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Transportation, Decarbonization, & Urban Environmental Change:

Evidence from Traffic, Air Pollution, and Heat Trends in New York City, 2010-2024

SUMMARY

Cities are increasingly expected to decarbonize transportation while also improving public health and preparing for climate risks. This paper synthesizes evidence from the analysis combining: citywide traffic activity (2014–2024), traffic intensity by city council district (2014–2024), and citywide environmental indicators, fine particulate matter (PM2.5), nitrogen dioxide (NO2), transportation greenhouse gas emissions, and annual mean temperature (2010–2024).

Three distinct trends emerge from the analysis. The first trend is related to the disruption caused by the pandemic's travel restrictions beginning in 2020. There was a significant drop in vehicle movement at the same time as a rapid increase in greenhouse gas emission reductions. A second pattern, which has been present since the start of 2018, involves a steady decline in both particulate matter (PM2.5) and nitrogen dioxide (NO2), which is directly tied to reduced greenhouse gas emissions from transportation. This trend appears to be a result of technological advancements, combined with policy initiatives. The third trend is related to PM2.5 levels increasing significantly during the summer of 2023 due to wildfires in the western U.S. During this time, there were increased asthma-related emergency room visits reported in New York, demonstrating how climate-related hazards can reverse local benefits gained through low-emission technologies and policies.

These three trends collectively demonstrate a "co-benefit" approach; reducing greenhouse gas emissions through transportation decarbonization can lead to improved air quality and climate mitigation; however, long-term health improvements will depend on specific corridor-based planning approaches within high-traffic areas as well as resilience measures against heat and smoke shocks.

RAW DATA SOURCE

- Traffic (Vehicle Counts / Volume)
  NYC Department of Transportation (NYC DOT)
- PM2.5 (Fine Particulate Matter)
  NYC Community Air Survey (NYCCAS)
- NO_2 (Nitrogen Dioxide)
  NYC Community Air Survey (NYCCAS)
- GHG (Transportation GHG – CO_2e)
  NYC Greenhouse Gas Emissions Inventory (Mayor's Office of Climate & Environmental Justice)
- Heat/Temperature (°C / °F)
  Meteostat Climate Data
- Spatial Mapping (Council Districts)
  NYC Open Data (Department of City Planning)
- Heat Vulnerability (Context / EJ layer)
  NYC Department of Health and Mental Hygiene (DOHMH)

INTRODUCTION

Transportation provides access to work, education, healthcare, and social life, yet it also shapes the urban environment through emissions, noise, and heat exposure. According to the Intergovernmental Panel on Climate Change (IPCC), transportation is one of the key areas for reducing greenhouse gas emissions by decreasing travel time or by adopting cleaner technologies more quickly (IPCC, 2022). As stated in the U.S. Environmental Protection Agency's (EPA) inventory of all sectors' GHG emissions, the transportation sector accounts for the most GHGs in the country (EPA, 2026). Because NYC is so densely populated, this issue is particularly relevant. For example, many of the main transportation corridors throughout NYC have high volumes of truck traffic and/or large numbers of passengers. These corridors also serve as conduits for pollutants to reach nearby residential buildings, offices, and educational institutions.

Two types of pollutants have well-established connections to transportation. Combustion-related pollution is a primary source of nitrogen dioxide (NO2), which tends to increase closer to heavy-traffic roadways; thus, the EPA recommends limiting exposure to pollutants located "in close proximity to busy streets," due to potential increased risk to public health (EPA, 2014). Particulate matter less than 2.5 microns (PM2.5) is a complex mixture from multiple sources (including vehicles, building boilers, and regional pollution transport) and has strong causal evidence linking exposure to cardiovascular and respiratory harms (EPA, 2019). Since 2021, the World Health Organization has recommended an annual mean PM2.5 guideline of 5 $\mu g/m^3$, reflecting evidence that adverse effects occur even at relatively low concentrations (WHO, 2021).

