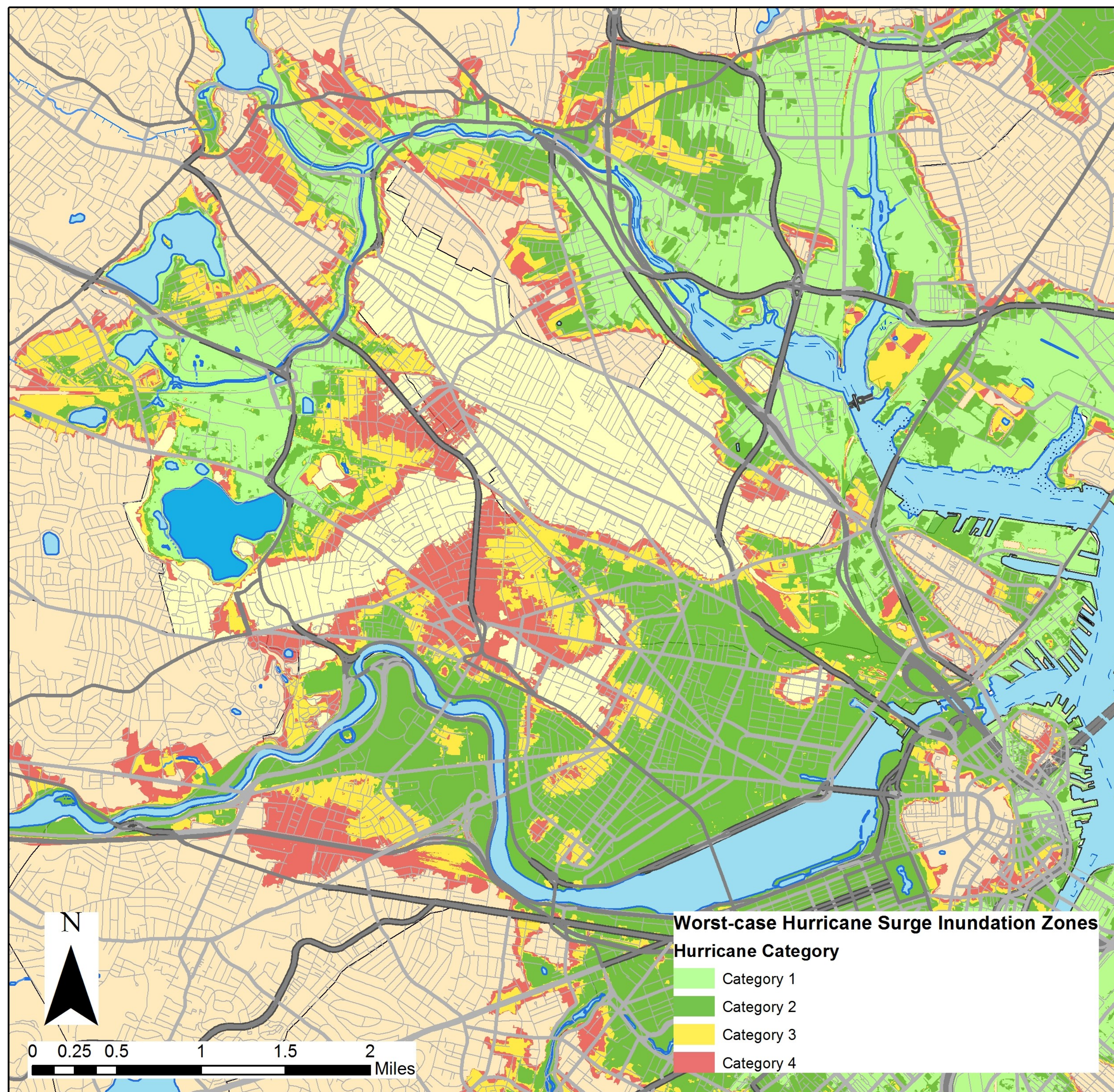


Worst Case Hurricane Surge Inundation: Are low-income populations more vulnerable?

