

IDENTIFICATION OF AT RISK POPULATIONS FOLLOWING THE SEPTEMBER 2018 MERRIMACK VALLEY GAS EXPLOSIONS

A series of gas explosions rocked the Merrimack Valley in the afternoon of September 13, 2018. The towns of Lawrence, Andover and North Andover, suffered from 80 fires and explosions in all.¹ As a result, one person lost their life, at least 25 were injured and more than 8,000 residents were temporarily displaced.² Upon returning home, residents were left without heat or hot water, many of them, for months.³

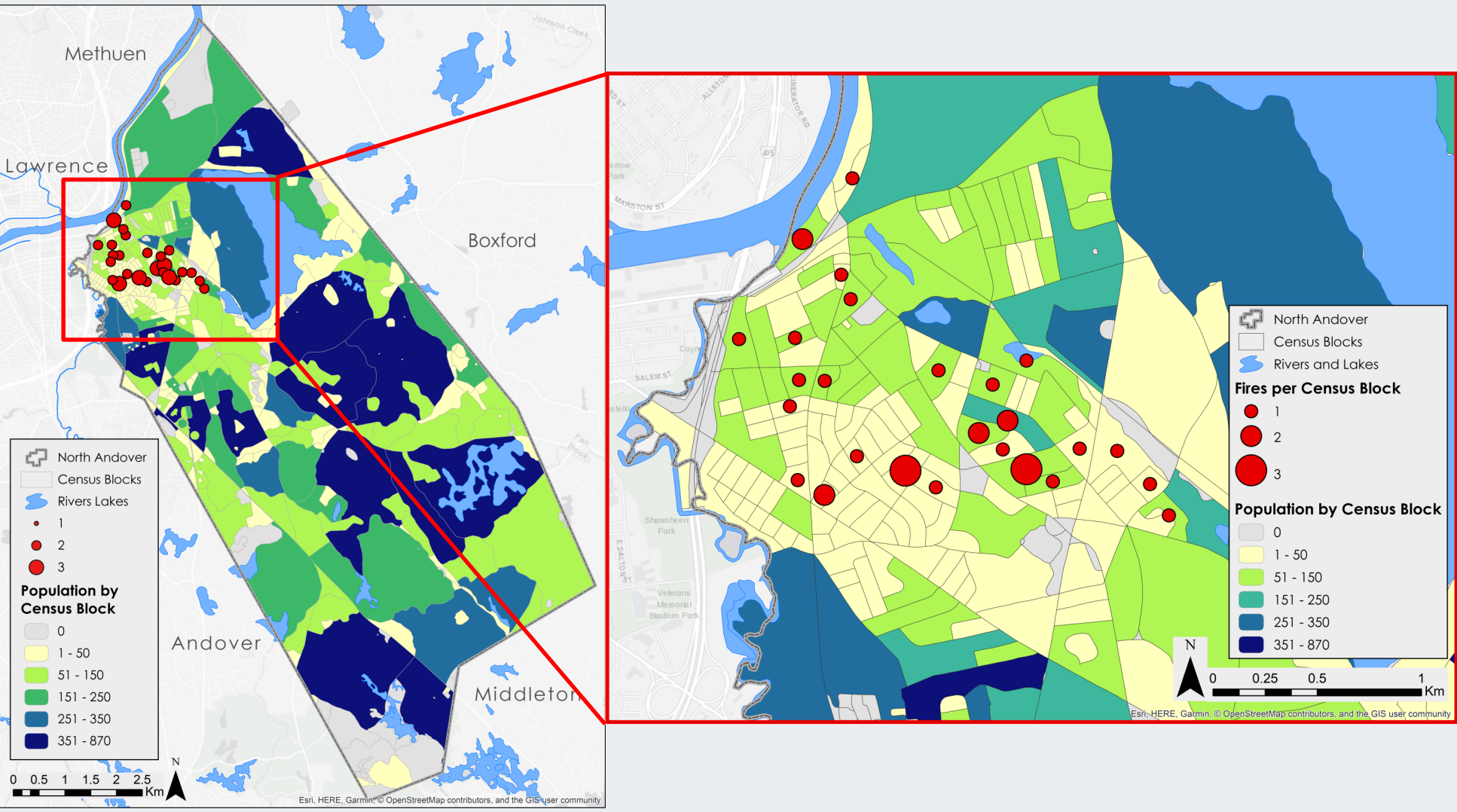
Continued Damage

In the subsequent months, pediatric hospitalists at Lawrence General Hospital noted a potential increase in patients presenting for respiratory and asthma-related illness. Smoke inhalation is generally well understood to have an acute effect on respiratory health, but much of the admittedly limited literature pertains to wildfires or the occupational exposure faced by firefighters.⁴⁻⁶ Less is understood about the long-term effects of smoke exposure, especially in urban settings or on the scale of the Merrimack Valley gas fires. Though it is expected that smoke exposure would result long-term negative health effects, the results of research is often mixed, and as noted in a literature review by O. Adetona *et al.* there is not enough evidence to draw a conclusion one way or the other. This gap in knowledge impacts populations like firefighters and urban residents that are exposed to smoke from structural fires and increasingly, wildfires. Additionally, certain populations are at a greater risk for respiratory illness from air pollution exposure, making an understanding of the long-term effect on vulnerable populations of particular importance.⁷

Populations, such as newborn babies and young children, those who already suffer from respiratory or cardiovascular illnesses, as well as marginalized communities and those of lower socio-economic status, are at a greater risk for respiratory illness following smoke exposure.^{6,7} It is important to understand if and how these populations have been affected. This project represents preliminary efforts of a larger study to identify at risk populations that live in North Andover, one of the communities affected by the Merrimack Valley fires.

METHODOLOGY

This project aims to depict the populations that are at the greatest risk for respiratory illness as a result of proximity to the North Andover gas fires. U.S. Census data from 2010 was obtained from MassGIS and included Census Block level boundaries and population and household counts. More extensive demographic data, including Block level population counts by age, gender, race and housing owner and rental demographics was obtained from the Summary File 1 (SF1) database published by the Census Bureau, and processed and made available by MassGIS. Other data layers obtained from MassGIS include Census 2010 TIGER Roads, MassDEP Hydrography (1:25,000) and Community Boundaries for cities and towns. The

