Using Environmental Protection Agency Data Tools to Map Particulate Matter 2.5 Near Public Housing Buildings and Major Roads in New York

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Abstract

The link between on-road traffic, particulate matter 2.5 (PM2.5) emissions, inequity, and mortality has been researched extensively (Dockery et al., 1993, Pinto de Moura and Reichmuth, 2019, Pope and Dockery, 2012); however, limited analysis exists of assessing risks for U.S. Department of Housing and Urban Development (HUD)-assisted public housing assets. This article aims to geographically review the potential risks of mortality from on-road PM2.5 exposure among HUD-assisted public housing residents who live within 500 meters and 150 meters of major roadways. HUD analysts can use the analytical approach and tools (MOVES and BenMAP-CE) in this article to better understand the dynamic and intersectional processes affecting air pollution exposure among public housing residents.

Background

Since 1990, the United States has reduced air pollution emissions (EPA, 2018); however, only moderate improvements were made in the reduction of airborne particulate matter 2.5 ($PM_{2.5}$).[1]

[1] The 2019 EPA Air quality report indicates that 24-hour $PM_{2.5}$ concentrations have decreased only 34 percent since 1990, compared with 74-percent reductions in carbon monoxide concentrations, and 89-percent reductions in sulfur dioxide concentrations.

$PM_{2.5}$ describes fine inhalable particles—thirty times smaller than the average human hair—originating from the combustion of fossil fuels and industrial processes (EPA, 2018). $PM_{2.5}$ particles are a public health concern and can cause respiratory and cardiovascular conditions, including asthma, bronchitis, ischemic heart disease, and even death (Frumkin, 2016). In 2010, the Environmental Protection Agency attributed 4–17 percent of premature deaths in U.S. urban areas to $PM_{2.5}$ (EPA, Office of Air Quality Planning and Standards, 2010).

On-road traffic contributed 7.1 percent of the total $PM_{2.5}$ emissions in the United States in 2017 (EPA, Office of Air and Radiation, 2017).[2] Ambient $PM_{2.5}$ concentration levels vary by the season, time of day, topography, meteorology, and proximity to roadways. Prior research indicates that $PM_{2.5}$ concentrations within 150 meters of major roadways can be 12–17 percent higher than areas 500 or more meters away (Ginzburg et al., 2015).

As of 2017, New York state (NYS) had the highest share of people living in public housing near major roadways.[3] In 2017, 5,390 buildings in NYS housed an estimated 431,000 individuals. Approximately 63 percent of New York City's public housing buildings were located within 500 meters of a major roadway, and while only 4 percent of buildings were within 150 meters, this represented a significant proportion (21 percent) of total individuals living in public housing (shown in exhibit 1).

Exhibit 1

States with Highest Percentage of National HUD-Assisted Public Housing

Rank	State	Public Housing Residents Within 150 Meters (percentage of nation total)	Public Housing Residents Between 150 to 500 Meters (percentage of nation total)
1	NY	21.23	19.55
2	PA	6.85	5.52
3	OH	5.22	4.62
4	TX	3.94	4.61
5	MA	3.78	3.77

Source: Created by author from HUD Picture of Subsidized Housing

Methodology

A proximity analysis was performed to identify public housing buildings within 150 and 500 meters of a major roadway, as shown in the first diagram of exhibit 2. Road-specific $PM_{2.5}$ hotspots near identified public housing buildings were estimated using the EPA's Motor Vehicle Emission Simulator (MOVES).[4] The second diagram in exhibit 2 illustrates annual tons of $PM_{2.5}$ due to on-

[2] Based on most recent 2017 data from EPA's National Emissions Inventory (NEI).

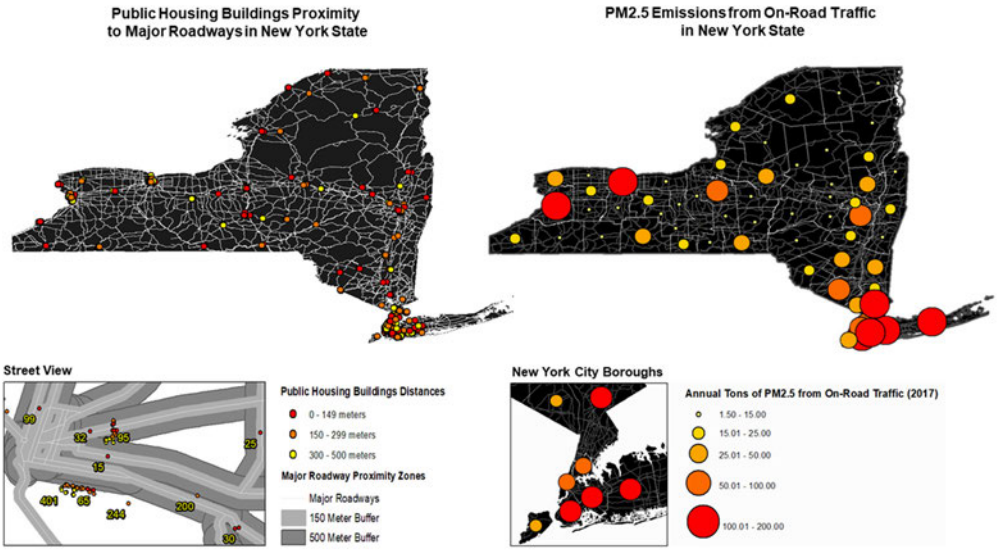
[3] A major roadway is defined as any highway that carries more than 125,000 vehicles per day.

