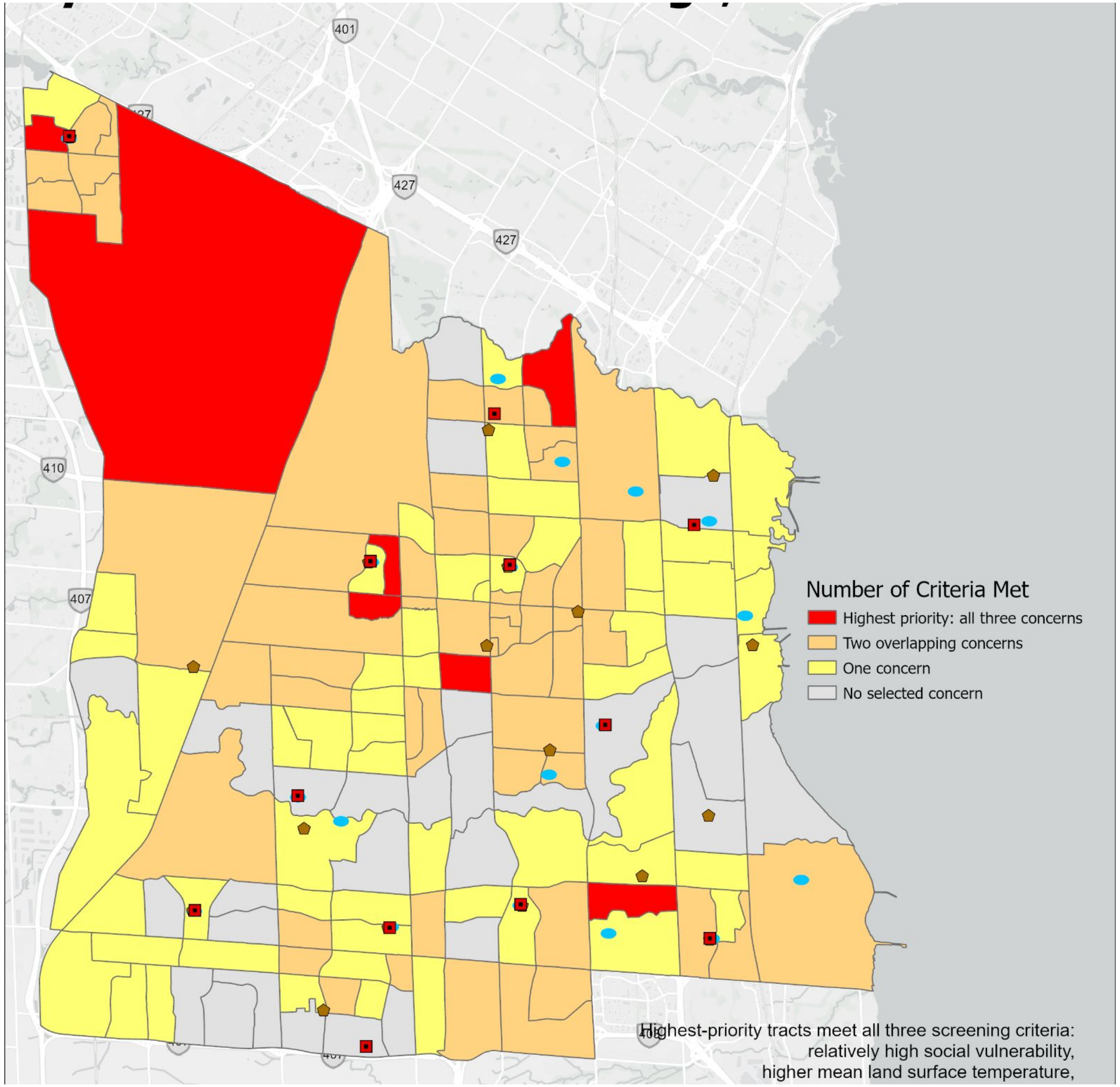
GIS in Community & Social Services



Executive Summary

A planning screen for where heat-response attention may be needed most.

1. Extreme heat risk is not distributed evenly across Mississauga.
2. This project combines observed heat exposure, social vulnerability, and mapped cooling-resource density.
3. The final map identifies tracts where multiple concerns overlap. It is a screening tool, not a prediction of heat illness.

Outcome

Priority Census Tracts are the places where multiple concerns overlap and where further local assessment, outreach, cooling services, and greening should be considered first.

Heat Exposure | Vulnerability | Cooling Access

Final result: Heat-response priority screening map

Problem and Heat-Risk Framework

Heat risk is created by both the physical environment and community vulnerability.

Research question

Where are residents most exposed to urban heat risk, and where should the City prioritize cooling, greening and outreach? OR

Where do higher urban heat exposure, greater social vulnerability, and lower cooling-resource density overlap in Mississauga?

Heat Risk = Heat exposure + Social vulnerability − Cooling capacity

- Heat exposure = places that physically get hotter.
- Social vulnerability = residents who may be more harmed by heat.
- Cooling capacity = places and services that help residents cope.
- Final map identifies overlaps, not direct causation.

Study area

- City of Mississauga, Ontario
- 147 Census Tracts
- All layers clipped or summarized to the city boundary

Data sources by component

Heat exposure	USGS Landsat 8 LST, 14 Aug 2024
Vulnerability	Statistics Canada 2021 Census
Cooling resources	City of Mississauga Open Data, 2026
Boundary / geography	Statistics Canada Census Tracts; Mississauga boundary

Data-quality check: all datasets cover Mississauga and were standardized to Census Tracts for comparison. Service locations are mapped points, not capacity records.

