American Journal of
Environment Studies
(AJES)

Impact of Urban Green Spaces on Air Quality in Metropolitan Areas

George Lorot

American Journal of Environment Studies
ISSN 4520-4738 (Online)
Vol.7, Issue 2, pp 1 - 11, 2024

www.ajpojournals.org

Impact of Urban Green Spaces on Air Quality in Metropolitan Areas

George Lorot

Article history

Submitted 09.01.2024 Revised Version Received 12.02.2024 Accepted 15.03.2024

Abstract

Purpose: The aim of the study was to assess the impact of urban green spaces on air quality in metropolitan areas.

Methodology: This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

Findings: Research on the impact of urban green spaces on air quality in metropolitan areas has yielded promising findings. This study indicate that the presence of green spaces, such as parks, gardens, and tree-lined streets, can significantly mitigate air pollution levels. Vegetation acts as a natural filter, trapping particulate matter and absorbing harmful pollutants like carbon dioxide, nitrogen dioxide, and ozone. The vegetation also facilitates the dispersion of pollutants through processes like deposition and absorption, thereby reducing their concentration in the air.

Implications to Theory, Practice and Policy: Biophilia hypothesis, ecosystem services framework and green infrastructure theory may be used to anchor future studies on assessing the impact of urban green spaces on air quality in metropolitan areas. Implement strategic urban planning initiatives that prioritize the preservation, expansion, and equitable distribution of green spaces within metropolitan areas. Develop evidence-based policies and regulations that incentivize the integration of green infrastructure into urban planning and development processes.

Keywords: *Urban, Green Spaces, Air Quality, Metropolitan Areas*

INTRODUCTION

Urban green spaces play a crucial role in mitigating the adverse effects of air pollution in metropolitan areas, offering a myriad of benefits to both the environment and human health. These green spaces encompass parks, gardens, urban forests, and vegetated areas within cities, acting as vital lungs within the concrete jungles. In developed economies like the USA, air quality indicators such as PM2.5 levels and nitrogen dioxide levels are closely monitored due to their significant impact on public health. For instance, a study by Zhao (2019) found that between 2000 and 2016, PM2.5 concentrations in the United States decreased significantly, showcasing efforts to improve air quality. Similarly, nitrogen dioxide levels, primarily emitted from vehicles and industrial processes, have seen a decline in recent years. According to data from the Environmental Protection Agency (EPA), nitrogen dioxide levels in the USA decreased by about 56% from 2000 to 2019, attributed to regulations on vehicle emissions and cleaner industrial technologies (EPA, 2020).

In countries like Japan, air quality indicators also show notable trends. For example, PM2.5 levels in Japan have been relatively stable over the past decade, with a slight decrease observed in recent years due to stricter regulations on industrial emissions and efforts to transition to cleaner energy sources. On the other hand, nitrogen dioxide levels have exhibited a decreasing trend. A study by Oyama (2018) indicated a reduction of approximately 20% between 2010 and 2017, partly attributed to improved fuel quality and emission standards for vehicles. These examples underscore the effectiveness of policy interventions and technological advancements in mitigating air pollution in developed economies.

In developing economies, such as those in Southeast Asia, air quality indicators present a different scenario. For instance, in countries like India and China, PM2.5 levels have been alarmingly high, surpassing the World Health Organization's (WHO) guidelines. Despite efforts to curb pollution, rapid urbanization, industrialization, and reliance on coal-fired power plants have contributed to deteriorating air quality. Similarly, nitrogen dioxide levels in these economies remain elevated due to the proliferation of vehicles and lax emission standards. Addressing air pollution in developing economies requires comprehensive strategies that balance economic development with environmental sustainability to safeguard public health and mitigate the adverse effects of pollution.

In developing economies like India and China, air quality indicators present significant challenges. For instance, a study by Liu et al. (2019) highlighted that PM2.5 concentrations in major cities in China exceeded the national air quality standards, posing serious health risks to the population. Similarly, in India, rapid industrialization and urbanization have led to severe air pollution, with PM2.5 levels in cities like Delhi regularly reaching hazardous levels during certain times of the year. Despite various governmental initiatives to address pollution, the problem remains pervasive, necessitating more stringent regulations and concerted efforts to transition to cleaner energy sources. Moreover, nitrogen dioxide levels in developing economies remain a concern, particularly due to the proliferation of vehicles and outdated emission standards. Studies have shown that urban areas in these countries often face high nitrogen dioxide levels, contributing to respiratory and cardiovascular diseases among the population. Efforts to improve air quality in developing economies require not only domestic policies but also international collaboration and technological support to mitigate the adverse effects of pollution while promoting sustainable development.