Urban policy must also contend with climate risks. The New York City Panel on Climate Change concludes that NYC is warming and faces increasing extreme-heat risk, with substantial public-health implications (NYC PCC, 2024). Climate change also amplifies wildfire smoke risk. During June 2023, smoke from wildfires in Canada drove widespread "unhealthy" and "very unhealthy" air quality across the region; a Centers for Disease Control and Prevention report documented the episode and associated increases in asthma-related emergency department visits in New York (Meek et al., 2023).

Within this context, the paper addresses a practical question: What do the analysis results suggest about co-movement between traffic activity, transport emissions, air pollution, and temperature in NYC from 2010 to 2024, and what does that imply for decarbonization policy that is also health- and resilience-oriented?

DATA AND METHODS

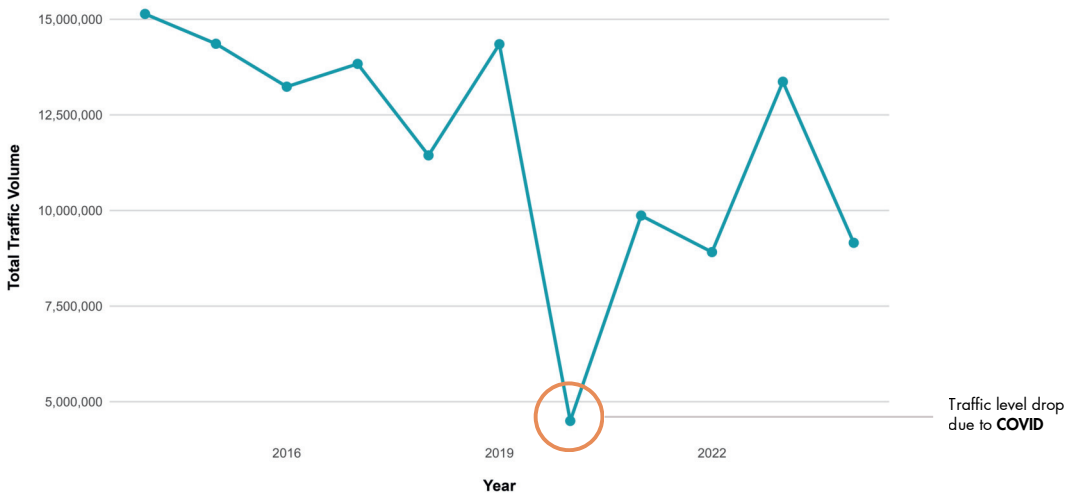
This paper's analysis compiles multiple official datasets into a consistent annual view using R and Python. Citywide traffic activity (2014–2024) is based on Automated Traffic Volume Counts collected by the New York City Department of Transportation using automated traffic recorders at selected crossings and roadways. Documentation for the dataset indicates that the total does not represent an entire year; therefore, citywide totals may be seen as a consistent traffic activity index rather than a full count of all city trips taken (NYC DOT, n.d.). Annual Air Quality Indicators (PM2.5, NO2) are provided by the City's air quality monitoring and reporting system. Vehicles and other combustion sources are noted as major contributors to air quality issues, but the New York City Department of Health and Mental Hygiene reports significant improvements in overall city air quality over time (NYC DOHMH, 2022a, 2022b). Greenhouse Gas Emissions from transportation are found within the greenhouse gas inventory work documented by the New York City Mayor's Office of Climate & Environmental Justice (NYC MOCEJ, 2023).

At the council-district level, the analysis summarizes average traffic intensity by district, classifies districts into five traffic bands (low to very high), and maps monitoring points to show where observations exist. This is important context because "low measured" traffic can sometimes reflect fewer observation points rather than low underlying traffic. The paper presents descriptive trends and uses bivariate scatterplots to explore associations between PM2.5 and (a) traffic activity (2014–2024) and (b) annual mean temperature (2010–2024). These associations are interpreted as patterns, not causal estimates, because annual averages cannot control for meteorology, fleet composition change, or non-transport sources.

