Mapping heat vulnerability in Flint

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UP506: Introduction to GIS

The ongoing trends of global climate change and an increasingly urban world population raise important questions regarding mitigation of and adaptation to rising temperatures. City residents stand to be particularly vulnerable, because they also face the urban heat island effect, in which cities are warmer than surrounding rural areas due to the effects of human-related activities.

Eric Klinenberg's 1995 book "Heat Wave: A Social Autopsy of Disaster in Chicago" explores the sociological component of extreme heat events, demonstrating that demographic characteristics such as income, age, and race play a critical role in heat vulnerability. Along these lines, this map for the city of Flint, MI, draws on demographic and land cover data to determine which regions of the city will be most at risk during extreme heat events.

Methodology

This study adapts methods from Colleen Reid et al.'s 2009 article "Mapping Community Determinants of Heat Vulnerability." The index is based on eight percentage indicators drawing from publicly available data, all of which have been identified as risk factors during heat-related events.

At the advice of University of Michigan faculty, demographic and physical indicators received equal weight, to balance population characteristics with elements of the built environment that actively generate or mitigate heat. Among demographic indicators, race and poverty received a higher weight due to Flint's distinctive population characteristics, with a large proportion of the population below the poverty line and/or self-identifying as not white. A higher percentage corresponds with higher heat vulnerability for all indicators except for tree canopy, where a higher tree proportion lowers vulnerability.
