



Green Belt Policy and Community Participation to Control Urban Heat and Air Pollution in Semarang City

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Abstract

Rapid urbanization in Semarang City has exacerbated the Urban Heat Island (UHI) phenomenon and degraded air quality. To address this, the government implemented the Green Belt Policy under Regional Regulation No. 8 of 2016. This study evaluates the policy's effectiveness in controlling urban heat and air pollution, focusing heavily on community participation. Using a mixed-method approach combining legal analysis and field research, primary data were gathered from the Public Works Department and the Environmental Agency, supplemented by direct observations and community interviews. The results show that while green belts successfully lower local temperatures and improve air quality, their full potential is hindered by limited maintenance budgets, inadequate human resources, and minimal public involvement stemming from a lack of awareness and incentives. To enhance the policy's impact, the study recommends strengthening regulatory enforcement, integrating community-based management, and adopting environmental monitoring technology, offering a replicable model for sustainable urban management in other cities.

INTRODUCTION

Rapid urbanization in Indonesia has triggered significant environmental transformations, particularly in metropolitan and capital cities of provinces. Semarang City, as the administrative and economic center of Central Java Province, exemplifies the dual nature of urban growth: while it accelerates infrastructure development and economic activity, it also generates severe ecological consequences. One of the most pressing environmental issues in Semarang is the Urban Heat Island (UHI) phenomenon, an increase in ambient temperature in urban cores compared to surrounding rural areas, combined with deteriorating air quality (Ramakreshnan et al., 2018).

According to preliminary data from the Environmental Agency (Dinas Lingkungan Hidup/DLH) of Semarang City, annual monitoring reports between 2020 and 2024 indicate that the city's Air Quality Index (AQI) has consistently fluctuated within the "moderate" to "unhealthy" range during dry seasons, with particulate matter (PM_{2.5} and PM₁₀) levels often exceeding the World Health Organization's recommended limits. Furthermore, the average urban surface temperature recorded by DLH and corroborated by satellite-based remote sensing has shown a steady upward trend, peaking at 36.6°C in certain densely built districts such as Semarang Tengah and Semarang Barat. These climatic and atmospheric conditions not only jeopardize public health, leading to increased incidence of respiratory diseases and heat stress, but also reduce the livability and competitiveness of the city (Putra et al., 2024).

In response, the Semarang City Government has adopted multiple urban greening measures, one of which is the Green Belt Policy, as stipulated in Semarang City Regional Regulation No. 8 of 2016 concerning the Management of Green Open Spaces (Ruang Terbuka Hijau) (Jansson & Lindgren, 2012). The policy mandates the allocation and maintenance of vegetated strips along road corridors, riverbanks, and

other designated areas. These green belts serve multiple functions:

- A. Ecological functions - absorbing carbon dioxide, trapping airborne particulates, and moderating microclimates;
- B. Social functions - enhancing aesthetic value, providing recreational buffers, and contributing to urban identity;
- C. Legal functions - fulfilling statutory requirements for green space coverage under Law No. 26/2007 on Spatial Planning.

Data from the Public Works Department (Dinas Pekerjaan Umum/DPU) of Semarang City reveals that, as of 2024, the total green belt area amounts to approximately [11.348] hectares, representing [29,25]% of the targeted 30% urban green space coverage stipulated in national and local regulations. While this marks progress compared to previous years, spatial distribution remains uneven: high-density commercial areas often have minimal or fragmented green belts, while peripheral zones enjoy more extensive coverage. Furthermore, DPU reports highlight that routine maintenance such as pruning, replanting, and irrigation is hindered by budgetary constraints, limited technical personnel, and occasional encroachment by informal vendors or illegal parking.

Despite the regulatory framework, implementation challenges persist. First, there is an enforcement gap, whereby violations of spatial allocations for green belts are inadequately sanctioned, reducing deterrence. Second, community participation is low; while the regulation allows citizen involvement in green belt planning and maintenance, public awareness of these rights and responsibilities remains limited. Third, inter-agency coordination is fragmented, with overlapping mandates between DLH, DPU, and the Parks and Horticulture Division, leading to inefficiencies in project execution and monitoring.

