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The impact of the air pollution on health in New York City

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Abstract

New York City is attempting to find a solution to an issue that many states and cities face: how to minimize air pollution so that it has fewer negative impacts on human health. Despite having the highest population in the United States (US), New York City typically has reasonably clean air. As the City and State of New York have worked to reduce emissions from local and regional sources, the air quality in New York City has improved during the past few decades. Despite these advancements, air pollution still poses a severe hazard to the health of everyone living in New York's environment. Various diseases including respiratory, circulatory, neurological, gastrointestinal, and urinary illnesses, which can be fatal, are intimately associated with air pollution. This review article will concentrate on how air pollution affects respiratory diseases such as asthma in children. In addition to analyzing the severe effects of air pollution on the vulnerable population, this review article will highlight the health repercussions of air pollution on New York City and its residents. furthermore, we argue for potential ideas and discoveries while also putting up a policy option to lower air pollution.

Keywords

Health impacts, air pollution, New York City, vulnerable population, respiratory diseases, asthma case

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Introduction

One of the foremost era challenges is air pollution that affects not only climate change, but also public and individual health due to increasing infection and mortality.[1] Air pollution, including fine particulate matter (i.e. PM2.5) and gases, constitutes an environmental risk to human health and well-being. Health impacts of air pollution have been extensively studied, as multiple human activities influence or are responsible of air pollution.[1–7] Air pollution is the presence of pollutants into the air, which are harmful to human health, other living organisms, as well as to the planet Earth. Lissåker et al.[2] considered air pollution to be a macroenvironmental problem that is caused by natural events such as wildfires and volcano eruption as well as human activities. The effects of air pollution on the human body vary depending on the type of pollutant and the length and level of exposure, as well as other factors, including a person's individual health risks and the cumulative impacts of multiple pollutants. According to the World Health Organization, each year air pollution is responsible for nearly seven million deaths around the globe.[8] Recent works reported the effects of the COVID-19 shutdown on spatial and temporal patterns of air pollution in New York City.[9] Data on major sources of PM2.5 and NO_2 pollution suggests that decreased vehicle traffic and commercial cooking contributed to declines in air

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pollution during the COVID-19 shutdown period. Pollution reductions occurred disproportionately in the city's central business district, with smaller changes in other areas of the city, such as those with the highest burden of air pollution-related health impacts. These findings emphasize the need to target pollution sources in communities that suffer the greatest from pollution exposure in the design of equitable environmental health policy.[9] Indeed, motor vehicles, including public transit buses, are a major source of air pollution in New York City and worldwide.[10] To address this problem, governments and transit agencies have implemented policies to introduce cleaner vehicles into transit fleets.[11] Beginning in 2000, the Metropolitan Transit Agency began deploying compressed natural gas, hybrid electric, and low-sulfur diesel buses to reduce urban air pollution. Lovasi and co-workers hypothesized that bus fleet changes incorporating cleaner vehicles would have detectable effects on air pollution concentrations between 2009 and 2014, as measured by the New York City Community Air Survey.[11] Zhang et al. evaluating the impact of the clean heat program on air pollution levels in New York City, where residual heating oil has been identified as a major source of multiple air pollutants, including fine particulate matter (PM2.5), sulfur dioxide (SO_2), nitrogen oxides (NO_x), and black carbon.[12]

Previous works reported the sources of indoor air pollution in New York City residences of asthmatic children.[13] Individuals spend ~90% of their time indoors in proximity to sources of particulate and gaseous air pollutants. The sulfur tracer method was used to separate indoor concentrations of particulate matter (PM2.5) mass, elements and thermally resolved carbon fractions by origin in New York City residences of asthmatic children. Mixed effects models were used to identify building characteristics and resident activities that contributed to observed concentrations. Habre and co-workers attributed 46% of indoor PM2.5 mass to indoor sources related to oxygen-carbon (OC) generation indoors. Outdoor sources accounted for 28% of indoor PM2.5 mass, mainly photochemical reaction products, metals and combustion products. Other indoor sources accounted for 26% and included re-suspension of crustal elements such as Al, Zn, Fe, Si, and Ca. Indoor sources accounted for ~72% of PM2.5 mass and likely contributed to differences in the composition of indoor and outdoor PM2.5 exposures.

This review provides an overview of current knowledge of the impact of the air pollution on health in New York City, allowing to identify relevant methods and gaps in the existing research on health impacts of air pollution. The review is organized as follows: the next section describes the methodology, follows by the definition of terms and characteristics of air pollution, the overview of solution framework, and the scope and roadmap. Next, we discussed the severity and impacts of air pollution on the vulnerable population in New York City, the policy solution on prospective of the issues to reduce air pollution, and we proposed solutions: actions to control air pollution, policy, services education, and data provided by the US Government. Finally, we concluded on the effectiveness of the solutions.

We conducted a systematic search to identify published literature qualifying and quantifying health impacts of air pollution in New York City. We searched six databases: Hollis, PubMed, ProQuest Central, Science Direct, Scopus, and Web of Science. Search criteria were: (1) key words: air pollution, health in New York City, climate change, air, O_3, SO_2, NO_x, CO, particle matter, PM, and mortality; (2) studies published during the last 30 years (between 1992 and 2022); and (3) only peer-review journal articles, government reports, and conference proceedings. We also searched manually for relevant references in articles found. Based on the search criteria, several studies were included in this review. The majority of these studies were peer-reviewed journal articles, and the other were proceedings papers and government reports. Although the focus of this review was on the impact of the air pollution on health in New York City, we also included a study on climate change affecting air pollution in health risk. In each of the studies, we examined its design, methods and, results of sensitivity analyses. Aspects of the study design we considered included study location, reference, and health effects. A basic method commonly applied in all the reviewed papers is introduced in the following section on "Discussion of the severity and impacts of air pollution on the vulnerable population in New York City," followed by a section on "Policy solution on prospective of the issues to reduce air pollution," which briefly provides the setting, methods and scope of each study.

Definition of terms

Description and characteristics of air pollution

Asthma flare-ups, lower respiratory infections, trachea, bronchial lung cancer, stroke and chronic obstructive pulmonary disease are a few of the disorders caused by air pollution in today's culture.[1] Evidence linking air pollution exposure to type 2 diabetes, obesity, systemic inflammation, Alzheimer's disease, and dementia was provided by the World Health Organization (WHO).[14]

When there are pollutants in the air, it causes harm to both people and other living things on the planet. The WHO estimates that air pollution causes about seven million deaths yearly.[15] Megacities, which are enormous urban sprawls, face various environmental problems, such as rising air pollution emissions.[16,17] Megacities are, therefore, frequently considered global risk zones, making their residents susceptible to the negative health effects of air pollution.[18,19] Such risks need to be assessed to support the introduction of national and international initiatives to enhance the sustainability of megacity life worldwide. For instance, New York City (NYC) is the largest city in the United States (US), but despite having a significant big population NYC, the authorities have work more for cleaner air compared to other larger cities. But, air pollution is still a concern for the environment.

Several contaminants in the air are still very dangerous, even though clean air legislation and regulations have improved the air quality in most big cities. The most common air contaminants are ground-level ozone and particulate matter (PM) (O_3). The two main types of air pollution are interior and outdoor pollution. Environment-related variables contribute to ambient air pollution. Indoor pollution is the term for the pollution that results from fuel burning inside a building. People who are exposed to high amounts of air pollution have a variety of sickness symptoms and states. These effects are divided into those that have immediate and long-term consequences on health.