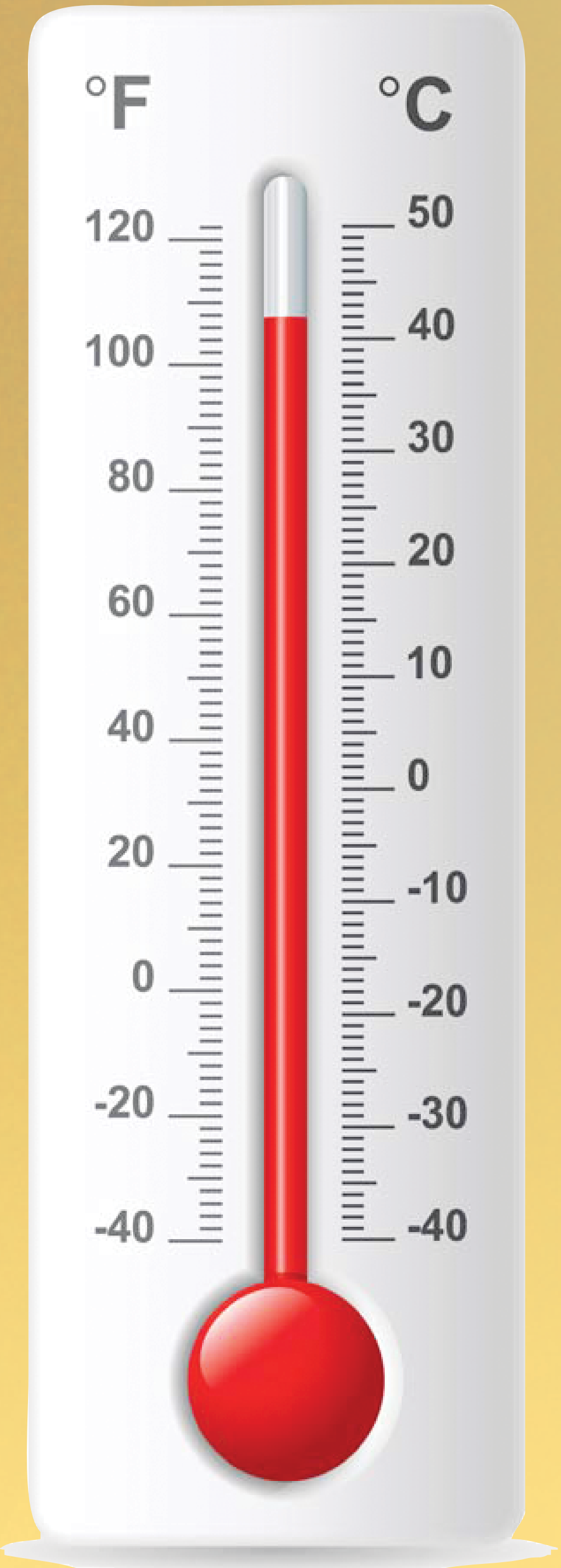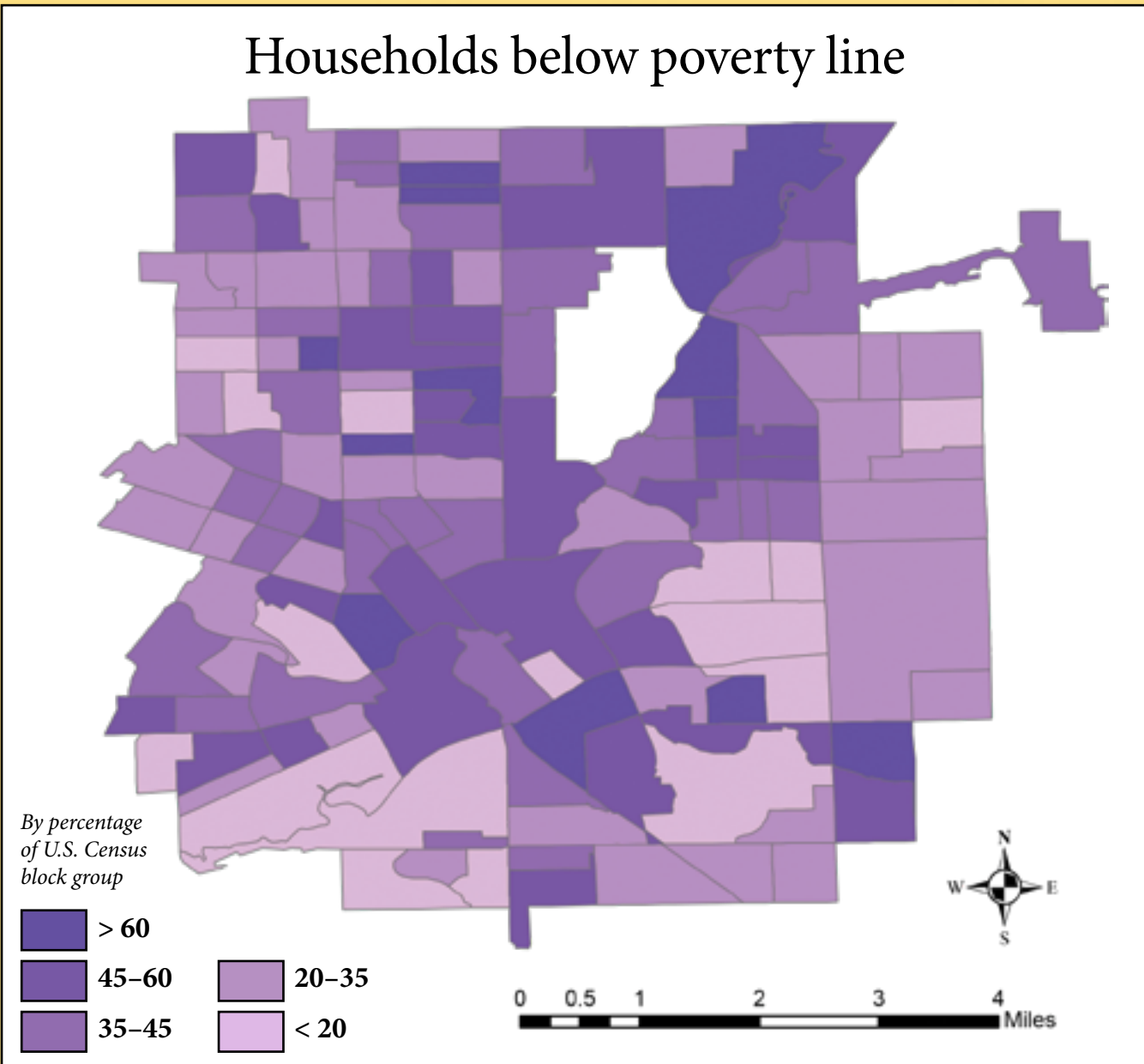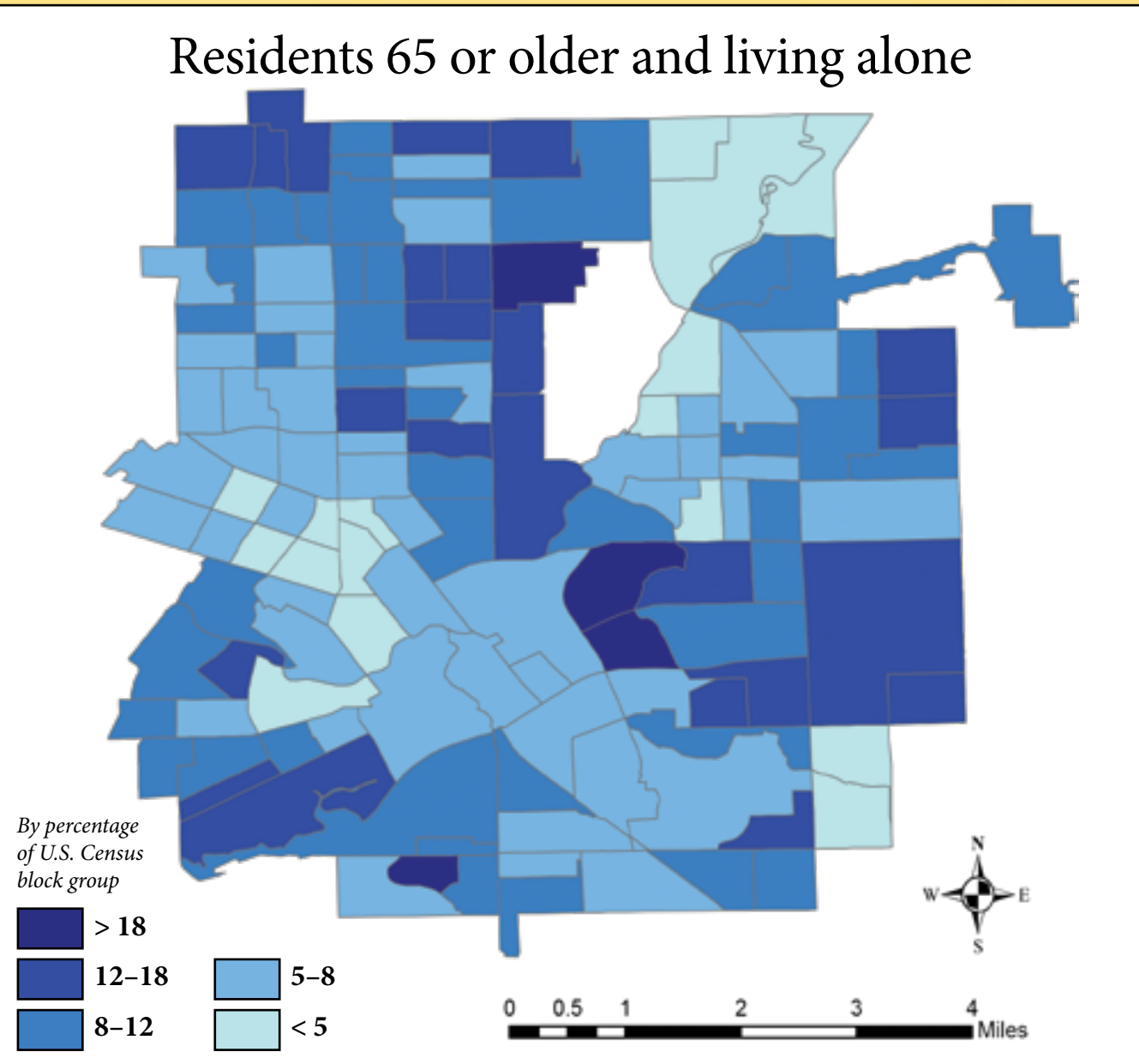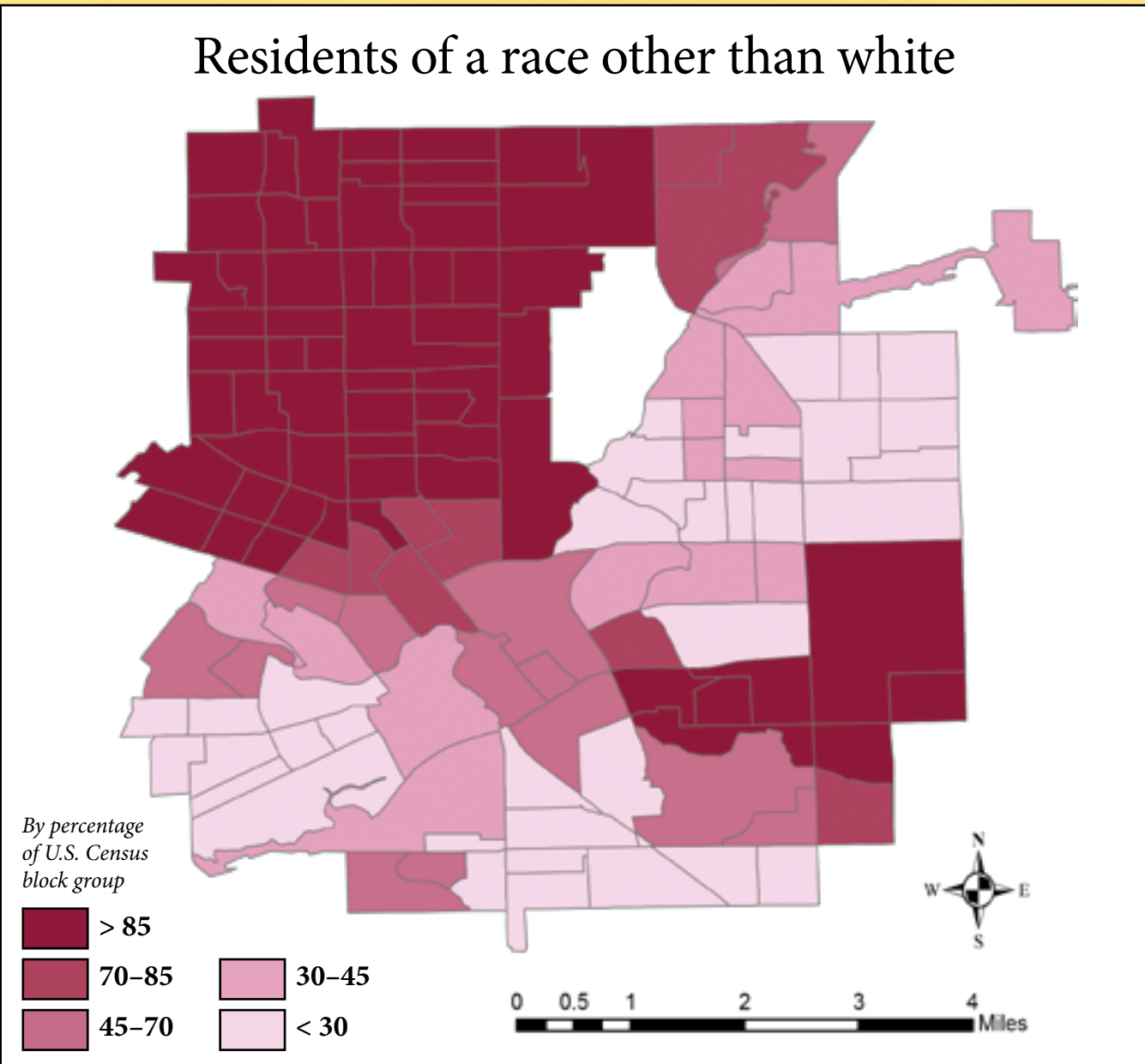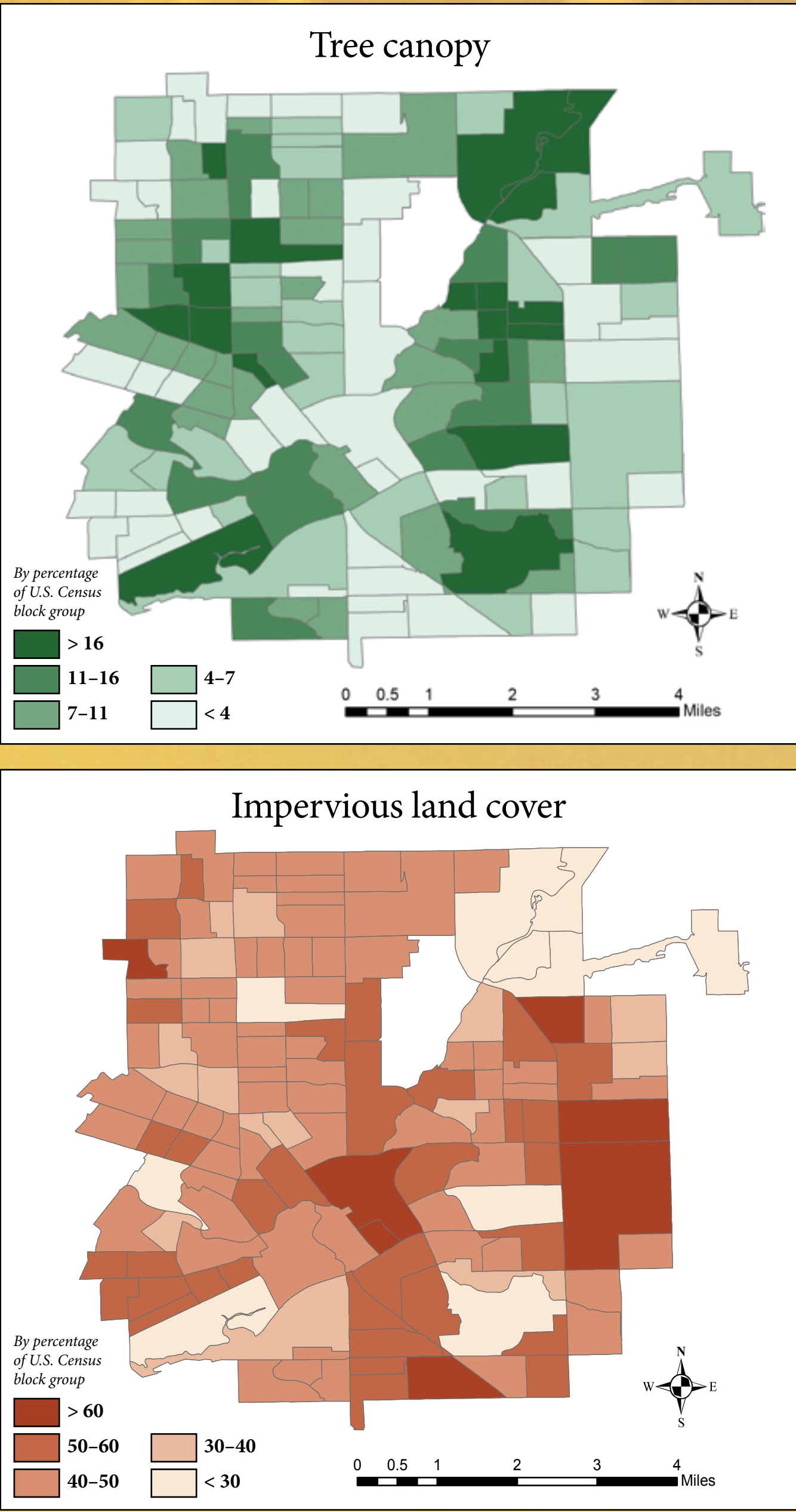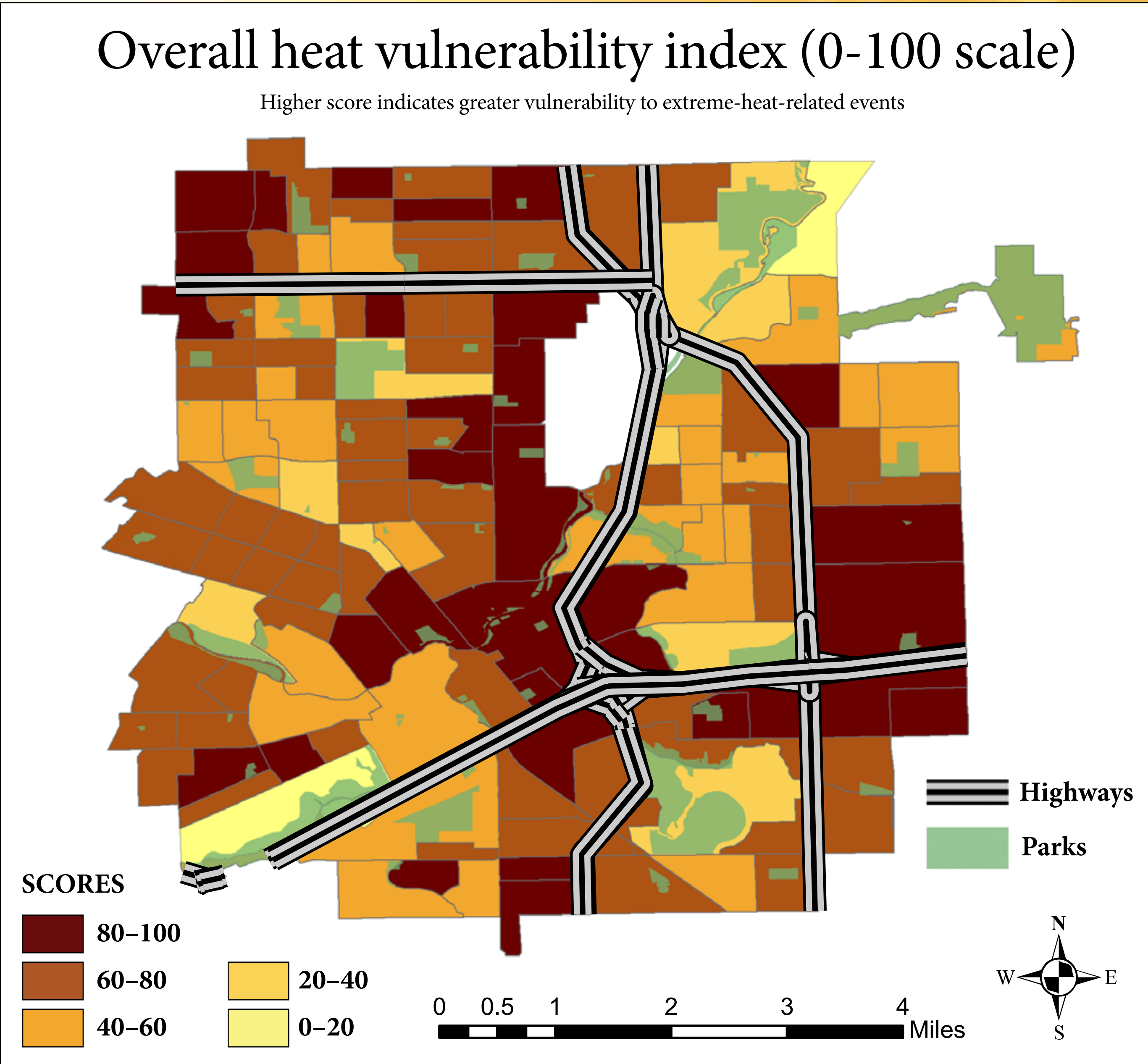
Indicator	Weight
Impervious land cover	25.0%
Tree canopy	25.0%
Residents of a race other than white	12.5%
Residents below the poverty level	12.5%
Residents older than 65	6.25%
Residents living alone	6.25%
Residents older than 65 living alone	6.25%
Residents without a high school diploma	6.25%