Existing literature has examined the technical and ecological benefits of green spaces in urban areas, with studies such as

Nurhanafi et al. (2016) focusing on spatial distribution and Supratiwi (2019) addressing policy implementation challenges. However, few works have adopted an integrated approach combining legal analysis, community participation dynamics, and empirical data from relevant government institutions. This gap is critical because policy effectiveness in environmental governance is not determined solely by the presence of vegetation but by the interaction between law, institutional capacity, and social engagement.

A fundamental catalyst for building this social engagement is environmental education. Fostering community participation requires more than legal mandates; it necessitates a comprehensive environmental literacy framework that develops affective disposition, ecological knowledge, and responsible behavior among citizens. Both formal education channels, such as the Adiwiyata school program, and non-formal approaches, like the Climate Village Program (Proklm), are crucial in transforming residents from passive observers into active stewards of urban green spaces. By educating the public on local ecological issues, communities can be empowered with the action skills needed to maintain and advocate for sustainable green belts.

Therefore, the overarching purpose of this research is to evaluate the implementation of the Green Belt Policy and to formulate an integrated governance model that leverages environmental education to maximize both ecological benefits and community involvement. Specifically, this study is guided by three primary research objectives:

1. To evaluate the effectiveness of the Green Belt Policy in controlling urban heat and air pollution in Semarang City, using both legal analysis and empirical environmental data from DLH and DPU;
2. To analyze the role of formal and non-formal environmental education in fostering environmental literacy and shaping community attitudes toward green space management; and
3. To identify strategies for enhancing community participation in green belt planning, maintenance, and monitoring.

By combining statutory and conceptual legal approaches, field observations, interviews, and analysis of institutional datasets, this research aims to produce evidence-based recommendations that strengthen the policy's ecological impact, foster civic engagement, and provide a replicable governance model for other cities facing similar environmental challenges. The outcomes are expected to contribute not only to the improvement of Semarang's urban environment but also to the broader discourse on sustainable city management in Indonesia.

METHOD

Research Design

This study employs a mixed-method design that integrates *legal normative analysis* with *empirical field research* (Indraswara, 2025). The legal normative component adopts both the statute approach and the conceptual approach, examining the legal framework of the Green Belt Policy as stipulated in Semarang City Regional Regulation No. 8 of 2016 and its relation to national environmental and spatial planning laws. The empirical component involves direct observation, semi-structured interviews, and analysis of secondary data obtained from relevant government agencies.

The choice of a mixed-method design is intended to bridge the gap between policy formulation and policy implementation, ensuring that the evaluation is grounded in both legal validity and environmental impact assessment.

A longitudinal analysis of environmental data from 2019-2024 was performed. For urban heat, a time-series analysis of average monthly temperature data was conducted to identify trends. To assess the microclimatic impact, a comparative statistical analysis (e.g., an independent samples t-test) was planned to compare surface temperature readings from green belt-adjacent areas versus non-green control areas, utilizing remote sensing data. For air

quality, trend analysis of available AQI and PM2.5 data was conducted, with a clear acknowledgment of data limitations due to inconsistent public reporting. GIS-based spatial analysis was used to overlay maps of green belt distribution with pollution and temperature hotspots to identify spatial correlations.

Data Sources

1. Primary Data

A. Institutional Data

- 1) Public Works Department (Dinas Pekerjaan Umum - DPU) of Semarang City:
 - a) Total green belt area by district (in hectares).
 - b) Percentage of achieved target compared to the mandatory 30% green space requirement.
 - c) Budget allocation and expenditure reports for green belt maintenance.
 - d) Documentation on vegetation types, maintenance schedules, and encroachment incidents.
- 2) Environmental Agency (Dinas Lingkungan Hidup - DLH) of Semarang City:
 - a) Annual Air Quality Index (AQI) reports (2019–2024).
 - b) Temperature and humidity monitoring data from fixed urban stations.
 - c) Pollution source identification (e.g., vehicle emissions, industrial activities).
 - d) Spatial heat map data derived from remote sensing.

