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Analysis of Urban Green Space and Vegetation Density on Air Quality in West Java

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ABSTRAK

Penelitian ini mengkaji pengaruh ruang hijau perkotaan dan kepadatan vegetasi terhadap kualitas udara di Jawa Barat dengan memasukkan persepsi masyarakat sebagai komponen analitis utama. Pendekatan kuantitatif digunakan dengan memanfaatkan data yang dikumpulkan dari 125 responden melalui kuesioner terstruktur berbasis skala Likert. Data dianalisis menggunakan IBM SPSS Statistics 25, meliputi statistik deskriptif, uji validitas dan reliabilitas, uji asumsi klasik, serta analisis regresi linier berganda. Hasil menunjukkan bahwa ruang hijau perkotaan memiliki efek positif dan signifikan terhadap kualitas udara, sementara kepadatan vegetasi juga menunjukkan pengaruh positif dan signifikan. Secara bersamaan, kedua variabel tersebut secara signifikan memengaruhi kualitas udara, sebagaimana dikonfirmasi oleh uji F. Koefisien determinasi menunjukkan bahwa 41,1% variasi dalam kualitas udara yang dirasakan dijelaskan oleh ruang hijau perkotaan dan kepadatan vegetasi. Temuan ini menyoroti pentingnya mengintegrasikan infrastruktur hijau dan pengelolaan vegetasi ke dalam kebijakan perencanaan perkotaan. Meningkatkan kuantitas dan kualitas ruang hijau dapat secara signifikan memperbaiki kondisi lingkungan dan kesejahteraan masyarakat. Studi ini memberikan implikasi praktis bagi pembuat kebijakan untuk mengembangkan strategi perkotaan berkelanjutan yang selaras dengan persepsi masyarakat dan kebutuhan lingkungan.

Kata Kunci: *Ruang Hijau Perkotaan, Kepadatan Vegetasi, Kualitas Udara, Persepsi Masyarakat, Jawa Barat*

ABSTRACT

This study examines the influence of urban green spaces and vegetation density on air quality in West Java by incorporating public perceptions as a key analytical component. A quantitative approach was employed using data collected from 125 respondents through a structured questionnaire based on a Likert scale. The data were analyzed using IBM SPSS Statistics 25, including descriptive statistics, validity and reliability tests, classical assumption tests, and multiple linear regression analysis. The results indicate that urban green spaces have a positive and significant effect on air quality, while vegetation density also shows a positive and significant influence. Simultaneously, both variables significantly affect air quality, as confirmed by the F-test. The coefficient of determination reveals that 41.1% of the variation in perceived air quality is explained by urban green spaces and vegetation density. These findings highlight the importance of integrating green infrastructure and vegetation management into urban planning policies. Enhancing both the quantity and quality of green spaces can significantly improve environmental conditions and public well-being. This study provides practical implications for policymakers to develop sustainable urban strategies that align with community perceptions and environmental needs.

Keywords: *Urban Green Spaces, Vegetation Density, Air Quality, Public Perception, West Java*

INTRODUCTION

Rapid urbanization has become a defining characteristic of regional development in West Java, driven by population growth, industrial expansion, and infrastructure development. While these processes support economic growth, they also exert significant pressure on environmental quality, particularly urban air quality. Increasing motorized transportation, industrial emissions, and land-use changes have led to deteriorating air conditions in major urban centers such as Bandung and Bekasi. Urbanization has resulted in a surge in vehicle use and industrial activity, contributing to worsening air quality (Mansa et al., 2025), with cities like Bandung experiencing high concentrations of pollutants such as PM2.5 and CO, closely associated with increased building density and reduced vegetation (Arista et al., 2019; Trianna, 2026). Poor air quality not only undermines environmental sustainability but also poses serious risks to public health, including respiratory diseases and a decline in overall quality of life.

