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OPTIMISING URBAN GREEN SPACES FOR SUSTAINABLE DEVELOPMENT: A GIS-BASED ANALYSIS IN SERANG CITY, INDONESIA

RAH ADI FAHMI GINANJAR[1]*, MUHAMMAD IMAN SANTOSO[2] AND ASEP RIDWAN[3]

[1]Faculty of Economics and Business, Universitas Sultan Ageng Tirtayasa, Serang, 42163 Banten, Indonesia. [2]Institute for Research and Community Services, Universitas Sultan Ageng Tirtayasa, Serang, 42163 Banten, Indonesia. [3]Faculty of Engineering, Universitas Sultan Ageng Tirtayasa, Serang, 42435 Banten, Indonesia.

**Corresponding author: rah.adi@untirta.ac.id*

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ABSTRACT

This research focuses on the issue of Urban Green Spaces (UGS) in Serang City, Banten, Java and how they relate to the 30% ecological land reserve mandated by national policies in Indonesia. At present, the coverage of green spaces is only 5.33% of the urban area, which translates to a shortfall of over 7,500 hectares. Based on high resolution satellite images and Geographic Information System (GIS) analysis, augmented by ground truthing and the Regional Spatial Plan, this study estimates about 1,548 hectares of city land may be converted to green spaces. If this is achieved, the city's green coverage wll increase by over 20% points, thus, closing the regulatory gap. The research further reveals the unequal distribution of green spaces within and across districts where some such as Kasemen and Taktakan, are worse off than others. Recommended measures include stringent spatial delineation zoning, reprioritised spatial allocation, and the adoption of vertical greening systems. These policies aim to improve the quality of the environment, climate change mitigation, and create more equitable urban space developments in Serang City as guided by national and municipal spatial policies. The recommendations can also serve other similarly poised cities as a speculative planning model.

Introduction

Urbanisation, a global phenomenon, has rapidly transformed landscapes, economies, and societies. Urban Green Spaces (UGS) are essential in sustainable city planning, as they provide the essential functions to improve the quality of life for urban residents; thus, managing and conserving them needs to be significantly considered when cities expand. In addition to mitigating the urban heat island effect, green areas also contribute to the absorption of stormwater, the filtering of air pollutants and fostering of urban biodiversity (Groenewegen *et al*., 2006; Lee & Maheswaran, 2011). Furthermore, these areas may provide some social and psychological payback by encouraging community engagements—promoting physical and social activities, that nurture mental well-being (Callaghan *et al*., 2021).

Recent research highlights the role of green spaces in cities to ameliorate climate change and reduce urban heat islands. The rise in temperatures is partially a consequence of decreased vegetation cover as a result of increased city density (Haaland & van den Bosch, 2015; Marando *et al*., 2022). In addition, planting more trees also reduces air pollution, provides shade for city dwellers, and supports resilience against climate change disasters such as flash floods and heatwaves (Muluneh & Worku, 2022). Despite the benefits, cities—

including those in developing countries—often struggle to meet their green space needs amidst rapid population growth (Turner *et al*., 2004; Paudel & States, 2023).

The literature also points to a clear and widespread realisation of the necessity for more sustainable urban planning practices, which utilises green designs. To create strategic green spaces, urban planners may use high-resolution satellite imagery for land-use planning (Fan *et al*., 2017) or build "green roofs" and "vertical gardens" in areas where many people live (Li & Sullivan, 2016). City authorities may also encourage the design of urban spaces that can be used for both ecological and recreational purposes (Pauleit & Duhme, 2000). These solutions aim to mitigate congestion and improve the quality of life, besides increasing the green infrastructure's environmental and social benefits.

However, there is still much to be discovered about how urban green spaces can best be identified. This includes theories of their creation, as well as approaches for their effective management in rapidly urbanising cities, where land resources are dwindling due to high development pressure (Chang *et al*., 2017; Girma *et al*., 2019). Although recent work has primarily examined green spaces' ecological and social functions, studies have yet to critically investigate spatial distributional patterns and accessibility in urban areas—key aspects for understanding equitable access from a social justice (SJ) perspective. Furthermore, studies are needed on the fusion of advanced geospatial data in urban green space planning to overcome challenges posed by identification protocols because it will help reduce inaccuracies and uncertainties (Roy *et al*., 2012; Gómez-Baggethun & Barton, 2013).