B. Field Observation

Direct observation of selected green belt sites representing high-density commercial zones, mixed-use urban corridors, and residential neighborhoods, focusing on vegetation health, physical continuity, and public accessibility.

C. Interviews

Semi-structured interviews with key stakeholders, including:

- 1) Officials from DPU and DLH.

- 2) Community leaders and members of local environmental NGOs.
- 3) Residents living adjacent to or utilizing green belt areas.

2. Secondary Data

- A. Academic literature on urban green belts, urban heat island mitigation, and environmental governance.
- B. Government policy documents, strategic plans, and regulatory guidelines.
- C. Comparative case studies from other Indonesian cities (e.g., Surabaya, Jakarta) implementing green belt or urban green space policies.

Data Collection Procedure

1. Document Review: Collection of regulatory texts, official reports, and planning documents from DPU and DLH.
2. Field Survey: On-site measurement of vegetation coverage, visual assessment of maintenance status, and photographic documentation.
3. Interview Process: Conducted in person where possible; each interview recorded (with consent) and transcribed for analysis.
4. Data Triangulation: Cross-validation between institutional data, field observation findings, and stakeholder interviews to ensure reliability.

Data Analysis

1. Legal Analysis:

The statute approach examines the conformity of Semarang's green belt regulations with higher-order legal frameworks, including Law No. 26/2007 on Spatial Planning and Law No. 32/2009 on Environmental Protection and Management. The conceptual approach interprets "green belt" functions beyond mere physical vegetation, considering it as an environmental governance tool.

2. Environmental Impact Analysis:

- A. Quantitative analysis of AQI trends and urban temperature changes over a 5-year period (2019-2024) using DLH datasets.
- B. GIS-based spatial mapping of green belt distribution relative to pollution hotspots and high-temperature zones.

- C. Correlation assessment between vegetation coverage (DPU data) and localized AQI improvements.
- 3. Socio-Legal Analysis:
Evaluation of community participation mechanisms, identification of barriers to engagement, and assessment of the policy's alignment with the right to a healthy environment.

Ethical Considerations

All interviews were conducted with informed consent, ensuring participant anonymity where requested (Xu et al., 2020). Institutional data usage was authorized by the relevant agencies, with adherence to applicable public information disclosure regulations.

RESULT AND DISCUSSION

1. Profile of Green Belt Areas in Semarang City (DPU Data)

Based on official records from the Public Works Department (DPU) of Semarang City, the total designated green belt area in 2024 reached [11.348] hectares, representing [29,25]% of the mandatory 30% green space requirement stipulated by national and local regulations. Spatial analysis indicates that green belt distribution is uneven:

A. High-density commercial areas such as Simpang Lima and Pemuda Street have fragmented or narrow green strips, primarily limited to ornamental trees and shrubs.

B. Peripheral residential zones such as Tembalang and Mijen exhibit more continuous and wider green corridors, often integrated with neighborhood parks.

While the aggregate figures are close to the target, a more in-depth analysis reveals significant issues related to the uneven spatial distribution of green space. The research paper explicitly highlights the highly unequal distribution of green spaces: densely populated commercial areas like Simpang Lima and Jalan Pemuda have only fragmented or narrow green spaces, while residential areas on the outskirts of the city like Tembalang and Mijen enjoy wider and more continuous green corridors.

These findings are reinforced by a visual analysis of the Green Open Space Plan Map, which is part of the Semarang City Spatial Plan (RTRW). The map shows a greater concentration of green areas in the southern and western parts of the city, such as in the Gunungpati and Mijen sub-districts, where green spaces are predominantly used for protection and urban agriculture (Wandari & Fariz, 2025).