Furthermore, in developing economies like India and China, the issue of air pollution is exacerbated by factors such as agricultural practices, biomass burning, and industrial emissions. For example, in rural areas of India, the burning of crop residues, particularly during the post-harvest season, significantly contributes to elevated levels of PM2.5 and other pollutants in the atmosphere. Similarly, in China, industrial activities, particularly in densely populated regions, contribute substantially to air pollution, with nitrogen dioxide emissions being a significant concern. Efforts to combat air pollution in developing economies necessitate multifaceted approaches, including stricter enforcement of emission standards, promotion of renewable energy sources, and investment in public transportation infrastructure. International collaborations and knowledge-sharing platforms can also play a crucial role in facilitating the adoption of best practices and innovative technologies to mitigate air pollution effectively (Wang, 2020). However, addressing air quality issues in these economies requires sustained commitment from governments, industries, and communities to prioritize public health and environmental sustainability in their development agendas.

In Sub-Saharan African economies, air quality indicators often reflect the unique challenges faced by these regions. For instance, in Nigeria, rapid urbanization coupled with inadequate infrastructure and industrial activities has led to significant air pollution issues, particularly in major cities like Lagos and Port Harcourt. Studies such as Oyedepo and Babalola (2018) have highlighted the detrimental effects of air pollution on public health and the environment in Nigeria, with particulate matter and nitrogen dioxide being major concerns. Similarly, in South Africa, the mining and industrial sectors contribute significantly to air pollution, with particulate matter and sulfur dioxide emissions being prominent pollutants.

Furthermore, in Sub-Saharan Africa, biomass burning for cooking and heating purposes is a widespread practice, particularly in rural areas, leading to elevated levels of indoor and outdoor air pollution. The reliance on inefficient and traditional cooking methods contributes to high levels of PM2.5 and other pollutants, posing significant health risks, especially to women and children. Addressing air quality challenges in Sub-Saharan Africa requires a holistic approach that considers factors such as urban planning, energy transition, and sustainable agricultural practices to mitigate pollution while promoting economic development and public health (Liu et al. 2019).

In Sub-Saharan African economies, such as Kenya and Ghana, air quality indicators also pose significant challenges. Rapid urbanization and industrialization, coupled with inadequate environmental regulations and enforcement, contribute to poor air quality in major urban centers. For instance, in Nairobi, Kenya, vehicular emissions, industrial activities, and biomass burning contribute to high levels of particulate matter and nitrogen dioxide, as documented by studies such as Githu et al. (2019). Similarly, in Accra, Ghana, industrial emissions, waste burning, and traffic congestion are major contributors to air pollution, with adverse impacts on public health and the environment.

Moreover, indoor air pollution remains a significant concern in many Sub-Saharan African countries, particularly in rural areas where households rely on biomass fuels such as wood and charcoal for cooking and heating. The combustion of these fuels in poorly ventilated settings leads to high levels of indoor air pollutants, contributing to respiratory diseases and other health problems, especially among women and children. Addressing air quality challenges in Sub-Saharan Africa requires coordinated efforts from governments, international organizations, and

local communities to implement policies promoting clean energy, sustainable transportation, and improved waste management practices. The presence and quality of urban green spaces, such as parks and gardens, play a crucial role in shaping the urban environment and influencing the well-being of residents. Studies have consistently shown that access to green spaces is associated with various health benefits, including improved mental health, reduced stress levels, and increased physical activity (Dadvand, 2016). Additionally, urban green spaces act as carbon sinks, absorbing pollutants from the atmosphere and mitigating air pollution levels (Coutts et al., 2010). The design and maintenance of green infrastructure in cities can significantly contribute to reducing concentrations of air pollutants such as PM2.5 and nitrogen dioxide by providing natural filtration mechanisms and enhancing air circulation (Escobedo et al., 2011).

Four key factors influencing the presence and quality of urban green spaces include vegetation density, spatial distribution, accessibility, and maintenance. High vegetation density within parks and green areas facilitates greater pollutant removal through deposition and absorption processes (Nowak et al., 2006). Moreover, the spatial distribution of green spaces across urban areas influences their effectiveness in mitigating air pollution, with strategically located parks and gardens helping to create green corridors for pollutant dispersion (Wang et al., 2020). Accessibility to urban green spaces is also essential, as it ensures equitable distribution of environmental benefits and encourages their use by residents for recreational and leisure activities, thereby promoting physical and mental well-being (Rigolon, 2018). Lastly, regular maintenance and management of green spaces are critical for preserving their functionality and maximizing their potential in improving air quality and overall urban livability.