The ecological and social impacts of urban green spaces have been studied in depth, yet there is still a lack of research focusing on their spatial distribution and the ease of access to these fields, especially in the context of rapidly urbanising secondary cities in the Global South (Roy *et al*., 2012; Gómez-Baggethun & Barton, 2013). Limited studies have applied high-resolution GIS and remote sensing technologies to evaluate green space coverage with sufficient policy-relevant precision (Fan *et al*., 2017; Zulian *et al*., 2021). In addition, integrated approaches to national planning frameworks, including the Regional Spatial Plan, tend to neglect spatial analyses (Girma *et al*., 2019). For the local authorities in Serang City, where green space coverage drastically lags behind national objectives, this research gap creates a void of useful information.

The current study aims to address this gap by proposing a novel integration of technical geospatial approaches with regulatory planning framework. Prior research has looked into the socio-cultural and ecological value of urban green areas, but the focus on their distribution and accessibility, especially within the context of rapidly urbanising secondary cities in the Global South, remains unresolved (Roy *et al*., 2012; Gómez-Baggethun & Barton, 2013). Very few studies used advanced GIS and remote-sensing data analysis to measure green space coverage with the required accuracy for effective purposive policy frameworks (Fan *et al*., 2017; Zulian *et al*., 2021). Furthermore, the inclusion of documents like the Regional Spatial Plan into spatial evaluation tends to be underexplored (Girma *et al*., 2019).

This study bridges these gaps by presenting a novel method at the intersection of urban green space planning and geospatial technology, incorporating high-resolution satellite imagery and datasets from drone surveys using land use data. Common tree-planting strategies face significant limitations, including their inability to identify potential green space areas and to furnish urban planners or policymakers with more precise and dependable information (Nowak & Greenfield, 2018; Zulian *et al*., 2021). As a case study, this research focuses on Serang City in Banten province, Java, Indonesia to provide an understanding of the constraints and opportunities that shape green space planning processes in urban areas.

This research focuses on Serang City, the provincial capital of Banten with a green space index significantly lower than the nationally recommended figures. Utilising remote sensing and GIS, along with integrating spatial policy documents, this study proposes an innovative framework for spatial planning with three primary objectives: (1) Assessing and creating a geographical representation for existing urban green spaces; (2) determining possible locations for future green space enhancements using GIS and satellite imagery; and (3) putting forward policies aimed towards equitable and sustainable green infrastructure development while proposing congruent policy recommendations.

Materials and Methods

UGS were used as a baseline for planning and utilising every urban area in Serang City. In order to systematically identify, classify and analyse the availability of UGS within Serang City, we conducted a multi-scale study that integrated remote sensing, GIS analysis, and field surveys.

Figure 1 demonstrates the proposed allocation of UGS within Serang City. Information was sourced from existing administrative records and spatial planning documents. Where digital records did not exist, additional data were obtained from Unmanned Aerial Vehicle (UAV) surveys. We used satellite imagery and aerial photographs to identify prevailing and feasible UGS and classify land cover/land use. We then used this verified data to develop a reservation plan to cover at least 30% of the city area with green space, thus, guarantees adherence to global sustainable urban development standards.

This study was based on the use of high-resolution satellite imagery together with land use maps inspired by the Regional Spatial Planning documents from primary data sources, as described in Girma *et al*. (2019). The datasets utilised made it possible to determine the existing UGS within the city, as well as to identify areas that were suitable for the future expansion of green spaces (Roy *et al*., 2012; Nowak & Greenfield, 2018).

Other researchers have popularly used the Maximum Likelihood Classification (MLC) algorithm for the supervised classification of high-resolution satellite images for the identification of in situ green spaces, which separated various land use types based on their spectral signatures (Chang *et al*., 2017; Zulian *et al*., 2021). Several macro and micro GIS tools could map possible space de-escalation areas; some sought to establish new greeneries. The literature on UGS, which had studied larger contiguous land surfaces at the macro level as well as smaller sites such as vacant lots, underutilised parcels, and rooftops was often equally referred to—typical for making a broad distinction (Haaland & van den Bosch, 2015; Pauleit & Duhme, 2000).