Conversely, in the denser city center, green spaces are more often found in narrow strips along riverbanks, railway lines, and small city parks. Historical data also confirms this pattern, with central sub-districts such as Central Semarang (11.9%), East Semarang (9.54%), and North Semarang (9.47%) recorded severe green space deficits, while Mijen recorded coverage of up to 82.79%. This inequality raises critical questions about environmental equity, where areas with the highest levels of pollution and population density have the most limited access to the benefits of green space (Rofiyanti et al., 2015).

DPU maintenance reports highlight that routine care (pruning, replanting, irrigation) is carried out only [2] times per year, falling short of the ideal [6] times per year due to budgetary and manpower constraints. Additionally, encroachment by informal street vendors and illegal vehicle parking has reduced the effective width of certain green belts.

The implementation of Semarang's Green Belt Policy faces fundamental structural challenges related to coverage and funding. Official data reveals a stark gap between policy aspirations and reality. As detailed in Table 1, the city's official public Green Open Space (RTH) constitutes only 7.5% of the total municipal area, a figure that is less than a third of the 30% mandated by national law.

This deficit in managed green space is compounded by a severe and chronic underfunding of maintenance operations. For the fiscal year 2024, the budget allocated for the upkeep of approximately 200 city parks and green spaces was IDR 6 billion. However, officials from the Department of

Housing and Settlements (Disperkim) estimate that an ideal budget to ensure adequate maintenance including routine watering, replanting, and infrastructure repair would be IDR 18 billion. This represents a 67% budget shortfall, which directly translates into the observed suboptimal maintenance, such as infrequent pruning and irrigation, and contributes to the degradation of these vital ecological assets.

Table 1. RTH coverage and maintenance budget in semarang city (2024)

Indicator	value
Official Public Open Space	7.5%
Total Vegetation	36.4%
2024 Park Maintenance Budget	IDR 6 Billion
Ideal Park Maintenance Budget	IDR 18 Billion

Source: (Dewi & Lituhayu, 2016)

2. Air Quality and Urban Temperature Trends (DLH Data)

Air Quality Index (AQI): This is a common index used by international platforms such as aqi.in and aqicn.org. The AQI is typically a real-time index based on the highest concentration of a specific pollutant at a given time, often PM 2.5 or ozone (O₃). The health warning scales and categories used in the AQI system are often more stringent and more directly reflect the acute health risks of a particular pollutant (Alwi Mashuri & Zulfa, 2020).

This complexity is compounded by the fact that air pollution in Semarang is dominated by different pollutants depending on the source and time of measurement. Several studies and reports identify Carbon Monoxide (CO) and Nitrogen Dioxide (NO₂) as the main pollutants, particularly from the transportation sector.

Meanwhile, real-time monitoring data consistently highlights PM_{2.5} and O₃ as critical parameters determining daily air quality levels. Therefore, a single IKU or AQI figure without specifying these critical parameters can be ambiguous and potentially lead to accidents (Marzuki, 2019)(Mashuri & Zulfa, 2022).

Environmental monitoring data from the Semarang City Environmental Agency (DLH) between 2019 and 2024 show a mixed trend in the Air Quality Index (AQI):

- A. Average AQI in central urban zones improved slightly from [92] in 2019 to [90] in 2024, though several peak-hour readings remain in the “unhealthy” category.
- B. Particulate matter (PM_{2.5} and PM₁₀) levels exhibit seasonal spikes during the dry season, often exceeding WHO thresholds.

Despite the implementation challenges, existing green belts do provide measurable, albeit localized, environmental benefits. As shown in Table 2, the UHI effect is a documented phenomenon in Semarang, with a historical warming trend and significant temperature differentials between urban and rural areas. The draft manuscript's claim that green belt-adjacent areas are cooler is supported by studies confirming the microclimate regulation function of urban vegetation.

However, the city-wide impact of these fragmented green spaces is insufficient to counteract the broader warming trend. Air quality data further illustrates this sub-optimal impact. While comprehensive, continuous AQI data for the 2019-2024 period is not consistently available, existing real-time data and specific studies indicate persistent pollution problems (Bhuyan et al., 2025). The limited and fragmented nature of the green belts means their capacity to absorb pollutants is easily overwhelmed by the scale of urban emissions, particularly from traffic (Suryadi et al., 2017).