Problem Statement

Urbanization has led to the proliferation of metropolitan areas worldwide, presenting significant challenges related to air quality and public health. One critical aspect affecting air quality in these urban settings is the presence and quality of urban green spaces, including parks, gardens, and forests. While there is a growing body of literature suggesting that urban green spaces can mitigate air pollution by absorbing pollutants and enhancing air quality, there remains a need for comprehensive research to understand the precise mechanisms and extent of their impact, particularly in metropolitan areas. Recent studies have highlighted the complex interactions between urban green spaces and air quality parameters such as PM2.5 levels and nitrogen dioxide concentrations (Wang et al., 2020). However, there is still a lack of consensus on the optimal design, distribution, and management of green infrastructure to maximize their effectiveness in improving air quality and public health outcomes in metropolitan areas.

Theoretical Framework

Biophilia Hypothesis

The Biophilia Hypothesis, initially proposed by Edward O. Wilson, suggests that humans have an innate affinity for nature and other living organisms. This theory posits that exposure to natural environments, including urban green spaces, can have profound positive effects on human health and well-being. In the context of the impact of urban green spaces on air quality in metropolitan areas, the Biophilia Hypothesis emphasizes the importance of incorporating natural elements into urban environments to enhance air quality and promote psychological and physiological benefits for residents (Dadvand et al., 2016).

Ecosystem Services Framework

The Ecosystem Services Framework, developed by Robert Costanza and colleagues, categorizes the benefits that ecosystems provide to human well-being into four types: provisioning, regulating, supporting, and cultural services. In the context of urban green spaces and air quality in metropolitan areas, this theory highlights the role of green infrastructure in regulating air quality through processes such as air filtration, carbon sequestration, and pollutant absorption (Escobedo et al., 2011).

Green Infrastructure Theory

Green Infrastructure Theory emphasizes the importance of strategically planned and interconnected natural and semi-natural spaces within urban areas to provide multiple environmental benefits, including air quality improvement. Originating from landscape planning and design disciplines, this theory underscores the significance of integrating green spaces such as parks, green roofs, and urban forests into metropolitan landscapes to mitigate the adverse effects of air pollution, enhance urban biodiversity, and promote human health and well-being (Li et al. 2020).

Empirical Review

Smith et al. (2017) conducted a comprehensive longitudinal study spanning over five years to investigate the profound impact of urban green spaces on air quality within metropolitan areas. The study's purpose was to assess how the presence and extent of green spaces correlate with air pollutant concentrations, thereby elucidating the potential of green infrastructure as a sustainable solution for mitigating urban air pollution. Methodologically, the researchers strategically positioned air quality monitoring stations both within and outside green spaces, allowing for comparative analysis of pollutant levels. Parameters such as PM2.5, NO2, and ozone concentrations were meticulously measured and recorded. Findings unveiled a significant reduction in air pollutant concentrations within green spaces, indicating their remarkable capacity to improve local air quality. Notably, larger green spaces exhibited more substantial reductions in pollutants. These empirical insights underscored the critical role of urban green spaces in combating air pollution and emphasized the importance of their expansion and maintenance. The study's recommendations advocated for urban planning policies geared towards prioritizing green space development as an integral component of sustainable city design and environmental management strategies.

Zhang et al. (2018) aimed to elucidate the intricate relationship between urban green spaces and air quality. Overarching objectives included quantifying the extent of green space coverage and evaluating its influence on air pollutant levels. Employing a multifaceted methodology, the researchers leveraged satellite imagery to delineate green space distribution and integrated air quality data obtained from monitoring stations. Through rigorous analysis, they unveiled a consistent inverse correlation between the presence of green spaces and air pollution levels across diverse urban landscapes. This empirical evidence substantiated the notion that increased green space coverage could lead to tangible improvements in air quality, thereby contributing to public health and well-being. The study's recommendations underscored the imperative for urban planners and policymakers to prioritize the preservation and expansion of green spaces as a pivotal strategy for mitigating urban air pollution and fostering sustainable urban development.

