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September 23, 2019

OVERSIGHT - PROTECTING HEALTH THROUGH IMPROVING AIR QUALITY

I. INTRODUCTION

On September 23, 2019, the Committee on Environmental Protection, chaired by Council Member Costa Constantinides, will hold an oversight hearing on "Protecting Health Through Improving Air Quality." The Committee expects to hear testimony from the New York City Department of Environmental Protection, the New York City Department of Health and Mental Hygiene, public health and environmental advocates, and interested members of the public.

II. Background

The United States Environmental Protection Agency sets permissible level regulations for six classes of commonly encountered airborne pollutants.[1] Permissible particulate matter, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead levels are regulated under both primary standards, which aim to prevent deleterious effects to human health, and secondary standards, which are aimed at protecting the environment and property.[2] Air quality data is plotted over a map of the various regions of the United States, and geographical areas where levels of specific pollutants exceed levels outlined in the clean air act regulations are said to be in non-attainment.[3] As of August 31, 2019, New York City is considered to be in attainment for 5 out of 6 criteria pollutants,[4] with the exception of ozone, where the city is considered to be in moderate non-attainment.[5]

New York City's air quality has improved drastically since the passage of clean heat regulations banning the combustion of No. 6 fuel oil, and phasing out the combustion of No. 4 fuel oil for heating purposes,[6] with citywide annual averages of black carbon declining 30% between 2009 and 2017,[7] nitric oxide levels declining 44% during the same time period,[8] nitrogen dioxide levels declining 26%,[9] fine particulate matter levels declining 30%,[10] and sulfur dioxide levels

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[1] United States Environmental Protection Agency. Clean Air Act Plain Language Guide. https://www.epa.gov/sites/production/files/2015-08/documents/peg.pdf (last accessed 9/16/19)
[2] Id.
[3] Id.
[4] U.S. Environmental Protection Agency. Green Book. Non-Attainment Areas for Criteria Pollutants. https://www.epa.gov/green-book (last accessed 9/16/
[5] U.S. Environmental Protection Agency. 8 Hour Ozone (2015) Designated Area/State Information. https://www3.epa.gov/airquality/greenbook/jbtc.html (last accessed 9/18/19)
[6] NYC Clean Heat. https://www.nyccleanheat.org/content/what-nyc-clean-heat (last accessed 9/18/2019)
[7] New York City Community Air Survey. Neighborhood Air Quality 2008-2017 https://nyc-ehs.net/besp-report/web/nyccas (last accessed 9/18/2019)
[8] Id.
[9] Id.
[10]Id.

below air quality monitor detection limits across much of the city.[11] Local car exhaust contributes significantly to New York City's ozone issues,[12] however the interstate transport of ozone pollution from states upwind of New York also plays a major role in New York City's non-attainment status.[13] While the overall air quality in New York City has been improving, the improvements have not been equitably distributed across the board, with comparatively high levels of black carbon, nitric oxide, nitrogen dioxide, and particulate matter clustered around Manhattan and Western Queens, and higher concentrations of ozone in Southeast Brooklyn, The Rockaways, and around John F. Kennedy (JFK) International Airport.[14]

III. AIR QUALITY AND ENVIRONMENTAL JUSTICE COMMUNITIES

When pollutant concentration estimates were combined with potency data and used to calculate cancer risks by census tracts in the United States and such cancer risks were then compared to socioeconomic status (SES) measures from the 1990 Census, a pattern emerged showing that estimated cancer risks associated with ambient air toxics were highest in tracts located in metropolitan areas that were highly segregated.[15] Statistical analysis in California suggests that environmentally damaging infrastructure such as peaker plants, (plants that generally only run when there is high demand), are more likely to be sited in economically disadvantaged

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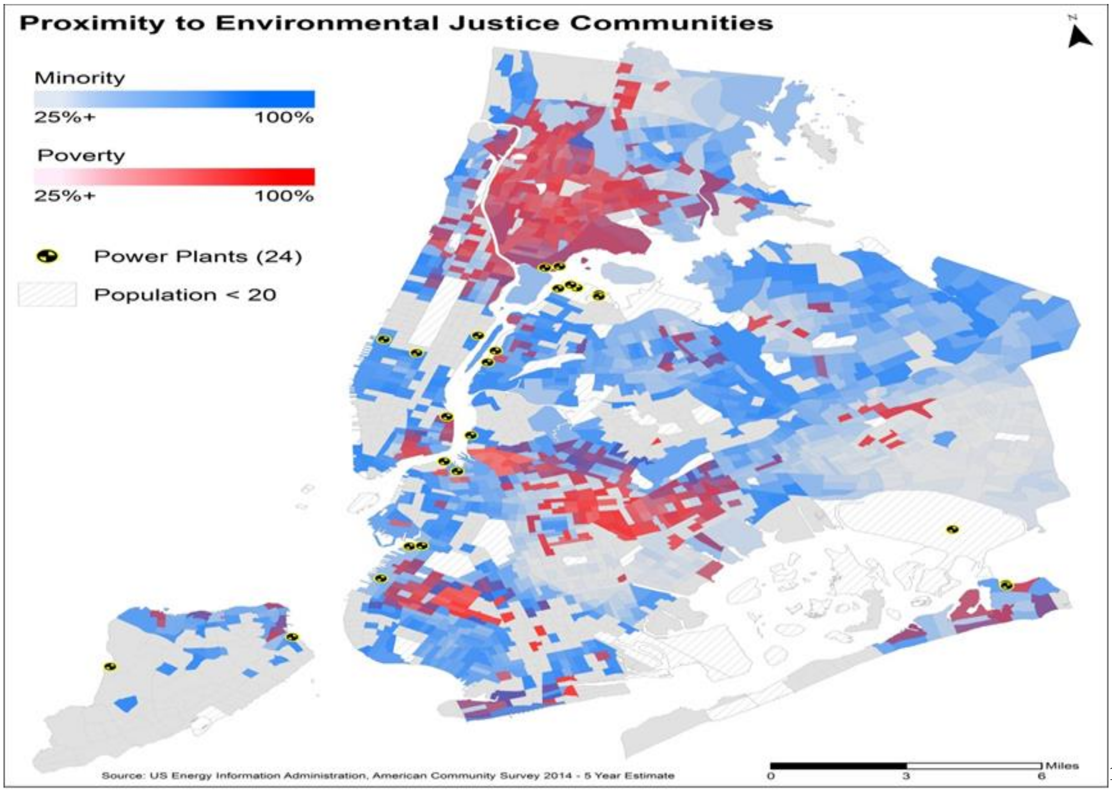
[11] Id.
[12] Id.
[13] United States District Court. Southern District of New York. Complaint for Declaratory and Injunctive Relief. State of New York V. The Environmental Protection Agency. Civil Case No.: 1:19-cv-3287. https://www.eenews.net/assets/2019/04/17/document_gw_03.pdf (last accessed 9/18/19)
[14] New York City Community Air Survey. Neighborhood Air Quality 2008-2017 https://nyc-ehs.net/besp-report/web/nyccas (last accessed 9/18/19)
[15] Morello Frosch, R, and Jesdale, B. Separate and Unequal: Residential Segregation and Estimated Cancer Risks Associated with Ambient Air Toxics in U.S. Metropolitan Areas Environmental Health Perspectives. October, 2005. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1392233/ (last accessed 9/18/2019)