The distribution of the cumulative results was then normalized into Z-scores, then converted to a 0–100 scale, 100 representing the most vulnerable block groups, 0 representing the least. These scores and indicators were then joined to a Census TIGER/Line basemap of Census block groups, with scores and percentages then plotted onto a graduated color map to indicate intensity. For the final index map, park and major highway overlays were generated to provide necessary infrastructural context.

Findings

The final vulnerability map shows that the most heat-vulnerable areas of Flint lie toward its central downtown area and close to major roadways, such as I-69, I-475, and M-54, an effect mitigated in areas with high tree canopy and parkland. These results are unsurprising given the high weights assigned to physical indicators.

However, the individual indicator maps show a mild correlation between race and level of green space, with nonwhite residents generally living in areas with fewer parks and trees. Planners and civic engineers focused on environmental justice should emphasize tree-planting efforts in the map's darker regions, as well as other heat-mitigating measures such as lighter-colored roofs, pavement and walls.

Overall heat vulnerability index (0-100 scale)

Higher score indicates greater vulnerability to extreme-heat-related events

Highways

Parks

SCORES

- 80–100
- 60–80
- 40–60
- 20–40
- 0–20

Tree canopy

By percentage of U.S. Census block group

- > 16
- 11–16
- 7–11
- 4–7
- < 4

Impervious land cover

By percentage of U.S. Census block group

- > 60
- 50–60
- 40–50
- 30–40
- < 30

Residents of a race other than white

By percentage of U.S. Census block group

- > 85
- 70–85
- 45–70
- 30–45
- < 30

Residents 65 or older and living alone

By percentage of U.S. Census block group

- > 18
- 12–18
- 8–12
- 5–8
- < 5

Households below poverty line

By percentage of U.S. Census block group

- > 60
- 45–60
- 35–45
- 20–35
- < 20

Data sources

- 2014 American Community Survey (5-Year)
- 2010 U.S. Decennial Census
- 2011 National Land Cover Database (raster maps)
- 2014 TIGER/Line Shapefiles (machine-readable data files) prepared by the U.S. Census Bureau

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Special thanks to Dr. Larissa Larsen of Taubman College for her advice on methodology and choice of case study.