Table 2. Key environmental indicators for semarang city (2019-2024)

Indicator	Data Point	Period
Average Temperature Trend	+0.0257 °C / year	1985-2016
Peak Recorded Temperature	38°C	October 2019
UHI Hotspot Temperature	37.3°C (Tugu Muda)	2024
Air Quality Index	Frequently "Unhealthy for Sensitive	2022-2025

		Groups" (Tidak Sehat untuk Kelompok Sensitif)	
PM	10	38.39 - 99.35	Undated
Concentration		µg/m ³ (at city terminals)	Study

Source: author's analysis (2025)

Table 2 presents a summary of key environmental data for Semarang City, compiled from a series of academic studies and monitoring data. Specifically, data on historical average temperature and peak temperature trends are sourced from research (Nurjani & Giyarsih, 2023), while the most recent Urban Heat Island (UHI) hotspot temperature data is taken from a study. Information on PM10 concentrations in high-traffic locations is from the Public Health Journal, and general air quality monitoring data refers to the aqi.in platform. This compilation provides a quantitative overview of the environmental challenges facing the city.

Temperature monitoring reveals that urban surface temperatures in green belt-adjacent areas are [3°C] lower on average compared to similar areas without green belts. This supports the microclimate regulation function of green belts as thermal buffers.

3. Community Participation in Green Belt Management

Interviews with community representatives and local environmental NGOs indicate that public involvement in green belt planning and maintenance is sporadic and largely event-based (e.g., tree planting campaigns). Barriers to sustained participation include:

- Low awareness of legal rights to contribute to green belt governance under Perda No. 8/2016.
- Lack of direct incentives (economic or social) for ongoing involvement.
- Perception that green belt management is solely the government's responsibility.

Successful cases of community engagement, such as the [Climate Village Program] initiative, demonstrate that when

local residents are provided with small grants or recognition programs, they are more willing to participate in regular maintenance. Example:

Climate Village Program (Proklim):

This is a national program recognized and awarded by the Semarang City Government. This program perfectly fits the description of an "award program" in the journal. In 2024, several sub-districts received awards, including Mangunsari (1st place) and Tugurejo (national award recipient).

4. Legal and Governance Analysis

From a legal perspective, the Green Belt Policy aligns with the broader framework of Law No. 26/2007 on Spatial Planning and Law No. 32/2009 on Environmental Protection and Management. However, enforcement remains weak:

- Violations of green belt spatial allocation often result in minimal penalties, reducing deterrence.
- Coordination between DPU and DLH is hindered by overlapping mandates, leading to gaps in monitoring and enforcement.

Integrating legal provisions with community-based monitoring could strengthen compliance and accountability. A central challenge identified is the low level of community participation. Interviews revealed a general lack of awareness among residents about their legal rights and responsibilities under Perda No. 8/2016, coupled with a perception that green space management is solely a government duty.

This finding reflects a 'participation paradox': while the legal framework allows for citizen involvement, the mechanisms for engagement are ineffective. This situation is consistent with challenges identified in other emerging economies, where a lack of institutional support, transparent information, and direct incentives can hinder meaningful community engagement. The participation in Semarang appears to be largely 'invited' and event-based (e.g., ceremonial tree planting), rather than a

sustained, citizen-led partnership (Bressane et al., 2024).

This falls into the lower rungs of participation typologies, such as consultation or tokenism, and fails to harness the potential for community stewardship that is crucial for the long-term sustainability of urban green spaces (Alvarado Vazquez et al., 2024).

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harness the potential for community stewardship that is crucial for the long-term sustainability of urban green spaces (Hipparkar et al., 2024).

Beyond weak enforcement, this analysis reveals structural and systemic governance failures. The problem of "overlapping mandates" is not simply a bureaucratic issue, but a visible manifestation of a crippling fragmentation of responsibilities. A surprise inspection by the Mayor of Semarang in the Kampung Kali area exemplifies this dysfunction, revealing that the Housing and Settlement Agency (Disperkim) is responsible for park development, the Public Works Agency (DPU) for the surrounding sidewalks, and the Environmental Agency (DLH) is only responsible for sidewalk cleanliness, but not the parks (Putri et al., 2022).