ANALYSIS

The analysis shows pronounced temporal variation in traffic activity, especially around major disruptions. Citywide traffic declines from the mid-2010s into 2018, rebounds in 2019, collapses in 2020, and then partially recovers (Figure 1). The 2020 collapse aligns with the COVID-19 mobility shock documented in NYC travel reporting and research on pandemic-era transport changes (NYC DCP, 2021; New York University, 2020). Beyond this broad pattern, the magnitude of change is particularly striking. The sharp decline of nearly 70% in 2020 represents an unprecedented contraction in urban mobility, effectively creating a "natural experiment" in reduced transportation activity. The rapid rebound in 2021 (+119.4%) further highlights the elasticity of urban travel demand, while the subsequent fluctuations suggest that post-pandemic recovery has not followed a smooth or stable trajectory. Instead, the system appears to be adjusting to a new equilibrium shaped by hybrid work, changing commuting patterns, and evolving economic conditions.

FIGURE 1: NYC CITY TRAFFIC VOLUME (2014 - 2024)

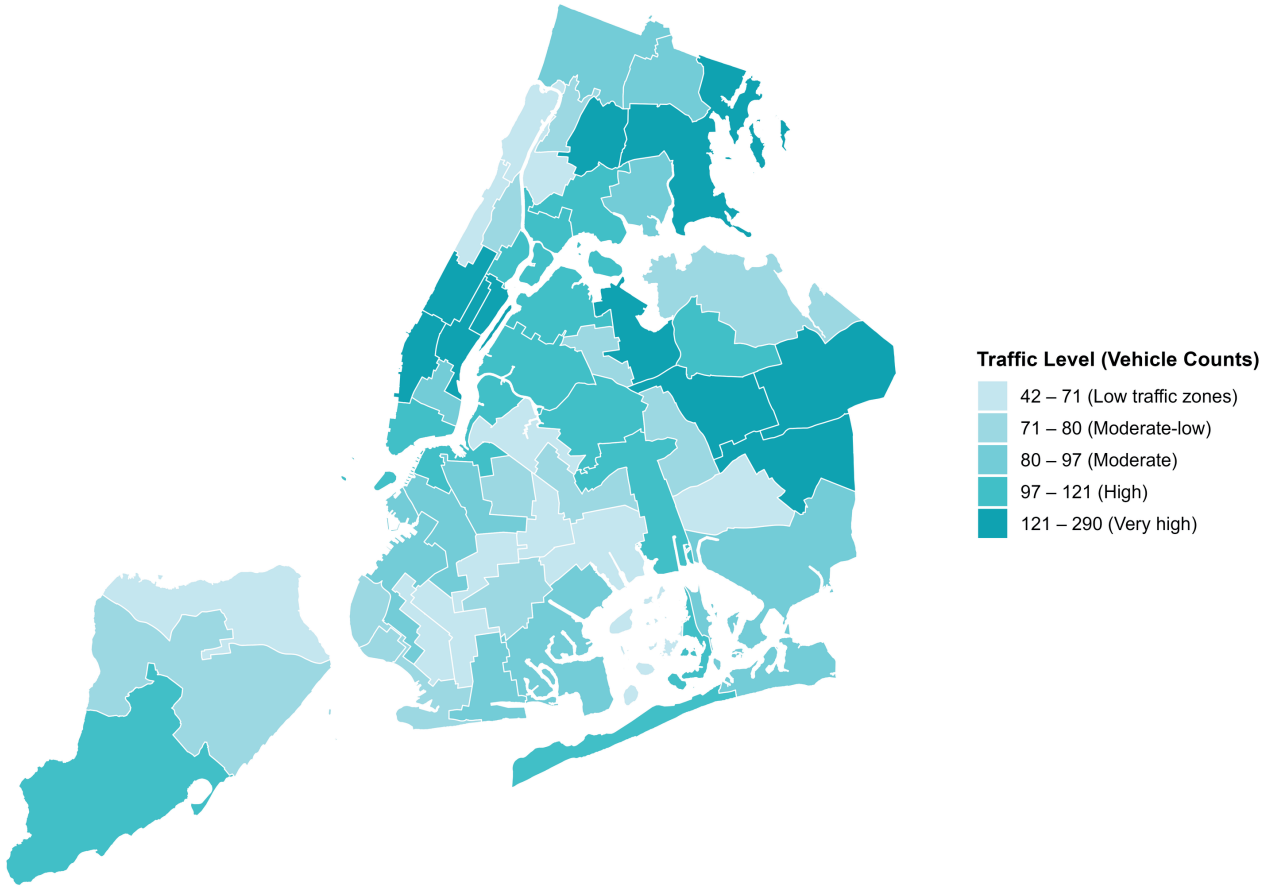