In response, the development and preservation of urban green spaces—such as parks, urban forests, and roadside vegetation—represent a key strategy to mitigate air pollution. These green areas play an important role in absorbing harmful pollutants, producing oxygen, and regulating urban microclimates (da Silva, 2025; Jena et al., 2023). Their effectiveness, however, is highly dependent on vegetation density, which determines the capacity to filter pollutants such as PM2.5, PM10, CO_2, and NOx, yet continues to decline due to ongoing urban expansion (Mansa et al., 2025). Rapid development has also led to the fragmentation of green spaces, reducing their ecological function and limiting their ability to improve environmental quality (Jena et al., 2023). Therefore, innovative approaches—such as integrated urban planning and community-based initiatives—are needed to restore and sustain urban green spaces as a critical component of environmental management (da Silva, 2025).

Despite the recognized importance of urban green spaces, there remains a gap between environmental policies and public perception regarding their effectiveness. Public perception is a critical dimension because it reflects how communities experience and evaluate environmental quality in their daily lives. In many cases, objective environmental improvements do not always align with perceived conditions, which can reduce the effectiveness of policy implementation if not properly addressed (Farahani & Maller, 2018). Moreover, public perception significantly influences the success of green space initiatives, as awareness, attitudes, and community engagement determine the level of support and utilization of these spaces (Atiqul Haq et al., 2021; Panwar & Mina, 2025). For instance, in cities like Delhi, residents acknowledge the cooling benefits of parks and strongly support increased tree coverage, demonstrating how perceived value shapes urban environmental behavior (Panwar & Mina, 2025).

However, several challenges persist in shaping positive public perception. Issues such as limited accessibility, safety concerns, and inadequate infrastructure often discourage communities from fully utilizing green spaces, even when their environmental benefits are evident (Panwar & Mina, 2025). This indicates a disconnect between policy intentions and actual user experience, where improvements in environmental quality may not be perceived or appreciated by the public (Farahani & Maller, 2018). Therefore, integrating public perception into environmental planning becomes essential. Multidisciplinary approaches, combined with community engagement and innovative planning tools, are needed to ensure that green space development aligns with public needs and expectations, thereby enhancing both environmental outcomes and social acceptance (Atiqul Haq et al., 2021; Farahani & Maller, 2018).

This study addresses the gap by examining the influence of urban green spaces and vegetation density on air quality in West Java through a quantitative approach based on public perception. Data were collected from 125 respondents using a structured Likert-scale questionnaire and analyzed with IBM SPSS Statistics 25 to assess both partial and simultaneous relationships among variables. The findings are expected to provide empirical evidence supporting the expansion and optimization of green infrastructure, while also offering practical insights for policymakers, urban planners, and stakeholders in regions such as Bandung and Bekasi. Ultimately, aligning environmental strategies with public perception can strengthen the role of urban green spaces as a sustainable solution to improve air quality and address environmental challenges in rapidly growing urban areas.

LITERATURE REVIEW

A. Urban Green Spaces

Urban green spaces are essential for sustainable urban development because they provide integrated ecological, social, and economic benefits. From an ecological perspective, these spaces support biodiversity, enhance ecosystem resilience to climate change, regulate microclimates by reducing urban heat island effects, and improve air quality by acting as "green lungs" that filter pollutants (Aqirah et al., 2025; Dhumketu et al., 2025). Socially, access to green spaces contributes to improved mental well-being by reducing stress and encouraging physical activity, while also functioning as public spaces that strengthen community interaction and cultural exchange (Dhumketu et al., 2025). Economically, the presence of well-maintained green areas can increase property values and stimulate local economic activity, as well as create employment opportunities through the development, maintenance, and management of green infrastructure (Dhumketu et al., 2025). However, in densely populated regions such as West Java, rapid land conversion continues to threaten the existence of these spaces, thereby weakening their critical role in supporting sustainable urban systems.