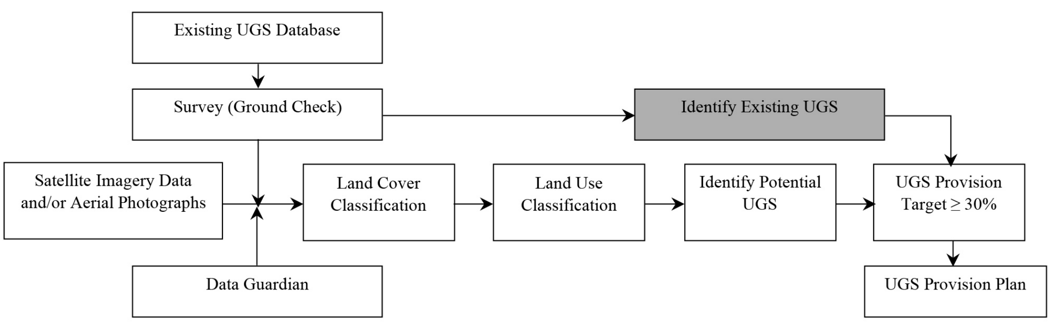


Figure 1: Flowchart showing the technical scheme for identification of potential green open spaces in Serang City, Indonesia
Source: Regulation of the Minister of ATR/BPN Number 14 of 2022

Validation of the remote sensing and GIS analysis included site observations and measurements of existing UGS. Others include interviews with urban planners (Gómez-Baggethun & Barton, 2013; Muluneh & Worku, 2022) and city-level actors such as representatives from environmental organisations or other community stakeholders. In addition, the surveys solicited qualitative data on residents' perception of their access and quality of UGS.

Data was analysed using both quantitative and qualitative techniques. For quantitative analyses, spatial metrics were used to assess the distribution, area, and accessibility of UGS. Qualitative analysis emphasised making meaning of interviews and field observations to reveal insights into why UGS might be socially or culturally important within the local context (Lee & Maheswaran, 2011; Li & Sullivan, 2016).

The study results were obtained from various analyses to develop a framework for green space planning. This framework can serve as a recommendation for urban planners and policymakers to enhance the provision and management of green spaces in Serang City. Specifically, synthesising spatial data, knowledge of stakeholder engagement, and environmental considerations had created a holistic approach to integrative strategies for sustainable UGS development (Turner *et al*., 2004; Fan *et al*., 2017).

In determining the accuracy of the land cover classification created using the high-resolution satellite imagery, we employed the Kappa coefficient method which considered the agreement that might occur by mere chance. The classification accuracy was above 85%, which implied that the results were reliable. The classified outputs were validated using ground-truth data collected from field surveys. For particular sample points, ground observations using GPS were checked against the mapped land cover to evaluate both positional and thematic accuracy.

While formulating recommendations on land use policy based on spatial analysis, ethical guidelines were followed to mitigate the risk of designing policies that could enable forced relocation, land tenure disputes, and erasure of marginalised groups. The findings were evidence-based, focused on inclusion, and anonymous. The spatial datasets used were either publicly available or accessible through institutional permission.

Results and Discussion

The UGS available in Serang City were still 55% below the standard provision and a gap analysis indicated the necessity of strategic intervention. Based on Table 1, the total area of existing green spaces in Serang City were only 425.244 ha (5.3251% of overall urban areas). This was far below the minimum requirement of 30% as defined by Indonesia's national urban planning regulations (Regulation of the Minister of Agrarian Affairs and Spatial Planning Number 14/2022). An approximate shortfall of 94.6749% (7,560.438 ha) still stood, indicating the urgency to develop and enhance green infrastructure in metropolitan cities.

The geographic distribution of UGS by district within the city underscored access inequities. For example, Curug district had a green space of only 0.9099%, whereas Kasemen district had 0.3274%. Our results were similar to previous studies in rapidly urbanising cities, where land use competition was high, and socio-economic inequities were noted for access and distribution of green spaces (Turner *et al*., 2004; Girma *et al*., 2019). This inequality had increased social disparities, as residents in green-poor neighbourhoods were deprived of the local agroecology's mental and physical productivity.