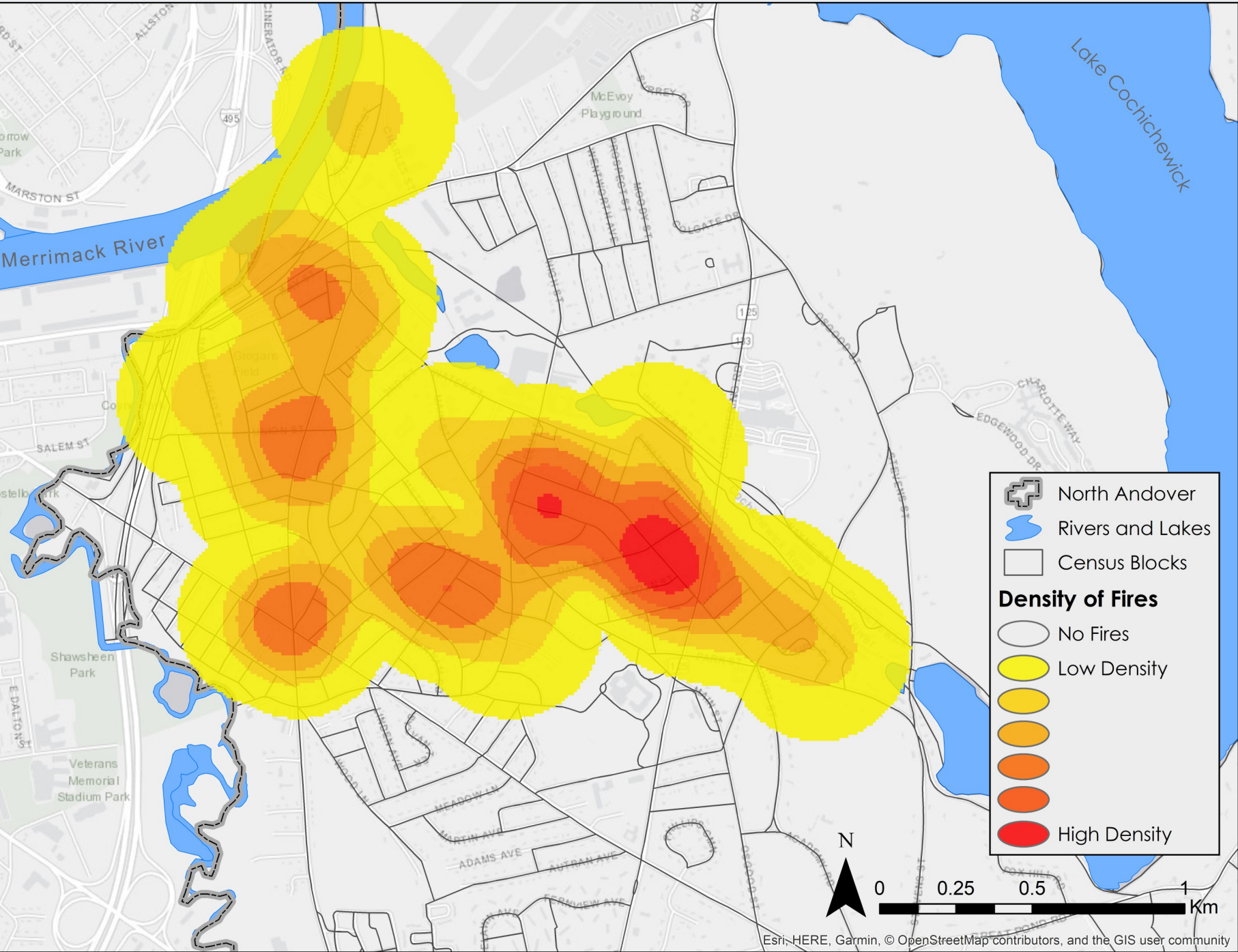


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