communities.[16] Plotting the location of New York City's in-city power plants over a map showing concentrations of self-identified minority status persons and percentages of communities at the federal poverty guideline suggests a similar trend.[17]

Figure 1: Proximity of Environmental Justice Communities to in-City Power Plants



[18]

As of 2018, 26 of New York City's waste transfer stations were located in just 3 neighborhoods, north Brooklyn, the South Bronx and southeast Queens.[19] Due to the high

[16] Physicians, Scientists, and Engineers for Healthy Energy "Natural Gas Power Plants in California's Disadvantaged Communities" (April 2017), https://www.psehealthyenergy.org/our-work/publications/archive/natural-gas-power-plants-in-californias-disadvantaged-communities/ (last accessed 9/18/19)
[17] Based on data illustrated in Figure 1
[18] This map shows the location of in-City power plants, and their proximity to environmental justice communities, which are defined by the percentage of each community that identifies as belonging to minority groups, and the percentage of each community that is at the federal poverty guidelines. Source of Data: US Energy Information Administration and the American Community Survey (2014).
[19] Eric. A. Goldstein. NYC Takes Steps Toward Environmental Justice. Natural Resources Defense Council. https://www.nrdc.org/experts/eric-goldstein/nyc-takes-step-toward-environmental-justice (last accessed (9/18/19)

concentration of waste transfer facilities in these neighborhoods, local residents are disproportionately burdened with the emissions from the vehicles carting waste to and from these stations, as well as the increased noise pollution that comes with the activity.[20] Given that even small fluctuations in airborne pollutant levels can have significant effects on health outcomes,[21] it is important to ensure that communities bear the cost of these environmental burdens equitably.

IV. EXPOSURE TO AIRBORNE POLLUTANTS AND EFFECTS ON HUMAN HEALTH

According to the United States Environmental Protection Agency, exposure to airborne pollutants has been linked to a variety of negative health outcomes, both physical and psychological.[22] Positive correlations have been found between exposure to elevated levels of airborne particulate matter and increases in suicide attempts, as well as exacerbated symptoms in populations afflicted with schizophrenia.[23] A study published in 2015 examining fine particulate matter's effects on anxiety levels in California nurses, found that those living between 50 and 200 meters from the nearest major roadway were more likely to suffer from anxiety than those living further than 200 meters away,[24] while another California study found a positive correlation between exposures to heightened atmospheric ozone levels and increased perceptions of anxiety.[25]

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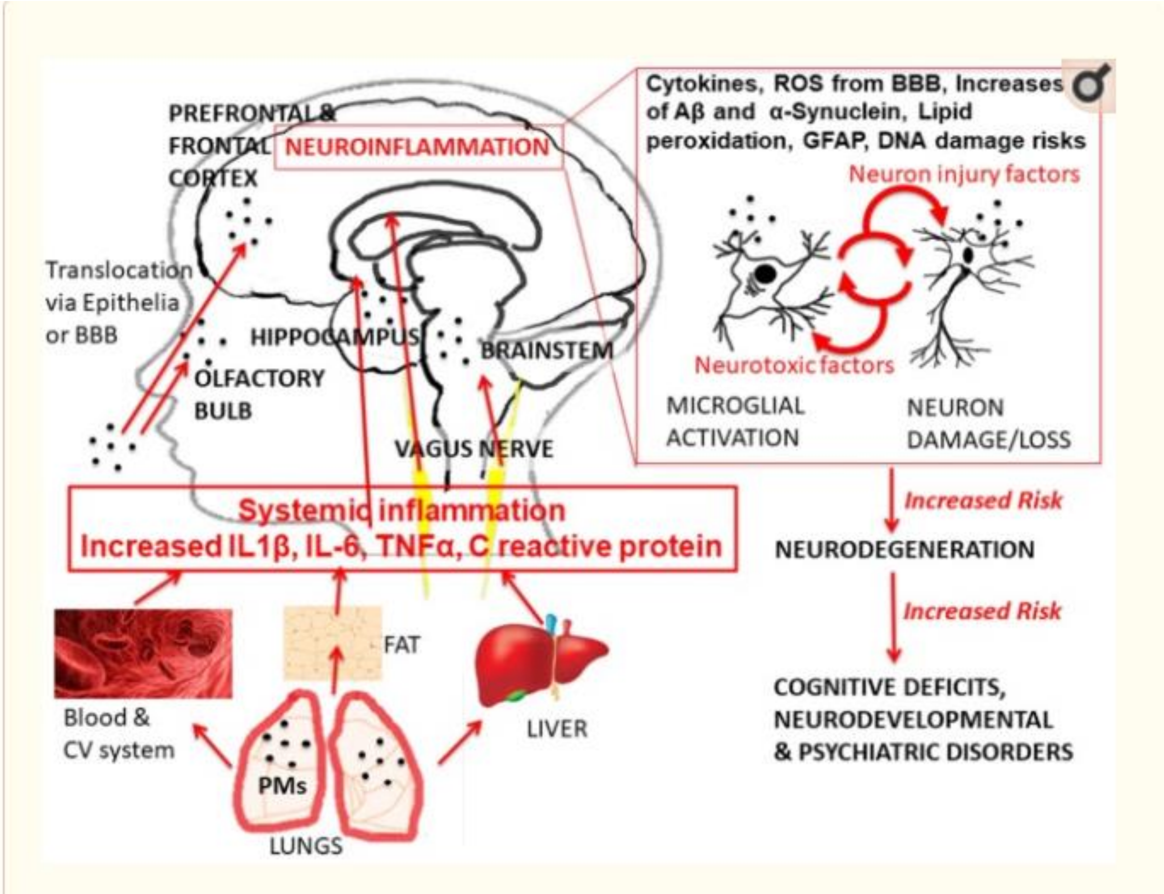
[20] Id.
[21] U.S Environmental Protection Agency. EnviroAtlas Eco-Health Relationship Browser. https://enviroatlas.epa.gov/enviroatlas/Tools/EcoHealth_RelationshipBrowser/index.html (last accessed 9/16/19)
[22] Id.
[23] Yackerson NS et al. 2014. The influence of air-suspended particulate concentration on the incidence of suicide attempts and exacerbation of schizophrenia. International journal of biometeorology, 58(1): 61-7.
[24] Power MC et al. 2015. The relation between past exposure to fine particulate air pollution and prevalent anxiety: observational cohort study, 350.
[25] Evans GW, SD Colome, DF Shearer. 1988. Psychological reactions to air pollution. Environmental Research 45(1): 1-15.