As shown in Figure 2, even though demand for UGS was not yet fulfilled with a wide gap in all Serang City districts (they did have a below-standard number for the area). Kasemen district displayed the most significant shortage of available green space in absolute terms, with

Table 1: Existing areas and gaps of green open spaces in Serang City

No.	UGS Typology*	Size (Ha)	UGS Area per District (Ha)					
			Curug	Walantaka	Serang	Cipocok Jaya	Taktakan	Kasemen
I	Serang City	26,618.94	3,896.01	3,656.00	2,655.00	3,410.00	6,116.22	6,885.71
II	Size of UGS							
A	UGS Area/Zone							
	1. Urban Forest	142.878	-	-	-	1.228	141.65	-
	2. Park	18.236	0.083	0.744	9.951	2.878	1.25	3.33
	3. Community TPU	242.03	72.336	38.957	39.426	47.256	24.322	19.733
	4. Government TPU	22.10	0.24	2.926	6.979	8.871	-	3.084
B	Other Regions/Zones	-	-	-	-	-	-	-
C	UGS Function Objects	-	-	-	-	-	-	-
	UGS Existing Total (II)	425.244	72.659	42.627	56.356	60.233	167.222	26.147
	UGS Standard**	7,985.682	1,168.803	1,096.80	769.50	1,023.00	1,834.866	2,065.713
	Percentage of Urban UGS 30% Fulfillment	5.3251	0.9099	0.5338	0.7058	0.7543	2.0940	0.3274
	Gap	(7,560.438)	(1,096.144)	(1,054.173)	(740.144)	(962.767)	(1,667.644)	(2,039.566)

Source: Results of the analysis (2023)
Note: *Regulation of the Minister of ATR/BPN Number 14 of 2022.

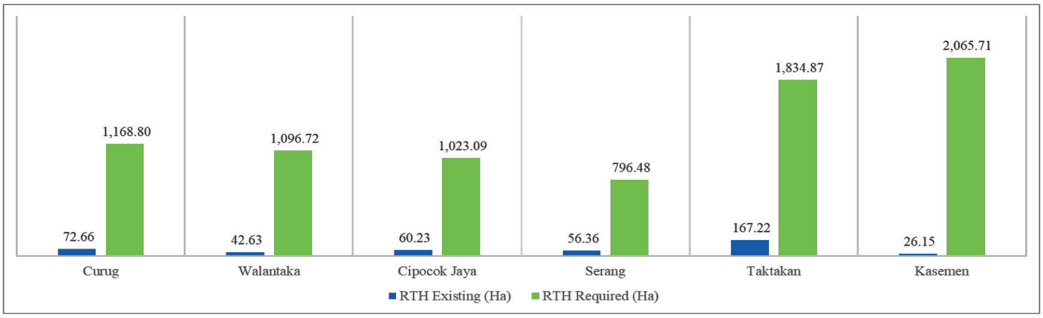


Figure 2: Comparison of required and existing urban green spaces (UGS) in Serang City
Source: Results of the analysis (2023)

a deficit of about 2,039.566 hectares, which was 35% of the district's total area. Taktakan came close with a 34% deficit of 1,667.644 hectares, but because of its longer spatial extent, Kasemen's land requirement was considerably greater.

Within this study, the Curug district demonstrated the maximum deficit of green space under the highest growth scenario, which reached 1,096.144 hectares. This figure came from a land-use simulation conducted to evaluate possible allocative imbalances within the urban area under the most pessimistic density scenario. The wide prevalence of this shortfall demands immediate, strategic interventions.

Socio-economic conditions significantly influenced the spatial allocation of green space. In Serang City, districts with lower average income levels and higher proportions of informal settlements such as Kasemen and Curug, also suffered from the lowest UGS coverage. Limited land ownership rights and weak institutional coordination between planning and enforcement bodies further complicated the inclusion of green spaces in urban layouts. These governance and equity dimensions were critical to understanding why some districts lagged in ecological infrastructure provision.

Figure 3 illustrates the spatial distribution of current and proposed UGS in Serang City. Although not a true heat map, the map showed the distribution patterns of green zones and UGS shortages across certain districts, including high-pressure zones such as Kasemen, Curug, and Taktakan. This layer, created from planning data and field surveys confirmed our conclusions concerning the inequitable distribution of green spaces within the districts.

Other Indonesian cities like Yogyakarta and Bekasi also experienced rapid urban growth and informal land use in the context of national green space mandates, which informed green space deficits. Ho Chi Minh City in Vietnam and Manila in the Philippines also experienced uncontrolled urban sprawl, leading to structural inequities in green space provision, besides lacking cuts to reap gaps and inconsistently enforced planning (Haaland & van den Bosch, 2015; Marando *et al*., 2022). These comparisons strengthened the argument for the need of policy reform regarding green spaces in Serang City.