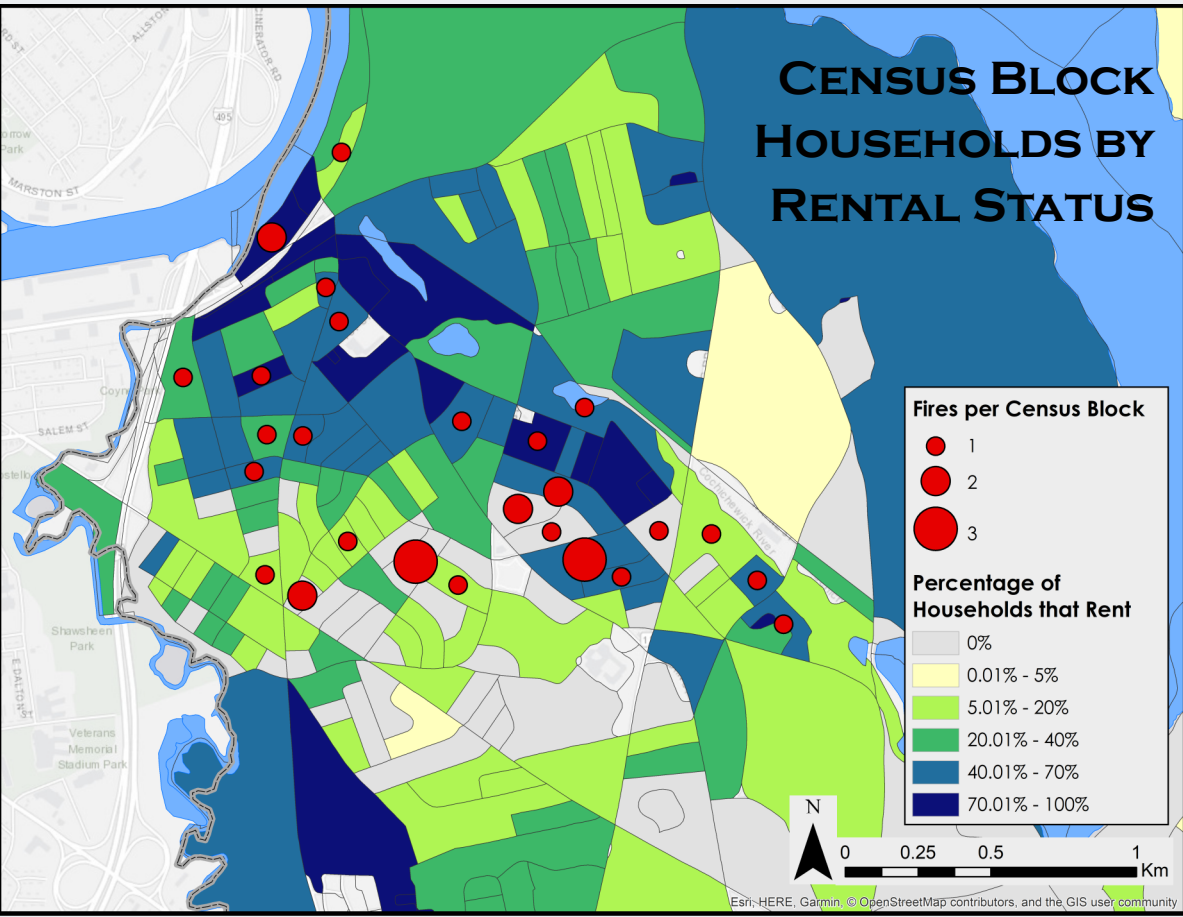
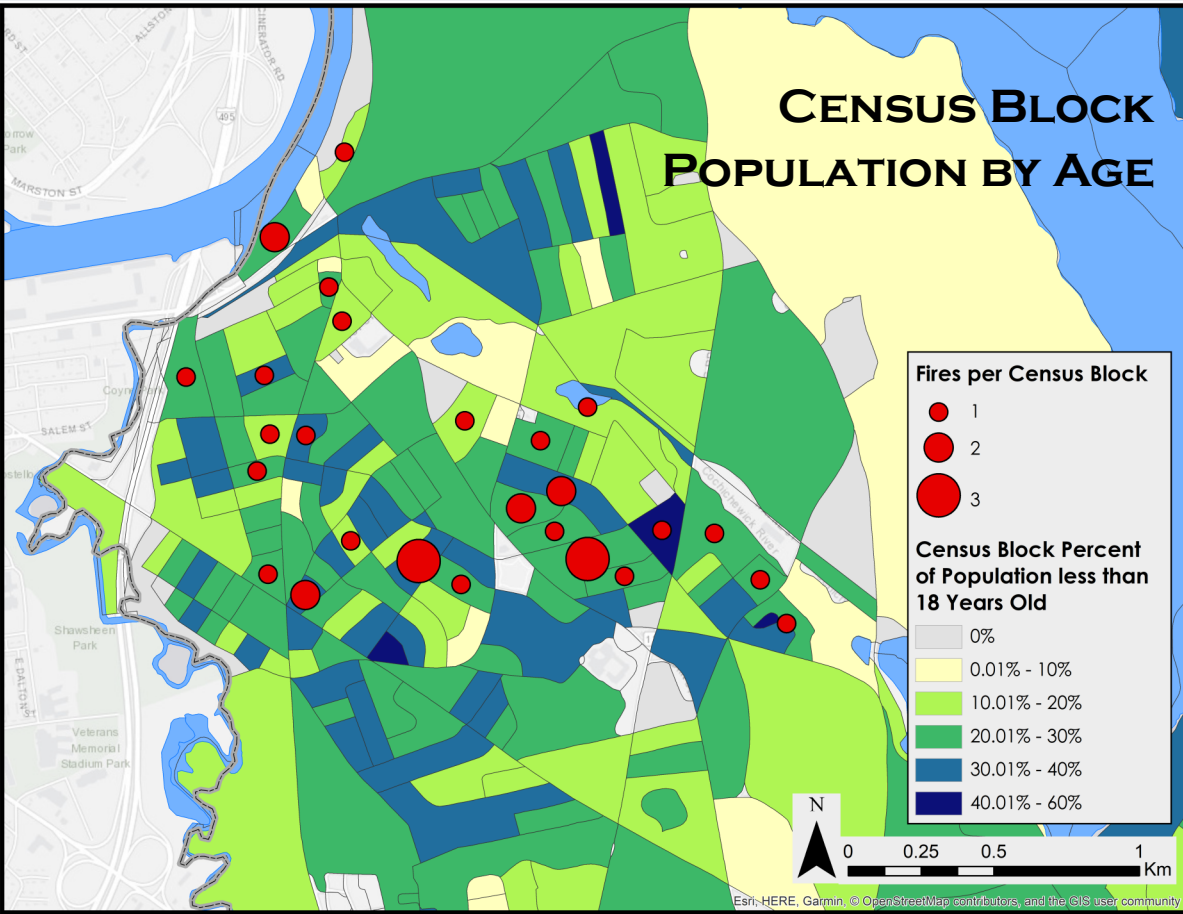