Children can be particularly vulnerable to the effects of exposure to airborne pollutants because they consume more air and water per unit of body size compared to adults, are more likely to be active outdoors during peak traffic hours, tend to play closer to the ground where particulate matter concentrations are highest, and because their epithelial barriers are not fully developed.[26] Childhood exposure to nitrous oxide, airborne particulate matter, and polycyclic aromatic hydrocarbons have been linked to low scores in intelligence and intellectual development tests applied to infants to school age children, a pattern that persists in both cross sectional and longitudinal studies.[27] Exposure is also linked to increased incidences of psychiatric disorders, difficulties with emotional self-regulation, and heightened incidences of ADHD symptoms.[28] Prenatal exposure has been positively correlated with heightened incidences of heart wall defects, valve defects, aortal defects,[29] and low birth weight in babies,[30] heightened risk of preeclampsia in mothers,[31] and a significant increase in the likelihood of childhood obesity for children born to mothers who were exposed to polycyclic aromatic hydrocarbons during pregnancy.[32]

[26] D'Anguilli A. Severe Urban Outdoor Air Pollution and Children's Structural and Functional Brain Development, From Evidence to Precautionary Strategic Action. Frontiers in Public Health. April, 2018. (last accessed 9/16/19)
[27] Id.
[28] Id.
[29] Ritz B, F Yu, et al 2002. Ambient air pollution and risk of birth defects in Southern California. American Journal of Epidemiology 155(1): 17-25.
[30] Ebisu, K et al. Airborne PM2.5 Chemical Components and Low Birth Weight in the Northeastern and Mid-Atlantic Regions of the United States. Environmental Health Perspectives. December 2012. https://ehp.niehs.nih.gov/doi/pdf/10.1289/ehp.1104763 (last accessed 9/16/2019)
[31] Wu YT, AM Prina, & C Brayne. 2015. The association between community environment and cognitive function: a systematic review. Social psychiatry and psychiatric epidemiology, 50(3): 351-62.
[32] D'Anguilli A. Severe Urban Outdoor Air Pollution and Children's Structural and Functional Brain Development, From Evidence to Precautionary Strategic Action. Frontiers in Public Health. April, 2018. (last accessed 9/16/19)

Figure 2: Current hypothesized pathways of urban air pollution effects [33]



The graph shows the exposure of urban outdoor air pollution [with specific example of exposure to particulate matter (PM)], the hierarchical cascade, and recursive mechanisms of action leading to the different health effects, with particular focus on healthy brain development outcomes. Abbreviations: IL-6, interleukin 6; IL-1β, interleukin 1 beta; TN F-α, tumor necrosis factor alpha; BBB, brain–blood barrier; ROS, reactive oxygen species; GFAP, astrogliosis; Aβ, beta amyloids. The anatomical illustrations (blood cells, liver, and adipose tissue) are modified versions of copyright- and attribution-free public domain images downloaded from https://pixabay.com/.

People living in environments with a high level of sulfate particles (23.5 micro-g/m3) were 36% more likely to have lung cancer compared to those living in a community with lower levels of sulfate particle pollution,[34] exposure to ozone levels in excess of 100 parts per billion has been linked to a 319% increase in death caused by lung cancer in non-smoking males,[35] and positive

[33] Id.
[34] Pope 3rd, CA, RT Burnett, et al. 2002. Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. Journal of the American Medical Association 287(9): 1132-41
[35] U.S Environmental Protection Agency. EnviroAtlas Eco-Health Relationship Browser. https://enviroatlas.epa.gov/enviroatlas/Tools/EcoHealth_RelationshipBrowser/index.html (last accessed 9/16/19)

correlations have been found between ambient concentrations of nitrous oxide and incidences of breast cancer in women.[36]

Cardiovascular events and rates of hospitalization for cardiovascular issues are positively correlated with increases in ambient particulate matter, with a 10 microgram per square meter increase in black smoke averaging a 4.8% increase in hospitalizations for populations 65 and over.[37] A 10 microgram per square meter increase in PM2.5 levels was associated with a 24% increase in the risk of a heart attack or stroke, and a 76% increase in the risk of death from cardiovascular disease in postmenopausal women.[38] Exposures to PM2.5, PM10, and nitrous oxide are strongly associated with increases in blood pressure,[39] while long term exposure to PM2.5 and nitrous oxide has been linked to heightened levels of inflammation biomarkers in the bloodstream.[40] Inflammation and oxidative stress on the brain has been linked to the manifestation of symptoms of depression,[41] while inflammation in the airways can contribute to the development of asthma as well as an increase in the severity of symptoms.[42]

Exposure to black carbon increases the likelihood of airway inflammation, and research suggests that high incidences of childhood and adult asthma rates in communities of low socioeconomic status and higher proportion of racial and ethnic minority residents is related to the

