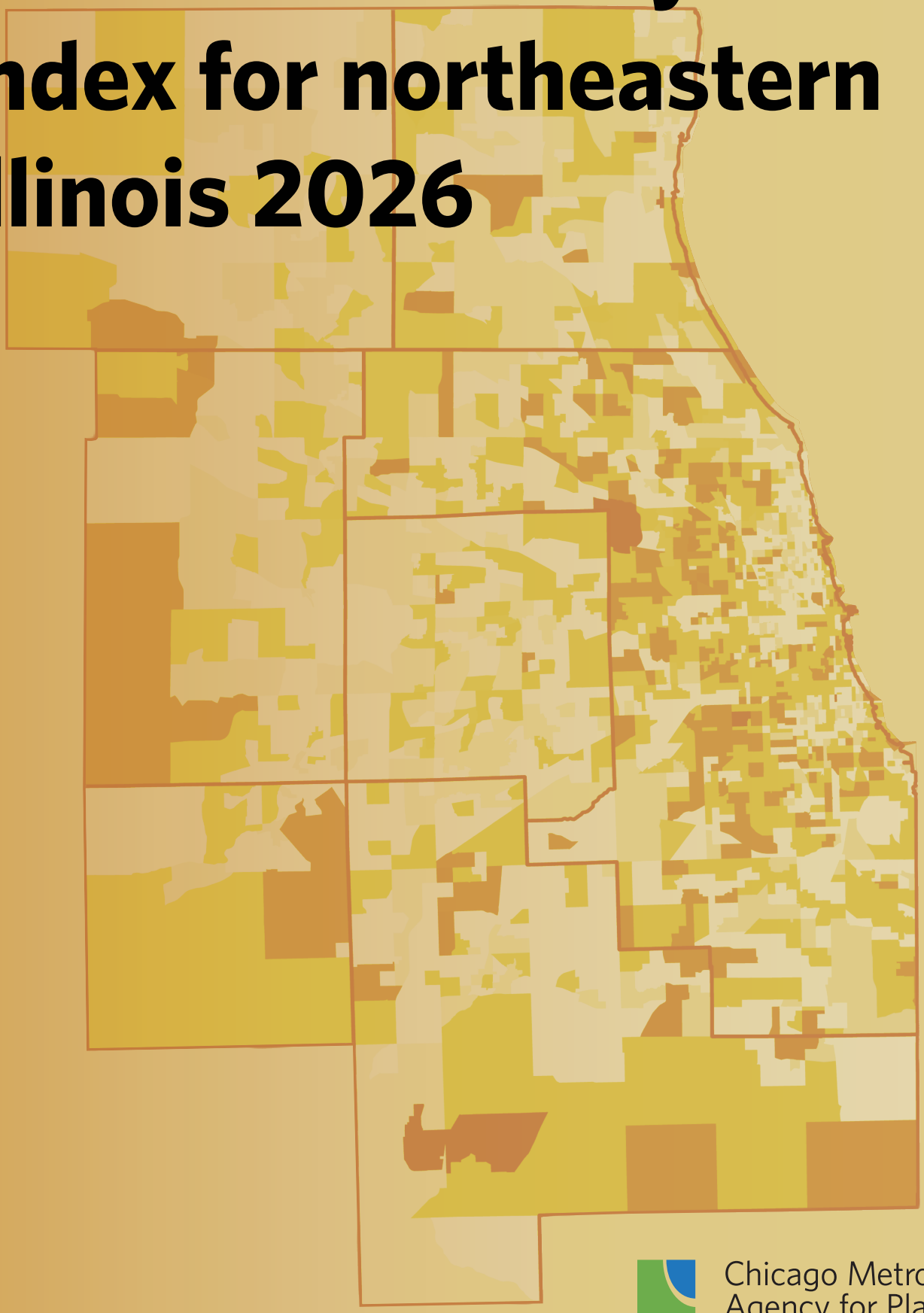
Heat vulnerability index for northeastern Illinois 2026



Chicago Metropolitan Agency for Planning

Acknowledgements

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Introduction

Climate change is already affecting people across northeastern Illinois. Temperatures are rising and everyone is facing growing risks to their health and safety. In fact, extreme heat is frequently the deadliest weather-related hazard in the United States each year.[1] These impacts are projected to intensify, underscoring the need for action now to both prepare the region for extreme heat and reduce the greenhouse gas emissions driving these harmful temperatures.