Social Vulnerability Method

A relative score was created from normalized Census indicators. But this approach took a while to arrive at.

Indicators or variables Selected

- seniors 65+
- children 0–14
- renter households
- apartment dwellings
- low-income residents
- one-person households
- core housing need

→

Percentages

Each indicator is divided by the appropriate population, household, or dwelling denominator.

→

Percentile ranks

The 147 tracts are ranked from lower to higher relative vulnerability for each indicator.

→

Vulnerability score

Average of the seven percentile-rank fields.

Why not add all "vulnerable people"?

The indicators are not mutually exclusive and they use different units: people, households, and dwellings. A percentile-score method avoids double-counting residents and keeps indicators comparable.

But Really WHY NOT add all “vulnerable people”?

Because the seven indicators do **not represent seven separate groups of people that can be safely added together, I could not calculate a reliable ‘rate of vulnerable population per CT’** like

This $\dfrac{\text{Total vulnerable population in a CT}}{\text{Total population in the CT}} \times 100$ won’t work because

1. The same person can appear in several indicators

One resident could be:

- aged 65+
- low income
- a renter
- living alone
- in core housing need

Adding those counts would count that person several times.

2. The indicators use different units

Some measure **people**:

- seniors
- children
- low-income residents

Others measure **households**:

- renters
- one-person households
- core housing need

Apartments measure **dwellings**.

You cannot correctly add people + households + dwellings and divide by population.

3. A true “percentage of vulnerable residents” would require individual-level or cross-tabulated data showing how many unique people meet at least one defined vulnerability condition.

Social Vulnerability Method

Percentage to Percentile to Vulnerability Score

In Each CT For each indicator

1) Normalized percentage is calculated.

2) Relative ranking of that indicator is done across all Mississauga CTs

Percentile Rank = $\dfrac{\text{Total vulnerable population in a CT}}{\text{Total population in the CT}} \times 100$

(converted to a comparable 0–100 percentile-rank scale)

3)The seven percentile ranks are averaged to create the **vulnerability score.**

Higher score = greater vulnerability.

Core Vulnerability Score

Average of 7 core percentile-rank fields

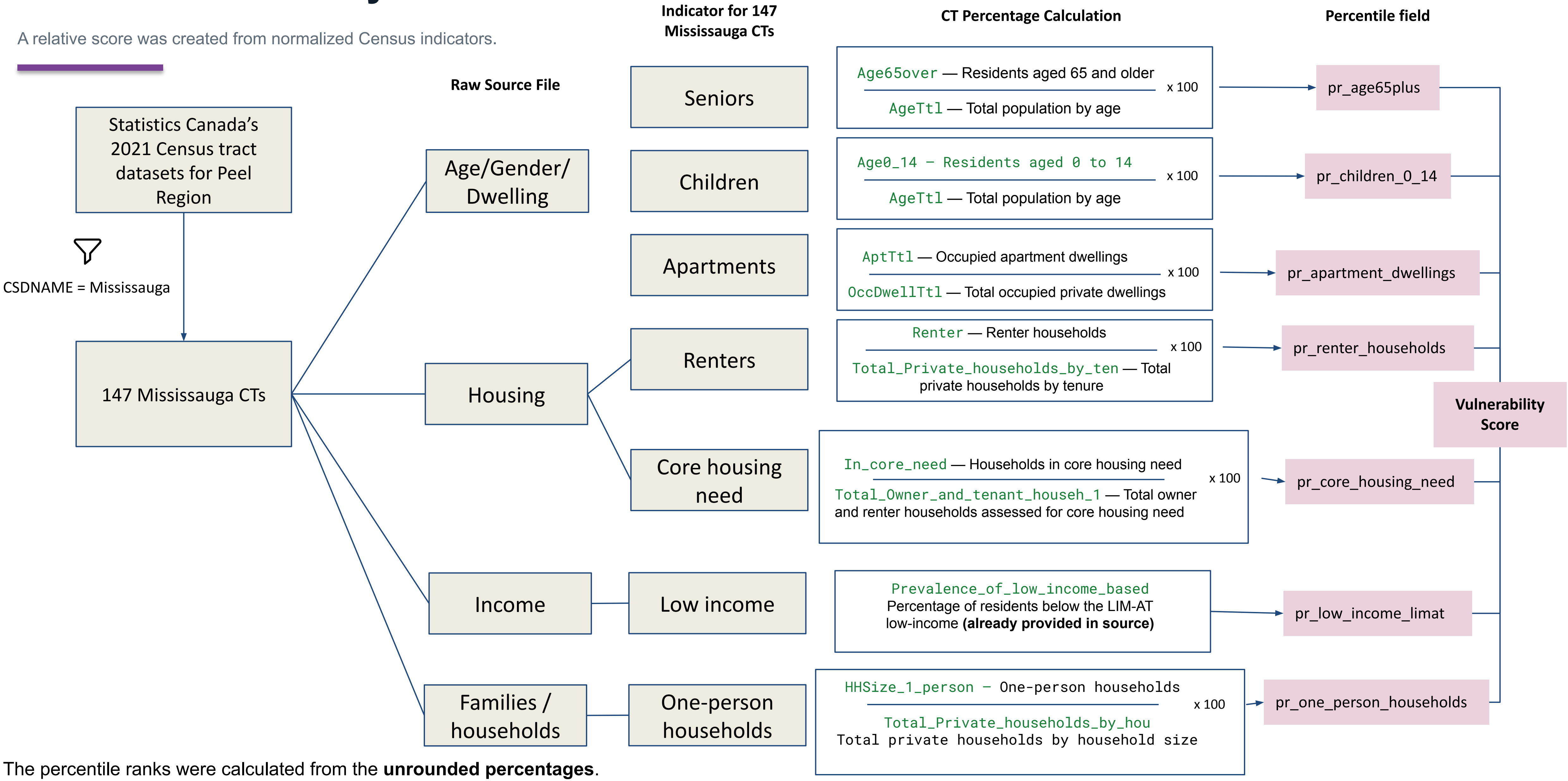
+ pr_age65plus
+ pr_children_0_14
+ pr_apartment_dwellings
+ pr_renter_households
+ pr_core_housing_need
+ pr_low_income_limat
+ pr_one_person_households