This review paper emphasizes how New Yorkers' health is impacted by air pollution. It concentrates on two prevalent air pollutants: O_3 and delicate particulate matter (PM2.5). High quantities of these pollutants are present in many cities due to the emissions from fuel burning, both directly and indirectly. Both pollutants have been thoroughly studied in NYC and are known to be responsible to critical conditions such as those related to lung and heart diseases. A dynamic and complex mixture of man-made pollutants and natural sources make up the current air pollution, frequently observed in urban areas. PM, O_3, sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), and lead are the six most prevalent ambient air pollutants. According to a recent study by Lelieveld et al., fine PM2.5 is responsible for nearly 3.3 million fatalities due to outdoor air pollution. The main origins of PM formation are industrial operations, sources associated with transportation (such as gasoline and diesel), coal and oil fuel combustion, agriculture, and road building. Coarse particles with diameters of 2.5–10 m (PM10), fine particles under 2.5 m (PM2.5), and ultrafine particles with diameters of less than 0.1 mm are typically the three splitting size classifications of PM.

Overview of solution framework

We suggest that tailpipe emissions from vehicles, buses, and trucks, which are significant sources of harmful air pollution in New York State (NYS), be subject to Federal legislation regarding the health effects of air pollution in NYS. This mandate would create driver responsibility and require cars, trucks, and buses to include fewer flammable gases. To facilitate this proposed legislation, a fee or tax would be included in every trip or travel, with the intent that this additional charge would fund proper waste emission and recovery. With a ubiquitous and cohesive national approach all manufacturers, distributors, cars, trucks, buses, municipalities, and travelers would be participating in a system aimed at furthering waste emission and gas reuse.

In this paper, we will provide some details on diseases related to air pollution that affects the respiratory system including cases of asthma, the circulatory system, the nervous system, the digestive system, and the urinary system. We will also discuss how air pollution affects the health of NYC's vulnerable population, including children and adults. We will also contrast the health effects of air pollution on children and adults in NYC with other crowded cities in the US and around the world, and we will suggest a national solution. Without a federal policy, we are unable to start establishing the unification of tailpipe emissions from vehicles, trucks, and buses, and amend the existing Clean Air Act (CAA). As evidence that mandating this change for all stakeholders in air pollution removes barriers to the completion and planning of several emission-reducing initiatives that will result in cleaner air and fewer severe illnesses and premature deaths in all parts of the city, we will compare the proposed solution to the existing municipal and the state ordinance that has been enacted in the US.

Scope and roadmap

NYC is attempting to solve a problem that many states and cities face—how to reduce air pollution to lessen adverse impacts on human health caused by the environment. NYC has a very clean air despite being the most populous city in the US. Since NYC and NYS have been working to reduce emissions from local and regional sources, the city's air quality has improved. Notwithstanding these advancements, all New Yorkers continue to face severe threats, which are cause health issues from air pollution. In this review essay, we pay close attention to how air pollution affects vulnerable groups with respiratory disorders, including children and asthma. This paper will concentrate on the harmful effects of air pollution on people's health in NYC, discuss how the most vulnerable population is affected, and propose a policy solution on the prospective of the issues to reduce air pollution, while simultaneously arguing on more solutions and funding.

Anthropogenic and natural sources of air pollution in New York City and its environ

The "anthropogenic" is the environmental change caused or influenced by people, either directly or indirectly. Fine particles in New York City's air come from sources both within and outside of the city; the outside sources account for more of the city's air pollution, but local sources account for differences in PM2.5 concentration between locations within the city of New York. PM2.5 in NYC's air also comes from outside the city, from sources far upwind.

The Health Department, in the ongoing New York City Community Air Survey (NYCCAS), is studying the impact of local sources such as traffic and burning residual oil on neighborhood air quality.[20]

Current air quality conditions were based on measured daily PM2.5 from all regulatory monitors within New York City and adjacent counties over 3 years (2005–2007).[20,21–25] The regulatory monitors do not capture the full range of neighborhood variations documented by the Health Department's NYCCAS. Preliminary analyses by the Health Department indicate that using NYCCAS data will produce similar results for city wide health impact estimates, but somewhat different results by neighborhood.[20] The influence of year-to-year changes in meteorology and unique emissions patterns was minimized by calculating baseline PM2.5 concentrations as a 3-year average. Since air pollution levels and health events vary by season, current conditions were defined as quarterly averages of daily PM2.5 concentrations. First, at each monitor, quarterly averages were calculated for each year and then averaged across the 3 years. Daily average concentrations for each quarter were then assigned to each of 42 New York City United Hospital Fund neighborhoods, using a method that assigns greater weight to monitors in or near to a neighborhood.[23]

Although ozone is always present in New York City's air, concentrations are much higher in the summer. Many studies of ozone (O_3) health effects focus on the warm season. For instance, the study by EPA Air Quality System included only New York City's ozone season from April 1st to September 30th.[20] The EPA Air Quality System recently reported current air quality conditions, which were based on ozone data from all regulatory monitors within the city of New York and adjacent counties over 3 years (2005–2007).[20] O_3, at ground level, is formed through reactions in the atmosphere when oxides of nitrogen (NO_x) emissions combine with other airborne pollutants in the presence of sunlight. Therefore, measured O_3 concentrations are often highest downwind from high-emissions areas. In areas where there are high concentrations of fresh combustion emissions, NO_x reacts with O_3 to reduce its concentrations. As a result, lower O_3 levels are observed near roadways, in city centers, and in other areas of high emissions density.[26]

In addition to fine particles and ozone, recently, NYCCAS measures air pollutants that pose the most harm to the public's health.[26] These air pollutants include: Nitrogen dioxide (NO_2) and nitric oxide (NO), which are part of a group of pollutants called "oxides of nitrogen" (NO_x). Exposures to NO_x are linked to increased emergency department visits and hospitalizations for respiratory conditions, particularly asthma. NO_x also react with other compounds in the atmosphere to form PM2.5 and O_3. NO_x is produced from a variety of combustion sources in NYC, including motor vehicles, buildings, marine vessels, and construction equipment. Sulfur dioxide (SO_2) in NYC is produced mainly from burning oils with high sulfur content, also known as residual fuel oil. Fuel oil in NYC is used mainly to heat buildings and for hot water, and some high-sulfur oil is also used to generate electric power and power marine vessels. SO_2 exposures can worsen lung diseases, causing hospitalizations and emergency department visits for asthma and other conditions. SO_2 also contributes to the formation of PM2.5 in the atmosphere, resulting in exposures downwind of where it is emitted. Black carbon (BC) is one component of PM2.5 and is emitted from diesel exhaust and other sources, such as oil burning. Diesel exhaust particles, indicated by BC, can cause irritation of the breathing passages, leading to respiratory symptoms such as cough, or asthma exacerbation, and may increase the risk of cancer.[26] BC pollution is also a contributor to global climate change. NYCCAS air quality monitoring began in December 2008. Samples are collected in all seasons for all pollutants, except O_3 and SO_2, where samples are collected in the summer and winter seasons, respectively.

The Table 1 (extract from NYC Health[26]) shows how the air quality in New York City has improved in recent decades, as the City and State of New York have worked to lower emissions from regional and local sources.[26]

Discussion of the severity and impacts of air pollution on the vulnerable population in New York City

Relevant diseases related to air pollution. Numerous epidemiological studies have revealed a strong correlation between air pollution and several diseases including fatalities.[27] The effects of air pollution on human health have also been found to have harmful effects on human life expectancy. The short and long-term effects of air pollution on human health are broken down into the following subsections. However, the impermanence of human existence caused by numerous diseases, are linked to air pollution.[28]

Respiratory diseases: Asthma case

The lungs are negatively impacted by pollution in the air. Emergency hospital visits, outpatient visits, hospitalizations for respiratory illnesses in adults and children, pediatric, decreased lung function, tuberculosis, with no limitation to the measles are some of the short-term impacts of air pollution on the respiratory system.[29] The Long-term effects of air pollution include lung function degradation, acute nasopharyngitis, along with lung cancer and with respiratory morbidities.[30] Sex, age, seasons, and geographic locations all have an impact on air pollution that are hazardous to human health. Nine out of ten people living in urban areas worldwide are impact upon

Table 1. Community district, annual average PM2.5 and per-year decline in levels.