B. Vegetation Density

Vegetation density refers to the level of plant coverage within a given area, typically measured through indicators such as canopy cover, leaf area index, or the number of trees per unit area, and it plays a crucial role in enhancing the environmental function of urban green spaces. High vegetation density increases the ability to absorb pollutants, trap particulate matter, and regulate temperature through shading and evapotranspiration processes (Jiang et al., 2019; Messias et al., 2024). Dense vegetation is particularly effective in reducing harmful pollutants such as PM2.5, PM10, and carbon monoxide (CO), as trees and plants act as natural filters by capturing airborne particles on their leaves and bark, while also contributing to carbon sequestration and reducing greenhouse gas concentrations (Fleischer et al., 2023; Hanansyah et al., 2022). However, its effectiveness is not solely determined by quantity, but also by factors such as species composition, spatial distribution, and maintenance practices; in rapidly developing urban areas, vegetation density often declines due to land-use changes, which ultimately weakens its environmental benefits.

C. Air Quality in Urban Areas

Air quality refers to the condition of the air based on pollutant concentrations and its suitability for human health and environmental sustainability, and in urban areas it is largely influenced by emissions from transportation, industrial activities, and energy consumption. Poor air quality is closely linked to serious health problems such as respiratory infections, cardiovascular diseases, and reduced life expectancy (Hersey & Gordon, 2021; Mor et al., 2021). In rapidly growing regions, air pollution has become a major environmental concern, with cities like Bandung and Bekasi frequently experiencing declining air quality due to traffic congestion and industrial emissions. Although the presence of green spaces and vegetation is widely recognized as a natural mitigation strategy to improve air quality, their effectiveness depends on various factors, including urban structure, sources of pollution, and the quality of environmental management practices (Liu et al., 2023; Zhang et al., 2021).

D. Public Perception of Environmental Quality

Public perception refers to how individuals or communities interpret and evaluate environmental conditions based on their experiences, knowledge, and expectations, and it plays a crucial role in environmental studies because it shapes behavior, policy acceptance, and community participation in environmental management (Kumar et al., 2022; Moynihan et al., 2022). Perception-based research commonly uses Likert scales to measure attitudes and opinions regarding environmental variables, providing important insights into how environmental conditions are actually experienced by the public, which may differ from objective or technical measurements (Dal Bello et al., 2022; Nurkolila & Sugiharto, 2022). For instance, even when air quality shows improvement based on scientific indicators, people may still perceive it as poor due to visible pollution or past experiences; therefore, integrating public perception into environmental research is essential to bridge the gap between scientific assessment and real societal conditions.

E. Hypothesis Development

The relationship between urban green spaces, vegetation density, and air quality has been widely examined in environmental and urban planning literature, showing that green areas with higher vegetation density are generally associated with better air quality due to their capacity to absorb pollutants and regulate environmental conditions. Vegetation plays a direct role in improving air quality through several mechanisms, including the absorption of harmful gases such as nitrogen oxides (NOx) and volatile organic compounds (VOCs), as well as the deposition of particulate matter, where studies have found significantly lower concentrations of PM2.5 and PM10 in green areas—for example, a botanical garden in Rio de Janeiro recorded PM2.5 levels 33% lower than nearby high-traffic zones (Junior et al., 2022). In addition, vegetation contributes to microclimate regulation by lowering temperature and increasing humidity, which in turn supports better pollutant dispersion and overall air quality (Yasir et al., 2025).

At a broader scale, the availability and spatial distribution of green spaces also influence their effectiveness, with research suggesting that a minimum of 27% green space coverage is required to significantly reduce particulate matter levels (Islam et al., 2024), although outcomes may vary depending on urban morphology, population density, and land-use patterns (Islam et al., 2024). Empirical studies consistently demonstrate that both green space availability and vegetation density have significant direct and indirect effects on air quality through their influence on temperature, humidity, and pollutant dispersion. However, most existing research tends to focus on physical and environmental measurements, with limited attention given to public perception as an evaluative dimension. Therefore, this study addresses the gap by examining how these relationships are perceived by the community using a quantitative approach, providing a more comprehensive understanding that integrates environmental conditions with societal perspectives.

Based on the theoretical and empirical review above, the following hypotheses are proposed:

H1: Urban green spaces have a positive and significant effect on air quality.

H2: Vegetation density has a positive and significant effect on air quality.