/ **7**

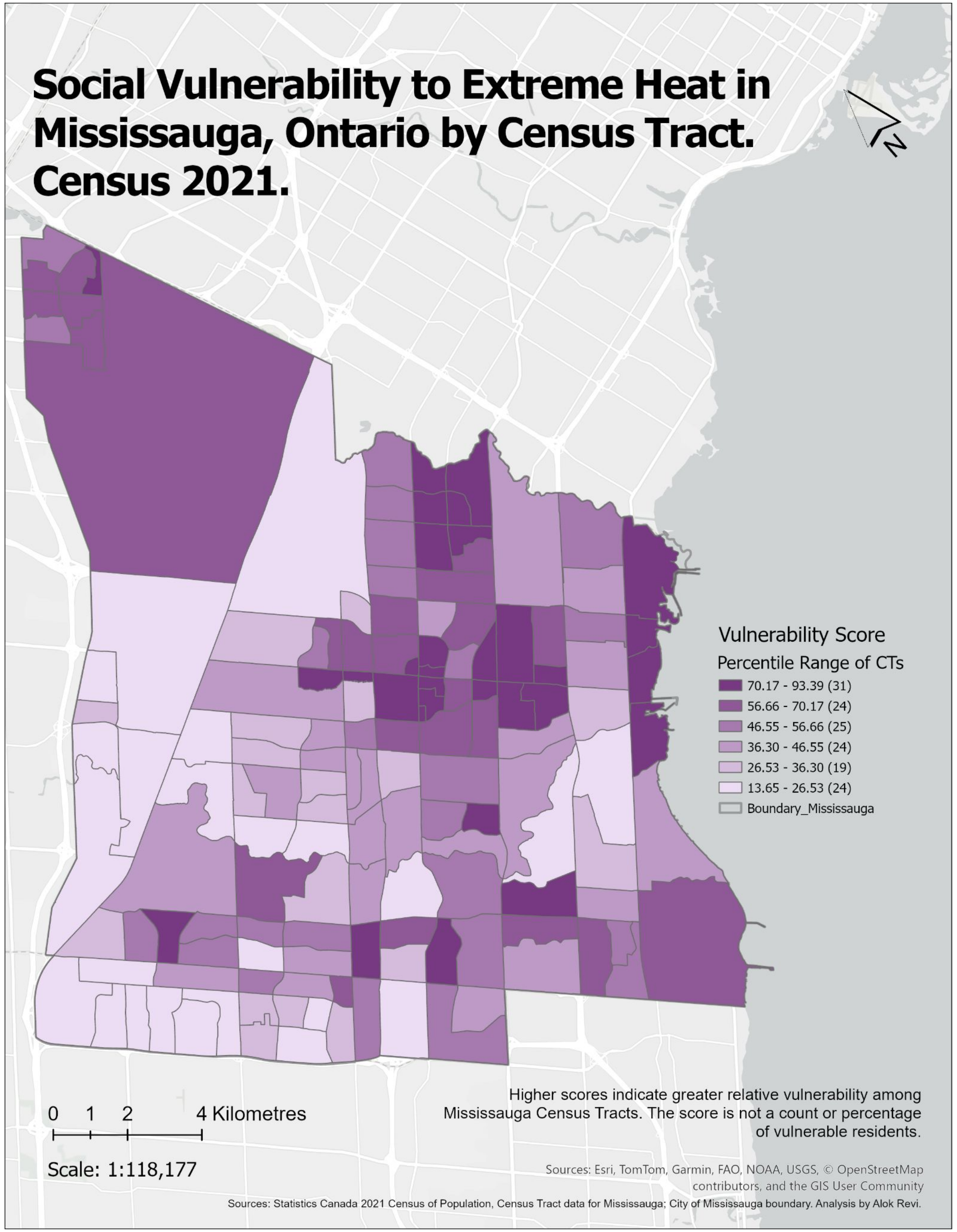
= **vuln_score_core**

Social Vulnerability Method

A relative score was created from normalized Census indicators.



The percentile ranks were calculated from the **unrounded percentages**.
Tied CTs receive the average of their ranks.



Map 1. Social Vulnerability

This map shows relative social vulnerability by Census Tract using a percentile-based score.

- Higher scores appear in several central, eastern, and scattered western tracts.