Without significant emissions reductions, the number of days 95 degrees and above could increase from today's historical average of 2 days per year to up to 45 days by 2100.[2] Very hot days will increase across northeastern Illinois, with the southern half of the region likely experiencing the greatest change.

More frequent extreme heat — combined with higher nighttime humidity that traps and holds heat — poses serious health risks ranging from dehydration and heat exhaustion to life-threatening heat stroke. Certain people face greater risk, including older adults, young children, pregnant people, outdoor workers, athletes, people with certain medical conditions or disabilities, those without air conditioning, and people who live alone.

To help communities prepare, CMAP developed a heat vulnerability index (HVI) that identifies large-scale priority areas across the region where heat resilience planning activities and resources should be focused. The HVI scores census tracts on a scale of 1 to 10 based on factors that increase the likelihood of heat-related health impacts. The higher an area's ranking, the more likely its residents will experience heat-related health risks. Because it is static, the HVI reflects risk based on where people live, not where they travel or how they cope during a heat wave.[3] While some areas show greater vulnerability for residents, people can experience heat-related risks anywhere.

The HVI is a tool that can support CMAP, local governments, and regional partners in advancing heat resilience through community engagement, local planning, policy research, investment decisions, and related activities. It also complements other efforts, such as the City of Chicago's heat vulnerability index (currently in development) and CMAP's analysis of transit rider vulnerability to extreme heat.[4]

Overview

The heat vulnerability index identifies census tracts in northeastern Illinois that are more vulnerable to extreme heat. Vulnerability is scored on a scale of 1 to 10, with 1 being the lowest vulnerability and 10 being the highest.

Heat vulnerability reflects the combination of exposure, sensitivity, and adaptability factors to estimate a person's or a community's capacity to manage extreme heat:

- **Exposure:** People living in dense urban areas with large areas of pavement and many rooftops have higher exposure because these surfaces trap heat.

- **Sensitivity:** Very young and very old residents are more sensitive to heat because their bodies must work harder to lower their internal temperature. Underlying health conditions like heart disease, diabetes, and others also increase sensitivity.
- **Adaptability:** People with lower incomes face challenges finding relief from extreme heat because they can't always afford to run air conditioning during a heat wave. People experiencing homelessness face even greater risks.

CMAP selected relevant data inputs that were available either at the census tract level or a smaller geographical area. Table 1 provides an overview of each heat-related factor and relevant data inputs. CMAP used principal component analysis to examine the inputs in combination with each other and identify those that explain most of the variation in the data Those were combined into a single summarized heat index score for each tract. See the Detailed methodology section for more details.

Table 1. Heat-related factors used in the 2026 heat vulnerability index

Component	Data inputs
Exposure	Mean of max surface temperature on hot summer days*
	Percent area covered by tree canopy
Sensitivity	Population younger than 5 years old
	Population older than 64 years old
	Population with a disability
	Population with asthma
	Population with coronary heart disease
	Population with diabetes
Adaptability	Population below the poverty line
	Population not fluent in English
	Population living alone and over the age of 64

* Hot summer days were identified by combining available low-cloud Landsat imagery between May and September when both the NOAA heat index was at a "caution" level or above and there was little to no rain recorded in the previous 48 hours.

Source: CMAP, 2026.

Results

This section summarizes key findings at regional and county scales, based on average HVI scores, alongside an analysis of which heat-related factors have a greater influence on the average scores. The findings describe where extreme heat could pose the most risk to human health and highlight the drivers of regional heat vulnerability.

