# Climate Adaptation in the Great Lakes Region: Evanston Metadata
# **Cold Season Climate Change Vulnerability in Evanston, IL**

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## Introduction

The GIS component of this project sought to address resource limitations that many municipalities in the Great Lakes basin face. Great Lake cities have limited resources for climate change adaptation. Effective planning and deployment of adaptive techniques requires an understanding of the locations within a particular city that are most vulnerable to climate change. By targeting resources in this way cities can "get the most bang for their buck". This end goal is the guiding framework for the GIS analyses carried out by the Climate Ready Great Lakes team.

Two methods of climate change vulnerability mapping are described in this section. The first is "extreme heat and flooding" or "warm season climate change vulnerability". The second is extreme cold and winter weather infrastructure damage or "cold season climate change vulnerability. The methodology for both types of maps is similar. Final discussion will focus on how cities may customize the analysis by providing their own data and/overlaying the results with suggested layers. There is also room for improving methodology which is discussed in the methods section of the appendix.

## Summary

Winter weather vulnerability is considerably more difficult to ascertain in the context of climate change. Impacts on human health and infrastructure are more complex than temperature alone. For example damage to physical infrastructure, "snowed-in" elders, and transportation system breakdowns are more likely to occur during weather fluctuations rather than sustained cold. Additionally, one day of extreme cold can drive an average down, while sustained cold is the main factor when considering danger to children. These types of fluctuations in temperature are difficult to capture at sufficiently small enough spatial and large enough temporal scales to differentiate relative vulnerability across census block groups.

Notwithstanding these methodological challenges the GIS analysis attempts to understand how extreme winter weather might affect various neighborhoods of Evanston, IL relative to each other. This decision was made in concert with the sustainability office of Evanston. The sustainability office requested the cold weather vulnerability analysis after reviewing the warm weather vulnerability map. The decision to pursue cold weather vulnerability mapping was made on a particularly blustery February day, which perhaps overstated the need for such an analysis.

The analysis drew on previous work which illustrated linkages between impacts of cold weather on families and poor nutritional outcomes; for many families a cold snap means they must answer the question "heat or eat?" (Bhattacharya et al, 2003). Input from Evanston, IL officials helped to guide the selection of social and built environment indicators that were chosen to develop the vulnerability index. Data mining of publicly available "311" information was utilized to determine where infrastructure was vulnerable to cold weather damage.

## Data Used

1. ASTER Global Emissivity Database, North America, Winter, 100 meter, HDF5 V003
   - Obtained from NASA Reverb website in HDF file format.
   - Shows average temperature of each 100 M pixel in winter months from 2000-2008.

2. US Census Data, obtained as polygons from SimplyMap database.
   - Housing Stock---Percent of housing in block group built in 1939 or earlier.
   - Percent of block group in poverty.
   - Percent of block group over 85 years old.
   - Percent of block group under 5 years old.
   - Percent of block group using electric heat.
   - Percent of block group using oil heat.
   - Percent of block group in housing with 5-9 units.
   - Percent of block group in housing with 9-20 units
   - Percent of block group in housing with 20-50 units
   - Percent of block group in housing with 50 or more units.

3. Pothole locations, publicly available through Evanston, IL website.

4. Warming center locations.

## Methods

1. Convert ASTER Emissivity data into a GeoTiff using R or Python (working program deposited in archive folder).
2. Convert Census polygons to raster datasets.
3. In raster calculator combine apartment data by calculating each of the four apartment data sets by 0.25.
4. Stretch census and ASTER to a standardized 0-100 relative grid.
5. Invert ASTER by taking the absolute value of Grid-100
6. Using raster calculator combine emissivity data and census data to winter weather vulnerability index

   (Temperature Invert * .34) + (Percent Under 5 * .11) + (Pre 1939 * .05) + (Apartments * .06) + (Percent over 85 * .11) + (Poverty * .11) + (Oil Heat * .11) + (Electric Heat * .11)
7. Place a 100 M buffer around potholes to indicate winter weather infrastructure damage zones.
8. Overlay warming centers.

## Suggestions for improved methodology and analysis

- Include water main locations. This was not possible in this analysis because of security concerns.
- Interpolate winter data such as snow depth from multiple weather stations around target area.
- Keep in mind the difference between “extreme cold” and “winter season vulnerability”. Extreme cold is somewhat easier to map, but vulnerability of infrastructure to extreme winter weather may be more useful, albeit harder to understand on a small spatial scale.

Bhattacharya, J., DeLeire, T., Haider, S., & Currie, J. (2003). Heat or eat? Cold-weather shocks and nutrition in poor American families. *American Journal of Public Health*, *93*(7), 1149-1154.

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