- The score reflects the overlap of demographic, housing, and income indicators.

- This is not a count of people; it is a relative planning score across Mississauga CTs.

Planning implication

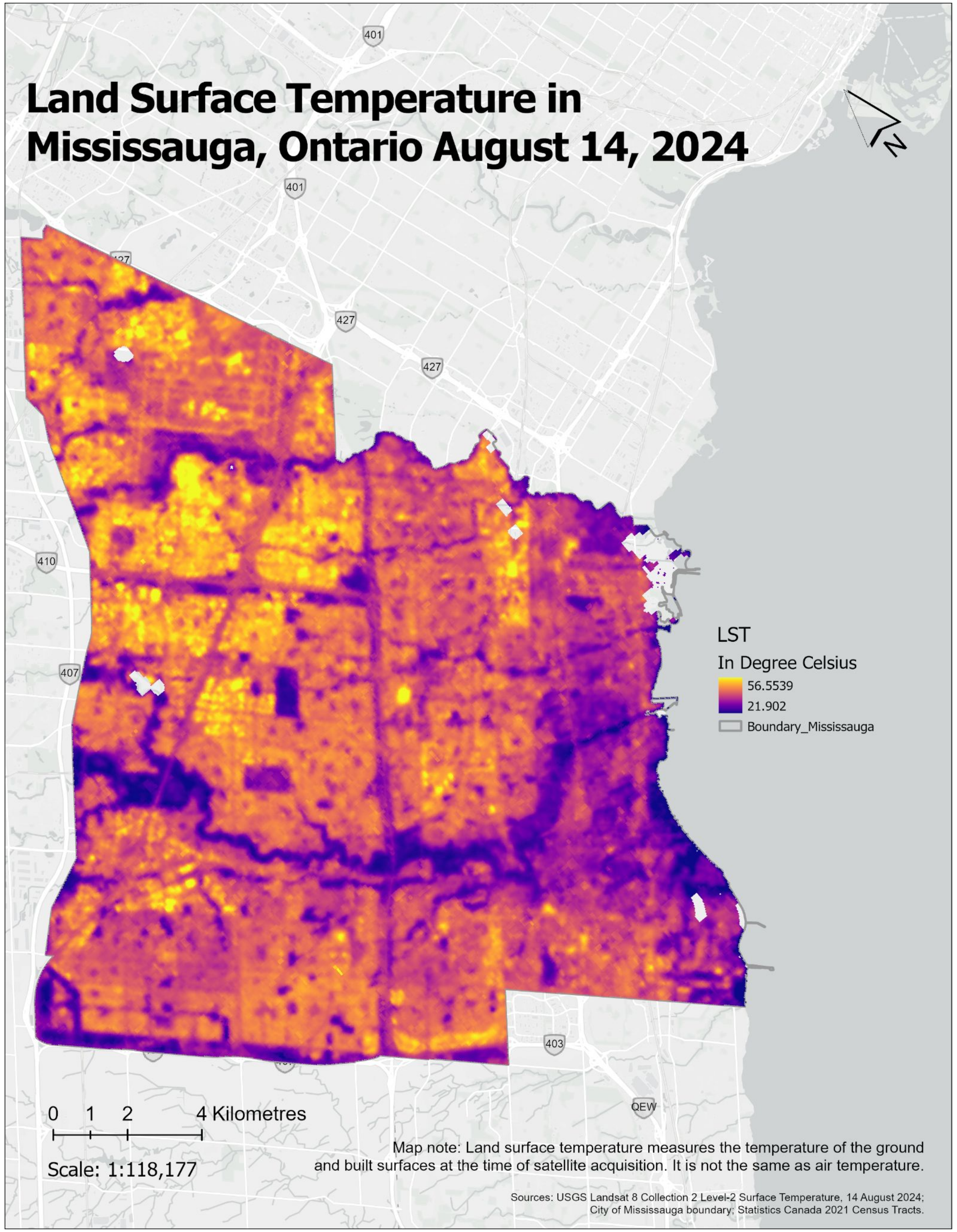
Vulnerability helps identify where heat outreach and cooling support may be more socially important, even if those areas are not the hottest surfaces.

Classification: Natural Breaks (Jenks)

Number of classes: 6

Field: vuln_score_core

Symbology: Sequential purple colour ramp; lighter purple shows lower relative social vulnerability and darker purple shows higher relative social vulnerability.



Map 2 a. Heat Exposure Method

Land surface temperature was used as the physical heat-exposure indicator.

- Landsat 8 surface-temperature data from 14 August 2024 were clipped to Mississauga.
- Raster values were converted to degrees Celsius.
- Zonal statistics summarized mean LST for each Census Tract.
- The raster map shows finer hot and cool patterns that are hidden after CT averaging.

Caveat

Use the CT map to screen citywide patterns, then use the raster map to locate specific hot surfaces such as parking lots, industrial areas, and exposed transit corridors.