This fragmentation creates "orphan assets" owned by no single agency, resulting in neglect and inefficiency. This governance failure is exacerbated by the disconnect between regulatory commitments and fiscal allocations. The existence of Regional Regulation No. 8/2016 pales in the face of a 67% maintenance budget deficit, effectively rendering the legal mandate to maintain green spaces unenforceable. Ironically, while formal city-level policies fail to mobilize participation, hyperlocal, community-driven initiatives like the Climate Village Program (Proklim) thrive and succeed, often with minimal support. This demonstrates the city government's failure to learn from, support, and scale proven bottom-up participation models, instead relying on ineffective top-down frameworks.

5. Comparative Insights from Other Cities

Benchmarking against Surabaya and Jakarta reveals that:

- A. Surabaya's adoption of a Community Green Stewardship Program has increased green belt coverage and public satisfaction.
- B. Jakarta's use of IoT-based air quality and vegetation health sensors enables real-time monitoring and targeted interventions.

Table 3. Comparative analysis of urban greening policies in Indonesian cities

Feature	Semarang (Studikasuk)	Surabaya (Benchmark Keberhasilan)	Jakarta dan Bandung (Benchmark Tantangan)
RTH Percentage	~7.5%	~22%	Jakarta & Bandung (Benchmark Tantangan) ~9%
Key Policy/ Program	Perda No. 8/2016	Green Transportation, Green Building Award, Park Revitalization	(Jakarta), ~12% (Bandung)
Community Participation	Low awareness, event-based	High engagement, economic integration (Taman Suroboyo), community initiatives (Griyo Maos)	Perda RTRW , Program Bandung Menanam
Primary Challenges	Budget deficit, weak enforcement, low participation		Severe land competition, weak enforcement, developer non-compliance

These cases illustrate the potential for Semarang to adopt hybrid governance models that combine legal enforcement with technological and civic engagement innovations.

To understand the root causes of Semarang's performance, a comparative analysis with other major Indonesian cities is instructive (see Table 3). The case of Surabaya serves as a powerful benchmark for success. With approximately 22% public RTH coverage, Surabaya has far surpassed both Semarang and the national minimum requirement. This achievement is not merely the result of a larger budget, but of a fundamentally different governance approach.

Surabaya has successfully implemented programs that integrate environmental goals with social and economic incentives. Initiatives like the 'Green Building Awareness Award' foster private sector involvement, while the development of parks like Taman Suroboyo explicitly incorporates space for local small-scale vendors, creating a direct economic stake for the community in the

park's success. Grassroots initiatives, such as the 'Griyo Maos' community reading park in Gunung Anyar, are encouraged and supported, fostering a strong sense of local ownership (Pemerintah Kota Surabaya, 2022).

Conversely, the experiences of Jakarta and Bandung offer cautionary tales that mirror Semarang's challenges. Both cities struggle with low RTH percentages (approx. 9% in Jakarta, 12% in Bandung) and face similar problems of weak legal enforcement, developer non-compliance, and the conversion of green spaces for commercial use.

Studies on RTH implementation in Jakarta highlight how a lack of coordination, limited human resources, and political biases can cripple policy effectiveness, leading to conflicts over land use rather than collaboration (Rahmanto, 2025). This comparative lens suggests that Semarang's primary obstacle is not a unique lack of resources, but rather its adherence to a governance model that has proven ineffective in other complex urban settings in Indonesia.

The key differentiator for success, as exemplified by Surabaya, is the strategic shift from a purely government-led, top-down model to an integrated, multi-stakeholder governance ecosystem that creates shared value and responsibility.