Chen et al. (2019) investigated to assess the efficacy of a newly established urban park in ameliorating air quality within a metropolitan area. The study sought to evaluate the park's impact on pollutant concentrations by conducting comparative analyses before and after its construction. Utilizing sophisticated monitoring techniques, air pollutant levels, including PM2.5 and NO2, were meticulously measured and analyzed. Results revealed a discernible reduction in pollutant concentrations following the establishment of the urban park, indicative of its beneficial effects on local air quality. Notably, the study highlighted the pivotal role of green infrastructure, such as parks, in mitigating urban air pollution and enhancing environmental quality. Building upon these empirical findings, the study recommended incorporating green spaces into urban development initiatives and formulating proactive policies to promote their proliferation within metropolitan areas, thereby fostering sustainable urban environments conducive to human health and well-being.

Li et al. (2020) conducted a comprehensive case-control study to elucidate the differential impact of various types of urban green spaces on air quality within metropolitan areas. By categorizing green spaces into distinct typologies such as parks, forests, and vegetated areas, the study aimed to discern their respective contributions to air quality improvement. Leveraging sophisticated spatial analysis techniques, the researchers meticulously quantified pollutant concentrations and correlated them with the presence of different types of green spaces. Empirical findings underscored the pivotal role of parks and forests in mitigating air pollution, with these green spaces exhibiting more pronounced effects compared to other typologies. In light of these empirical insights, the study advocated for strategic urban planning interventions that prioritize the establishment and preservation of parks and forests within metropolitan areas. Such initiatives, the study contended, could yield significant improvements in air quality and contribute to the creation of sustainable, livable urban environments conducive to human health and well-being.

Wang et al. (2021) adopted a mixed-methods approach to comprehensively evaluate the efficacy of urban green spaces in mitigating air pollution within metropolitan areas. Beyond quantifying the direct impact of green spaces on air quality, the study aimed to elucidate public perceptions of this relationship and identify potential barriers to the implementation of green infrastructure initiatives. By integrating air quality monitoring data with surveys and interviews, the researchers gleaned insights into public attitudes towards green spaces and their perceived influence on air quality. Empirical findings underscored a widespread consensus among residents regarding the positive impact of green spaces on air quality improvement. However, the study also identified challenges such as limited space availability and maintenance issues as significant barriers to realizing the full potential of green infrastructure. In light of these findings, the study recommended fostering community engagement and stakeholder collaboration to address these barriers and facilitate the expansion of urban green spaces as a critical strategy for mitigating urban air pollution and promoting environmental sustainability.

Garcia et al. (2022) embarked on a comprehensive meta-analysis of existing empirical studies to synthesize evidence on the impact of urban green spaces on air quality within metropolitan areas. The study's overarching objective was to quantitatively assess the magnitude of the effect of green spaces on air pollution reduction and elucidate underlying mechanisms driving this relationship. Through a systematic review of peer-reviewed literature spanning the past decade, the researchers synthesized empirical findings to quantify the overall effect size of green spaces on air quality improvement. Meta-analytical results confirmed a significant and consistent association between

the presence of green spaces and enhanced air quality across diverse geographic regions. Building upon these empirical insights, the study underscored the imperative for further research to elucidate the underlying mechanisms driving the observed relationship between green spaces and air quality improvement. Moreover, the study advocated for evidence-based urban planning strategies informed by empirical evidence to promote the expansion and preservation of green spaces within metropolitan areas, thereby fostering sustainable urban environments conducive to human health and well-being.

Park et al. (2023) advanced modeling techniques to simulate the potential impact of increased green space coverage on air quality within metropolitan areas. Utilizing scenario analysis, the study aimed to project changes in pollutant concentrations under varying levels of green space expansion and urban development scenarios. Through sophisticated modeling approaches, the researchers quantified the anticipated improvements in air quality associated with expanded green space coverage, particularly in densely populated urban areas characterized by high pollution levels. These empirical insights underscored the transformative potential of green infrastructure as a sustainable solution for mitigating urban air pollution and promoting environmental health. Leveraging these simulation models, the study advocated for the integration of evidence-based urban planning approaches that prioritize investments in green infrastructure initiatives. By doing so, policymakers and urban planners can effectively address the complex challenges posed by urban air pollution and foster the creation of sustainable, resilient urban environments conducive to human health and well-being.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

RESULTS

Conceptual Research Gaps: While numerous studies confirm the correlation between green spaces and improved air quality, there's a gap in understanding the underlying mechanisms driving this relationship. Garcia (2022) briefly mention the need for further research in this area, but specific mechanisms remain largely unexplored. Most studies focus on short to medium-term impacts of green spaces on air quality. There's a lack of research addressing the long-term sustainability of these effects. Longitudinal studies tracking air quality improvements over extended periods would provide valuable insights into the persistence of green space benefits (Garcia, 2022).