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 Projection Model: Universal Transverse Mercator Zone 19N

Worst Case Hurricane Surge Inundation Zones in Cambridge and Somerville

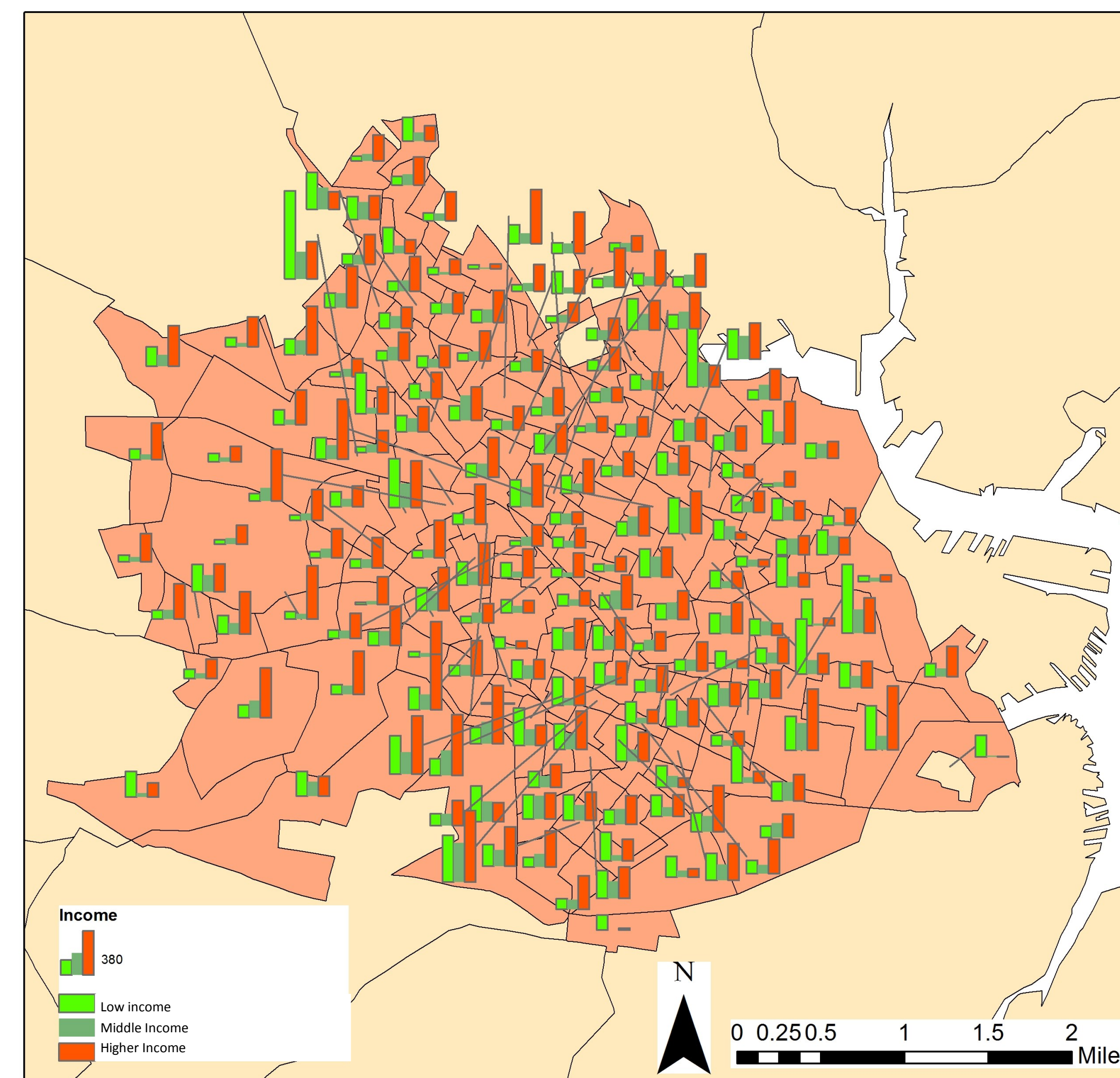


Overview

Studies have indicated that disadvantaged populations are most vulnerable to the health and displacement effects of climate change¹. Furthermore, hurricane intensity is expected to increase as climate change accelerates.² 2012's hurricane Sandy was a brutal reminder of this, displacing thousands in New York and New Jersey, and many of the communities hit by Sandy are still rebuilding today, over three years later.³ Many news stories and publications have emphasized the vulnerability of the Boston area, and climate change adaptation efforts now being implemented are designed to mitigate the damage that is anticipated over the coming decades⁴. This project will look at the number of vulnerable people and households in Cambridge and Somerville. Climate change is often framed as an environmental justice issue—is this true for low-income populations living in Cambridge and Somerville?

¹Physicians for Social Responsibility. Health Implications of Global Warming: Impacts on Vulnerable Populations. <http://www.psr.org/assets/pdfs/vulnerable-populations.pdf>
²Johnson, J.M., Moore, L.J., Ellis, K., Murray, A.B., Adams, P.N., Mackenzie, R.A., & Jaeger, J.M. (2015). Recent shifts in coastline change and shoreline stabilization linked to climate change. *Earth Surface Processes and Landforms*, 40 (5), 569-585.
³Parbhoo, R. (2015.) Three years Later, Freeport Still Rebuilding After Sandy. <http://www.jongislandreport.org>
⁴Massachusetts Climate Change Adaptation Coalition. <http://www.massadapt.org>