6. Strategic Recommendations

Based on the findings, the following strategies are proposed:

1. **Reform Governance and Strengthen Enforcement:** Instead of the generic Strengthen Regulatory Enforcement, propose: Establish a multi-agency 'Green Space Task Force' with dedicated authority from the Mayor's office to audit developer compliance with the 10% private RTH mandate. This task force should have the power to impose meaningful, escalating penalties for non-compliance, addressing the enforcement weaknesses mirrored in Jakarta and Bandung. To enhance transparency, the task force must

publish an annual public 'Green Compliance Report' detailing the RTH contributions of all new major developments.

2. **Incentivize and Empower Community Participation:** Transform Enhance Community Incentives into a concrete program: Pilot a 'Community Green Stewardship Program' in at least three sub-districts, modeled on Surabaya's successful grassroots initiatives like 'Griyo Maos'. This program would provide micro-grants, technical assistance (e.g., horticultural training), and formal recognition to neighborhood groups for the maintenance, beautification, and activation of local green belts. This shifts the dynamic from passive residents to active stewards and builds social capital (Margi Arum & Widiyarta, 2023).
3. **Integrate Green Spaces with Local Economy:** Propose a new, economically-focused recommendation based on the Surabaya model: In the planning of new or revitalized parks and green corridors, formally integrate spaces for local micro, small, and medium enterprises (MSMEs), particularly for street food vendors and small-scale recreational services. This approach, successfully demonstrated at Surabaya's Taman Suroboyo, creates a direct economic linkage between the community and the green space, fostering a virtuous cycle of use, economic benefit, and local guardianship (Wijayanto & Hidayati, 2017).
4. **Leverage Technology for Monitoring and Engagement:** Refine Integrate Technology with a dual purpose: Deploy a limited network of low-cost, IoT-based air quality and temperature sensors in high-use green belts, making the data publicly accessible via a city dashboard. This serves a dual purpose: providing real-time environmental data for policy evaluation and fostering citizen science. Furthermore, develop a public-facing GIS portal that maps all official RTH,

allowing residents to report encroachment or maintenance issues directly, thereby creating a community-based monitoring system.

These strategies aim to maximize the ecological and social benefits of green belts while ensuring policy sustainability.

7. Data on the Distribution of Green Belts in Semarang City

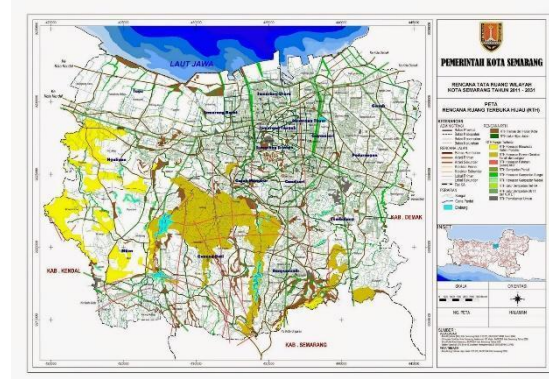


Figure 1. Green belt in semarang city

Based on the Green Open Space (RTH) Plan Map which is part of the Semarang City Regional Spatial Plan (RTRW) for 2011-2031, it can be seen that the concept of green belts in this city is designed as an integrated and diverse network, not only limited to city parks.

Visually, this network of greenways stretches along linear patterns vital to the city. Greenways are clearly allocated along the boundaries of major rivers that divide the city, such as the Kali Garang and Kali Kreo. They function not only as catchment areas and flood control areas, but also as ecological corridors connecting the upstream areas in the south with the coast in the north. Furthermore, the greenways are planned to follow the network of main roads, both arterial and collector, which serve as pollution buffers and provide shade for the city.

This map also shows the uneven distribution of green open space, with a greater concentration of green areas in the southern and western parts of the city, such as in the Gunungpati and Mijen sub-districts. These areas are dominated by green open spaces designated for protection, disaster-prone areas, and urban agriculture, indicated by the brown and yellow colors. Conversely, in the denser downtown area, green open spaces are more often found in

narrow strips along riverbanks, along railway lines, and in smaller city parks.