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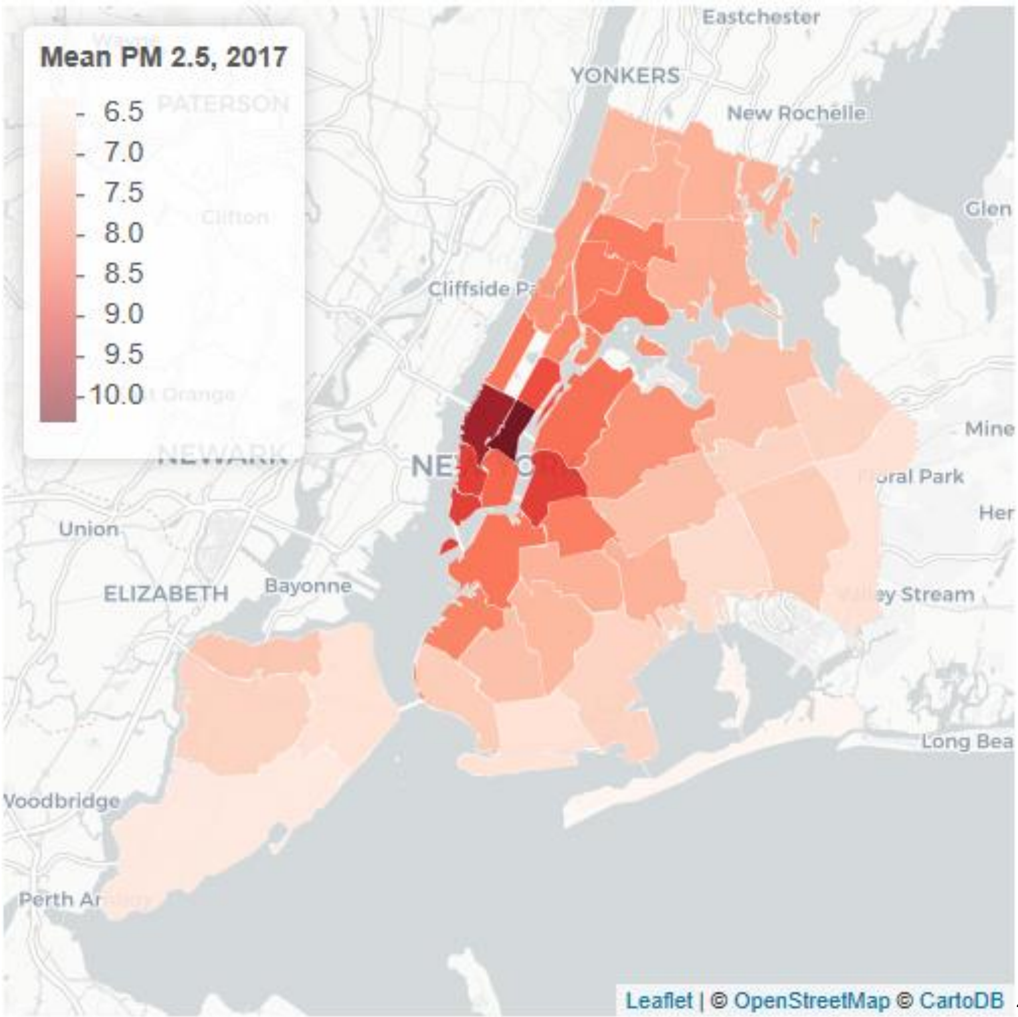
[36] Hystad P, PJ Villeneuve, et al. 2015. Exposure to traffic-related air pollution and the risk of developing breast cancer among women in eight Canadian provinces: a case-control study. Environment international, 74: 240-8.
[37] Prescott GJ, GR Cohen, et al. 1998. Urban air pollution and cardiopulmonary ill health: a 14.5 year time series study. Occupational and Environmental Medicine 55(10): 697-4.
[38] Miller KA, DS Siscovick, et al. 2007. Long-term exposure to air pollution and incidence of cardiovascular events in women. New England Journal of Medicine 356(5): 447-58.
[39] U.S Environmental Protection Agency. EnviroAtlas Eco-Health Relationship Browser. https://enviroatlas.epa.gov/enviroatlas/Tools/EcoHealth_RelationshipBrowser/index.html (last accessed 9/16/19)
[40] Id.
[41] MohanKumar SM et al. Particulate matter, oxidative stress and neurotoxicity. Neurotoxicology. May, 2008. https://www.sciencedirect.com/science/article/pii/S0161813X07002720 (last accessed 9/16/2019)
[42] Air Pollution May Explain Asthma Hot Spots in NYC. Columbia Mailman School of Public Health. CHILD AND ADOLESCENT HEALTH, ENVIRONMENTAL HEALTH Mar. 27 2012 https://www.mailman.columbia.edu/public-health-now/news/air-pollution-may-explain-childhood-asthma-hot-spots-nyc (last accessed 9/16/2019)

higher ambient levels of airborne pollutants such as black carbon and PM2.5 in these areas.[43] New York City's community air survey findings from 2009 to 2017 confirm the presence of high levels of fine particulate matter, nitrogen dioxide, and nitric oxide in areas with high traffic density, building density, and in industrial areas.[44]