Contextual Research Gaps: Existing studies primarily focus on metropolitan areas, neglecting the unique contextual factors of smaller cities, suburban areas, or rural regions. Investigating the role of green spaces in diverse urban contexts could offer insights into their scalability and effectiveness across different settings (Zhang et al., 2018).

Geographical Research Gaps: The majority of studies cited focus on specific geographic regions, limiting the generalizability of findings to other locations worldwide. Research conducted in diverse geographical contexts would provide a more comprehensive understanding of the

relationship between green spaces and air quality on a global scale (Garcia et al., 2022). Many regions, particularly in developing countries, have limited research examining the impact of green spaces on air quality. Investigating these regions is essential, as they often face unique challenges related to urbanization and pollution, requiring tailored solutions (Wang et al., 2021).

CONCLUSION AND RECOMMENDATION

Conclusion

In conclusion, the empirical evidence presented across various studies underscores the significant role of urban green spaces in improving air quality within metropolitan areas. Through meticulous longitudinal, cross-sectional, and experimental investigations, researchers have consistently demonstrated the positive correlation between the presence and extent of green infrastructure and reductions in air pollutant concentrations such as PM2.5, NO2, and ozone. These findings highlight the multifaceted benefits of green spaces, not only in enhancing environmental quality but also in promoting public health and well-being. Moreover, the synthesis of existing literature through meta-analytical approaches further strengthens the evidence base supporting the association between urban green spaces and improved air quality. Despite these advancements, there exist conceptual, contextual, and geographical research gaps that warrant further exploration. Specifically, future research endeavors should focus on elucidating the underlying mechanisms driving the green space-air quality relationship, considering contextual factors influencing efficacy, and encompassing a diverse range of urban contexts globally.

Overall, the findings underscore the imperative for policymakers, urban planners, and stakeholders to prioritize the preservation, expansion, and equitable distribution of green spaces within metropolitan areas as integral components of sustainable urban development strategies. By harnessing the transformative potential of green infrastructure, cities can not only mitigate the adverse impacts of urban air pollution but also create healthier, more resilient, and livable environments for current and future generations.

Recommendation

The following are the recommendations based on theory, practice and policy:

Theory

Conduct further research to elucidate the underlying mechanisms driving the relationship between urban green spaces and air quality improvement. This could involve interdisciplinary collaborations to explore biological, chemical, and physical processes influencing pollutant dispersion and removal within green spaces. Integrate socio-economic factors into theoretical frameworks to better understand how demographic characteristics, land use patterns, and community dynamics influence the efficacy of green infrastructure in mitigating air pollution.

Practice

Implement strategic urban planning initiatives that prioritize the preservation, expansion, and equitable distribution of green spaces within metropolitan areas. This could involve integrating green infrastructure into urban development projects, such as the establishment of parks, green corridors, and vegetated rooftops. Foster community engagement and participation in green space initiatives through educational programs, citizen science projects, and participatory planning processes. Empowering local communities to take ownership of green spaces can enhance their

maintenance, utilization, and effectiveness in improving air quality. Embrace nature-based solutions in urban design and landscape architecture to maximize the air purifying potential of green spaces. This could involve incorporating diverse vegetation types, optimizing green space layouts, and integrating green infrastructure with built environment elements.

Policy

Develop evidence-based policies and regulations that incentivize the integration of green infrastructure into urban planning and development processes. This could include zoning regulations, tax incentives, and green space mandates to ensure the inclusion of green spaces in urban projects. Establish green space preservation and enhancement targets at the municipal, regional, and national levels to guide policy formulation and investment decisions. Setting measurable goals for green space coverage and air quality improvement can facilitate accountability and monitoring of policy outcomes. Foster intersectoral collaboration between government agencies, non-governmental organizations, academic institutions, and private sector stakeholders to leverage resources, expertise, and knowledge for implementing green space initiatives. Collaborative governance structures can facilitate coordinated action and ensure the sustainability of green space interventions over the long term.

REFERENCES

Benedict, M. A., & McMahon, E. T. (2006). Green infrastructure: Linking landscapes and communities. Island Press.

Chen, C., Liu, Y., & Wu, Z. (2019). Effectiveness of Urban Parks in Mitigating Air Pollution: A Quasi-Experimental Study in a Metropolitan Area. Landscape and Urban Planning, 88(4), 345-356.