The HVI measures vulnerability to extreme heat across all census tracts in the region. After averaging scores across each county, Cook has the highest vulnerability to extreme heat and Lake has the lowest at 5.3 and 3.7 respectively (Table 2). Similarly, Cook County has the highest

share of residents living in census tracts with high or very high vulnerability and Lake County has the lowest share at 58 percent and 13 percent respectively (Table 3).

Table 2. Average HVI score by county, 2026

County	Average HVI score
Cook	5.3
DuPage	4.4
Kane	4.5
Kendall	5.1
Lake	3.7
McHenry	4.0
Will	4.7
CMAP region	5.0

Source: CMAP, 2026.

Table 3. Percent of county population in census tracts with high or very high heat vulnerability, 2026

County	Population in census tracts with high or very high heat vulnerability (HVI score of 5.7 or higher)
Cook	58%
DuPage	22%
Kane	28%
Kendall	45%
Lake	13%
McHenry	15%
Will	25%
CMAP region	44%

Source: CMAP, 2026.

Key findings

Much of the region faces high or very high vulnerability

Nearly half of the region (44 percent) lives in census tracts with high or very high heat vulnerability, defined as having an HVI index score of 5.7 or higher.

The central and southwest portions of the region have the highest vulnerability

Parts of Cook, Kane, Kendall, and Will counties have the greatest heat vulnerability, spanning some of northeastern Illinois' most urban and rural communities.

Surface temperature and tree cover drive vulnerability in Cook, Kendall, and Will counties

In Cook County, dense development creates extensive impervious surfaces that absorb and retain heat, intensifying the urban heat island effect. In Kendall and Will counties, intensive agriculture limits tree cover, reducing natural shade and cooling and contributing to higher surface temperatures.

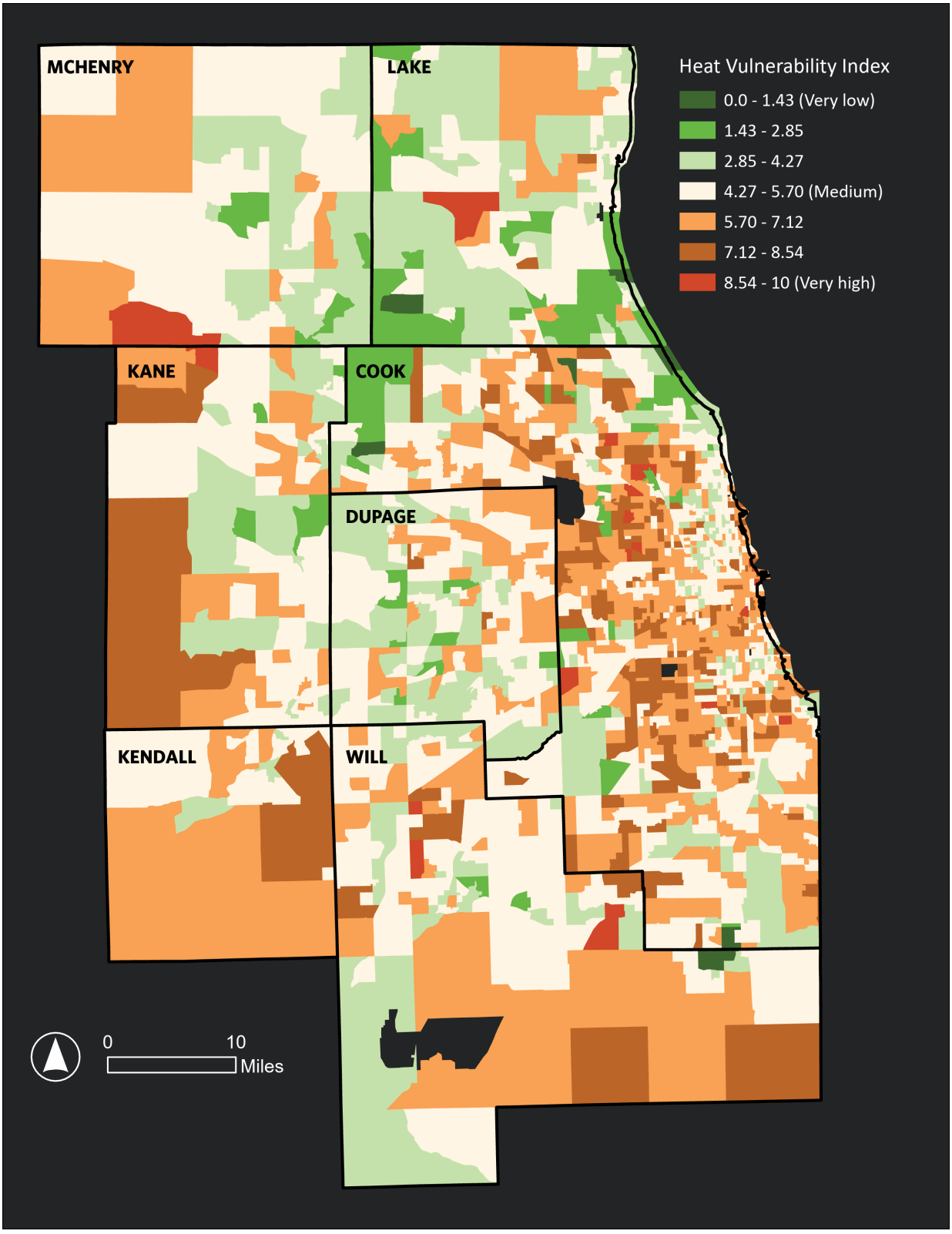
Advanced age and health conditions increase vulnerability in DuPage, Kane, Kendall, and McHenry counties