Borough	Geography	ID	Annual Average 2010	Annual Average 2011	Annual Average 2012	Annual Average 2013	Annual Average 2014	Annual Average 2015	Annual Average 2016	Slope (Per Year Decline)	
Manhattan	Midtown (CD5) Fordham and University Heights (CD5)	105	16.1	15.5	14.8	14.2	14.3	14.2	12.3	11.34	–0.61
Bronx	Highbridge and Concourse (CD4)	205	12.1	11.4	11.7	10.5	10.1	10.1	9.8	8.34	–0.47
Manhattan	Stuyvesant town and Turtle Bay (CD12)	106	12	11.2	11.6	10.4	10	10	9.7	8.25	–.46
Manhattan	Washington heights and Inwood (CD12)	112	11.6	10.7	11.1	9.9	9.5	9.5	9.4	7.79	–0.46
Bronx	Kingsbridge Heights and Bedford (CD7)	207	11.5	10.7	11.1	9.8	9.4	9.5	9.3	7.78	–0.46
Manhattan	Upper East Side (CD8)	108	12.9	11.9	12.1	11.2	11.1	11.2	10.2	9.1	–0.45
Manhattan	Central Harlem (CD10)	110	11.6	10.6	11.1	9.9	9.6	9.7	9.3	7.89	–0.45
Manhattan	Morningside Heights and Hamilton Heights(CD9)	109	11.7	10.7	11.2	9.9	9.4	9.5	9.3	7.85	–0.44
Bronx	Morrisania and Crotona (CD3)	203	11.4	10.6	11.1	9.9	9.4	9.5	9.3	7.85	–0.44
Bronx	Belmont and East Tremont (CD6)	206	11.5	10.7	11.2	9.9	9.5	9.6	9.4	7.86	–0.43
Manhattan	Upper West Side (CD7)	107	12.2	11	11.5	10.4	10.3	10.4	9.8	8.49	–0.42
Manhattan	Financial District (CD1)	101	13.1	12.1	12.3	11.3	11.1	11.4	10.6	9.56	–0.42
Bronx	Riverdale and Fieldson (Cd8)	208	11	10.1	10.7	9.3	8.9	9	9.2	7.49	–0.41
Bronx	Mott Haven and Melrose (CD1)	201	11.9	10.9	11.6	10.4	10	10.1	9.9	8.55	–0.40
Staten Island	Tottenville and Great kills (CD3)	503	9.7	8.8	9.3	8.3	7.8	8.2	7.3	6.62	–0.39
Bronx	Parkchester and Soundview (CD6)	209	10.8	10	10.7	9.4	8.9	9.1	9	7.6	–0.39
Manhattan	Upper West Side (CD7)	406	10.6	9.8	10.1	9.1	8.7	8.9	8.5	7.5	–0.38
Manhattan	Financial District (CD1)	111	11.5	10.4	11.1	10	9.7	9.8	9.6	8.17	–0.38
Bronx	Morrissania and Crotona (CD3)	104	13.2	11.9	12.4	11.4	11.4	11.6	10.9	9.76	–0.37
Bronx	Belmont and East Tremont (CD6)	211	10.6	9.7	10.4	6.2	8.7	8.9	8.9	7.4	–0.37
Queens	Rego Park and Forest Hills (CD3)	202	11.6	9.7	11.5	10.3	9.8	8.7	8.9	7.4	–0.327
Brooklyn	Flatbush and Midwood (CD14)	102	12.8	11.6	12.1	11.1	10.9	11.2	10.6	9.53	–0.37
Queens	Kew Gardens and Woodhaven (CD14)	408	10	9.3	9.7	8.6	8.2	8.4	8.2	7.01	–0.37
Queens	Elmhurst and Corona (CD4)	314	10.3	9.7	10.1	8.9	8.6	8.9	8.4	7.45	–0.36
Brooklyn	South Crown Heights and Lefferts Gardens (CD9)	409	10.3	9.7	8.6	8.4	8.7	8.3	8.7	7.29	–0.36
Queens	Flushing and Whitestone (CD7)	404	10.7	9.8	10.3	9.2	8.9	9.2	8.7	7.71	–0.36
Queens	Jackson Heights(CD3)	309	10.6	9.9	10.2	9.1	8.6	9	8.7	7.77	–0.36
Queens Flushing and Whitestone (CD7)	Flushing and Whitestone (CD7)	407	10.2	9.4	10.1	8.9	8.4	8.7	8.5	7.26	–0.35
Queens	Jackson Heights (CD3)	403	10.3	9.2	9.9	8.8	8.4	8.7	8.3	7.27	–0.35

(continued)

Table 1. (continued)

Borough	Geography	ID	Annual Average 2009	Annual Average 2010	Annual Average 2011	Annual Average 2012	Annual Average 2013	Annual Average 2014	Annual Average 2015	Annual Average 2016	Slope (Per Year Decline)
Brooklyn	East Flatbush (CD17)	317	10.6	9.9	10.2	9.1	8.7	9.1	8.7	7.79	−0.35
Bronx	Williamsbridge and Baychester (CD12)	212	10.6	9.6	10.4	9	8.7	8.9	9.1	7.46	−0.35
Queens	South Ozone Park and Haward Beach (CD10)	410	9.8	9	9.2	8.1	8	8.2	7.9	6.85	−0.35
Brooklyn	Crown Heights and prospect heights (CD8)	308	10.8	10	10.4	9.2	8.8	9.2	8.9	7.98	−0.35
Brooklyn	Borough Park (CD12)	312	10.3	9.6	10.1	8.9	8.8	9.2	8.9	7.98	−0.35
Brooklyn	Bensonhurst (CD11)	311	10.3	9.6	10.1	8.9	8.5	8.9	8.5	7.49	−0.35
Brooklyn	Brownsville (CD16)	316	10.8	10	10.3	9.1	8.8	9.2	8.9	7.97	−0.34
Queens	Jamaica and Hollis (CD12)	412	9.9	9.2	9.5	8.4	8.3	8.4	8.2	6.98	−0.34
Brooklyn	Coney Island (CD13)	313	9.4	8.8	9.5	8.3	8.1	8.4	7.8	6.78	−0.34
Brooklyn	Sheepshead Bay (CD15)	315	9.6	8.9	8.3	8.1	8.1	8.4	7.8	6.78	−0.34
Brooklyn	Bay Ridge and Dyker Heights (CD10)	310	10.2	9.4	10	8.8	8.4	8.8	8.4	7.39	−0.34
Staten Island	South Beach and Willlowbrook (CD2)	502	9.8	8.8	9.5	8.3	8.1	8.5	7.8	6.89	−0.34
Queens	Bayside and little Neck (CD11)	411	9.7	9	9.7	8.5	8.1	8.3	8.2	6.87	−0.34
Bronx	Throgs Neck and Co-op City (CD10)	210	10.5	9.5	10.4	9.1	8.7	8.9	9	7.51	−0.34
Queens	Queens Village (CD13)	413	9.4	8.7	9.2	8.1	7.9	8	7.9	6.53	−0.33
Brooklyn	East New York and Starrett City (CD5)	305	10.8	9.9	10.4	9.2	8.1	7.9	8	7.73	−0.33
Brooklyn	Bedford Stuyvesant (CD3)	318	9.8	9.1	9.5	8.3	8.2	8.5	8.1	7.08	−0.32
Brooklyn	Flatlands and Canarsie (CD18)	501	10	8.9	9.6	8.4	8.1	8.6	8.2	7.11	−0.32
Staten Island	St.George and Stapleton (CD1)	103	11.8	10.6	11.3	10.1	9.9	10.3	6.9	8.9	−0.32
Manhattan	Lower East Side and Chinatown (CD3)	302	11.6	10.5	11.3	10.1	9.9	10.3	9.9	8.9	−0.32
Queens	Ridgewood and Maspeth (CD5)	405	10.7	9.7	10.2	9.1	8.8	9.2	8.9	7.97	−0.31
Queens	Long Island City and Astoria (CD1)	401	10.7	9.4	10.4	9.2	8.9	9.2	9	7.82	−0.31
Brooklyn	Bushwick (CD4)	302	11.6	10.6	11.3	10.1	9.9	10.3	9.9	8.9	−0.32
Brooklyn	Fort Greene and Brooklyn Heights (CD4)	304	10.8	9.8	10.3	9.2	8.8	9.3	9	8.07	−0.32
Brooklyn	Sunset Park (CD7)	307	11.1	10.3	10.9	9.7	9.2	9.7	9.6	8.52	−0.31
Queens	Rockway and Broad Channel (CD14)	414	8.8	8	8.4	7.4	7.6	7.7	7.2	5.98	−0.31
Brooklyn	Park Slope and Carroll Gardens (CD2)	306	11.4	10.4	11.1	9.9	9.4	9.9	9.9	8.86	−0.29
Queens	Woodside and Sunnyside (CD2)	402	11.9	10.6	11.5	10.3	10.1	10.5	10.3	9.27	−0.28
Brooklyn	Greenpoint and Williamsburg (CD1)	301	12	10.7	11.6	10.4	10.1	10.6	10.6	9.55	−0.25