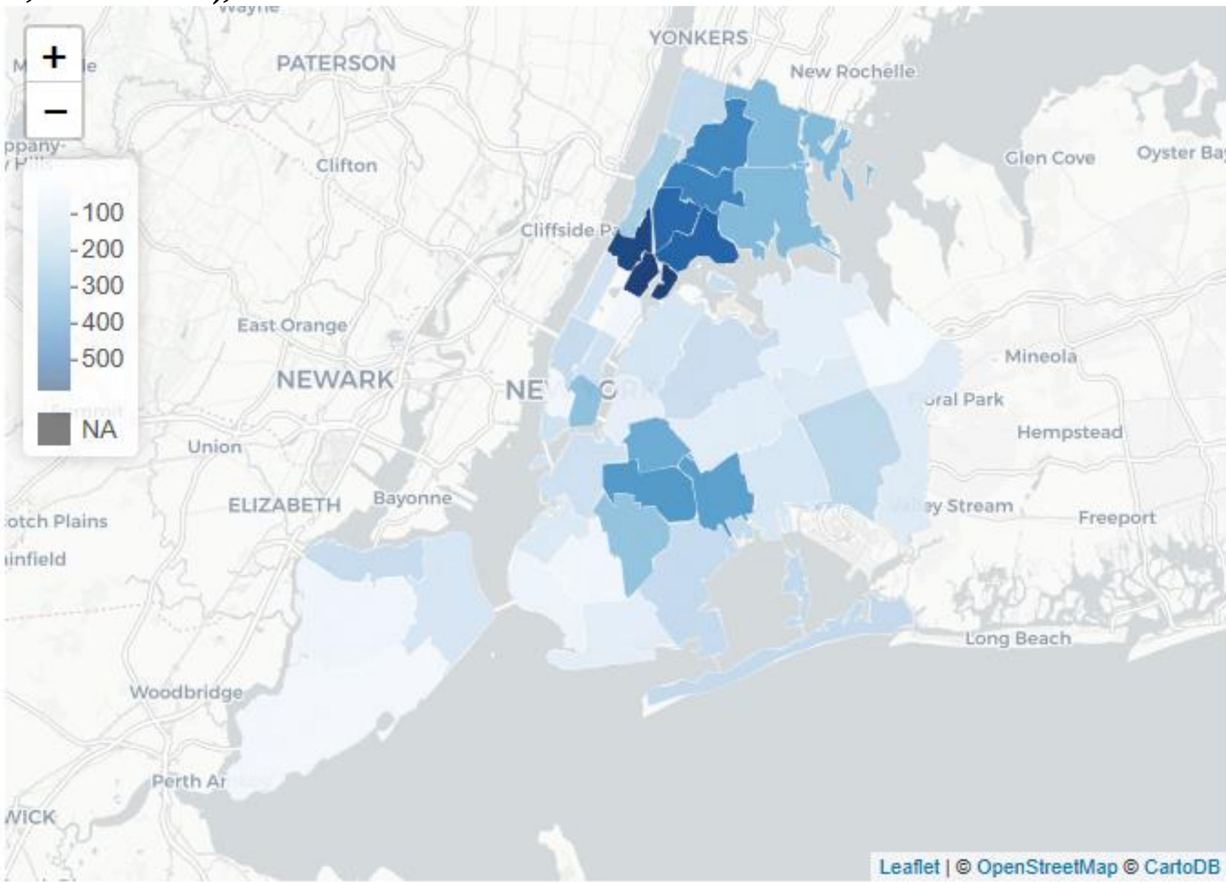
Figure 2: Distribution of PM 2.5 by UHF (United Hospital Fund Neighborhoods)



[45]

[43] Cornell, AG, et al. Domestic airborne black carbon and exhaled nitric oxide in children in NYC. Journal of Exposure Science & Environmental Epidemiology. 2012. https://www.nature.com/articles/jes20123 (last accessed 9/17/2019)
[44] New York City Community Air Survey. Neighborhood Air Quality 2008-2017 https://nyc-ehs.net/besp-report/web/nyccas (last accessed 9/18/2019)
[45] Mean PM 2.5, 2017, UHF 42 Air samples collected at specific NYCCAS monitoring sites along with information about emissions sources were incorporated into a statistical model that predicted pollutant concentrations at all locations in NYC for the specified time period. The results were then assigned to the appropriate NYC

Figure 3: Asthma Emergency Department Visits (Children 5 to 17 Yrs Old), Rate (per 10,000 residents), 2016[46]



The city wide rate, per 10,000 residents is 215.3 emergency department (ED) visits. These visits include both patients who are treated and released in the ED (outpatients) and who are admitted as inpatients through the emergency department. An ED visit is included if it has an ICD-9 principal diagnosis code of 493 or an ICD-10 principal diagnosis code of J45. New York hospitals began using the ICD-10 system on October 1, 2015. Because the ICD systems are similar in how they classify childhood asthma data can be compared across years.

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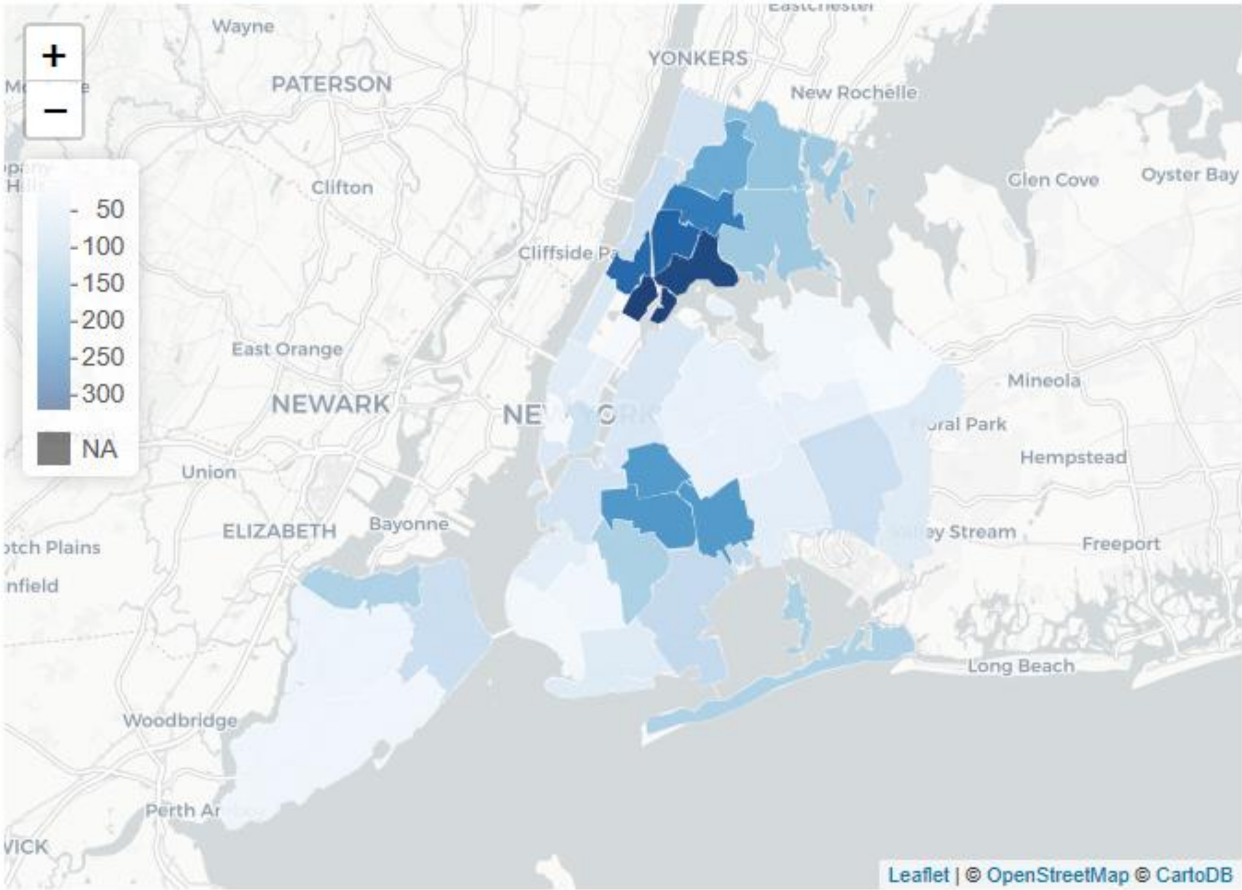
neighborhood and averaged. In NYC, fine particulate matter is measured in units of micrograms per cubic meter of air.