These counties have larger populations of residents 65 and older and higher rates of health conditions such as diabetes, asthma, coronary disease, and other related conditions and disabilities. This increases sensitivity to heat and heightens the risk of heat-related illnesses during extreme temperature events.

Communities with more tree canopy are less vulnerable

Trees cool surrounding areas by providing shade and releasing water vapor. For example, Lake County has a relatively large share of older adults and residents with health risks, yet it has the lowest average vulnerability score in the region, in part due to expansive tree coverage.

Figure 1. Heat vulnerability index, 2026



Source: CMAP, 2026.

Results by county

This section:

- Summarizes heat vulnerability for each county
- Describes general patterns and areas of the county with higher vulnerability
- Identifies the top heat-related factors that contribute to heat vulnerability across each county

The results show how vulnerability varies across counties and municipalities depending on heat exposure and demographic and health characteristics of the population. Census tracts may vary from county trends described below. For more specific census tract analysis, the data viewer provides more detailed data to understand the underlying factors of heat vulnerability.

Cook

Cook County has moderate vulnerability to extreme heat, scoring an average of 5.3. However, 58 percent of its residents live in census tracts with high or very high heat vulnerability, the largest share of any other county in the region. The highest vulnerability scores are found in the northwest, west, and south suburbs, as well as the Northwest, Southwest, and far South sides of Chicago.

Dense development patterns, extensive impervious cover, and limited trees, parks, and open space cause surface temperatures to be high, especially on Chicago's South and Southwest sides. In contrast, the north and southwest portions of the county have more census tracts with 40 percent or more tree canopy, which helps cool these areas. In south Cook, higher rates of poverty and health conditions like asthma, coronary disease, and diabetes contribute to elevated vulnerability scores.

DuPage

DuPage County has moderate vulnerability to extreme heat, scoring an average of 4.4. Less than a quarter of residents (22 percent) live in census tracts with high or very high vulnerability, which are found in small pockets across the county.

Higher concentrations of people 65 and older countywide and a prevalence of residents with limited English proficiency in the west and northeastern parts of the county contribute to vulnerability. Despite this, the county's tree canopy density is the second highest in the region, reducing vulnerability.

Kane

Kane County has moderate vulnerability to extreme heat, with an average score of 4.5. More than a quarter of residents (28 percent) live in census tracts with high or very high vulnerability.