Traffic intensity is spatially concentrated rather than evenly distributed. The district-level map shows substantial variation in both average and total traffic intensity by council district (Figure 2). This uneven spatial distribution is a key finding: rather than citywide averages driving exposure, a relatively small number of districts bear a disproportionate share of the traffic burden.

This matters for exposure because pollutant concentrations from roadway traffic are often highest on or just downwind of a road and typically decline toward background within hundreds of feet (distance varies by conditions), as summarised in EPA guidance (EPA, 2014). A long-standing synthesis similarly emphasizes that proximity to busy roads is associated with higher exposure and increased health risks (Health Effects Institute, 2010).

The clustering of high-traffic districts suggests that transportation-related environmental burdens are geographically concentrated. This reinforces the importance of place-based policy interventions, as citywide averages may mask localized hotspots of both traffic congestion and pollution exposure. In particular, districts classified within the highest traffic intensity bands consistently exhibit higher average segment volumes, indicating persistent structural patterns in mobility flows rather than temporary anomalies.

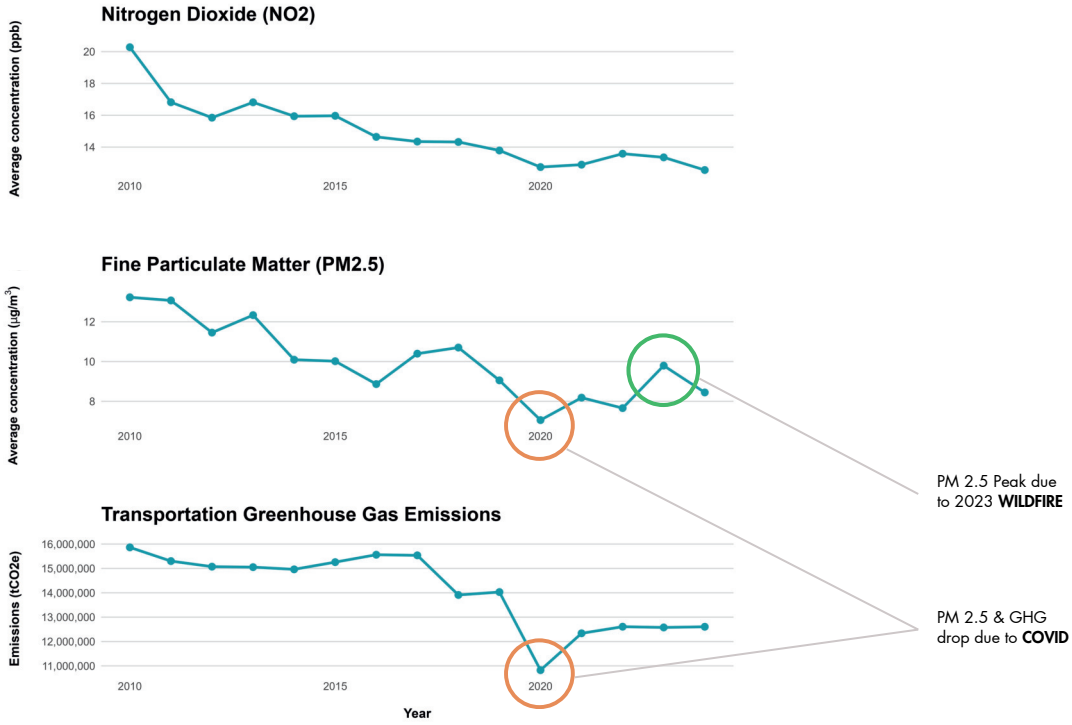
FIGURE 2: NYC HIGH TRAFFIC ZONES BY COUNCIL DISTRICT (2014 - 2024)