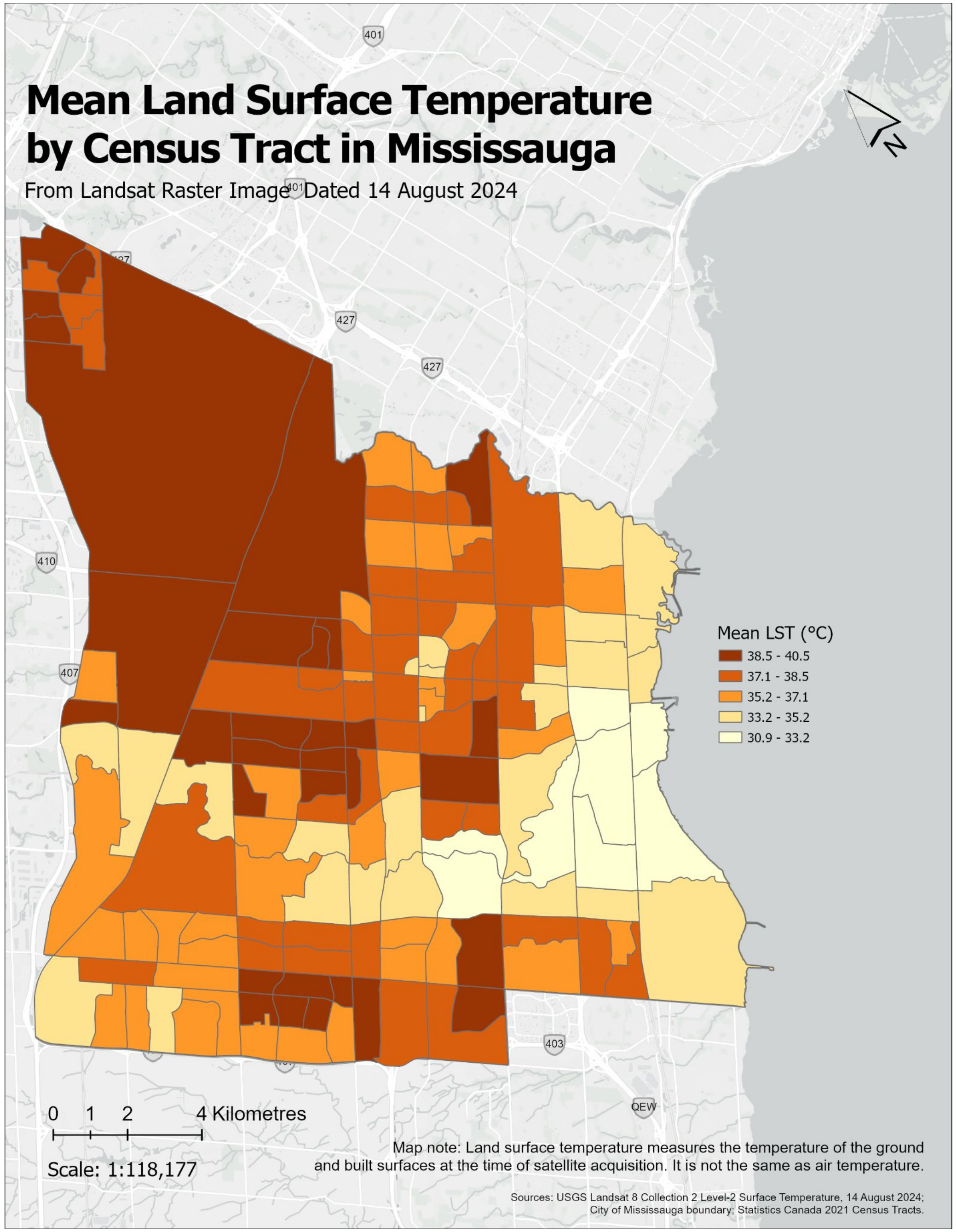
Classification: Continuous stretch

Number of classes: Continuous values, not divided into classes

Field: Value

Symbology: Continuous purple-to-yellow colour ramp; dark purple shows lower land surface temperatures and bright yellow shows higher land surface temperatures.

Map 2. Mean Land Surface Temperature by CT



This map aggregates the raster temperature surface to Census Tracts so heat exposure can be compared with Census vulnerability and service data.

- Higher mean LST values are concentrated in northwestern Mississauga and several central/southern tracts.

- Lower mean LST values appear more often near the eastern and lake-adjacent areas.

- Averaging by CT supports comparison, but it smooths local hot spots within each tract.