The highest scores are concentrated in the western part of the county where a low tree canopy and extensive agricultural land increases surface temperatures. Kane County also has elevated health risks, including higher rates of coronary disease in western Kane and high rates of

asthma in Auroa and Elgin. Higher poverty levels in the county's more urban areas further contribute to heat vulnerability.

Kendall

Kendall County has moderate vulnerability to extreme heat, with an average score of 5.1. However, nearly half its residents (45 percent) live in census tracts with high or very high vulnerability, with the highest scores concentrated in the eastern and southern parts of the county.

Although Kendall County has lower density development and less impervious cover than other parts of the region, extensive agricultural lands result in a limited tree canopy. This lack of shade and cooling contribute to the county experiencing some of the highest surface temperatures in the region.

Lake

Lake County has moderately low vulnerability to extreme heat, with an average score of 3.7. Only 13 percent of residents live in census tracts with high or very high heat vulnerability, the lowest in the region.

The county also has the highest tree cover density, which helps reduce temperatures. Despite this, there are notable concentrations of residents 65 and older near northwest Mundelein and Lake Forest. On the east side of the county, Waukegan and North Chicago experience higher rates of poverty and health conditions — both factors that can increase heat vulnerability.

McHenry

McHenry County has moderately low vulnerability to extreme heat, scoring an average of 4.0. Only 15 percent of residents live in census tracts with high or very high heat vulnerability, primarily in western McHenry County and in communities like Huntley and Marengo.

Among the counties analyzed, McHenry has the highest share of residents 65 and over and experiences higher rates of coronary disease in the northwest — both factors that can increase sensitivity to extreme heat. In the more populated communities of eastern McHenry, extensive tree canopy coverage helps cool surface temperatures and reduce vulnerability for these at-risk groups.

Will

Will County has moderate vulnerability to extreme heat, scoring an average of 4.7. A quarter of residents (25 percent) live in census tracts with high or very high vulnerability, largely concentrated in the county's southern portion.

Like Kendall County, extensive agricultural land limits tree cover in southern Will, contributing to higher temperatures. Romeoville and Frankfort have the highest heat vulnerability. Both communities have high rates of residents 65 and older, and Romeoville also has a high rate of children under 5 years old — both groups that are more sensitive to extreme heat. In Joliet, higher poverty rates and lower English proficiency among residents contribute to vulnerability.

Detailed methodology

Calculating vulnerability

The HVI was developed to identify areas in northeastern Illinois that may have increased heat vulnerability. Vulnerability — of any system to any kind of hazard — can be understood as a combination of exposure, sensitivity, and adaptability (Table 4).[5]

Table 4. Elements of heat vulnerability

Element	Description	Example
Exposure	Contact with and severity of the extreme heat hazard	People living in dense urban areas with extensive pavement and rooftops have higher exposure because these surfaces trap heat
Sensitivity	Degree to which a person is generally affected by extreme heat; may be direct or indirect	Younger and older residents are more sensitive to heat because their bodies must work harder to lower their internal temperature. Underlying health conditions like heart disease and diabetes also increase sensitivity
Adaptability	The ability to adjust, react, and cope with extreme heat	People with lower incomes face challenges finding relief from extreme heat because they can't always afford to run air conditioning during a heat wave

Source: CMAP, 2026.

There is no consensus on exactly which factors should be included when creating a heat vulnerability index, and different approaches often face challenges related to data availability and quality. [6]

For this analysis, CMAP selected the following data inputs, each of which is available at the census tract level or smaller; common in other HVI analyses; and is particularly relevant to northeastern Illinois based on previous research (Table 5).[7] See Appendix A for data that was considered but not included in this analysis.

Exposure

Exposure to heat was quantified using two data sources: land surface temperature and tree canopy coverage. CMAP calculated a summary value using maximum land surface temperatures across nine years of data from the Landsat satellite imaging program. While surface temperature is an imperfect proxy for air temperature and the "real feel" experience of heat, this dataset made it possible to combine many localized hot and cool spots into a single value for each census tract.[8] CMAP also used tree canopy coverage estimated from analysis of imagery data provided by Ecopia, Inc.