The city-wide low prevalence of UGS had left considerable social and health consequences. Research showed that insufficient green spaces in urban areas were associated with high number of urban heat islands, worse air quality, and lesser biodiversity (Groenewegen *et al*., 2006; Nowak & Greenfield, 2018), which all impaired liveability within these regions. As such, addressing this deficit was not just a question of compliance with norms and standards, but also about improving the quality of life for the people in Serang City.

This research utilised geospatial methods such as satellite image analysis, land use suitability evaluation, NDVI mapping, and proximity buffer analysis to explore the potential green space development sites that could address the large deficit seen. The identification of areas suitable for being converted into green spaces was done using high-resolution satellite imagery and GIS analysis, the land selection for prospective green space development was carried out using spatial overlay analysis, taking into account existing land cover, slope (< 15%), distance from built-up areas, availability of vacant land, and regulatory designations.

The classification of the satellite image was conducted through supervised classification and the suitability modelling was performed with weighted overlay in QGIS and ArcGIS, which resulted in the selection of approximately 15,489.538 hectares (Figure 3 & Appendix 1) of land where it might be possible to convert accommodating more greeneries within the city limits. This highlighted area is over and above the existing deficit, which meant Serang City had space that exceeded 30% if planned correctly.

In the event of urban sprawl, law-abiding compliance with Indonesia's 30% green area requirement mandated that foresighted land-use forecasting be integrated into spatial planning. This model could be modified to test different metropolitan area expansion hypotheses and add new development areas needed to include green buffer zones and parks. Updating the Regional Spatial Plan would regularly be needed to accommodate changing spatial requirements or shifts in ecological concerns.

Green spaces were categorised into three broad groups: (1) Large contiguous areas that are good candidates for major urban parks or nature reserves; (2) smaller plots that could act as community parks or green corridors; and (3) unconventional spaces such as rooftops and vacant lots, suitable to be converted to urban gardens by growing vegetables. The multi-scale strategy guaranteed the exploration of all possibilities, from large urban (municipal) parks to small neighbourhood green spaces (Pauleit & Duhme, 2000; Haaland & van den Bosch, 2015).

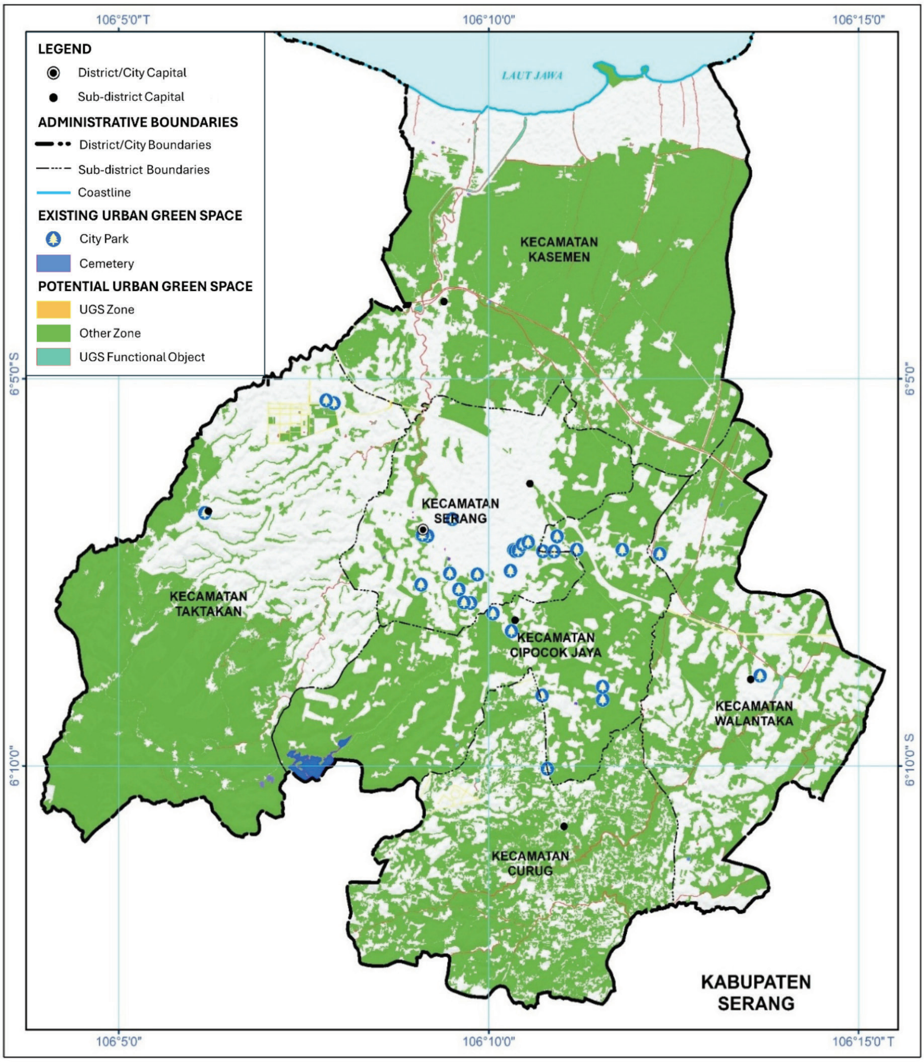
The identification process also considered its proximity to residential facilities, accessibility, and ecological connectivity. The goal was to locate the most residents within one kilometre from a high-quality park. Ecological connectivity in the assessment would guarantee that new green spaces could supply recreational services and develop climate resilience through connecting fragmented habitats and biodiversity (Zulian *et al*., 2021).