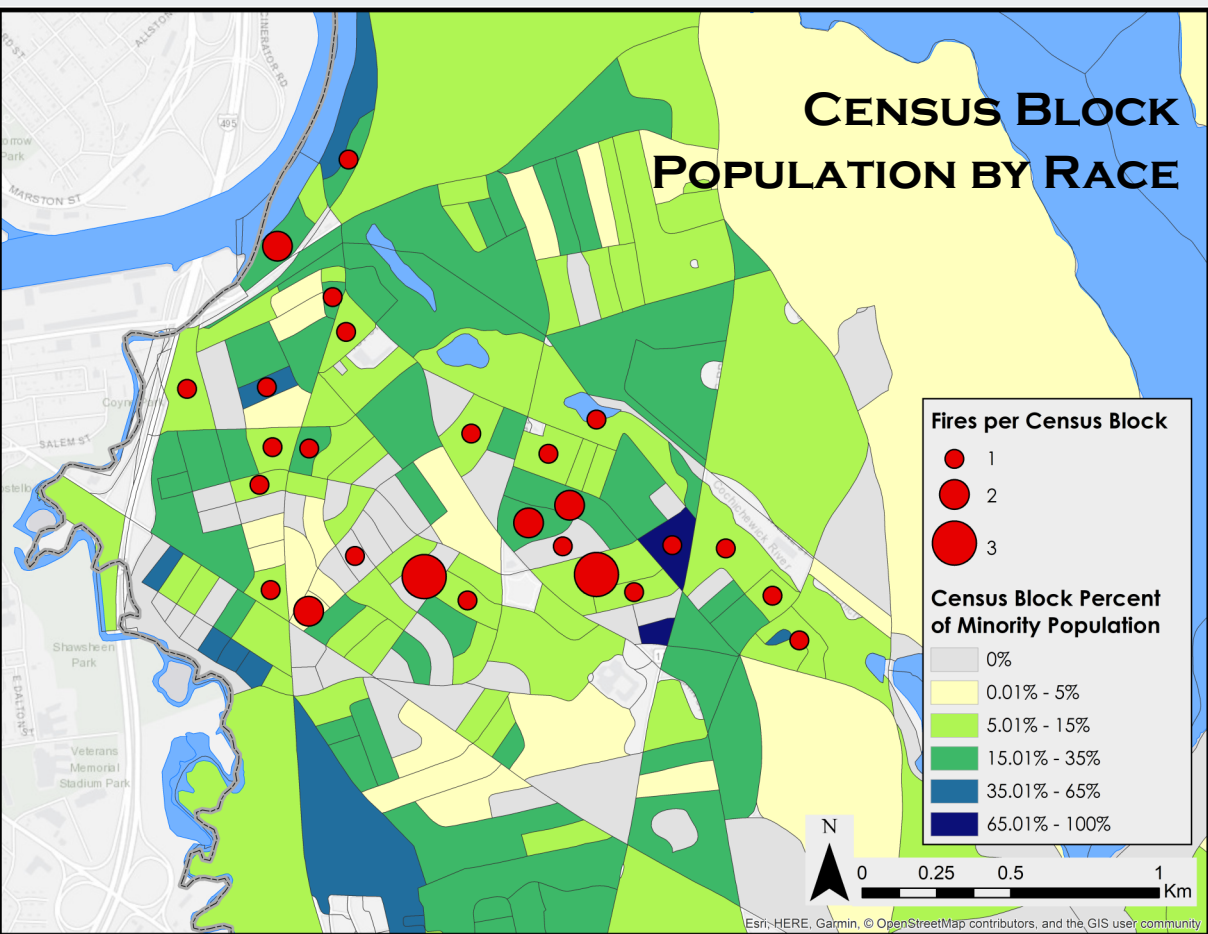
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locations of the fires were provided by the North Andover Fire Department, which were geocoded using TIGER Lines.