Citywide environmental indicators show long-run improvements, but also vulnerability to shocks. The analysis indicates declining NO_2 and PM2.5 between 2010 and 2024 and a reduction in transport greenhouse gas emissions over the same period (Figure 3). City reporting documents substantial improvements in air quality over the last decade-plus (NYC DOHMH, 2022a). However, these long-term improvements are not linear. Instead, they are punctuated by external shocks that temporarily disrupt or reverse trends. Two events are especially prominent. The year 2020 aligns with the COVID-19 shock and coincides with the analysis of reduced traffic, lower PM2.5 and NO_2, and a sharp drop in transport greenhouse gas emissions. This reinforces the close linkage between transportation activity and environmental outcomes.

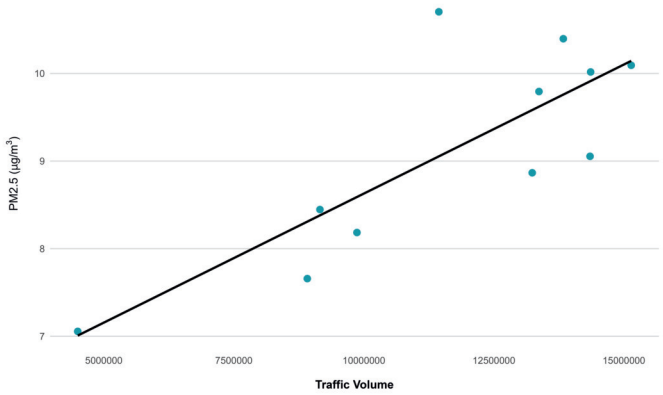
In contrast, the year 2023 shows an increase in PM2.5, consistent with the wildfire smoke episode documented in New York by public health surveillance (Meek et al., 2023). This spike occurs despite relatively high traffic recovery, suggesting that not all pollution changes are driven by local transportation sources. Instead, it highlights the growing importance of regional and climate-driven factors, such as wildfire events, in shaping urban air quality. Taken together, these findings suggest that while transportation decarbonization can drive sustained improvements, urban environmental conditions remain sensitive to both local activity levels and broader climatic events.

FIGURE 3: NYC TRANSPORTATION - RELATION ENVIRONMENTAL TRENDS (2010 - 2024)



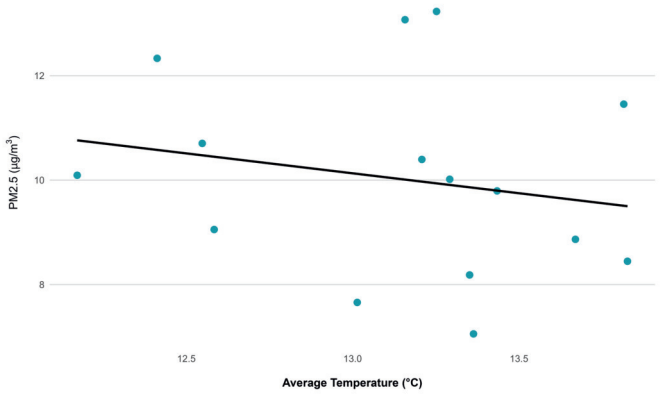
The analysis further explores whether PM2.5 aligns more closely with traffic or temperature. The traffic–PM2.5 scatter (2014–2024) shows a positive association (Figure 4). This pattern is consistent with traffic contributing to urban PM through both tailpipe emissions and non-exhaust pathways such as brake/tire wear and resuspended dust (EPA, 2014; Fussell et al., 2022). Importantly, the relationship is not perfectly linear, indicating that while traffic is a major contributor, other factors - such as atmospheric conditions, regional transport of pollutants, and episodic events - also play a role. Still, the overall upward trend suggests that higher traffic volumes are generally associated with higher PM2.5 concentrations, reinforcing the central role of transportation in urban air pollution.