Table 2. Population and annual average concentration of TSP, SO_2 and NO_2in different megacities (Source Gurjar et al.[19]).

Megacities in 2000	Population ×1000	TSP(µg^{-3})	SO_2(µg^{-3})	NO_2(µg^{-3})
Tokyo	34,000	40	19	55
Mexico City	18,500	201	47	56
New York	18,000	27	22	63
Sao Paulo	17,500	53	18	47
Mumbai (Bombay)	16,000	243	19	43
Kolkata (Calcutta)	13,500	312	19	37
Shanghai	13,000	246	53	73
Buenos Aires	12,500	185	20	20
Delhi	12,000	405	18	36
Los Angeles (long beach— Santa—ana)	11,500	39	9	66
Osaka-Kobe	11,500	34	19	45
Jakarta	11,000	271	35	120
Beijing	11,000	377	90	122
Rio de Janeiro	11,000	139	15	60
Cairo	10,500	539	37	59
Dhaka	10,000	516	120	83
Moscow	10,000	150	15	170
Karachi	10,000	668	13	30

air pollution, that continues to be a severe public health concern.[31] A substantial body of prior research demonstrates that air pollution has a significant role in developing lung disease and worsens its effects in vulnerable populations worldwide, that include children, elderly, and people with poor socioeconomic status. Exposure to various outdoor air pollutants particulate matter (PM), Ozone pollution (O_3) and Nitrogen Oxide (NO_x) has the significantly increased asthma, chronic obstructive pulmonary disease (COPD), lung cancer, and respiratory infections and illnesses. Asthma, being of the most prevalent chronic disorders in children, it does not discriminate its effects on adults. Symptoms of asthma include chest tightness and pain, coughing, wheezing, shortness of breath. According to Roemer et al., roughly 7.6% of children under 16 years of age have asthma, while roughly 5.9% of those over the age of 15 have asthma.[32] According to Li's recent research, exposure to ambient PM2.5, PM10, SO_2, and NO_2 enhanced the probability of having active tuberculosis.[33] How can we reduce the negative impacts on human health brought on by respiratory diseases? To decrease the consequences of air pollution on human health and lung disease, continued monitoring is necessary.[31] Governments, corporations, energy-based companies, and the general public must collaborate globally to equally solve issues on national, and international levels—Table 2 provides air respiratory disorders.[34]

Circulatory diseases

The circulatory system also known as the cardiovascular system is one of the most crucial systems of any person's normal functionality. It is a continuous pathway of tubular system made up of veins and arteries that carries blood from the heart to the lungs to get oxygen, then sends oxygenated blood to the rest of the body. Recent studies have shown that the circulatory system's health can be negatively impacted by air pollution, that leads to emergency outpatient visit, hospital admissions for diagnosis of or worsen cardiovascular disease, hypertension, or another form of circulatory disease.[35] It is noteworthy that blood pressure is a component of the circulatory system, even though it is also linked to the nervous system. This may be because changes in blood pressure are related to impairment or damage to the circulatory system.[36]

Numerous studies have shown that exposure to ambient air pollution raises the risk of cardiovascular illnesses, with its being a significant leading cause of death worldwide. As well as recent studies conclude the correlation between air pollution and that air pollution and diabetes.[37] A great many epidemiological studies, controlled exposures in human subjects, in vivo animal models, and in vitro assays have demonstrated that oxidative stress plays a significant role in circulatory system diseases brought on by exposure to air pollution in terms of the intrinsic causes for the detrimental effects of air pollution on circulatory system health.[38] We can observe from the points described above that exposure to ambient air pollution has negatively affected our circulatory system. Table 3 provides a quick summary of the effect impact air pollution on circulatory illnesses.[34]

Nervous system diseases

The nervous system, which is mainly made up of nerve tissues, is the system that controls the body's physiological

Table 3. Health impacts from current PM_{25} exposure and benefits of reducing exposure in New York City.

Health Effect	Age Groups Affected (in years)	Annual Health Events Attributable to Current PM_{25} Levels	Annual Health Events Avoided if PM_{25} Levels were Reduced by 10%	Annual Health Events Avoided if PM_{25} Levels were Reduced to Cleanest Air of Any Large City
Premature mortality	30 and above	3200	350	760
Hospital admissions for respitory conditions	20 and above	1200	130	280
Hospital admissions for cardiovascular conditions	40 and above	920	100	220
Emergency department visits for asthma	Under 18	2400	270	580
Emergency department visits for asthma	18 and above	3600	390	850

Table 4. Health impacts from current O_3i exposure and benefits of reducing exposure in New York City.

Health Effect	Age Groups Affected (in years)	Annual Health Events Attributable to Current O_3 Levels	Annual Health Events Avoided if O_3Levels were Reduced by 10%
Premature mortality	All ages	400	80
Hospital admissions for asthma	Under 18	420	90
Hospital admissions for asthma	18 and above	450	90
Emergency department visits for asthma	Under 18	1800	370
	18 and older	2900	600

function. It's made up of two parts, the central and peripheral system, which is a crucial part of daily humans' actions. According to Table 4, air pollution is strongly linked to nervous system health, including poor sleep, sleep disorders, insomnia, Parkinson's disease, suicide attempts, and various eye illnesses. This serves as a warning to reduce air pollution.[39] Numerous studies have revealed that long-term exposure to ambient air pollution plays a negative role on the nervous system. With illnesses that included suicide attempts, vascular dementia, illnesses and disease of the eyes, cognitive performance and the interpretation of false reality disorder: Schizophrenia.

Urinary diseases

The health of the urinary system is also impacted by air pollution.[34] The majority of studies have concentrated on how air pollution affects renal function. Additionally, more research should be done on how air pollution affects urinary system illnesses.