Sensitivity

Sensitivity measures included demographic and health variables. Demographic data was sourced from the U.S. Census Bureau's five-year American Community Survey (ACS) program, while health data was collected from the Center for Disease Control's PLACES dataset. Neither of these datasets is a count of the population, but instead provide modeled estimates based on a sampled subset of the population, so some variance is expected.

Adaptability

Adaptability measures are a combination of behavioral choices and the resources that may allow or limit different behavior choices. CMAP included variables describing poverty status, household isolation, and English fluency sourced from the ACS.

Table 5. Data inputs used in the 2026 HVI

Component	Data inputs	Source	Year
Exposure	Mean of max surface temperature on hot summer days*	Landsat[9]	2013-2022
	Percent area covered by tree canopy	Ecopia[10]	2023
Sensitivity	Population younger than 5 years old	ACS[11]	2022
	Population older than 64 years old	ACS	2022
	Population with a disability	ACS	2022
	Population with asthma	PLACES[12]	2022
	Population with coronary heart disease	PLACES	2022
	Population with diabetes	PLACES	2022
Adaptability	Population below the poverty line	ACS	2022
	Population not fluent in English	ACS	2022
	Population living alone and over the age of 64	ACS	2022

* Hot summer days were identified by combining available low-cloud Landsat imagery between May and September when both the NOAA heat index was at a "caution" level or above and there was little to no rain recorded in the previous 48 hours.

Source: CMAP, 2026.

Analysis

Because vulnerability reflects the combined influence of many factors, CMAP used principal component analysis to examine all inputs together and identify those that explain most of the variation in the data. Principal component analysis is commonly used in heat vulnerability indices because it condenses many data inputs into fewer variables that explain most of the information. [13]

CMAP selected the top four components for the index, as they together explained over 85 percent of the total variance (Table 6). Inputs were considered significant contributors to a component if their calculated weight was at least 0.35 or less than -0.35. If a variable has a

large positive or negative weight, or eigenvector value, it is a major contributor to that principal component.

Table 6. Principal components, listed in order of variance

Component	Percent variance explained	Cumulative percent variance explained	Significant input variables	Significant input eigenvector values
Health factors	43.7%	43.7%	Coronary disease	0.427
			Diabetes	0.423
			Asthma	0.415
			Disability	0.375
Environmental exposure	20.0%	63.7%	Surface temperature	-0.614
			Tree cover	0.613
Isolated and/or dependent on others	11.2%	74.9%	Living alone	-0.707
			Not fluent in English	0.376
			Under 5 years	0.370
Poverty and advanced age	7.1%	82.0%	Poverty	-0.701
			Over 64 years	0.500

Source: CMAP, 2026.

Next, CMAP used the four components to generate a single summarized index value for each census tract. Each component was isolated, normalized to a value between 1 and 6, and then totaled. The combined values were normalized again from 0 to 10. Finally, CMAP joined these index values to a shapefile of 2020 Census tracts to produce the heat vulnerability index.

Limitations and future refinements

While creating the HVI, CMAP encountered several limitations related to data availability and processing. The following section outlines these issues. As this is the region's first heat vulnerability index, CMAP will continue working with regional partners to explore future improvements, including new data inputs, methodological refinements, and enhanced decision-support tools. Additional information on data considered but not included in the index is detailed in Appendix A.

Heat data

The primary heat exposure dataset is Landsat satellite-derived surface temperature, an imperfect proxy for on-the-ground "feels-like" conditions people experience during heat waves. It also may not fully account for prevailing winds or how buildings and other structures can block cooler air from reaching residents. Weather sensors that capture temperature, humidity,

and air quality are rapidly advancing and will be an important addition to future heat vulnerability work in northeastern Illinois.