FIGURE 4: TRAFFIC VS PM 2.5



The temperature PM2.5 scatter (2010–2024) shows a weak association (Figure 5), suggesting that annual mean temperature is not a strong standalone predictor of annual PM2.5 in this dataset. This does not imply heat is unimportant; rather, it suggests that annual averages obscure short-term dynamics such as heat waves, stagnation events, and extreme pollution episodes. This distinction is critical. Heat may influence pollution indirectly - by altering atmospheric chemistry, increasing energy demand, or intensifying stagnation conditions - but these effects are better captured at finer temporal scales than annual averages. The findings therefore point to the need for future analyses that integrate high-frequency data to better capture heat–pollution interactions.

FIGURE 5: TEMPERATURE VS PM 2.5



DISCUSSION

The analysis supports a "co-benefits" framing while also showing why policy needs to be multi-pronged. The COVID-19 discontinuity in 2020 provides a clear example where reduced travel demand coincided with lower transport emissions and lower PM2.5. This is directionally consistent with broader evidence that lockdowns reduced air pollution, though effects varied by location, meteorology, and pollutant chemistry (Venter et al., 2020). However, the longer-term decline in PM2.5 and NO_2 suggests that sustained improvements are not driven solely by traffic reductions, but also by technological change, fuel standards, and broader environmental regulation.

At the same time, the findings emphasize that exposure is highly localized. Traffic intensity is concentrated in a limited number of districts, meaning that environmental and public health burdens are not evenly distributed across the city. This spatial pattern underscores the importance of place-based interventions, particularly along high-traffic corridors where near-road pollution exposure is greatest. Citywide averages may therefore mask critical inequalities in environmental conditions and associated health risks. The analysis also highlights emerging challenges related to non-exhaust emissions and climate vulnerability. Even as electrification reduces tailpipe emissions, sources such as brake and tire wear, along with resuspended road dust, will remain significant contributors to particulate matter. In addition, the 2023 wildfire smoke episode demonstrates that local improvements in air quality can be temporarily reversed by regional and climate-driven events. This suggests that decarbonization alone is insufficient without parallel investments in resilience and public health preparedness.

These patterns align closely with the rationale behind existing policy directions. Measures such as congestion pricing, corridor-based demand management, and the NYC Streets Plan reflect the need to reduce traffic intensity in high-burden areas. Similarly, federal and state emission standards and climate legislation support the observed long-term declines in pollutants. Finally, growing attention to heat and air-quality resilience in planning frameworks reflects the increasing importance of preparing for episodic environmental shocks.

Overall, the findings suggest that effective urban environmental policy must integrate transportation decarbonization, spatial targeting of high-exposure areas, and resilience strategies to address both long-term trends and short-term disruptions.

POLICY IMPLICATIONS

NYC's climate targets imply sustained transport decarbonization. NYC's "80 x 50" roadmap and New York State's Climate Act require large emissions reductions over time (New York City, 2016; NYS CA, n.d.). The analysis points to three priorities: reduce traffic intensity in the highest-traffic districts and corridors; accelerate electrification for high-mileage fleets; and protect mobility and health during climate extremes (heat and smoke).

International evidence suggests that demand management, such as congestion charging, can reduce traffic and influence air quality, but impacts depend on fleet incentives and complementary measures. Evaluations of London's congestion charge find small average air-quality changes and complex pollutant outcomes, underscoring that pricing works best when paired with clean fleet transitions and attractive alternatives (Kelly et al., 2011; Green et al., 2020). In NYC, this points toward pairing any demand management with bus priority, safe cycling networks, and freight electrification aligned with the intent of the NYC Streets Plan (NYC DOT, 2021). The POLICY TABLE below translates these ideas into a policy menu connected directly to patterns found from the analysis.