[46] Plotted with data from NYC.gov Environment and Health Data Portal http://a816-dohbesp.nyc.gov/IndicatorPublic/VisualizationData.aspx?id=2379,4466a0,11,Summarize (last accessed 9/17/2019)

Figure 4: Asthma Emergency Department Visits (Adults), Age Adjusted Rate (per 10,000 residents), 2016[47]



The city wide age-adjusted rate, per 10,000 residents is 99.1 emergency department (ED) visits. Number of asthma-related ED visits among NYC adults (18 years and older). ED visits include both patients who are treated and released in the ED (outpatients) and who are admitted as inpatients through the emergency department.

Ambient levels of sulfur dioxide have been positively associated with increases in hospital admissions for chronic bronchitis and emphysema, and nitrous oxide, nitrogen dioxide, and PM10 levels are negatively associated with lung function.[48] Overall, there is a strong correlation between exposure to air pollution, especially fine particulate matter, and various causes of mortality.[49] A

[47]Plotted with data from NYC.gov Environment and Health Data Portal: http://a816-dohbesp.nyc.gov/IndicatorPublic/VisualizationData.aspx?id=2380,4466a0,11,Summarize (last accessed 9/18/19)
[48] U.S Environmental Protection Agency. EnviroAtlas Eco-Health Relationship Browser. https://enviroatlas.epa.gov/enviroatlas/Tools/EcoHealth_RelationshipBrowser/index.html (last accessed 9/16/19)
[49] Id.

study of six cities found that an average of 3% fewer people died for every reduction of one micro-g/m3 in the average levels of PM2.5 fine particulate matter, meaning that each micro-g/m3 reduction is approximate to saving 75,000 people per year in the United States (U.S.).[50] Although New York City is considered to be in moderate non-attainment for ozone levels, the statewide estimated benefits of achieving attainment are significant.[51]

Attainment Provides Prevention of:	
Deaths from effects of ozone	13 - 22
Deaths from effects of PM2.5	31 - 70
Nonfatal heart attacks	4 - 36
Hospital admissions & emergency room visits	134
Acute bronchitis events	48
Upper & lower respiratory symptom events	1,540
Exacerbated asthma events	32,200
Missed work & school days	26,320
Restricted activity days	86,800

[52]

V. Potential Strategies for the Mitigation of Airborne Pollutants

High levels of fine particulate matter (PM2.5), nitrogen dioxide (NO_2), nitrous oxide (NO_x), and black carbon (BC), are associated with areas of high traffic activity, higher density of buildings with heat and hot water boilers, and industrial areas, whereas the highest ozone levels

[50] Laden et al. Reduction in Fine Particulate Air Pollution and Mortality, Extended Follow-up of the Harvard Six Cities Study. The American Journal of Respiratory and Critical Care Medicine. March, 2006. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2662950/ (last accessed 9/18/2019)
[51] New York Department of Environmental Conservation. Proposed Subpart 227-3 Regulatory Impact Statement Summary. http://www.dec.ny.gov/regulations/116180.html#13 (last accessed 9/18/2019)
[52] Id.

are found in the outer boroughs, downwind of high emissions areas, and in areas with fewer combustion emissions.[53] While the combustion of fuel for transportation and the production of heat and hot water are responsible for a significant portion of the airborne pollutants in the city,[54] simple cycle and regenerative combustion turbines at power plants across the state, many of them used as peaker plants, can account for over a third of New York's daily power plant nitrous oxide (NOx) emissions while producing less electricity for consumers than cleaner sources.[55] The Calpine JFK Emergency Generation Center has six emergency boilers that burn natural gas. The newest of these boilers is 32 years old, while the oldest is 63 years old.[56] Because these old turbines emit approximately 30 times more NOx than modern turbines, upgrading obsolete technology has the potential to significantly improve air quality in the region.[57]

Trees have also been shown to mitigate the effects of airborne pollutants through a variety of mechanisms. Trees possess the ability to remove particulate matter from the air, either through absorption via stomata, or via deposition of particulate matter onto their leaf surfaces.[58] Trees with particularly hairy leaves, or complex structures with fine needles were shown to be the most effective at these functions.[59] According to the New York City Street Tree Map, New York City's