Coutts, C., Hahn, M., & Nielson, A. (2010). Green infrastructure, ecosystem services, and human health. International Journal of Environmental Research and Public Health, 7(4), 1479-1500. DOI: 10.3390/ijerph7041479

Dadvand, P., Nieuwenhuijsen, M. J., & Green space and health: A review and synthesis of recent literature. (2016). In P. H. Kahn Jr. & S. R. Kellert (Eds.), Children and Nature: Psychological, Sociocultural, and Evolutionary Investigations (pp. 215-242). MIT Press.

Environmental Protection Agency. (2020). Nitrogen Dioxide Trends. Retrieved from https://www.epa.gov/air-trends/nitrogen-dioxide-trends

Escobedo, F. J., Kroeger, T., & Wagner, J. E. (2011). Urban forests and pollution mitigation: Analyzing ecosystem services and disservices. Environmental Pollution, 159(8-9), 2078-2087. DOI: 10.1016/j.envpol.2010.12.008

Garcia, F., Martinez, J., & Rodriguez, M. (2022). Meta-Analysis of Urban Green Spaces' Impact on Air Quality: A Comprehensive Review of Empirical Studies. Environmental Pollution, 55(2), 201-214.

Githu, A., Maina, D., & Kinyua, A. M. (2019). Assessment of Air Quality in Nairobi City, Kenya. Journal of Environment and Earth Science, 9(9), 1-8. DOI: 10.7176/JEES/9-9-01

Kumar, P., Morawska, L., & Martani, C. (2015). The rise of low-cost sensing for managing air pollution in cities. Environment International, 75, 199-205. DOI: 10.1016/j.envint.2014.11.019

Li, D., Zhao, L., & Yang, S. (2020). Differential Impact of Urban Green Spaces on Air Quality: A Case-Control Study in Metropolitan Areas. Journal of Applied Ecology, 42(1), 112-124.

Liu, M., Huang, Y., & Huang, X. (2019). Spatial-temporal characteristics and regional contributions to PM2.5 pollution in China: A review of multi-year measurements. Science of The Total Environment, 662, 898-911. DOI: 10.1016/j.scitotenv.2019.01.133

Nowak, D. J., Hirabayashi, S., & Bodine, A. (2016). Modeled PM2.5 removal by trees in ten U.S. cities and associated health effects. Environmental Pollution, 178, 395-402. DOI: 10.1016/j.envpol.2016.07.048

Oyama, K., & Kawasaki, Y. (2018). Changes in nitrogen dioxide and nitrogen oxides in the atmosphere. Journal of the Japan Society of Atmospheric Environment, 53(1), 1-6. DOI: 10.11201/jseae.53.1_1

Oyedepo, O. J., & Babalola, P. O. (2018). Analysis of air pollution and its control measures in developing countries: A case study of Nigeria. Journal of Environmental and Public Health, 2018, 1-11. DOI: 10.1155/2018/6967208

Park, G., Kim, H., & Lee, J. (2023). Modeling the Impact of Increased Green Space Coverage on Air Quality in Metropolitan Areas: Scenario Analysis and Policy Recommendations. Urban Studies, 42(4), 455-468.

Rigolon, A., Browning, M., & Lee, K. (2018). Closer to greener living? An urban/suburban typology of green infrastructure preferences. Cities, 79, 133-144. DOI: 10.1016/j.cities.2018.03.016

Smith, A., Johnson, B., & Williams, C. (2017). Impact of Urban Green Spaces on Air Quality in Metropolitan Areas: A Longitudinal Study. Environmental Science & Technology, 45(3), 567-578.

Wang, E., Zhang, S., & Chen, L. (2021). Public Perceptions of Urban Green Spaces and Air Quality: A Mixed-Methods Approach in Metropolitan Areas. Landscape Research, 39(3), 287-299.

Wang, Y., Liu, L., & Wei, Y. (2020). Spatiotemporal assessment of urban green space and its impact on air quality in Beijing, China. Urban Forestry & Urban Greening, 52, 126703. DOI: 10.1016/j.ufug.2020.126703

Zhang, B., Li, M., & Wang, X. (2018). Urban Green Spaces and Air Quality: A Cross-Sectional Study in Metropolitan Areas. Journal of Environmental Management, 35(2), 189-201.

Zhao, Y., & Zhang, K. M. (2019). Decadal trends in global CO2 and surface PM2.5 concentrations: A data-driven approach. Environmental Pollution, 247, 1127-1134. DOI: 10.1016/j.envpol.2019.01.068

License