New York City Air Quality by Neighborhood and Income

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Problem

Scope:

Large metropolitan areas around the world struggle with mitigating unhealthy and worsening air pollution. These pollutants, particularly NO_2, exacerbate cardiovascular diseases and cancer, posing stark risks to large populations. New York City in particular is home to 8.2 million people, and millions of pollution cars, businesses, and industries. Because of this, air quality improvements and legislations are crucial for keeping pollution at bay and protecting public health.

Purpose of the Study:

- Identify factors that contribute to the worsening or improving air quality in Manhattan to better recognize future opportunities for environmental legislation and improvement.
- Analyze the relationship between air quality, time, and economic privilege.

Background

Research Gaps:

- Limited focus on long-term, neighborhood-specific trends in pollutant exposure.
- Socioeconomic factors often excluded from policy evaluations.

Study Objectives:

- Combine spatial and temporal analysis of pollution data.
- Evaluate the connection between air quality disparities and income levels.
- Identify trends between air quality, income, neighborhoods, time, and legislations.

Approach

Data Collection:

- Air pollutant concentration (NO_2, $PM_{2.5}$) and socioeconomic data by neighborhood.
- Sources: NYC air quality reports and census income data.

Analysis Techniques:

- Linear regression, temporal trends analysis, and regression modeling to correlate income and pollutant levels.

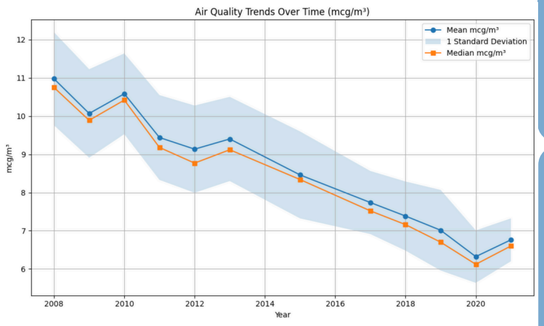
Modeling:

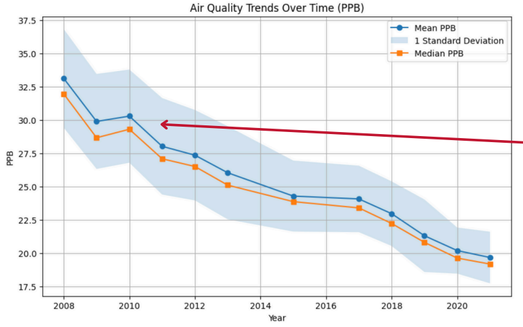
- Used quadratic regression to predict air quality trends (2009–2030).
- Used linear regression to determine a relationship between median income and pollutant concentration for given neighborhoods.

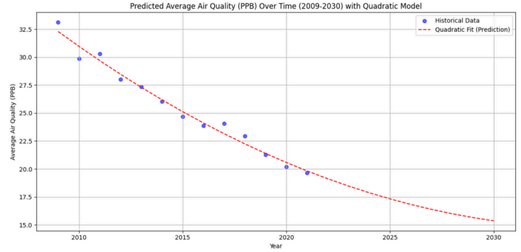
Visualization:

- Scatter plots, bar charts, quadratic models, and linear models for analysis.

Air Quality vs. Time







Key Findings

Key Findings:

- A positive linear relationship between PPB concentration and annual median income
  - Suggests that wealthier neighborhoods actually have lower quality air.
- Strong negative trend in air pollutant concentration over time in all neighborhoods in NYC
  - Suggests working improvements to air quality and public health.

Evaluation

Predictions:

- High demand and high density neighborhoods are often more expensive, meaning residents have a higher income, which could contribute to the higher pollutant concentrations in those areas.
- Citywide air quality improves overall, but neighborhood disparities remain.

Future:

- As shown in the "Air Quality Trends Over Time" tables, air quality showed a significant improvement from 2010-2011, which can be attributed to the "Clean Heat Program" which mandated conversion from No. 6 oil in boilers to cleaner burning fuel sources. This greatly limited various harmful pollutants from entering the air [1].
- Similar legislation in the future has the potential to further improve air quality, in New York as well as other places.

Implications

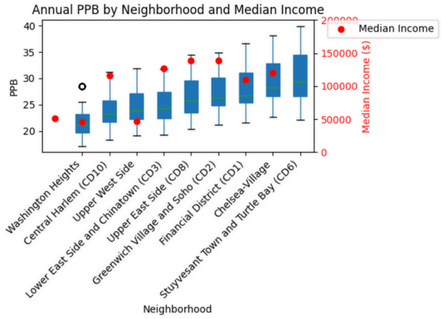
Policy Recommendations:

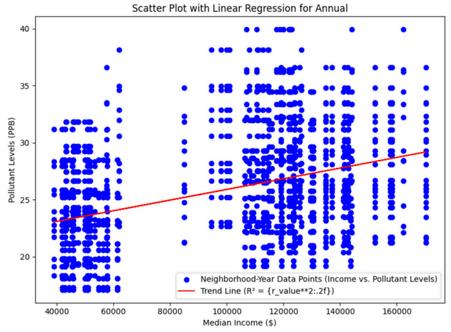
- Future policies should focus on addressing environmental inequities by prioritizing interventions in neighborhoods with persistently high pollutant levels.
- Socioeconomic factors must be integrated into urban planning and environmental legislation to ensure equitable outcomes.

Future Research Direction:

- Further studies should expand the scope to include additional pollutants and explore borough-wide trends for a comprehensive understanding of air quality disparities.
- Investigating the long-term health impacts of pollutant exposure in vulnerable neighborhoods could support more robust public health initiatives.
- Investigating other metropolitan areas to determine if these trends persist in other locations.

Neighborhood Air Quality vs. Median Income





Slope: 4.675809546034031e-05
Intercept: 21.21916766024822
R-squared: 0.14017290484392886
P-value: 3.1647249440609816e-58
Standard Error: 2.7972090911900947e-06

References

[1] Lau, Kathleen, et al. "Major Air Pollution and Climate Policies in NYC and Trends in NYC Air Quality 1998–2021." Frontiers, Frontiers, 30 Sept. 2024, www.frontiersin.org/journals/public-health/articles/10.3389/fpubh.2024.1474534/full.
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[3] Mananga, Eugene S, et al. "The Impact of the Air Pollution on Health in New York City." Journal of Public Health Research, U.S. National Library of Medicine, 29 Nov. 2023, pmc.ncbi.nlm.nih.gov/articles/PMC10687960/.
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