Impact of air pollution on human health in the vulnerable population in New York City children, adults

People in low-income communities, where air pollution is often most vital. Children along with the elderly, are particularly severely struck with health concerns brought on by air pollution. Measuring air pollution and its effects on health is essential policy and action that can improve a city's air quality. With an estimated 6% of annual deaths being attributed to air pollution, it is one of New Yorkers' biggest environmental dangers. The New York City Department of Health and Mental Hygiene employed procedures created in the United States in a recent study to determine the effect of air pollution on the number of fatalities, hospital admissions, and emergency room visits in NYC that are brought on by exposure to PM2.5 and ozone at present concentrations.[40] Health Department estimates that PM2.5 pollution in NYC results in more than 3000 annual deaths, 2000 hospital admissions for heart and lung problems, and roughly 6000 emergency room visits for asthma in children and adults, as shown in Table 2 of the NYC Environmental Protection. While achieving to aim for "significantly cleanest air city," New York City would have by far the higher public health advantages. A modest 10% reduction in current PM2.5 levels might avert more than 300 premature deaths, 200 hospital admissions, and 600 emergency room visits yearly.[20] According to Table 3 of NYC Environmental Protection,[40] ozone is responsible for an estimated 400 total fatalities, more than 800 hospital admissions, and more than 4000 trips to emergency rooms amongst both adults and children. More than 80 premature deaths, 180 hospital admissions, and 950 emergency room visits might have been avoided yearly if ozone levels are reduced by 10%.[20] According to other Health Department estimations, elderly persons, children and adults with asthma, and residents of low-income areas are dealing with the ramifications of polluted air in New York city. Tables 2 and 3 of New York city[20] show that even small decreases in the pollutants' levels could avert hundreds of fatalities, hospital admissions, and emergency room visits.[20] The study demonstrates that, despite improvements in air quality, air pollution still poses one of the greatest environmental dangers to New Yorkers, accounting for about 6% of annual fatalities. Important local pollution sources must be addressed to lower this toll.[20]

Comparison of air pollution in New York City versus populated cities of the US and around the world

In a research done by, IQAir that indicated 97% of American cities did not exceed WHO air quality standards, NYC was deemed the eighth most polluted city in the United States.[41] With strict laws and enforcement from the state's proactive air pollution control program, that implements controls permitting and imposing emissions restrictions. With the restrictions in place the NYC metro region has reduced its PM2.5 pollution by 40% over the last 20 years (New York State Department of Environmental Conservation, Air). Sewer overflows, runoff, land pollution from plastic bottles and rubbish, and air pollution are the leading causes of pollution in NYC. The city has come up with creative solutions to some of these concerns in recently years, like deploying hybrid buses and city cars to cut emissions. Nearly half of the city's total greenhouse gas emissions in NYC come from burning fuels for space and water heating. Los Angeles (LA) was the city with the most significant pollution in 2021, per IQAir.[42] PM2.5 is often known as aerosol particles harmful to human health. LA exceeded the permissible threshold limit for PM2.5 levels, that were measured more than two times (13.7 μg) the limit. According to Dr. Christi Schroeder, manager of IQAir's quality science program, "We're witnessing steadily rising concentrations of PM2.5, and in some of the most populous areas in the United States, we're actually back to pre-pandemic levels." "levels," IQAir's quality science manager, Dr. Christi Schroeder, said. Despite being the most inhabitants in the US, NYC typically has reasonably clean air. The severity of wildfires is getting worse, along with the burning of fossil fuels and automobile pollutants, all of which contribute to the bad air quality in NYC.

Comparison of health impacts of air pollution in New York City versus populated cities of the US and around the world

Megacities are huge urban sprawls that struggle with numerous environmental issues, such as skyrocketing air pollution emissions.[16,17] Megacities are frequently in high-risk zones, making their residents susceptible to the negative health effects of air pollution.[18,19] To help launch national and international efforts to improve the sustainability of megacity life around the world, such dangers need to be quantified. A spreadsheet model called Risk of Mortality/Morbidity due to Air Pollution (Ri-MAP) is used to assess the excess numbers of deaths and illnesses in megacities. I analyzed the health hazards in megacities in terms of mortality and morbidity related to air pollution.[43] The authors used the WHO's recommended limits for the air pollutants SO_2, NO_2, and total suspended particles (TSP), and they looked into concentration-response connections and the idea of population attributable-risk proportions. According to Gurjar et al. findings, the total excess cases of mortality from these pollutants are extremely rare in some megacities, including Los Angeles, New York City, Osaka, Kobe, Sao Paulo, and Tokyo. Karachi, on the other hand, has the greatest annual rate of cases (15,000), which is distinguished by a very high concentration of total TSP. The cities with the greatest rates of cardiovascular death include Dhaka (7000/yr), Beijing (5500/yr), Karachi (5200/yr), Cairo (5000/yr), and Delhi (3500/yr). The cardiovascular mortality trend is paralleled by the morbidity caused by COPD. The most urgent need for improvement in air quality is in the megacities of South Asia, where excessive mortality and morbidity from abnormally high levels of air pollution are a major health threat. When compared to straightforward air quality indices, the risk estimations used from Ri-MAP provide a realistic baseline assessment for the effects of ambient air pollution. The estimations from the Ri-Map can also be extended upon and enhanced when air pollution monitoring networks are built. The effects of air pollution emissions in megacities have been the subject of numerous research. For instance, Gurjar et al. examined and classified megacities based on their ambient air quality, traces of gas emissions, and particle emissions. By calculating the Multi Pollutant Index (MPI) for the 18 major megacities in the world, the effects of air pollution are highlighted in the MPI. The megacities in various developing countries of Asia, notably Dhaka (Bangladesh) and Karachi (Pakistan), concluded to have some of the worst air quality. This ranking is based on the overall effects of air pollutants integrated inside the MPI. The work did not yet calculate the direct health effects of air pollutants in terms of mortality or morbidity attributable to specific contaminants to assist in the definition of efficient pollution management methods. Pulmonary mortality in Figure 1 depicts the increased number of respiratory-related deaths projected using the Ri-MAP model because of the combined impact of the three pollutants taken into consideration (TSP, SO_2 and NO_2). In this category too, are similar tendency is seen, but there aren't any extra cases in LA, NYC, Osaka, Kobe, Sao Paulo, or Tokyo. On the other hand, Dhaka (2100 cases annually) and Karachi (2100 cases annually), together

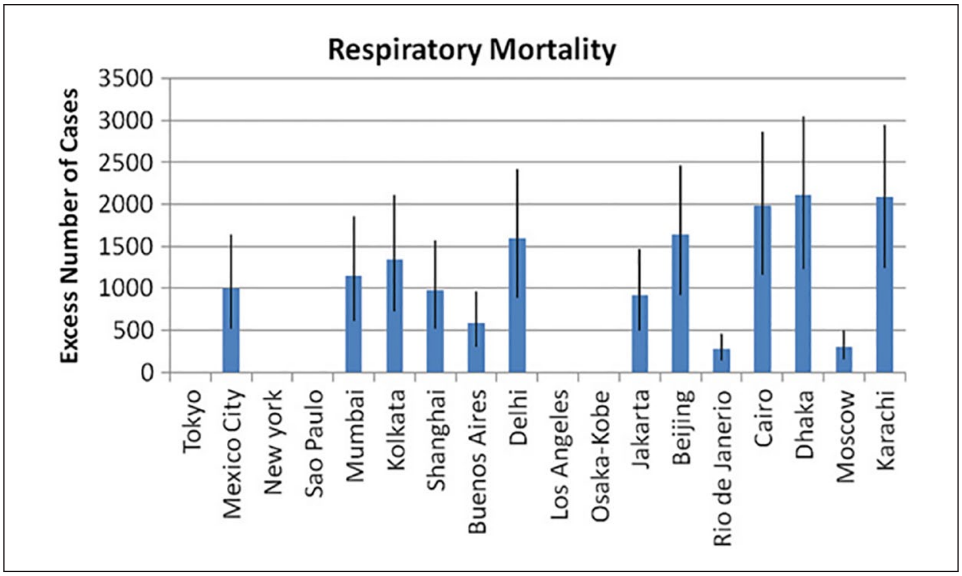

Figure 1. Excess number of cases "DN(c)" of respiratory mortality/year represenatative of the late 1990s/2000. Source Gurjar et al.[43].

