Air Pollution and Socioeconomic Traits in Somerville, MA

Introduction

Air pollution has been a major issue in urban centers around the world ever since the start of the industrial revolution. Nowadays, the modern internal combustion engine produces a plethora of air pollutants, including, but not limited to particulate matter 2.5 microns in diameter ($PM_{2.5}$) and nitrogen dioxide (NO_2).

These air pollutants have become an issue in urban neighborhoods, as wind can suspend large amounts of pollutants in the air for extended durations of time. Numerous studies have shown that these air particles can cause lasting health issues in humans.

For my study I analyzed pollution data gathered in the City of Somerville, Massachusetts. In detail, I focused my study area on the Ten Hills neighborhood, located next to interstate 93 and the Mystic River. Figure 1 shows a map of the study area.

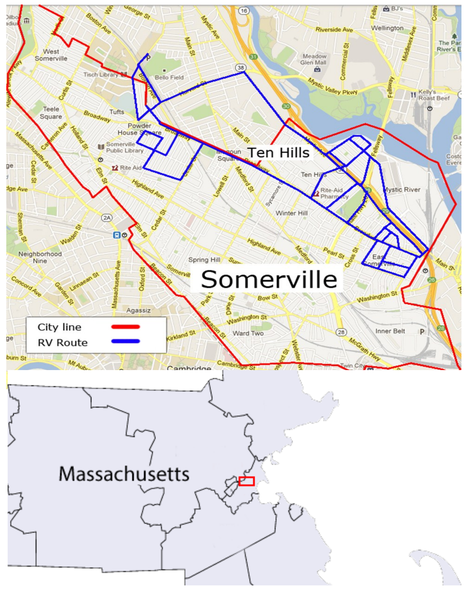
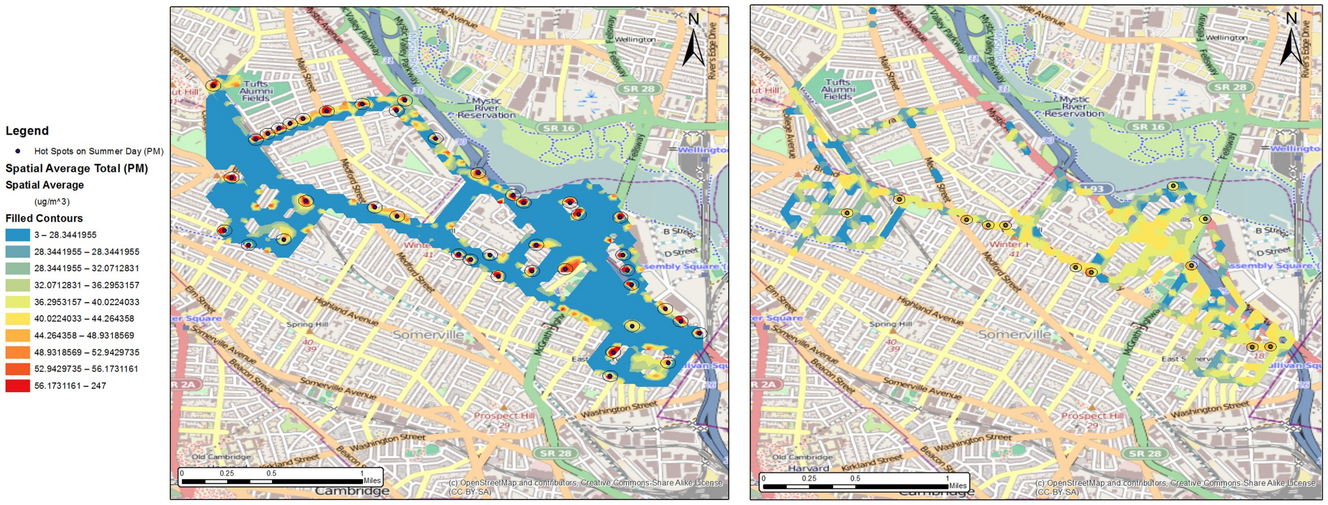


Figure 1: Map of Study Area

The motivation behind my study is to compare existing air pollution concentration data with socioeconomic data from the United States 2010 Census and determine whether there is a correlation between air pollution concentration and socioeconomic characteristics of neighborhoods.

I predict that neighborhoods near areas with high concentrations of air pollution will have different socioeconomic properties than neighborhoods near areas with low concentrations of pollution.