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[53] New York City Community Air Survey. Neighborhood Air Quality 2008-2017 https://nyc-ehs.net/besp-report/web/nyccas (last accessed 9/18/2019)
[54] Id.
[55] NYSERDA. Governor Cuomo Announces Proposed Regulations to Improve Air Quality and Reduce Harmful Ozone Caused by Power Plant Emissions. February 28, 2019. https://www.nyserda.ny.gov/About/Newsroom/2019-Announcements/2019-02-28-Governor-Cuomo-Announces-Proposed-Regulations-to-Improve-Air-Quality-and-Reduce-Harmful-Ozone (last accessed 9/18/190
[56] New York Department Of Environmental Conservation. Permit Review Report. Permit ID: 2-6308-00096/00009. https://www.dec.ny.gov/dardata/boss/afs/permits/prr_263080009600009_r2_1.pdf (last accessed 9/18/19)
[57] NYSERDA. Governor Cuomo Announces Proposed Regulations to Improve Air Quality and Reduce Harmful Ozone Caused by Power Plant Emissions. February 28, 2019. https://www.nyserda.ny.gov/About/Newsroom/2019-Announcements/2019-02-28-Governor-Cuomo-Announces-Proposed-Regulations-to-Improve-Air-Quality-and-Reduce-Harmful-Ozone (last accessed 9/18/190
[58] Beckett, P, et al. Particulate pollution capture by urban trees: Effect of species and windspeed. Global Change Biology. 2000.
[59] Id.

urban forest removes 635 tons of airborne pollutants from the environment every year, not including carbon captured.[60] Roadside greenbelts have been found to reduce total suspended particles by up to 65%,[61] and higher levels of greenery within and surrounding school boundaries have been associated with lower levels of NO_2, ultrafine particles, and traffic related PM2.5, both indoors and out.[62] A study of New York City street trees found that increased tree density was correlated with lower overall asthma prevalence, as well as lower rates of childhood asthma.[63] Increased tree density has also been shown to reduce ambient temperature at the street level, mitigating the urban heat island effect, and reducing heat vulnerability during the summer months.[64] Unfortunately, the density of the urban canopy is positively correlated with neighborhood median income, and in some models, negatively correlated with race,[65] exacerbating equity issues for populations that often already lack the resources to overcome the unequal distribution of environmental stressors and benefits.[66]

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[60] New York City Parks Department. NYC Street Tree Map

[61] Islam M N, K-S Rahman, et al. 2012. Pollution attenuation by roadside greenbelt in and around urban areas. Urban Forestry & Urban Greening 11(4): 460-464.

[62] Dadvand P, MJ Nieuwenhuijsen, et al. 2015. Green spaces and cognitive development in primary schoolchildren. Proceedings of the National Academy of Sciences, 112(26): 7937-42.

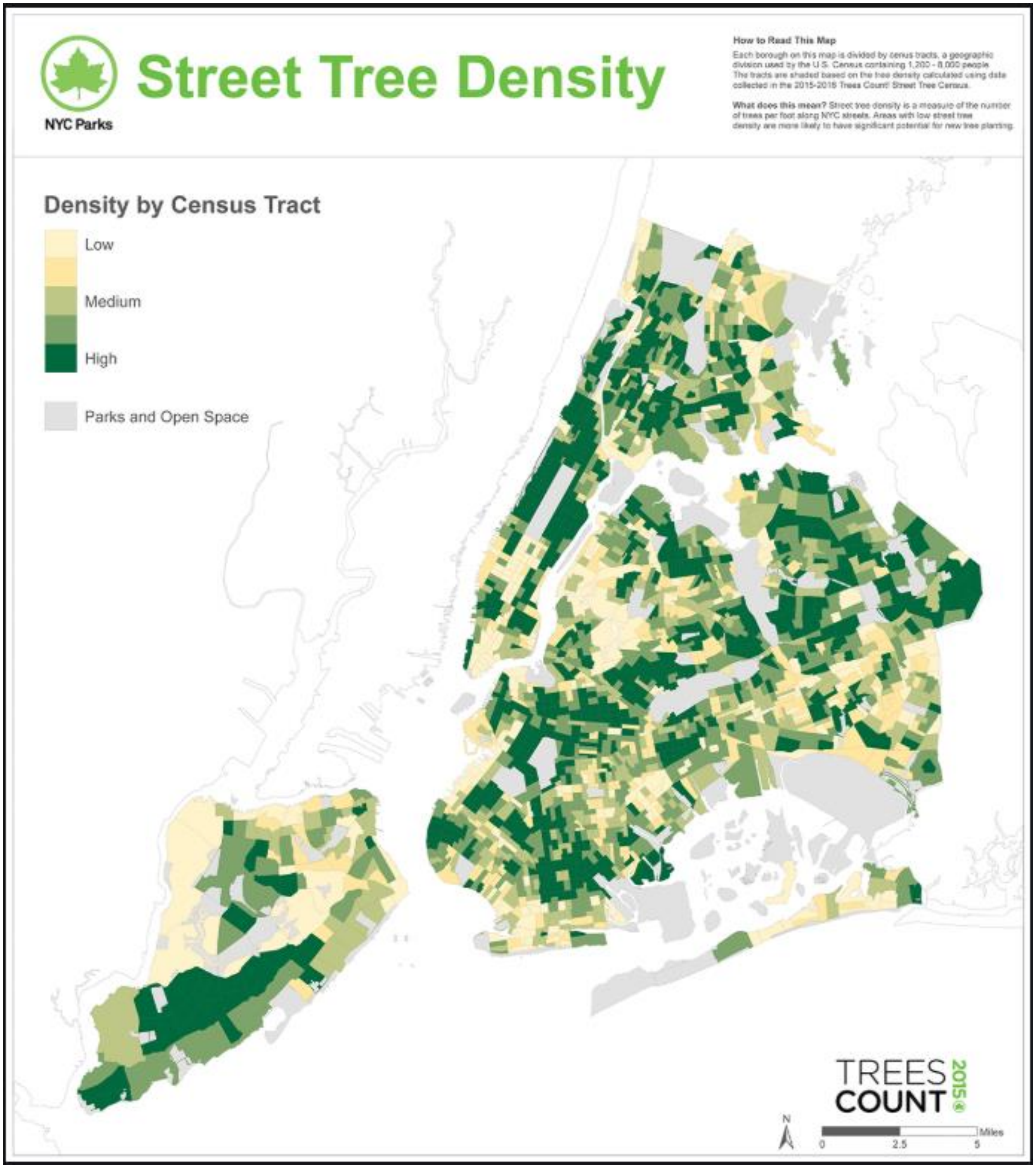
[63] Lovasi GS, JW Quinn, et al. 2008. Children living in areas with more street trees have lower asthma prevalence. Journal of Epidemiology and Community Health 62:647-9.