with Beijing (1600 cases annually), Delhi (1600 cases annually), and Kolkata (1300 cases annually), show the largest number of cases. The Ri-MAP's purpose is to analyze the health hazards in various megacities, and then rank according to the levels of air pollution, drawing on the case study of the megacity Delhi. We have mainly used ambient air quality data available for the late 1990s and 2000 due to the absence of reliable data for ambient air pollutant concentrations in the megacities for the period after 2000. The reported estimates in Table 2 may be viewed as a lower limit, particularly for megacities in emerging nations, given the expansion in populations, economic activity, and related urban air pollution over time.[43] We used the Ri-MAP model to analyze the health hazards in various megacities and then rank them according to the levels of air pollution, drawing on the case study of the megacity Delhi. We have mainly used ambient air quality data available for the late 1990s and 2000 due to the absence of reliable data for ambient air pollutant concentrations in the megacities for the period after 2000. The reported estimates in Table 4 shows a lower limit, particularly for megacities in emerging nations, given the expansion in populations, economic activity, and related urban air pollution over time. The population and yearly average concentration of TSP, SO_2, and NO_2 in several megacities used in Ri-MAP are shown in Table 2. Drawing on the case study of the megacity Delhi, we used the Ri-MAP model to examine the health risks in other megacities and then rank them according to the levels of air pollution. Due to the lack of trustworthy data for ambient air pollutant concentrations in the megacities for the time period following 2000, we have mostly used ambient air quality data that were available during the late 1990s and 2000. Given the long-term increases in urban air pollution due to economic activity, population growth, and megacities in emerging countries, the published figures limitations resulted lower. Table 2 displays the population and annual average concentration of TSP, SO_2, and NO_2 in several megacities used in Ri-MAP. The work determined the excess number of fatalities (i.e. total mortality) by taking into consideration the combined effects of the three criterion air pollutants (TSP, SO_2 and NO_2). Megacities like Osaka, Kobe, Sao Paulo, Los Angeles, New York City, and Tokyo exhibit a very low number of excess cases since the Ri-MAP model only assesses the influence of pollutants above the WHO guideline level (WHO[44],WHO[45],WHO[46]). Karachi has the highest excess case rate (15,000/yr), along with the highest TSP concentration, even if the SO_2 and NO_2 concentrations are not the highest. It is hypothesized that Karachi may be impacted by high concentrations of primary particles (such road dust) and organic compounds from the use of biofuel and biomass burning. These chemicals (sulfate and nitrate) are significant precursor gases for aerosols. The top five megacities on that list after Karachi are Dhaka (14,700 per year), Cairo (14,100 per year), Beijing (11,500 per year), and Delhi (10,500 per year). As a result, compared to other megacities, these cities are characterized by a higher health risk from air pollution. Figure 2 displays the 95% confidence interval's ranges for the surplus cases.

Comparison of asthma children versus asthma adults in New York City

There are also additional factors that help to lessen the negative health effects of air pollution on US people, like pregnant women eating more seafood.[6] However, Lissaker

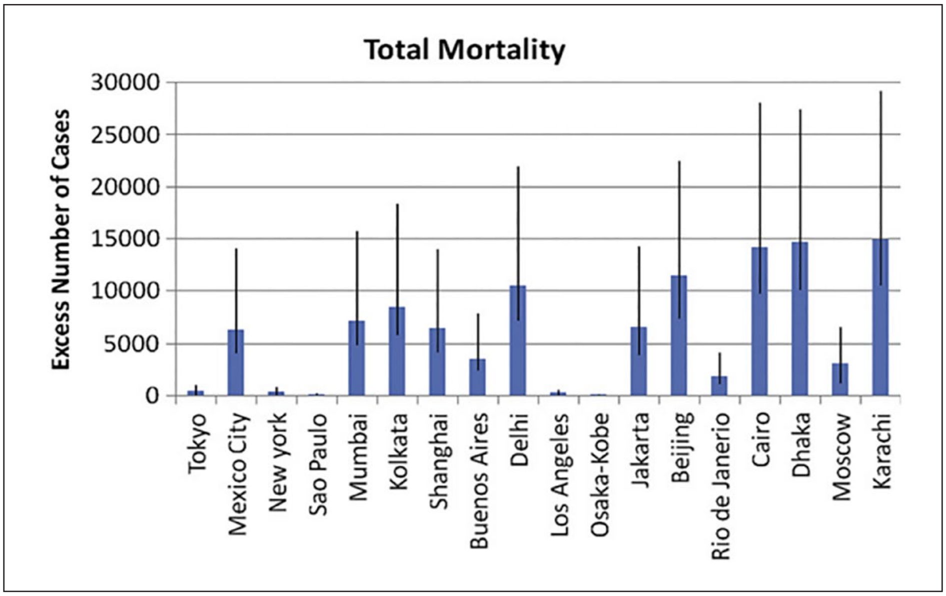

Figure 2. Excess number of cases "DN(c)" of otal mortality/year represenatative of the late 1990s/2000.
Source Gurjar et al.[43].

et al. pointed out that Jedrsychowski study has several drawbacks because there is a dearth of data on attitudes toward air pollution.[2] For example, people with a history of asthma that began several years before the study may be less concerned about air pollution and less likely to act than people who have only recently been diagnosed with the condition. For instance, a school-based sample found that 15.5% of 4–5-year-old Bronx children had asthma, compared to 9.2% of NYC students overall and 8.9% of US kids between the ages of 2 and 17.[47] Children in the Bronx have significantly higher rates of asthma morbidity than children in other US cities. According to Tables 3 and 4, which are based on 2005–2007 data on air pollution, mortality and illnesses, from the NYC Health article, more than 1.1 million adults in NYS suffer from asthma.[48] Asthma has no age restrictions, although children are more likely than to be infected by it than adults. Asthma disproportionately affects Black and Latino/a children nationwide and in NYC, as well as those who live in high-poverty areas.

In the Bronx, 17% of children age 13 and under have been diagnosed with asthma compared to 11% of NYC children aged 13 and under who has asthma.[48] In a number of high-poverty areas of the Bronx, at least two-thirds of the locals are persons of color. Compared to the rest of NYC, these areas consistently have the greatest rates of asthma-related morbidity.[47] High poverty areas frequently have subpar housing that is not maintained, exposing individuals to various environmental asthma triggers such as rodents, dust, mildew, and smoking.[47] The frequency and severity of asthma symptoms and exacerbations may then be increased because of these environmental triggers. Other well-established asthma risk factors, such as household exposures, may contribute to differences in asthma-related outcomes in low-income populations. High poverty communities may not receive the best care and treatment for asthma because of environmental injustice, neighborhood-level economic and social stressors like stress, crime, poverty, and an unequal health care system.[47] High poverty areas have higher rates of emergency room visits, where acute asthma episodes are treated but controller drugs for managing asthma and preventing subsequent episodes are sometimes not administered. Due to a lack of continuity of care between the emergency room and primary care physician, episodic management of asthma may result. Additional impediments to excellent care are created by issues like language barriers, cultural differences, and low health literacy, which can result in poor treatment adherence.[47]

Alternatively, there is also a growing interest in quantifying the health impacts of climate change. Chang et al. examined the risks of future ozone levels on non-accidental mortality across 19 urban communities in Southeastern United States.[49] The work presented a modeling framework that integrates data from climate model outputs, historical meteorology and ozone observations, and a health surveillance database. Future ozone concentrations for the period 2041–2050 were then projected using calibrated climate model output data from the North American Regional Climate Change Assessment Program. In the same vein, Sujaritpong et al. has predicted the climate change to affect future air quality, with inevitable consequences for health.[50] Quantifying the health effects of air pollution under a changing climate is crucial to provide