Theoretical Framework of Environmental Education in Green Belt Management

Environmental education within the scope of green belt management cannot be viewed merely as information transfer, but must follow a comprehensive environmental literacy framework. Referring to Hungerford and Volk's theory, the formation of responsible pro-environmental behavior is influenced by three categories of variables: entry-level variables, ownership variables, and empowerment variables. In Semarang, low community participation in green belt maintenance is often caused by a failure to establish ownership variables, where residents perceive green public spaces as entirely the government's responsibility without any sense of personal ownership (stewardship).

Entry-level variables include environmental sensitivity and basic ecological knowledge, which serve as an initial foundation. Environmental education must ensure that residents understand the basic principles of the green belt's function, not merely as an aesthetic element, but as life-saving infrastructure. Furthermore, ownership variables involve a deep understanding of Semarang's specific environmental issues, such as tidal flooding and extreme temperature increases, which are then linked to residents' emotional investment. Finally, empowerment variables provide residents with technical skills (action skills) to carry out concrete interventions, such as planting and caring for shade trees in their own yards or along street green belts (Szczytko et al., 2019).

Table 4. Environmental education in green belt management

Dimensions of Environmental Literacy	Key Components	Applications in Green Belt Policy
Affective Disposition	Attitude, sensitivity, locus of control	Cultivating a sense of pride in city park
Cognitive Competency	Issue analysis, problem solving skills	Able to identify sick trees/need pruning

Ecological Knowledge	Knowledge of earth systems and socio-political	Understanding the relationship between green open space and spatial planning law
Responsible Behavior	Real and sustainable action	Actively involved in green communities or Proklm

Adiwiyata and Environmentally Conscious School Transformation

The formal education sector in Semarang plays a crucial role in instilling the values of green belt sustainability through the Adiwiyata program. This program is not simply an effort to green the school environment, but rather a model for integrating environmental management into the curriculum and school culture as a whole. Adiwiyata schools in Semarang, such as SMK N 2, have demonstrated that utilizing school land for green open space (accounting for almost 50% of the total land area) can serve as a living laboratory for students to learn directly about climate change mitigation (Setyowati & Aji, 2015).

The success of formal environmental education also depends heavily on teachers' capacity as agents of change. Training educators to develop teaching materials that are contextualized to local environmental issues in Semarang such as tidal flooding in coastal areas or high temperatures in the city center is crucial. By presenting real-life problems in the classroom, students not only learn theory but are also encouraged to think critically and seek innovative solutions, such as designing vertical gardens for densely populated areas or promoting the use of public transportation to reduce air pollution (Radite Rangi Ananta et al., 2024).

CONCLUSION

This study demonstrates that while Semarang's Green Belt Policy, mandated by Regional Regulation No. 8 of 2016, provides localized ecological benefits in mitigating urban heat and modestly improving air quality, its overall effectiveness is severely

constrained by a significant governance gap. This gap is evidenced by a chronic 67% shortfall in the maintenance budget and a public green space coverage of only 7.5%, falling far short of the national 30% mandate. The policy's impact is further limited by a top-down implementation model that results in minimal community participation, despite existing legal provisions allowing for citizen involvement.

To address these implementation challenges, this study highlights the critical role of formal and non-formal environmental education in transforming community attitudes. Initiatives such as the Climate Village Program (Proklm) and Participatory Action Research (PAR) in areas like Kuripan Kidul prove that providing residents with ecological knowledge and practical skills such as composting and urban farming effectively shifts their behavior from passive observers to active environmental stewards. This educational approach is essential to overcome the prevailing perception that green space management is exclusively a government responsibility.

Ultimately, a comparative analysis reveals that realizing the full potential of Semarang's green infrastructure requires a fundamental shift from a government-centric management paradigm to a collaborative, multi-stakeholder governance ecosystem. Enhancing community participation necessitates the integration of social and economic incentives, such as awarding best-performing neighborhoods and integrating local micro-enterprises into park management. By strengthening regulatory enforcement, integrating technological monitoring, and institutionalizing continuous environmental education, policymakers can foster the sustained civic engagement needed for successful and equitable urban environmental management.

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