Cambridge and Somerville Households by Income



Methodology

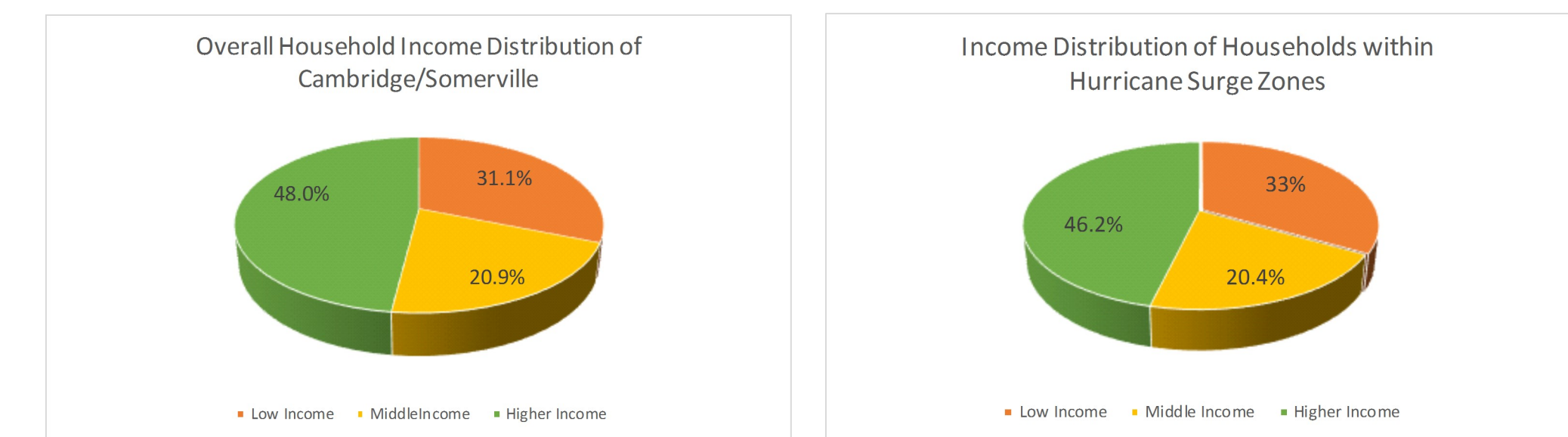
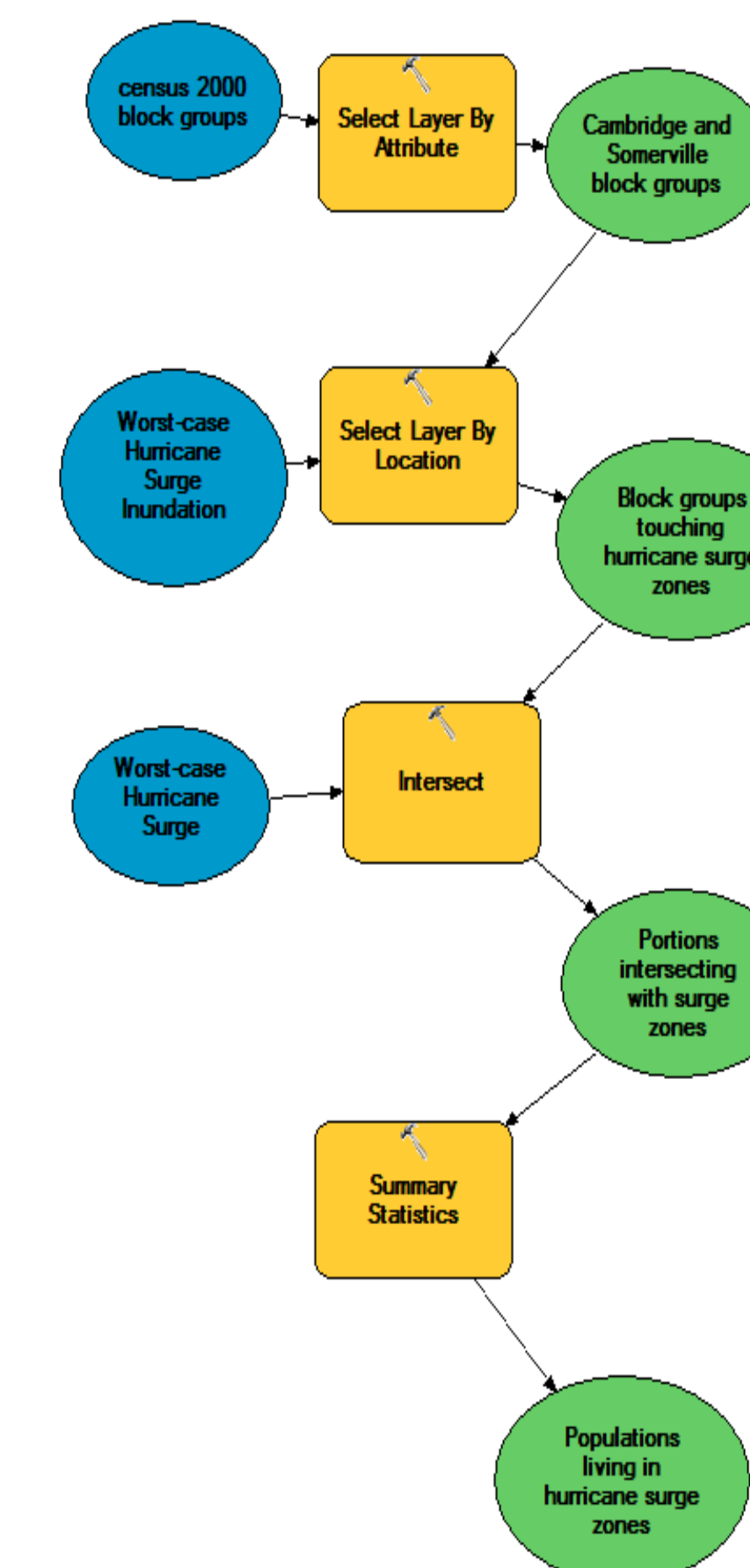
Key datasets used are the 2000 United States census household income data and the Worst-Case Hurricane Surge Zone raster, which is designed by the U.S. Army Corps or Engineers to assist in hurricane preparedness operations. Inundation areas are determined by subtracting elevation data from worst case hurricane surge values, which are calculated using Sea Lake and Overland Surge from Hurricanes (SLOSH) model data developed by the National Hurricane Center.