Figures 2 and 3: Buffer Zones and Spatial Average Maps for $PM_{2.5}$ and NO_2 respectively

Air Pollution Data

The air pollution data in my study came from the Community Assessment of Freeway Exposure and Health (CAFEH) Study carried out by Tufts University. I used $PM_{2.5}$ and NO_2 data to carry out my analysis.

The CAFEH study gathered hundreds of thousands of data points in total. I narrowed their dataset down to data collected during the day (9 AM to 4 PM) in the summer (June 20 to September 22).

Table 1 shows the statistical characteristics of each of the aforementioned datasets.

Table 1: Statistical Characteristics of Air Pollution Data

	$PM_{2.5}$ (μg/m^3)	
	Total	Summer Day
Data Points	30,205	4,220
Average	21.74	27.55
Standard Deviation	15.86	17.40
Skew	Positive	Positive
	NO_2 (ppb)	
	Total	Summer Day
Data Points	58,809	4,616
Average	20.32	14.45
Standard Deviation	15.42	15.25
Skew	None	Positive

Methodology

The majority of my study is based off of "high-risk areas", determined through analyzing air pollution concentration data. I used kernel smoothing to produce a spatial average map for both $PM_{2.5}$ and NO_2. I then used EPA's 24-hour exposure threshold as the boundary between high concentration and low concentration of pollution.

Next, I created point features for all areas of high concentrations of $PM_{2.5}$ and NO_2. Furthermore, because air pollutants can be carried by the wind, I used the buffer tool to create buffers around each point-source. These buffer zones create my high-risk areas. Figures 2 and 3 show the high-risk areas for $PM_{2.5}$ and NO_2 along with their buffer zones.

Next, I used the query tool to select blocks from my US 2010 Census data layer that intersects my high-risk areas. These are my high-risk blocks. I also queried for blocks that do not intersect high-risk areas but do intersect points of low pollution concentration, these are my low-risk blocks.

Finally, I compared the statistical analysis of these blocks to determine whether there is a difference in socioeconomic traits of blocks inside the high-risk areas versus blocks in the low-risk areas.

Poster by Qingchuan Liu
Civil and Environmental Engineering 187—Geographic Information Systems
Air pollution data provided by Professor John Durant of Tufts University
US 2010 Census data provided by MassGIS
Road map data provided by Esri
12/17/2012

Tufts University | School of Engineering

Project Findings

As seen in Table 2, blocks lying within the high-risk area for $PM_{2.5}$ has a 13.3 percent higher population density than blocks lying within the low-risk area.

The same trend applies for the average minority ratio, there is a 22.1 percent higher minority ratio in high-risk blocks.

Nitrogen dioxide data showed mixed results when put under the same comparisons. While the population densities for high-risk blocks were 12.5 percent higher than the population densities of low-risk blocks, the minority ratio was 5.9 percent lower.

Table 2: Statistical Comparisons

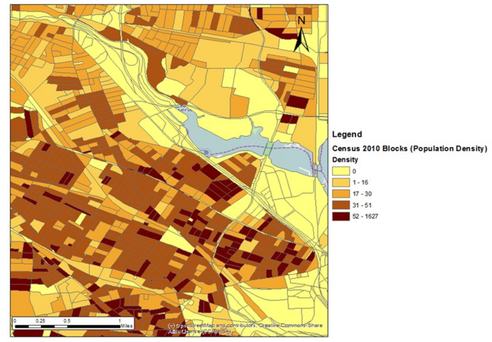
	Summer Day - $PM_{2.5}$	
	High-Risk Blocks	Low-Risk Blocks
Population Density	28.633	24.827
Minority Ratio	0.199	0.155
	Summer Day - NO_2	
	High-Risk Block	Low-Risk Blocks
Population Density	30.500	26.688
Minority Ratio	0.17	0.18

Thus, my study revealed a limited positive correlation between air pollution concentration and population density, and no correlation between air pollution concentration and minority ratio.

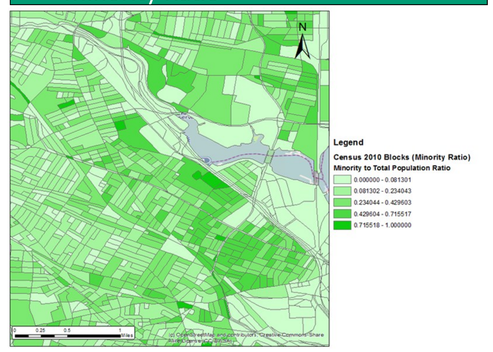
US 2010 Census Data

Total Population

Population Density



Minority Ratio



Average Age