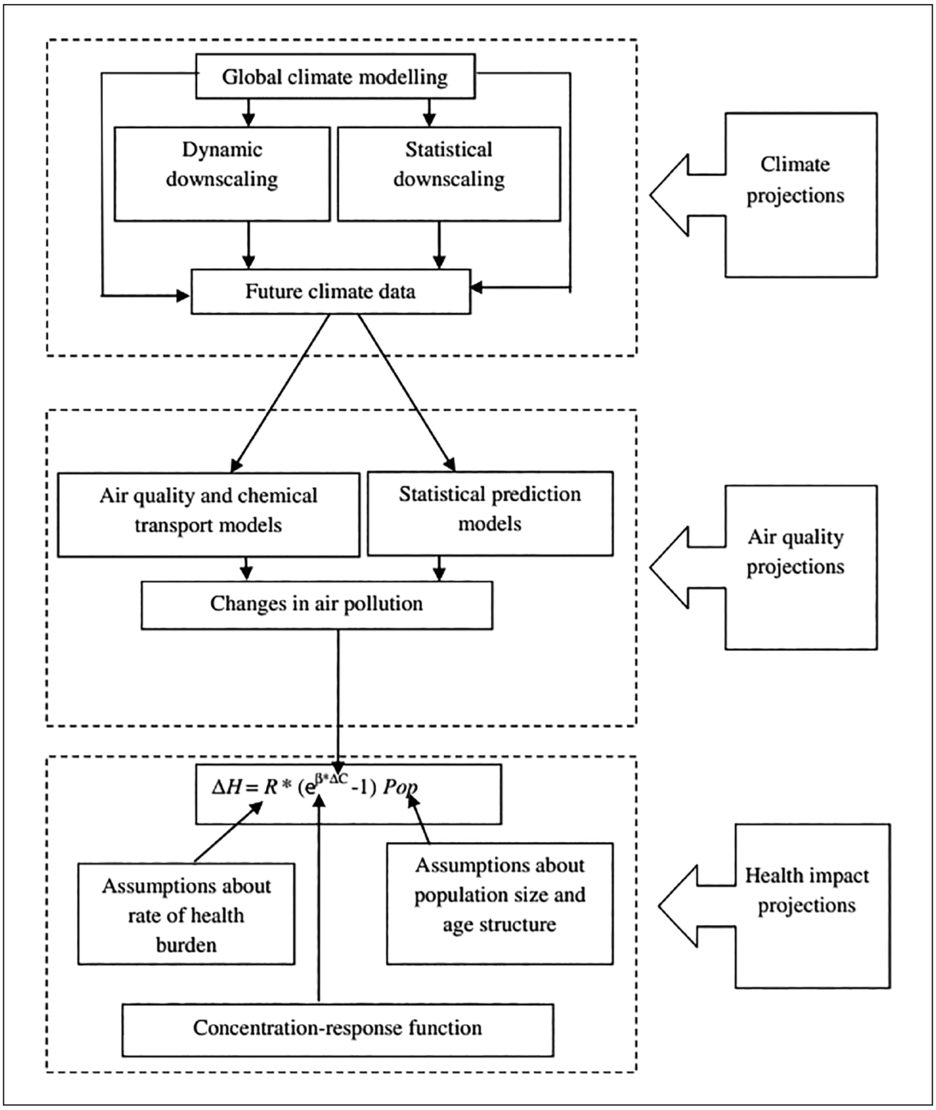

Figure 3. Major steps for projecting health impacts associated with air pollution and climate change (from Sujaritpong et al.[50]).

evidence for actions to safeguard future populations. Sujaritpong identified knowledge gaps for future research include future health impacts from extreme air pollution events, interactions between temperature and air pollution effects on public health under a changing climate, and how population adaptation and behavioral changes in a warmer climate may modify exposure to air pollution and health consequences. The health impacts of air pollution are likely to be modified by climate change,[51] due mainly to the exposure of populations to raised levels of air pollutants such as volatile organic compounds, O_3 and some components of secondary particles. Moreover, Bell et al., and Ren et al. suggest recent epidemiological evidence where temperature may modify the effects of ozone on mortality and several studies by Armstrong et al. and Kalkstein et al, have examined the adverse health impacts of future temperature and heat waves.[52–55] Assessing the joint impact of temperature and air pollution due to climate change is an important future research direction. Figure 3 show some major steps for projecting health impacts associated with air pollution and climate change.[50] In Figure 3, ΔH is the Change in health outcome resulting from changes in air pollution exposure, R is the baseline annual mortality or morbidity rate, and β is the log relative risk associated with a unit change in air pollution exposure. ΔC estimates the change in air pollution concentration, and future exposed population.

Policy solution on prospective of the issues to reduce air pollution

New York City policy solutions: Ordinance successes and failures. NYC Air Pollution Control Code (Air Code) preserves, protects, and improves the air resources of the City of New York.[40] The city's policy claims that every person must be entitled to air that is not harmful to life, health, and enjoyment of their property. The NYC Department of Environmental Protection (DEP) is a city agency whose primary purpose is to manage and protect the city's water supply. Another role the DEP plays is regulating air quality. The DEP is responsible for updating and enforcing the Air Code that ultimately improves the air resources of the city.[56]

The City of New York's air resources are preserved, improved, and protected under the NYC Air Pollution Control Code (Air Code).[40] According to the city's policy, everyone must have the right to clean air and enjoyment of their property. The management and protection of the city's water supply is the main responsibility of the NYC Department of Environmental Protection (DEP). The DEP is also responsible for controlling air quality. The DEP oversees keeping the city's air resources up to date and enforcing the Air Code.[56] DEP is also in charge of processing and enforcing several Air Code requirements, including those pertaining to equipment applications, renewal requests, applications for new boilers and heating equipment, and compliances. NYC has recently taken a few steps to reduce emissions from local sources of pollution, including the passing of legislation to control emissions from a variety of sources, such as idling vehicles, privately operated diesel-powered sightseeing buses, school buses, and the municipally owned and operated heavy-duty fleet, which includes sanitation trucks and other diesel-fueled vehicles.[57] The city's first sustainability strategy, PlaNYC 2030, was introduced in 2007 by Mayor Michael R. Bloomberg of New York City, to improve the environment and the quality of life of New Yorkers. A vast project known as PlaNYC were created in response to the Department of City Planning's 2006 prediction that NYC's population would increase by one million people by the year 2030. The plan's 10 sustainability objectives were divided into six categories: land, water, air, transportation, energy, and climate change. Each PlaNYC goal was supported by a number of projects and sub-initiatives that sought to attain that goal.[58] The NYC Community Air Survey (NYCCAS), the largest thorough street-level air monitoring survey in the U.S., was started by the Mayor's Office of Long-Term Planning and Sustainability (OLTPS) and the NYC Department of Health and Mental Hygiene in an effort to understand the City's current boiler installations. Prior to this initiative, the Environmental Protection Agency (EPA) and Department of Environmental Conservation (DEC) carried out air pollution monitoring by looking at overall average concentrations on a large regional scale, which was better suited to depicting general trends than to measuring human exposure. To further understand neighborhood level variances, the Mayor's OLTPS and the NYC Department of Health and Mental Hygiene agreed to obtain an enhanced measurement of human exposure to air pollutants in PlayNYC. It was acknowledged that not all New Yorkers were equally affected by changes in air quality, despite tremendous advances in this area. In order to enhance the air quality and, by extension, the health of New Yorkers in every community, required better and accurate monitoring of human exposure to air quality.

New York state policy solutions: Ordinance successes and failures

The air quality in major cities around the world. On March 1, 2020, the first incidence of COVID-19 in NYS was confirmed, and on March 20, the NY governor formally declared "New York on President Lyndon Johnson signed the Clean Air Act into law on December 15, 1963." Since then, it has acted as one of the principles guiding air quality in the US. The Clean Air Act (CAA) has undergone significant amendments over time, reflecting the best practices of the eras in which they were passed. The Environmental Protection Agency (EPA) is responsible for enforcing the CAA, which places restrictions on specific air pollutants, including the maximum amount that can be present in the air nationwide.

Since the enforcement and improvements of the CAA, reduction levels of common pollutants, harmful air pollution, ground-level ozone, and lead pollution were the result of the considerable modifications mandated by this comprehensive federal law and subsequent amendments in later federal legislation. According to a 2018 analysis, the original legislation and CAA revisions may have contributed to a 60% decline in manufacturing industry emissions between 1990 and 2008.