H3: Urban green spaces and vegetation density simultaneously have a positive and significant effect on air quality.

RESEARCH METHODS

A. Research Design

This study employs a quantitative research approach with an explanatory design to examine the influence of urban green spaces and vegetation density on air quality based on public perceptions. The quantitative approach is chosen to enable statistical testing of relationships among variables and to provide generalizable findings. The study focuses on perception-based data collected from respondents living in urban areas of West Java. The explanatory design aims to identify both partial and simultaneous effects of independent variables—urban green spaces and vegetation density—on the dependent variable, namely air quality. The analysis is conducted using IBM SPSS Statistics 25 to ensure robust statistical evaluation.

B. Population and Sample

The population of this study consists of urban residents in West Java who experience air quality conditions in their daily lives, and due to the broad scope of this population, a sample of 125 respondents was selected using a non-probability sampling technique, specifically purposive sampling, with criteria including individuals residing in urban areas of West Java, aged 17 years or older, and having lived in the area for at least one year; this sample size is considered sufficient for quantitative analysis using regression techniques and meets the minimum requirements for statistical testing.

C. Data Collection Techniques

Primary data were collected through a structured questionnaire distributed to respondents using a Likert scale ranging from 1 to 5 (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree), with statements designed to measure perceptions related to urban green spaces, vegetation density, and air quality; the data collection process was conducted both online and offline to ensure broader participation and representation of respondents.

D. Operational Definition of Variables

This study involves three main variables measured using Likert-scale items and analyzed quantitatively, namely Urban Green Spaces (X1), Vegetation Density (X2), and Air Quality (Y). Urban Green Spaces (X1) refer to the availability and accessibility of green areas such as parks, urban forests, and public open spaces, with indicators including availability of green spaces, accessibility to green areas, and quality and maintenance of these spaces. Vegetation Density (X2) refers to the level of plant coverage and tree density in urban areas, measured through indicators such as the number of trees in the surrounding environment, canopy coverage, and perceived vegetation density. Meanwhile, Air Quality (Y) reflects the perceived cleanliness and healthiness of the air in urban environments, with indicators including perceived air cleanliness, frequency of pollution exposure, and comfort in breathing outdoor air.

E. Data Analysis Techniques

Data analysis in this study is conducted using IBM SPSS Statistics 25 through several stages, starting with descriptive analysis to summarize respondent characteristics and provide an overview of each variable, followed by validity and reliability tests where validity is assessed using Pearson correlation to ensure each questionnaire item measures the intended construct and reliability is evaluated using Cronbach's Alpha to determine instrument consistency. Classical assumption tests are then performed, including normality tests (Kolmogorov-Smirnov or Shapiro-Wilk), multicollinearity tests using Variance Inflation Factor (VIF), and heteroscedasticity tests to ensure the suitability of regression analysis. Furthermore, multiple linear regression analysis is applied to examine the influence of urban green spaces (X1) and vegetation density (X2) on air quality (Y), using the model $Y = a + b_1X_1 + b_2X_2 + e$, where Y represents air quality, a is the constant, b_1 and b_2 are regression coefficients, X_1 denotes urban green spaces, X_2 represents vegetation density, and e is the error term. Hypothesis testing is conducted using the t-test to analyze partial effects and the F-test to examine simultaneous effects, while the coefficient of determination (R^2) is used to measure the proportion of variance in air quality explained by the independent variables.

RESULTS AND DISCUSSION

A. Respondent Characteristics

This study involved 125 respondents from urban areas in West Java. The demographic distribution is presented in Table 1.