The model shows four key tools used in the calculation of populations in hurricane surge zones:

- 1) Select layer by attribute selects block groups within Cambridge and Somerville
- 2) Select layer by location highlights only those block groups which intersect with the hurricane surge zone raster
- 3) Intersect selects only the portions of the block group that intersect with the hurricane surge zone raster. From this, a new column, cut_pop, was created in the attribute table to calculate the portion of the block group that intersect with the raster.
- 4) Summary statistics calculates the sum of all people and households living in hurricane surge zones

The model was run three times using block data and block group data to determine the total number of people at risk, and the census's income data to determine the overall number of people within each income group who would be affected.

Low income households were defined as any household with an income of \$30,000 or less. This number was chosen because the Massachusetts Department of Energy and Environmental Affairs considers \$30,515 as the threshold for low-income households in their classification of Environmental Justice Populations. This number was chosen because it is 65% of the median household income value of \$46,956. Medium income were defined as households with an income between \$30,001 and \$50,000, just above the median household income. Any household with incomes of greater than \$50,000 were considered higher income.



Results

The majority of people living in Cambridge and Somerville do live within hurricane surge inundation zones and thus, would be affected by a hurricane. According to the 2000 block group data, 108,337 people live within hurricane surge inundation zones. This is amounts to 61% of the total population of Cambridge and Somerville, which is 178,851. Individual block data, which would be expected to be more precise and thus provide a more accurate count, reveals a greater number of people living within surge zones, 118,854, or 66% of the total population.

As the census does not provide income data at the block level, block group data is used to determine the percentage of households within each income bracket who would be affected in the case of a hurricane storm surge. In total, there are 85,141 households located within hurricane surge inundation zones. The charts above show the although the greatest number of households in Cambridge and Somerville overall and in hurricane surge inundation zones are higher income, low income households are somewhat more likely to be located within hurricane surge inundation zones; 61% of all low income households are located in these zones. This is compared to 55% of middle income households and 54% of higher income households who are located in hurricane surge inundation zones.

| | Low Income | Middle Income | Higher Income |
|--|------------|---------------|---------------|
| Households located in hurricane surge inundation zones | 16,040 | 9,847 | 22,270 |
| Total Number of Households in Cambridge and Somerville | 26,492 | 17,770 | 40,879 |

Limitations

This model is useful as a tool for illustrating an interesting environmental justice phenomenon, but as a planning tool, there are several limitations. First, the census data is dated, and as census data is only taken every 10 years, it can not reliably capture population change and flux that occurs within that time. Because data is captured at the household level, it can not account for homeless populations, who are likely to be the most vulnerable.

The hurricane surge zones data only accounts for storms categories 1 through 4. Hurricanes of categories 5 and 6 may affect other households outside of the parameters of this map, and the likelihood of these storms can be expected to increase with the increasingly frequent and intense weather events that are predicted.

Finally, granularity issues are inherent within block group data, which assumes that population is distributed evenly, which we know to be untrue. Therefore, the cut population counts of households and populations will not be exactly accurate.

Low-income populations are just one of the environmental justice populations highlighted by the Massachusetts Department of Energy and Environmental Affairs. This model could easily be adapted to determine whether minority or non-English speaking households are more likely to be located in hurricane inundation zones, which would further assist with disaster preparedness awareness and outreach efforts.

Conclusions

Based on this model, we can conclude that the majority of households within Cambridge and Somerville are located within hurricane surge inundation zones, and low-income people are somewhat more likely to live in these areas. Efforts should be taken to educate all residents of Cambridge and Somerville about disaster preparedness, and special effort should be taken to promote education at community centers or other organizations serving low income people.

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