Validation

A key limitation of this analysis is the lack of validation of the HVI against real-world data on heat-related impacts in northeastern Illinois. Relevant data could include increased ambulance calls and urgent care visits, heat-related hospitalizations, or heat-related deaths during and immediately after a heat wave. However, accessing this data at the scale needed (equal to or better than census tracts) is difficult. Notably, ongoing work to develop an HVI for the City of Chicago will incorporate this kind of validation data; CMAP looks forward to learning from the city's analysis.

Temporal scale

Another challenge involves differences in temporal scale. The HVI attempts to characterize vulnerability during a typical summer heat wave and does not account for unique conditions associated with anomalous heat waves, such as those in the early spring or late autumn. It also does not account for the increasing frequency of heat waves expected as climate change continues to affect the region.

Geographic

The regional HVI is also constrained geographically. Census tract data reflects where people live, not where they may travel during a heat wave — movements that can increase or decrease individual vulnerability. Census tracts are also an imperfect unit as they vary widely in size and population. For example, in rural areas, a single tract may encompass communities that have higher vulnerability. But when the data is summarized at the tract level, that level of detail is lost.

Appendix A: Other inputs considered

The following are input datasets that CMAP considered but did not use in the development of the 2026 HVI (Table 7).

Table 7. Other input datasets considered for the 2026 heat vulnerability index

Component	Input dataset	Description	Reason for exclusion
Adaptability or exposure	Cooling centers	Government-sponsored places of temporary refuge from heat	Incomplete regionwide data on the locations, operating hours, and amenities available at cooling centers
Adaptability	Air conditioning (A/C)	Presence and/or use of A/C in the home	A/C presence and usage data not available regionwide at the level of detail desired*
Adaptability	Social connectedness	The tendency of people to check in on, or be checked in on, by family, friends, or neighbors during a heat wave	Unable to identify an appropriate data source at the level of detail or regionwide scale desired
Exposure	Impervious surface	Proportion of an area covered in impervious surfaces that tend to absorb and hold heat longer than natural surfaces	Already accounted for in the surface temperature input
Exposure	Humidity and wet-bulb temperature	Humidity is related to evaporative potential, which directly relates to how the human body cools itself. Wet-bulb temperature is a measurement that incorporates both temperature and humidity, which better reflects the heat stress experienced by the human body.	Not widely available regionwide and too much variability across different heat waves; wrong temporal scale for the analysis
Adaptability	Access to vehicle	Whether or not a household has access to a vehicle, which may provide access to healthcare, cooling centers, or	Too much regional variability — lack of access to a vehicle may impede medical care for someone in a rural area, but

		other ways of escaping the heat	not having a vehicle is much more normal and not an issue in urban areas
Adaptability	Access to the internet	Whether or not a household has access to the internet and therefore access to information about a heatwave	Lack of regional variability — the study area is generally well connected, and English fluency may be considered as a better indicator of access to information about heat waves
Exposure	Population that works outdoors in the summer	The number of people who work primarily outdoors during the summer	Unable to locate this data or confidently produce this information from known employment data sources

*CMAP developed the HVI before ACS data A/C availability was released. This data could be considered for future updates. The county assessor's data on building age and improvements as well as utility data on A/C usage should also be explored.

Appendix B: Extreme heat resources

Data and research

Chicago Metropolitan Agency for Planning: *Transportation Resilience Improvement Plan*.

- A report that identifies where our transportation system is more vulnerable to extreme weather and includes information on infrastructure asset and transit rider vulnerability to heat. Visit http://cmap.is/trip.

Illinois State Climatologist: Climate Change Impacts and Factsheet

- Information on how climate change contributes to longer and more intense heat in Illinois. Visit https://stateclimatologist.web.illinois.edu/climate-change-in-illinois/.

National Oceanic and Atmospheric Administration: National Integrated Heat Health Information System

- Heat planning research, webinars, data tools, and communication resources. Also includes a live map of heat watches, warnings, and advisories for the continental United States. Visit https://www.heat.gov/.