Table 1. Respondent Characteristics

Characteristics	Category	Frequency	Percentage (%)
Gender	Male	68	54.4
	Female	57	45.6
Age	17–25	40	32.0
	26–35	52	41.6
	36–45	23	18.4
	>45	10	8.0

Education	High School	38	30.4
	Bachelor	65	52.0
	Postgraduate	22	17.6

The respondent characteristics indicate a relatively balanced gender distribution, with males slightly dominating (54.4%) compared to females (45.6%), suggesting that perspectives are fairly representative across genders. In terms of age, the majority of respondents fall within the productive age groups of 26–35 years (41.6%) and 17–25 years (32.0%), reflecting a population that is actively engaged with urban environmental conditions and likely more aware of issues related to air quality and green spaces. Meanwhile, respondents aged 36–45 years (18.4%) and over 45 years (8.0%) are less represented but still contribute to diversity in perception. Regarding education, most respondents hold a bachelor's degree (52.0%), followed by high school graduates (30.4%) and postgraduate degree holders (17.6%), indicating that the sample is relatively well-educated, which may enhance the reliability of perception-based data as respondents are more likely to understand and critically evaluate environmental conditions.

B. Descriptive Statistics

Descriptive analysis provides an overview of respondents' perceptions regarding each variable.

Table 2. Descriptive Statistics

Variable	Mean	Std. Deviation	Category
Urban Green Spaces (X1)	3.78	0.65	Good
Vegetation Density (X2)	3.65	0.70	Good
Air Quality (Y)	3.52	0.72	Moderate

The descriptive statistics indicate that respondents generally perceive urban environmental conditions in West Java as relatively positive, particularly in terms of urban green spaces (mean = 3.78) and vegetation density (mean = 3.65), both categorized as "good," suggesting that the availability, accessibility, and presence of vegetation are considered adequate by the community. However, air quality (mean = 3.52) is only categorized as "moderate," reflecting that despite the presence of green spaces, respondents still experience noticeable environmental issues related to air pollution. The relatively similar standard deviations (0.65–0.72) across variables indicate a consistent spread of responses, meaning perceptions are fairly homogeneous among respondents. This pattern implies that while green infrastructure is perceived positively, its current condition may not yet be sufficient to significantly improve overall air quality, highlighting a gap between environmental provision and perceived environmental outcomes.

C. Validity and Reliability Test

All questionnaire items showed correlation coefficients (r-count) greater than the r-table value (0.176), indicating validity. Reliability testing produced Cronbach's Alpha values above 0.70 for all variables.

Table 3. Reliability Test Results

Variable	Cronbach's Alpha	Criteria
Urban Green Spaces	0.812	Reliable
Vegetation Density	0.834	Reliable
Air Quality	0.801	Reliable

The reliability test results indicate that all variables in this study have high internal consistency, as reflected by Cronbach's Alpha values exceeding the commonly accepted threshold of 0.70. Urban Green Spaces show an alpha of 0.812, Vegetation Density 0.834, and Air Quality 0.801, all categorized as reliable, meaning that the measurement items used for each variable are consistent and stable in capturing the intended constructs. The relatively close range of alpha values also suggests that the questionnaire is well-structured and balanced across variables, with no significant inconsistencies in respondent answers. Therefore, the instrument used in this study can be considered dependable for further statistical analysis, including regression and hypothesis testing.

D. Classical Assumption Tests

Before conducting multiple linear regression analysis, this study performed classical assumption tests to ensure that the regression model meets the requirements of Best Linear Unbiased Estimator (BLUE). The tests include normality, multicollinearity, and heteroscedasticity tests. All analyses were conducted using IBM SPSS Statistics 25.

1. Normality Test

The normality test aims to determine whether the residuals in the regression model are normally distributed. In this study, the Kolmogorov-Smirnov test was used.

Table 4. Normality Test Results

Test Method	Statistic Value	Sig. (p-value)	Criteria	Conclusion
Kolmogorov-Smirnov	0.073	0.087	$p > 0.05$	Normal Distribution

The significance value of 0.087 is greater than 0.05, indicating that the residuals are normally distributed. Therefore, the normality assumption is fulfilled, and the regression model is suitable for further analysis.

2. Multicollinearity Test

The multicollinearity test is conducted to examine whether there is a high correlation among independent variables. This study uses the Tolerance and Variance Inflation Factor (VIF) indicators.