Outputs created include choropleth maps of demographics overlaid with a count of the number of fires per Census Block. Joins were used to connect demographic information with fire locations and summary tables generated to provide population counts in Blocks that had one or more gas fire. Finally, a kernel density map of the fires was produced to demonstrate the density of fire locations, while also masking the exact addresses of fires.



Kernel Density of Merrimack Valley Gas Incident fires in North Andover, Massachusetts.



RESULTS

In all, 34 fires were mapped in North Andover, all of which were concentrated in the Northwestern corner of the city, and spread out over 25 Census Blocks. The kernel density map provides a useful visual of how the fires were distributed. A total of 1,673 people lived in the affected Blocks, nearly a quarter of which are people aged less than 18 years. The most populous race identified was Non-hispanic White, which accounts for 85% of the population in the area. Only occupied housing units were included in the household count, but of those, 49% of households rented their place of residence.

Population Living in Census Blocks Affected by Gas Fires			
	Total Affected Census Block Population	Population less than 18 Years Old	Minority Population
Average People per Block	64	15	10
Sum of Population in All Affected Blocks	1673	406	257
Percentage of Total Affected Population		24 %	15 %

DISCUSSION

The Merrimack Valley gas explosions had a momentous impact on the mental and physical health of residents in the area. This initial analysis provides information regarding the demographics of the population living in the affected area in North Andover. Such information is useful for understanding how many people were impacted and which vulnerable populations live in the area. This information may be predictive of the increased patient load seen by the hospital, or may be representative of the demographics of patients presenting with respiratory illness. With the addition of patient data, it will be possible to assess this hypothesis and determine if health effects of the fire were felt equally by residents or if certain vulnerable populations were disproportionately affected.

The most important next step in this study will begin once the locations of the Lawrence and Andover fires and patient histories and addresses have been collected. With this additional data, it will be possible to map densities of patients presenting with respiratory illness and measure Euclidean distances from patients and fires. Hotspot analysis can be performed to identify hotspots or cold spots of respiratory illness patients. Additionally, hospital records of pediatric patients presenting with respiratory illness from the last three years will allow for spatiotemporal analysis to determine if the spatial distribution of cases has changed over time.

Households Living in Census Blocks Affected by Gas Fires

	Total Number of Households	Rental Households
Average Number of Households per Affected Block	27	13
Sum of Households in All Affected Blocks	696	340
Percentage of Total Affected Households		49 %

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Projection: NAD 1983 State Plane, Massachusetts Mainland, 2001

Data Sources: Town of North Andover,

Massachusetts Fire Department,

MassGIS, TigerLine, Massachusetts

DPH Bureau of Environmental Health,

ESRI Datamaps 10