The first of its kind in the United States, a new statewide community air monitoring effort was unveiled by NYS Governor Kathy Hochul on September 21, 2021.[59] According to Governor Hochul, this new initiative will use cutting-edge technology to assess the air quality in communities throughout New York State and will collaborate with experts to identify the most effective ways to reduce pollution in order to address the injustice that has for too long burdened vulnerable areas of our state. In areas that have historically been overwhelmed by pollution, NYS will conduct hyperlocal air quality evaluations and develop customized plans to reduce both air pollution and climate-changing greenhouse gases. All New Yorkers will benefit from the State's greenhouse gas reduction measures under its historic Climate Leadership and Community Protection Act, which will be overseen by the State DEC and the NYS Energy Research and Development Authority. The Climate Leadership and Community Protection Act (Climate Act) was ratified on July 18, 2019.[60] The air monitoring initiative, which was announced during Climate Week 2021, supports New York's ambitious plan to reduce greenhouse gas emissions by 85% by 2050 and safeguard public health. In December 2019, a brand-new, and dangerous virus called, coronavirus (COVID-19) surfaced in

Wuhan, China. The first confirmed COVID-19 case in the United States happened January 21, 2020. Due to the virus's contagiousness and rapid growth, some governors in the US issued executive decrees to try and stop the illness from infecting more people. NYS was one of the states that used such tactics.[61] According to numerous reports, the government-sponsored shutdowns were implemented. This executive order stipulated tactics like stay-at-home orders, lockdowns, social seclusion, and complete elimination of on-site employment at non-essential firms. On April 4th, when the NYS outbreak peaked, there were up to 12,000 new COVID-19 cases reported each day.[62]

Proposed solutions: Actions to control air pollution, policy, services, education, and data provided by the US Government

Reduced energy usage at home and employment will assist to lessening air pollution levels. In the ideal scenario, the thermostat for the air conditioner should be set to 78 degrees or low cold in the summer. With thermostat for the heat should be lowered in the winter as well. Both the city's rule against idling cars and its drive to minimize pollution and encourage energy conservation must be adhered to the law of idling vehicles.[40] No individual shall permit the engine of a motor vehicle to idle for more than 3 min when parked, standing, or stopping, according to NYC Administrative Code, Title 24, Section 24-163.[57] With some exemptions to this rule, being a legally permitted emergency vehicles and vehicles, whose engine drives a loading, unloading, or processing mechanism are exempt from the rule.

The public's exposure to hazardous pollutants, which have been linked to a wide range of unfavorable health effects, would be significantly impacted by the regulations NYC and NYS established to reduce soot pollution and improve air quality. Regulations adopted by NYC and NYS are heavily influenced by environmental monitoring data from the NYC Department of Health and Mental Hygiene's NYC Community Air Survey (NYCCAS).[48] Government agencies are increasingly in need of scientific advisors due to the increased significance of science in decision-making. Analysis of monitoring data has become a more important component of environmental policy, and such data have significantly contributed to the current air quality environment.[63] A quantitative assessment of the risk to public health is necessary for developing policies. For the reason that, consequences for air quality regulation, several studies have been committed to determining background pollution amounts that are significant for policy.[64] It is vital to know the background of ambient pollution levels in order to calculate human exposure and to compare with subsequent data in order to measure and monitor progress.

The evidence for the harmful effects of PM2.5 and ozone as studies have shown does not easily portray the public health dimensions of the air pollution problem and the comparison to other challenges facing the city.[20] There are numerous estimations, which cannot capture the human toll behind the statistics—frightening trips to the emergency room for children with asthma and their families, heart attacks and disabling strokes, and the untimely deaths of loved ones. In one of the World Health Organization's studies, outdoor particulate air pollution is responsible for 800,000 premature deaths globally each year.[65] The city's air quality has improved in recent decades, air pollution causes 6% of annual deaths in the city each year, making it one of the most significant environmental health problems. Furthermore, air quality improvements will have significant and immediate health benefits only to reduce smoking rates, among preventive measures taken by the city in its initiative to find a potential solution. The toll reduction from air pollution, needed to address important local sources, such as motor vehicle exhaust, building heating oil, and aging power plants with outmoded technology. As per the city's sustainability plan, PlaNYC, and many emission reduction initiatives have been completed or launched and others planned. The steps needed will produce many benefits beyond health in helping to reduce greenhouse gas emissions. Investments and behavior changes are also needed to benefit New Yorkers' to understanding of the burden of air pollution on their health. The health benefits of addressing the issue and the costs of inaction[20] environmental and climate policies will reduce fossil fuel emissions and the criticism for lack of equity in the distribution of health and economic benefits.[42] Perera et al. used the national citywide air quality improvement scenario across the city and did not assess the differential impact of specific emission reduction strategies on disadvantaged neighborhoods.

It will be important to ensure that NYC clean air and climate action measures, such as the Transportation and Climate Initiative, the planned NYC Congestion Pricing Plan, Low Emissions Zones, and other policies aimed at reducing emissions from transportation and other sources, are implemented in ways that provide equal or greater benefits and mitigate any potential harm to disadvantaged communities. While systemic changes and comprehensive equity-centered policies address issues of healthcare access, housing, education, and labor to address stark disparities in health outcomes in communities of color and low-income communities.[66] Recently, Shukla et al. developed a new ZIP Code-Level Air Pollution Policy Assessment (ZAPPA) tool for NYC by integrating two reduced form models Community Air Quality Tools (C-TOOLS) and the Co-Benefits Risk Assessment Health Impacts Screening and Mapping Tool (COBRA) that propagate emissions changes to estimate air pollution exposures and health benefits.

Shukla et al. demonstrated how ZAPPA can be used to compare estimated health savings from proposed policies, and support emissions-based sensitivity analyses for the development of new policies. While ZAPPA makes a significant advance in estimating concentrations of primary pollutants at high resolution from local sources in other reduced form models, we notice limitations which estimate secondary aerosols due to various simplifying assumptions about the emissions to air quality relationships.[67] ZAPPA has several unique benefits compared to typical chemical transport models including resolution, efficiency, ease use, and integrated assessment that, make it a powerful tool for comparing policy options and ensuring that benefits are distributed equitably. ZAPPA can be expanded to other cities in the U.S. and the world for assessing PM2.5-based health impacts, designing emissions reduction scenarios, and to further identify vulnerable populations with disproportionate exposures to air pollution sources. Specifically, future extensions of ZAPPA can add emerging knowledge on new adverse health impacts of exposure to PM2.5 and incorporate treatment for additional pollutants, such as NO_2 from combustion sources, which are also known to cause adverse human health impacts.[68]

Conclusion: Effectiveness of the solutions

In conclusion, NYC has made significant progress in assessing air quality, mandating reductions in heating oil emissions at city and state levels, and lowering pollution from construction vehicles, school buses, ferries, and private trucks. However, despite years of improvement, air pollution in New York City is still a paramount concern. The availability of scientific data is primarily responsible for the integration of economic factors, good communication, and multiple tactics inefficient policy decisions. Data is required to analyze the effectiveness of reducing air pollution, as well as to provide a gage of potential human exposure and potential health effects.[69] The NYC Community Air Survey is a very thorough undertaking that helped shape the state and city policies that's following and progressing to complete the targeted measures under PlaNYC that lower levels of smog in the entire city and lessen variation between communities. Charles-Guzman identifies elements that contributed to the effective implementation of the most thorough air quality strategy NYC had seen in more than 30 years.[70] Which includes the availability of an affordable technical solution, the contribution of research to the conceptualization of the problem, the development of policy networks, and the function of institutions and regulation (governance). I suggest that prior to, during, and after the policy creation process, stakeholder engagement should be increased. This will help to create win-win environmental policies that can be put into action in the short, intermediate, and long terms.[71-87]

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