[64] Ziter, C. et al. Scale-dependent interactions between tree canopy cover and impervious surfaces reduce daytime urban heat during summer. PNAS April 9, 2019 https://www.pnas.org/content/116/15/7575 (last accessed 9/19/2019)

[65] Schwartz, K. et al. Trees Grow on Money: Urban Tree Canopy Cover and Environmental Justice. PLOS One. April, 2015. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4382324/ (last accessed 9/18/19)

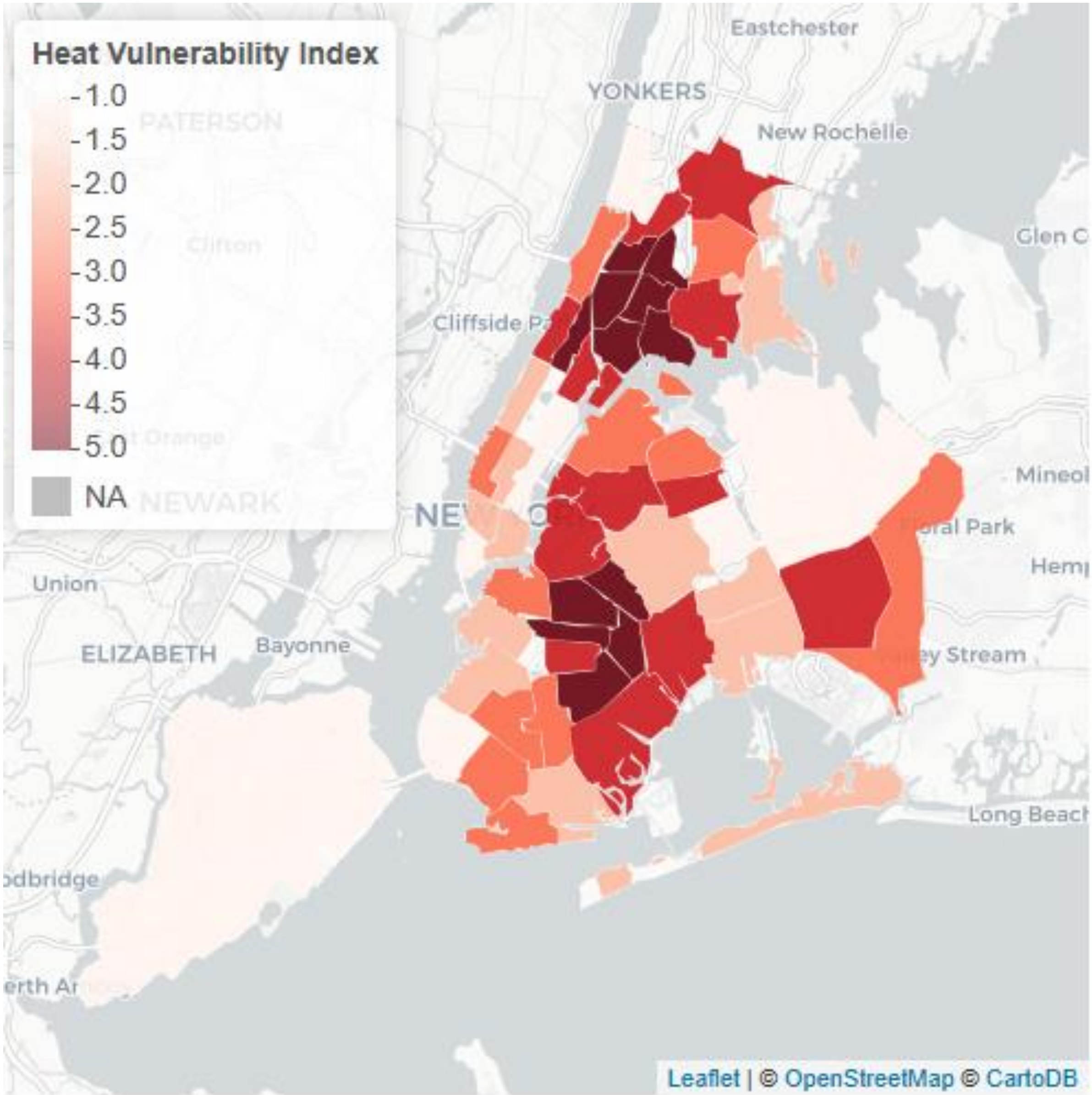
[66]

Figure 5: NYC Street Tree Density Map (2015)[67]



[67] New York City Parks Department. Tree Count 2015. https://www.nycgovparks.org/trees/treescount (last accessed 9/19/19)

Figure 6: Heat Vulnerability Index by Community District, 2010[68]



The Heat Vulnerability Index (HVI) is a measure of how at risk a neighborhood is during extreme heat compared to other neighborhoods. In NYC, the risk of illness or death related to heat waves is higher in communities with higher surface temperatures and less green space, and poor communities of color that have experienced historical racism and segregation. ** How Calculated: ** Each neighborhood receives a score from 1 (lowest risk) to 5 (highest risk) based on results from a statistical model that uses social and environmental factors to estimate risk of heat- related death across NYC neighborhoods. A low vulnerability score does not mean no risk. Every neighborhood has residents at risk for heat illness and death, particularly people who do not have or use air conditioning AND are older adults, or have chronic health conditions or severe mental illnesses. Data is from 2010

[68] Plotted with data from NYC.gov Environment and Health Data Portal:

Ultimately, there is no single strategy that will completely address the inequitable distribution of environmental stressors such as airborne pollutants. The electrification of space and water heating, including greater implementation of technologies such as air and ground source heat exchangers, geothermal heat pumps, and solar thermal water heaters, the switch to non-combustion dependent renewable energy production, and greater adoption of zero emissions vehicles are all viable strategies to reduce the local production of airborne particulate emissions, while the equitable distribution of environmental resources such as green space can help to mitigate the effects of airborne particulates that do not come from local sources. Such equitable distribution is particularly important to ensure that individual communities do not bear a disproportionate brunt of the consequences for the modern conveniences enjoyed by all.