[4] MOVES is a structured query language-based tool that considers details related to geographic bounds, time span, vehicles and equipment, types of emission, and emission processes to calculate emissions from roads.

road traffic in 2017, aggregated by NY county. To estimate the impacts of $PM_{2.5}$ exposure, BenMAP-CE was applied.[5]

Exhibit 2

Left: Public Housing Buildings Proximity to Major Roadways in New York State. Right: $PM_{2.5}$ Emissions from On-Road Traffic in New York State.



PM2.5 = particulate matter 2.5.

Source: Created by author from MOVES and HUD Public Housing Buildings eGIS storefront

Findings

New York state $PM_{2.5}$ emissions were within National Ambient Air Quality Standards (NAAQS); the average county-level $PM_{2.5}$ emissions from roads totaled 30.6 tons in 2017. Over 20 counties demonstrated above average on-road $PM_{2.5}$ emissions (see exhibit 3). Within each county in exhibit 3, 2017 $PM_{2.5}$-associated mortality rates by census tract are highlighted.[6,7] Eighty-one public housing buildings (1.5 percent of the NYS total) were within 500 meters of a major roadway and located in a census tract where the $PM_{2.5}$-associated mortality rate was twice the state average (60 per 100,000).

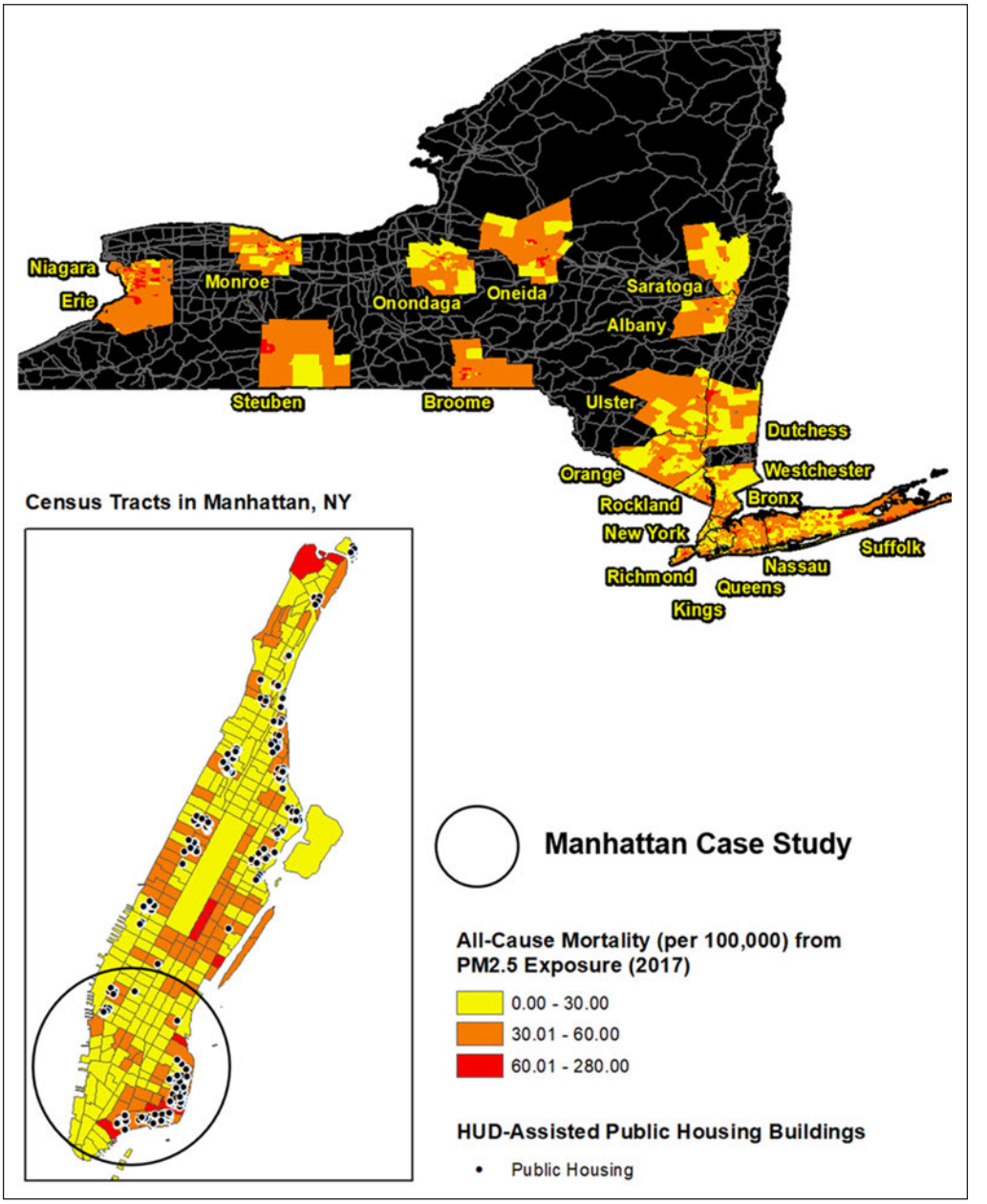
[5] The EPA BenMap-CE tool quantifies the health impact related to ambient $PM_{2.5}$ by quantifying human health impacts and economic values of air quality changes in the context of a designated time, place, and pollutant. Additional analysis required to remove confounding factors in analysis.

