Assessment of Hazardous Air Pollution in San Francisco Neighborhoods: Identifying Major Sources

Maggie Walsh

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# Introduction

Toxic contamination of the air, especially in urban areas, has been a subject of public concern and scientific study for decades. The Clean Air Act Amendments of 1990 introduced 187 toxic pollutants called hazardous air pollutants (HAPs)(“United states code, 1994 edition, supplement 3, title 42 - the public health and welfare” 1997).These HAPs are released from both natural and anthropogenic sources, and are classified distinctly from criteria pollutants like ground-level ozone, carbon monoxide, and lead(Strum and Scheffe 2016). Although HAPs are usually released from the same sources as criteria pollutants they are distinct because of their link to cancer and other serious health problems(Strum and Scheffe 2016).

Major anthropogenic sources of HAPs includes transportation (mobile), industry and power production (point), and smaller, local sources such as dry cleaners (area) (Strum and Scheffe 2016). Health risks from mobile sources of HAPs has become a great concern, especially in expanding cities where workers commute by car in huge numbers (Mayer 1999). HAPs released from mobile sources alone have been shown to lead to birth defects such as low birth weight of babies (Wilhelm et al. 2012). There have been arguments that the work of the EPA to enforce the Clean Air Act focuses too much on point sources, when a large volume of HAPs come from area and mobile sources (Axelrad et al. 1999, Strum and Scheffe 2016).

This observation is of particular importance to the inhabitants of the city of San Francisco. San Francisco has a relatively small industrial zone compared to a multitude of mobile sources combined with smaller area sources. This suggests a greater need to focus on mobile and area sources in research. Although nationwide studies are necessary to evaluate general trends, there is an additional need for nuanced analysis of different areas. The goal of this field study was to assess the presence of various HAPs in the air in different neighborhoods in the city of San Francisco, and analyze how the relative toxic profiles compare, in light of different polluting factors present in that area. The question that I asked was: among the sources of air pollution in the city of San Francisco, what are the sources most impactful to health in terms of emission of hazardous air pollutants? The best guess would be mobile sources, namely cars, at least in areas with major freeways that get a higher volume of traffic. I also hypothesized that construction sites are a major emitter, since they utilize fuel burning machinery and work with hazardous materials, often times disturbing land and dislodging any hazardous pollution from the ground into the air. A large population will elicit large amounts of mobile source pollution as well as area source pollution. Residential heating systems are examples of area sources of pollution that will add up quickly. I thought the more densely populated parts of San Francisco will see large amounts of area source pollution as well.

Analyzing the sources of air pollution urban populations are actually being exposed to has immense implications for the environmental justice movement. Historically, environmental justice too has centered around the pollution emission from stationary sources such as hazardous waste dumps or large factories (Mohai et al. 2009). Recognizing major sources of pollution often leads to discovery of how it disproportionately effects racial/ethnic minorities and the lower class. Knowledge of negative health effects from pollution can make these communities better prepared to resist such oppression (Wier et al. 2009).

# Methods

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## Site Locations and Descriptions

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## Field Sampling Design

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## Data Analysis and Statistics

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# Results

## Subsections are ok in the results section too

Add a number of code chunks in the Results section. These should read in, subset and plot the data as needed (no need to save any figures to pdf, since they will be put into the rendered document when you click ‘knit’), and, for any hypotheses that you want to test, an appropriate statistical test.

# If you add any additional packages here, make sure they are  
# also listed in the DESCRIPTION file  
library("dplyr")

##   
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':  
##   
## filter, lag

## The following objects are masked from 'package:base':  
##   
## intersect, setdiff, setequal, union

library("tidyr")  
library("ggplot2")  
library("readr")

# Discussion

# Sources Cited

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