National Oceanic and Atmospheric Administration: United States Climate Resilience Toolkit,

- Tools, information, and strategies for climate resilience. Also includes a lookup tool that describes future warming and available tools for your county. Visit https://toolkit.climate.gov/.

To share with residents

City of Chicago Department of Public Health: Learn What to Do: Heat Preparedness

- A resource lists how to identify heat exhaustion and stroke, tips for staying safe during heat waves, and links to cooling center locations in Chicago. Visit https://www.chicago.gov/city/en/depts/cdph/supp_info/public_health_preparedness/heat-preparedness.html.

Illinois Emergency Management Agency: Ready Illinois: Extreme Heat

- A list of tips and recommendations for Illinois residents on how to stay safe during a heat wave and links to other heat-related statewide resources, including cooling center locations. Visit https://ready.illinois.gov/hazards/extremetempshot.html.

National Weather Service: Chicago Forecast Office

- The local authority for weather alerts in northeastern Illinois. Visit https://www.weather.gov/lot/.

Endnotes

[1] National Oceanic and Atmospheric Administration's National Weather Service, Weather Related Fatality and Injury Statistics, https://www.weather.gov/hazstat/.

[2] CMAP, Risk-based Vulnerability Assessment, November 2025, https://cmap.illinois.gov/wp-content/uploads/dlm_uploads/Risk-based-Vulnerability-Assessment.pdf.

[3] Five shifts to rethink urban heat assessment and action, Sharma et al., *npj Urban Sustainability,* (2026) https://www.nature.com/articles/s42949-026-00451-9.

[4] Defusing Disasters Working Group, https://buffett.northwestern.edu/research/global-working-groups/defusing-disasters.html. As part of the Transportation Resilience Improvement Plan, CMAP analyzed transit rider vulnerability to extreme heat and calculated risk scores for bus stops and train stations in the region. Learn more at https://datahub.cmap.illinois.gov/maps/129814bb647d4b3fa7b1791e522b7e39/about.

[5] Intergovernmental Panel on Climate Change, Third Assessment Report Synthesis Report Box SPM-1, p.225, (2001), https://www.ipcc.ch/report/ar3/syr/.

[6] A Systematic Review of the Development and Validation of the Heat Vulnerability Index: Major Factors, Methods, and Spatial Units, Niu et al., *Nature,* (2021), https://link.springer.com/article/10.1007/s40641-021-00173-3.

[7] Excess Hospital Admissions During the July 1995 Heat Wave in Chicago, Semenza et al., *American Journal of Preventative Medicine,* (1999), https://pubmed.ncbi.nlm.nih.gov/10493281/; Heat-related mortality during a 1999 heat wave in Chicago, Naughton et al., *American Journal of Preventative Medicine,* (2002) https://pubmed.ncbi.nlm.nih.gov/11988377/.

[8] Satellite Remote Sensing of Surface Urban Heat Islands: Progress, Challenges and Perspectives, Zhou et al., *Remote Sensing,* (2018) https://www.mdpi.com/2072-4292/11/1/48.

[9] NASA/USGS Landsat Program is the longest continuous space-based imagery record of Earth's surface, available at https://landsat.gsfc.nasa.gov/.

[10] Ecopia, Inc. is the provider of imagery and machine learning-derived spatial datasets for the CMAP region. This data was acquired with the support of IDOT and NOAA.

[11] The U.S. Census Bureau's American Community Survey (ACS) program provides local population and housing information annually. All data used in this analysis comes from the five-year ACS, 2018-2022, available at: https://www.census.gov/programs-surveys/acs/.

[12] PLACES: Local Data for Better Health is a project by the CDC to make health information for local communities available to researchers and planners, available athttps://www.cdc.gov/places/index.html.

[13] Ibid., 4.

FY27-0006

The Chicago Metropolitan Agency for Planning (CMAP) is the region's comprehensive planning organization. The agency and its partners developed and are now implementing ON TO 2050, a long-range plan to help the seven counties and 284 communities of northeastern Illinois implement strategies that address transportation, housing, economic development, open space, the environment, and other quality-of-life issues.

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