Caveat

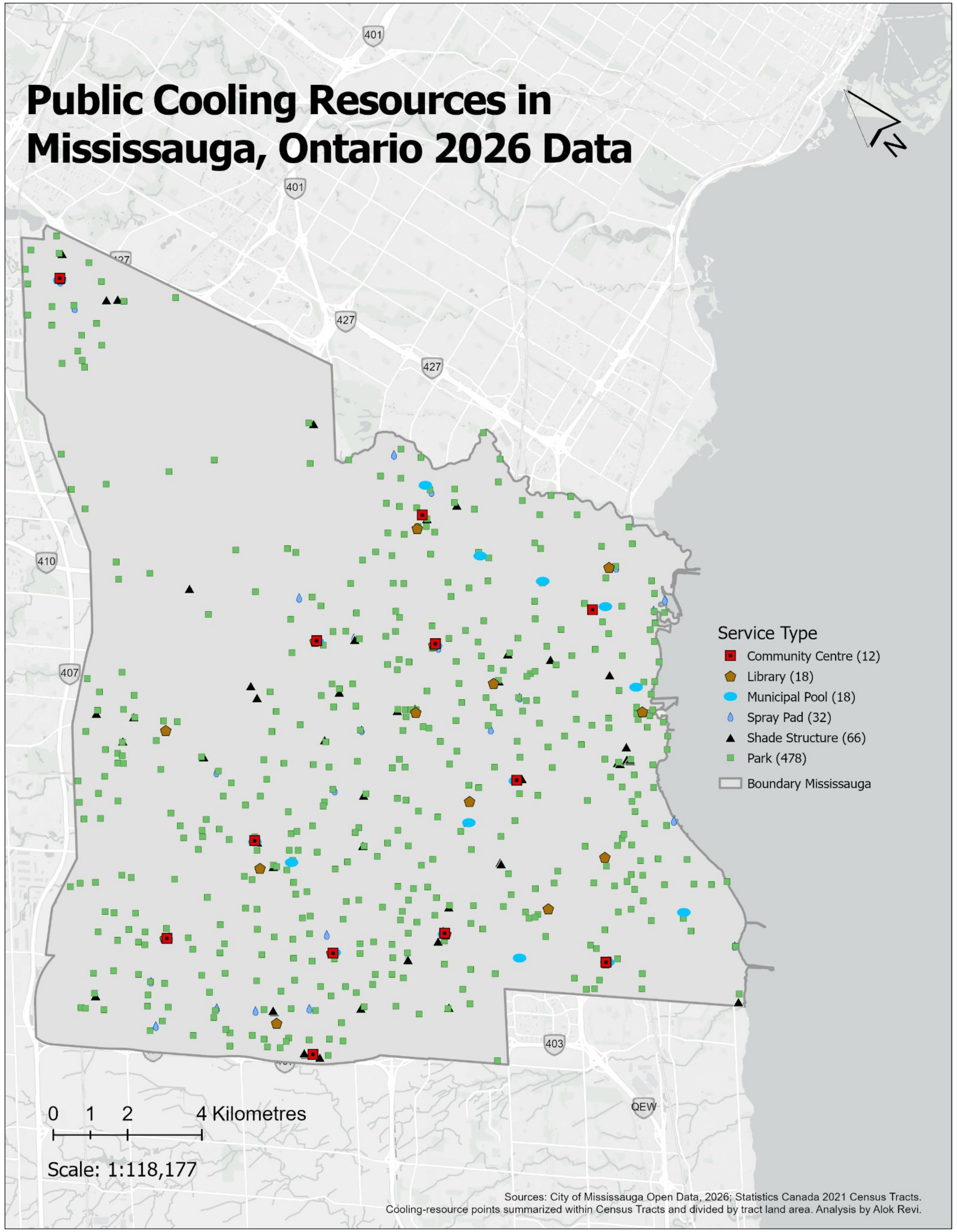
LST is not air temperature. It measures the temperature of ground and built surfaces at the time of satellite acquisition.

Classification: Natural Breaks (Jenks)

Number of classes: 5

Field: ZonalSt_01.MEAN

Symbology: Sequential yellow-to-dark-brown colour ramp; lighter colours show lower mean land surface temperature and darker colours show higher mean land surface temperature.



Cooling Resources Method

Mapped public cooling options were counted and standardized by tract area.

Cooling-resource inventory

- community centres
- libraries
- municipal pools
- spray pads
- parks
- shade structures

Spatial method

- Summarize mapped points within each Census Tract.
- Calculate density: cooling options ÷ CT land area.
- Use density as a screening proxy, not a capacity measure.

Important interpretation

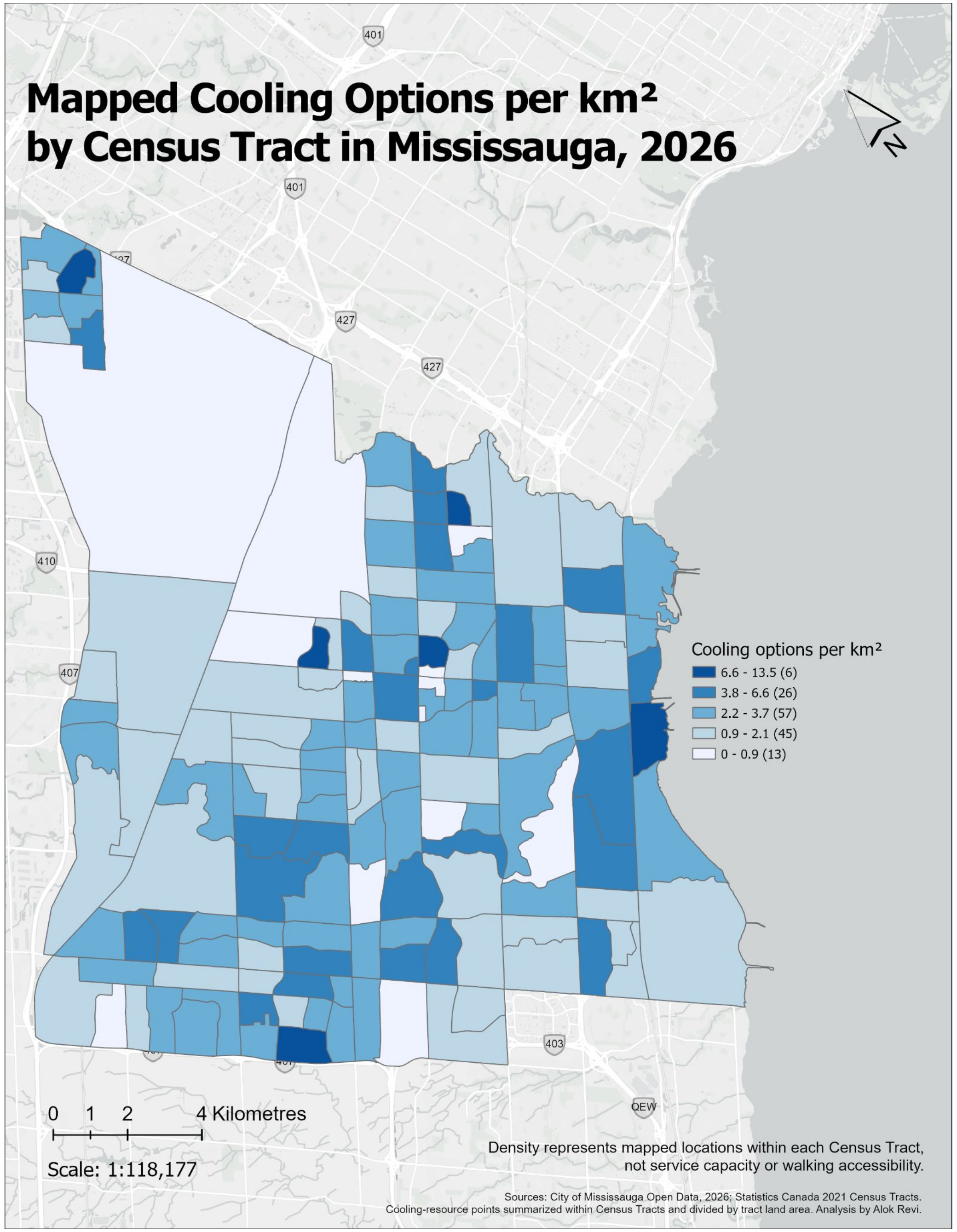
This measures mapped location density, not facility capacity, opening hours, shade quality, accessibility, or walking time. It is useful for screening, but should not be treated as a complete service-access model.