POLICY TABLE: POLICY OPTIONS LINKING TRANSPORT DECARBONIZATION WITH AIR QUALITY AND HEAT OUTCOMES

Policy	**Mechanism suggested by the analysis**	**Equity and feasibility notes**	**Core metrics to track**
Corridor-focused demand management (pricing, curb management, anti-idling)	Targets the minority of districts/corridors with very high traffic intensity; reduces stop–start traffic and idling	Pair with transit improvements and rebate/revenue recycling to avoid regressive impacts	Corridor vehicle counts/speeds; bus travel time; near-road NO2/PM2.5
Bus priority and reliability upgrades	Enables mode shift away from private vehicles, reducing emissions per passenger-km	Requires dedicated lanes and enforcement; prioritize high-ridership and high-heat corridors.	Bus speeds; ridership; reliability; mode share
Electrification of high-mileage fleets (buses, municipal, for-hire)	Reduces tailpipe NOx and exhaust PM where vehicles run most	Charging infrastructure, workforce training, depot upgrades	Fleet % electric; chargers installed; tailpipe emissions avoided
Freight transition (clean trucks, consolidation hubs)	Reduces disproportionate diesel impacts and total delivery trips	Prioritize small operators and environmental justice areas	Heavy-duty traffic counts; fleet age/fuel; deliveries per zone
Non-exhaust PM mitigation (speed management, smoothing flow, street cleaning)	Addresses brake/tire wear and resuspended dust that persist even under electrification	Requires operations funding and design-speed choices	Speed/acceleration profiles; road-dust proxies; PM composition
Heat and smoke resilience (shade/shelter, filtration, service protocols)	Protects riders and workers during extreme heat and wildfire smoke shocks	Coordinate with public health; prioritize vulnerable neighborhoods	Shelter coverage; heat/AQI-triggered protocols; indoor filtration outcomes

CONCLUSION

Overall, the analysis shows that transportation, air pollution, and climate trends in New York City are strongly interconnected, with clear evidence that reductions in traffic and emissions contribute to improved air quality over time, while also revealing that these gains are uneven across space and vulnerable to external shocks such as the COVID-19 disruption and the 2023 wildfire smoke event; importantly, the concentration of traffic in specific districts highlights that environmental and public health impacts are highly localized, underscoring the need for targeted, corridor-based policies alongside broader decarbonization strategies. Future research should use high-frequency and spatially detailed data, while incorporating land-use patterns, to better capture short-term heat–pollution dynamics and localized exposure patterns.

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APPENDIX:

TABLE 1: COUNCIL-DISTRICT TRAFFIC INTENSITY CLASSIFICATION AND MONITORING COVERAGE, 2014–2024

Traffic Rank (1 = Highest Traffic)	NYC Council District	Traffic Intensity Category (Vehicle Counts Range)	Average Traffic Volume per Road Segment (Vehicle Counts)	Number of Road Segments Analyzed	Total Traffic Observations (All Years Combined)
1	5	121 – 290 (Very high)	232.3	10	9,047
2	24	121 – 290 (Very high)	219.9	35	17,543
3	3	121 – 290 (Very high)	186.1	26	10,162
4	4	121 – 290 (Very high)	172.9	44	21,033
5	27	121 – 290 (Very high)	157.1	34	24,671
6	15	121 – 290 (Very high)	155.5	32	14,661
7	23	121 – 290 (Very high)	152.9	22	19,294
8	13	121 – 290 (Very high)	140.6	45	29,135
9	21	121 – 290 (Very high)	134.4	40	32,801
10	6	121 – 290 (Very high)	134.4	53	32,829
11	1	97 – 121 (High)	130.7	63	35,429
12	36	97 – 121 (High)	127.1	47	29,188
13	25	97 – 121 (High)	125.3	20	8,742
14	20	97 – 121 (High)	124.8	32	19,473
15	12	97 – 121 (High)	123.3	41	36,091
16	29	97 – 121 (High)	123.1	42	19,378
17	32	97 – 121 (High)	122.3	44	23,814
18	30	97 – 121 (High)	120.8	46	36,311
19	37	97 – 121 (High)	120.8	46	19,322
20	33	97 – 121 (High)	120.2	43	22,523
21	10	80 – 97 (Moderate)	115.1	56	31,285
22	19	80 – 97 (Moderate)	106.4	28	16,205
23	34	80 – 97 (Moderate)	104.7	48	27,593
24	38	80 – 97 (Moderate)	102.5	32	22,189
25	2	80 – 97 (Moderate)	101.2	44	15,711
26	46	80 – 97 (Moderate)	99.7	48	22,126
27	9	80 – 97 (Moderate)	93.9	17	15,783
28	11	80 – 97 (Moderate)	92	32	19,976
29	45	80 – 97 (Moderate)	91.9	23	13,298
30	14	80 – 97 (Moderate)	86.4	54	37,507
31	16	71 – 80 (Moderate-low)	80.2	35	21,825
32	17	71 – 80 (Moderate-low)	80	21	12,381
33	48	71 – 80 (Moderate-low)	79.4	24	11,457
34	8	71 – 80 (Moderate-low)	79.4	17	14,181
35	22	71 – 80 (Moderate-low)	79.3	23	12,741
36	35	71 – 80 (Moderate-low)	79	32	23,594
37	51	71 – 80 (Moderate-low)	78.3	34	23,615
38	40	71 – 80 (Moderate-low)	77.8	42	25,294
39	31	71 – 80 (Moderate-low)	76.9	34	19,264
40	47	71 – 80 (Moderate-low)	75.9	30	13,194
41	18	42 – 71 (Low traffic zones)	69.4	29	16,129
42	26	42 – 71 (Low traffic zones)	68.6	45	23,204
43	50	42 – 71 (Low traffic zones)	66.6	34	19,708
44	49	42 – 71 (Low traffic zones)	63.5	17	15,386
45	39	42 – 71 (Low traffic zones)	62.2	39	23,635
46	42	42 – 71 (Low traffic zones)	59.7	21	13,904
47	28	42 – 71 (Low traffic zones)	53.7	16	15,190
48	43	42 – 71 (Low traffic zones)	51.9	16	7,891
49	7	42 – 71 (Low traffic zones)	50.3	23	10,034
50	41	42 – 71 (Low traffic zones)	43.5	23	8,282
51	44	42 – 71 (Low traffic zones)	42.9	19	6,963

TABLE 2: TOP COUNCIL DISTRICTS BY AVERAGE TRAFFIC INTENSITY, 2014–2024

NYC Council District	Average Traffic Volume per Segment (Vehicle Counts)	Traffic Intensity Category	Number of Road Segments Analyzed	Total Traffic Observations (All Years Combined)
5	232.3	121 – 290 (Very high)	10	9,047
24	219.9	121 – 290 (Very high)	35	17,543
3	186.1	121 – 290 (Very high)	26	10,162
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15	155.5	121 – 290 (Very high)	32	14,661
23	152.9	121 – 290 (Very high)	22	19,294
13	140.6	121 – 290 (Very high)	45	29,135
21	134.4	121 – 290 (Very high)	40	32,801
6	134.4	121 – 290 (Very high)	53	32,829

TABLE 3: SELECTED ENVIRONMENTAL AND TRANSPORTATION INDICATORS, 2010–2024

Year	Average PM2.5 Concentration ($\mu g/m^3$)	Average NO_2 Concentration (ppb)	Transportation Greenhouse Gas Emissions (tCO_2e)	Average Annual Temperature (°C)
2010	13.23	20.28	15,865,112	13.25
2014	10.09	15.94	14,962,943	12.17
2019	9.05	13.79	14,030,183	12.58
2020	7.06	12.74	10,824,740	13.36
2023	9.79	13.35	12,578,561	13.43
2024	8.45	12.56	12,605,779	13.83

PART 1:

This is part one of the series for our Net Zero Cities Focus. The next part will be published at NYU URBAN LAB by October 2026, focusing on Housing Affordability.

CONTACT & INQUIRIES:

For further information, data access, or questions regarding the analysis or report, please contact NYU URBAN LAB - a Center for learning and teaching at the intersection of real estate and social economics at https://urbanlab.nyu.edu/contact-us/; or the author, **Mahin R. Tawrat**, at mt5661@nyu.edu, or mahinrtawrat@gmail.com. The NYU Urban Lab produces research, hosts events, and teaches classes that blend the best information we have from mass media, industry associations and academia into a consumable format to forward the advancement of best in class real estate in cities.

Focus Areas:

- Housing Affordability
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