Table 5. Multicollinearity Test Results

Variable	Tolerance	VIF	Criteria	Conclusion
Urban Green Spaces (X1)	0.689	1.451	Tolerance > 0.10; VIF < 10	No Multicollinearity
Vegetation Density (X2)	0.689	1.451	Tolerance > 0.10; VIF < 10	No Multicollinearity

The multicollinearity test results indicate that there is no multicollinearity problem between the independent variables in this study, as both Urban Green Spaces (X1) and Vegetation Density (X2) have tolerance values of 0.689 (greater than 0.10) and VIF values of 1.451 (less than 10). These results meet the standard criteria, confirming that the two variables are not highly correlated with each other and can be included simultaneously in the regression model without causing distortion in the estimation of coefficients. This suggests that each variable contributes independently to explaining variations in air quality, allowing for more reliable and accurate interpretation of the regression analysis results.

3. Heteroscedasticity Test

The heteroscedasticity test aims to determine whether there is inequality in the variance of residuals across observations. In this study, the Glejser test was used by regressing the absolute residual values against the independent variables.

Table 6. Heteroscedasticity Test Results

Variable	Coefficient	Sig. (p-value)	Criteria	Conclusion
Urban Green Spaces (X1)	0.052	0.314	$p > 0.05$	No Heteroscedasticity
Vegetation Density (X2)	0.061	0.276	$p > 0.05$	No Heteroscedasticity

The heteroscedasticity test results indicate that the regression model does not suffer from heteroscedasticity, as both independent variables—Urban Green Spaces (X1) and Vegetation Density (X2)—have significance values of 0.314 and 0.276, respectively, which are greater than the 0.05 threshold. This means that the variance of the residuals is constant across observations, fulfilling one of the key assumptions of linear regression. As a result, the model can be considered stable and reliable, and the estimated coefficients can be interpreted without concern for bias caused by unequal error variance.

E. Multiple Linear Regression Analysis

The regression analysis was conducted using IBM SPSS Statistics 25.

Table 4. Regression Results

Variable	Coefficient (β)	t-value	Sig.
Constant	1.215	3.102	0.002
Urban Green Spaces (X1)	0.421	4.865	0.000
Vegetation Density (X2)	0.356	3.978	0.000

The regression results indicate that both Urban Green Spaces (X1) and Vegetation Density (X2) have a positive and statistically significant effect on Air Quality (Y), as shown by their coefficients ($\beta = 0.421$ and $\beta = 0.356$) with t-values of 4.865 and 3.978 and significance levels of 0.000 ($p < 0.05$). This means that improvements in the availability and quality of green spaces, as well as higher vegetation density, are associated with better perceived air quality. Among the two variables, Urban Green Spaces have a slightly stronger influence, suggesting that accessibility and overall condition of green areas play a more dominant role compared to vegetation density alone. The constant value of 1.215, which is also significant ($p = 0.002$), indicates the baseline level of air quality when both independent variables are held constant. Overall, these findings confirm that both factors contribute meaningfully to improving urban air quality.

F. Hypothesis Testing

Table 5. Hypothesis Testing Results

Hypothesis	Statement	Result
H1	Urban green spaces → Air quality	Accepted
H2	Vegetation density → Air quality	Accepted
H3	X1 & X2 simultaneously → Air quality	Accepted

The hypothesis testing results show that both independent variables, Urban Green Spaces (X1) and Vegetation Density (X2), have a significant partial effect on Air Quality (Y), as indicated by t-test values with significance levels of $p = 0.000$ for both variables, which are below the 0.05 threshold. Furthermore, the F-test result ($F = 42.56$; $p = 0.000 < 0.05$) confirms that the independent variables simultaneously have a significant influence on air quality, indicating that the regression model as a whole is statistically significant and capable of explaining the relationship between the variables.

The coefficient of determination shows an R value of 0.641, indicating a moderately strong relationship between the independent variables and air quality, while the R^2 value of 0.411 (with an adjusted R^2 of 0.402) suggests that 41.1% of the variation in air quality can be explained by urban green spaces and vegetation density, with the remaining 58.9% influenced by other factors not included in the model.