Classification: Unique Values

Number of classes: 6 service types

Field: Service Type

Symbology: Distinct symbols and colours represent community centres, libraries, municipal pools, spray pads, shade structures and parks.



Map 3. Cooling Options per km²

This map shows the density of mapped public cooling options within each Census Tract.

- Resource density varies across the city and is not evenly distributed.

- Some tracts have few or no mapped options per km², even when neighbouring tracts have more resources.

- The map is useful for screening weaker public cooling support, but it does not replace walking-distance or service-area analysis.

Planning implication

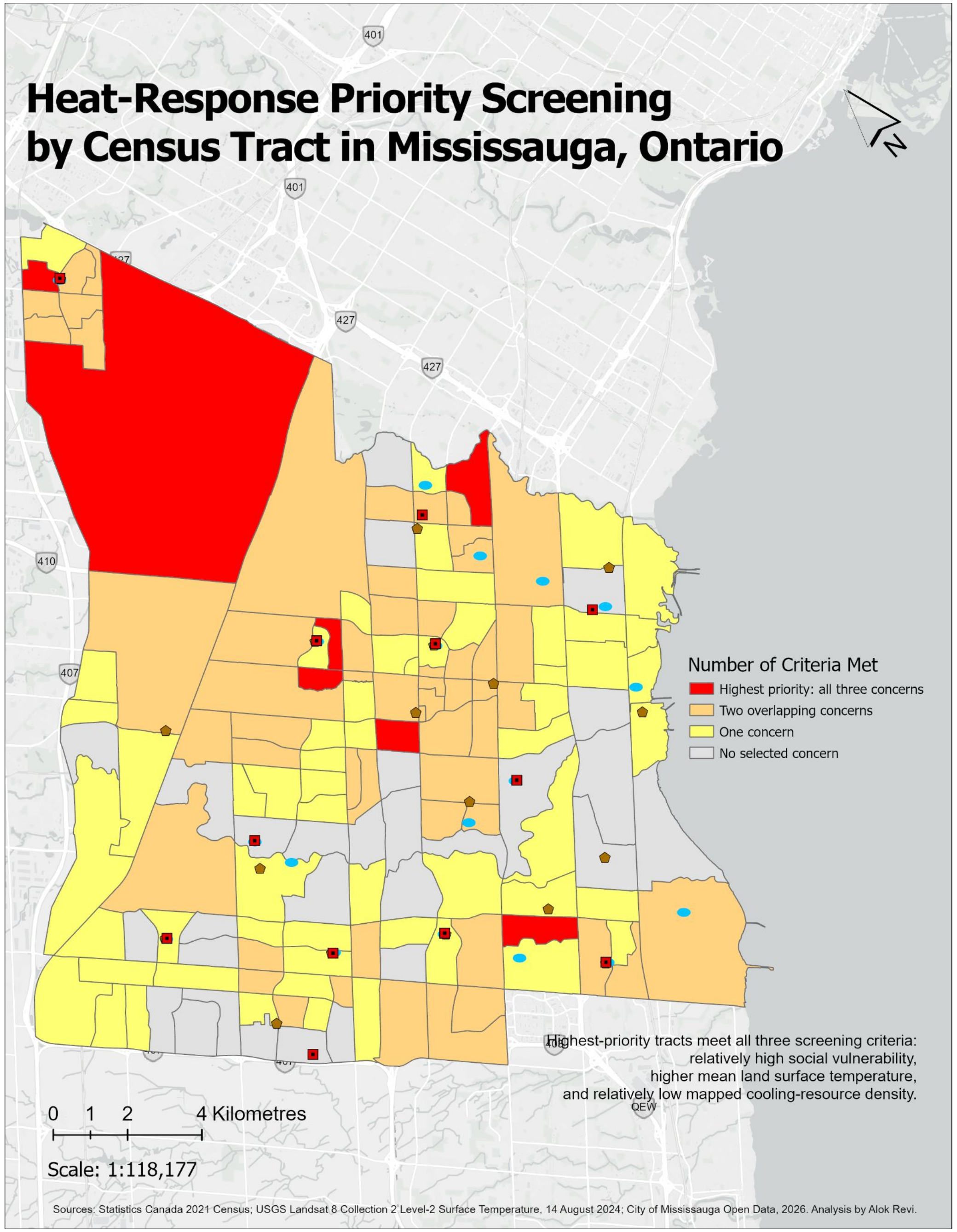
Lower-density tracts should be checked for access to libraries, community centres, pools, shaded parks, transit, and temporary heat-response hubs.