[6] There were no reductions in mortality rates from $PM_{2.5}$ in 2017; therefore, the scale in exhibit 3 starts at zero and does not include any negative integers.

[7] Counties around urban areas may correlate with higher $PM_{2.5}$ levels due to a combination of greater energy needs, industry, traffic, and other sources of combustion. Outliers in less urbanized locations may occur due to industrial hotspots, like coal manufacturing, etc.

Exhibit 3

A Closer Look at $PM_{2.5}$ Mortality Risks in Counties with Highest $PM_{2.5}$ Levels from Roads



PM2.5 = particulate matter 2.5.

Source: Created by author from BenMAP and HUD Public Housing Buildings eGIS storefront

Manhattan (NY) had the highest Average Annual Daily Traffic (AADT) density of the state, with a daily average of 12,682 vehicles per mile of road.[8] Despite higher traffic volume in Manhattan, exhibit 4 shows that the mortality rate from $PM_{2.5}$ in Manhattan (30 per 100,000 persons) was lower than the NYS average (33 per 100,000 persons). Neighborhoods near major roadways, however, such as the Franklin D. Roosevelt (FDR) Drive in lower Manhattan (highlighted in exhibit 3), are exposed to higher $PM_{2.5}$ concentrations. The average mortality rate from $PM_{2.5}$ around this roadway was 44 per 100,000—higher than both state and national averages in 2017.[9,10]

Exhibit 4

All Cause Mortality due to $PM_{2.5}$ in the United States, New York, and Manhattan

Region	Population	All Cause Mortality due to $PM_{2.5}$ in 2017		All Cause Mortality Rate per 100,000 due to $PM_{2.5}$ in 2017	
		Mean	95% CI	Mean	95% CI
United States	324,135,293	135,571	88,831 - 176,760	41	27 - 55
NY State	19,760,388	6,449	4,326 - 8,590	33	22 - 43
Manhattan County	1,641,713	488	327 - 650	30	20 - 40
Manhattan Case Study	48,188	21	14 - 29	44	30 - 59

CI = confidence interval. PM2.5 = particulate matter 2.5.

Source: Created by author from BenMAP

Discussion

This analysis provides a high-level overview of one pollutant, in proximity to one infrastructural element, in accordance with one risk factor.[11] To provide more detailed perspective, additional analysis should be introduced to assess HUD-assisted property in proximity to other sources of $PM_{2.5}$, such as industrial hotspots. More granularity could also be investigated on public housing within 50 meters of major roadways using MOVES and BenMap-CE.

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[8] Manhattan was selected as a case study in an urban area of NYS where major roadways are well-known and traffic is dense. Kings County had the highest number of people living in HUD-assisted public housing (126,104) in 2017 and Suffolk County had the highest $PM_{2.5}$ levels.

[9] Without review of the demographics of this area, such as age, it is possible that a more vulnerable population lives in this area. It would be useful in future analysis to consider these factors.

[10] This finding suggests the significance of closer analysis of near-road $PM_{2.5}$ levels and mortality, which may differ from regional averages. No major sources of industry were present that might confound the trend in this Manhattan case study. For geographic context, this major roadway leads to the Brooklyn Bridge.

[11] The original version of this article is available from the author upon request.

Author

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