Discussion

The findings of this study show that urban green spaces have a significant positive effect on air quality, indicating that the greater the availability and accessibility of green areas, the better the environmental conditions perceived by the public. In urban areas such as Bandung, the presence of parks and urban forests contributes to improved air circulation and greater pollutant absorption, which supports environmental theories that place green spaces as key elements of sustainable urban ecosystems. This result confirms that green infrastructure is not merely an aesthetic component of the city, but an important ecological asset that directly contributes to environmental quality and urban livability.

The positive effect of green spaces on air quality can be explained through the ecological functions of vegetation in urban environments. Vegetation, especially trees, is able to absorb airborne pollutants through leaf surfaces and reduce concentrations of harmful substances such as NO_2 and PM2.5 by around 30–50% in densely vegetated areas (Shahini & Shahini, 2025). In addition, through photosynthesis, plants act as natural filters that capture pollutants while releasing oxygen into the atmosphere, thereby contributing to cleaner and healthier urban air (Edeigba et al., 2024). These findings strengthen the view that the environmental benefits of green spaces are closely linked to the biological functions of the vegetation they contain.

This study also finds that vegetation density has a significant influence on air quality. Dense vegetation strengthens the capacity of urban green areas to filter pollutants and regulate temperature, meaning that environmental improvement depends not only on the presence of green spaces but also on their ecological quality. Green spaces with high tree coverage tend to be perceived as having cleaner and healthier air. This is consistent with previous studies showing that dense vegetation can help reduce surface temperatures by 4–7°C compared to built-up areas, thereby mitigating the urban heat island effect (Shahini & Shahini, 2025), while also creating localized cooling that improves thermal comfort and reduces energy demand for cooling (Yasir et al., 2025).

When examined simultaneously, urban green spaces and vegetation density both make a significant contribution to air quality, which implies that urban environmental management must adopt an integrated approach. Expanding green space alone without ensuring sufficient vegetation density may not produce optimal environmental benefits. Likewise, dense vegetation concentrated in only a few locations may not be enough to significantly improve air quality at the broader urban scale. Beyond air pollution control, urban green spaces also provide wider ecosystem services, including supporting biodiversity by offering habitat for various species (Edeigba et al., 2024) and improving water management by retaining around 20–40% of precipitation, which helps reduce flooding risk and maintain soil health (Shahini & Shahini, 2025). This shows that the role of green infrastructure extends beyond air quality and contributes to overall urban ecological resilience.

However, the coefficient of determination indicates that more than half of the variation in air quality is explained by other factors outside this model, such as traffic emissions, industrial activities, and urban planning policies. This demonstrates that urban environmental problems are complex and cannot be addressed solely through green infrastructure. Even so, this study reinforces the importance of integrating green space development and vegetation management into urban planning policies in West Java. Policymakers should therefore focus not only on increasing the extent of green areas, but also on improving vegetation density and ecological quality so that the benefits for air quality and environmental sustainability can be achieved more effectively and consistently.

CONCLUSION

This study concludes that urban green spaces and vegetation density play a significant role in improving air quality based on public perceptions in West Java, as both variables have been empirically proven to have positive and significant effects, both partially and simultaneously. Urban green spaces contribute to better air quality by providing areas for pollutant absorption and environmental regulation, while vegetation density strengthens this function through its ability to filter airborne particles and regulate microclimates. These findings indicate that the effectiveness of green infrastructure is determined not only by its availability but also by the quality and density of vegetation within these spaces.

However, the coefficient of determination shows that a considerable portion of air quality variation is influenced by other factors such as transportation emissions, industrial activities, and urban planning policies. This highlights the complexity of urban environmental issues and the need for a comprehensive and integrated approach to environmental management. Therefore, improving air quality cannot rely solely on expanding green spaces but must also be supported by broader strategies, including emission control and sustainable urban planning. Overall, this study emphasizes the importance for policymakers and urban planners to prioritize sustainable green infrastructure development by both increasing the extent of green spaces and enhancing vegetation density to create healthier and more livable urban environments.

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