Classification: Natural Breaks (Jenks)

Number of classes: 5

Field: Cooling options per km²

Symbology: Sequential blue colour ramp; lighter blue shows lower density of mapped cooling options and darker blue shows higher density.



Heat-Response Priority Screening

Each Census Tract receives one point for each concern it meets.

- High social vulnerability: vulnerability score ≥ 60.
- Higher heat exposure: mean LST ≥ 37.1°C.
- Lower cooling-resource density: low-cooling score ≥ 60.
- Red tracts meet all three criteria and should be prioritized for further assessment.

Take Away

Score-3 tracts should be reviewed first for heat outreach, indoor cooling access, shade, and greening opportunities.”

Classification: Unique Values using manually defined categories

Number of classes: 4

Field: priority_n

Symbology: Ordered grey-to-red colour scheme; grey shows no selected concern, yellow shows one concern, orange shows two overlapping concerns and red shows the highest priority where all three concerns overlap.

Key Findings

The strongest planning case appears where multiple concerns overlap.

1

Heat exposure and social vulnerability do not perfectly overlap.

Some of the hottest tracts are not the same places as the highest vulnerability tracts.

2

Cooling resources are present, but uneven.

Mapped options are distributed across the city, but density varies by Census Tract.

3

Priority tracts need closer local assessment.

Red tracts meet all three criteria and should be checked for residents, facility access, shade, and walkability.

4

The northwest pattern needs careful interpretation.

Large CTs and non-residential land uses can influence LST and density results, so ground-truthing is essential.

Interpretation based on the four map layers: vulnerability score, mean LST, cooling options density, and final priority screening.

Recommendations

Each recommendation connects directly to map evidence.

Prioritize red score-3 tracts	Use them for local review, summer outreach, temporary cooling programming, and heat-response planning.
Strengthen public cooling hubs	Use libraries, community centres, pools, and other public facilities near priority areas as heat-response hubs.
Test real access	Run walking or transit service-area analysis to see whether residents can actually reach cooling options.
Target shade and greening	Use the detailed LST raster inside priority tracts to locate hot parking lots, apartment areas, transit stops, and public lands.
Improve the next model	Add tree canopy, impervious surface, and multi-date temperature data to support more precise intervention planning.

Recommended next GIS step

Build a 10–15 minute walking-access or transit-access layer around indoor public cooling sites, then overlay it with score-3 and score-2 priority tracts.

Limitations and Caveats

The results are useful for screening, but they are not a final operational heat plan.

- Landsat LST is from a single date and is not the same as air temperature or night-time heat exposure.
- Mean LST by Census Tract hides smaller hot and cool places inside each tract.
- Census indicators are area-level summaries and should not be assigned to every resident.
- Cooling-resource density measures mapped locations, not capacity, opening hours, accessibility, shade quality, or walking time.
- Tree canopy was not scored separately; LST partly reflects vegetation and built surfaces, but future work should add a consistent canopy layer.
- Large or non-residential Census Tracts require ground-truthing before recommendations are applied.

Conclusion

GIS identifies where heat-response planning should look first.

Heat-response planning should not focus only on the hottest surfaces or only on vulnerable populations. The strongest planning case occurs where heat exposure, social vulnerability, and weaker cooling-resource support overlap.

Evidence-based outreach | **Targeted cooling access** | **Shade and greening** | **Further monitoring**

The final priority map should be used as a starting point for local assessment, service planning, and future community heat-resilience work in Mississauga.

Appendix: Methods and Data Notes

Key formulas, data decisions, and interpretation notes.

Core formulas

- Vulnerability score = average of seven percentile-rank fields
- Cooling options per km² = mapped cooling options ÷ CT land area
- Priority criteria met = high vulnerability + higher LST + low cooling density

Final priority criteria

- High vulnerability: vuln_score_core ≥ 60
- Higher heat exposure: mean LST ≥ 37.1°C
- Low cooling density: low_cooling_capacity_score ≥ 60

Data notes

Statistics Canada 2021 Census Tracts provide the social and geographic analysis unit. USGS Landsat 8 Collection 2 Level-2 Surface Temperature provides the heat-exposure raster. City of Mississauga Open Data provides public cooling-resource locations. All outputs should be interpreted as relative screening layers for planning and community-service discussion.

Presentation note

Future work should add tree canopy, impervious surface, multi-date heat imagery, facility hours, accessibility attributes, and network-based service areas.