Competition for land was one of the obstacles in developing green spaces in Serang City. Urban sprawl and high population density in the city had caused various problems such as an increase in residential, commercial, and industrial land demand at the cost of forest parks. Furthermore, non-adherence to land use regulations was prevalent and the misuse of officially designated green space for other purposes had aggravated the issue (Chang *et al*., 2017).

In addition, field surveys found that numerous green spaces were in poor condition, which reduced their usefulness and aesthetic value. Their presence did not necessarily benefit residents, as supporting infrastructures and amenities were often absent (Groenewegen *et al*., 2006). Poor access and limited facilities surrounding these areas are frequently reported by locals, suggesting a gap between the provision of green spaces and their practical use.

To resolve these issues, this study provided an integrated model to improve the provision of green spaces in Serang City. First, it would be necessary to ensure that land use regulations were enforced to maintain the identity of areas earmarked as green zones. Second, districts with the lowest green-space coverage should be the focus of improvement. Third, enhancing the maintenance and accessibility of extant green spaces is critical to provide ecosystem services to residents (Gómez-Baggethun & Barton, 2013; Muluneh & Worku, 2022).

In addition, innovative solutions such as vertical gardens could be studied to maximise the utilisation of scarce land in urban settings. These measures not only allowed for the creation of more green spaces, but also provided improvements for the urban microclimate and well-being (Li & Sullivan, 2016; Nowak &



Map History:

- Administrative boundaries of Serang City based on Permendagri Number 98/2014, Serang City Regulation Number 07/2017
- Coastline using the interpretation of SPOT Image 6 of 2014-2017
- Regional Spatial Plan of Serang City for 2020-2040
- Detailed Spatial Plan and Sub-district Zoning Regulations
- As a base map is the RBI KSP Map Scale 1:50,000 Year 2017

Figure 3: Spatial distribution of existing and potential urban green spaces in Serang City
Source: Compiled by authors

Greenfield, 2018). The lack of green space provision in Serang City showed how much the city needed a strategic approach to urban development based on sustainability and well-being. This study provided spatially explicit analyses of UGS deficiencies and development potential by combining high-resolution satellite imagery, supervised land classification, and suitability analysis with GIS overlay and proximity buffer analysis. Such results could assist policymakers to make informed decisions for example through prioritisation of green space allocation in underserved areas, ecological alignment of zoning changes, and real-time land cover data driven updates of Regional Spatial Plans (Lee & Maheswaran, 2011; Zulian *et al*., 2021).

In addition, the research demonstrated that green space and landscape arrangements must involve local communities in the planning process. Public participation in decision-making could help ensure that green spaces catered to local needs and provided an opportunity for the public to get involved (Haaland & van den Bosch, 2015). In conclusion, this study provided a comprehensive overview of black spots as existing and future green spaces in Serang City, which revealed constraints and the potential for enhancing availability and accessibility to green spaces. If combined with targeted interventions and strategic planning, the findings could address current deficits and achieve long-lasting sustainability performance at the neighbourhood level and liveability within urban areas.

Conclusions

The analysis uncovered a significant lack of green space in Serang City and recommended tailored approaches to enhance ecological land use. Major actions include enforcing zoning regulations, allocating public and underused sites for inexpensive greening opportunities, as well as some form of vertical green infrastructure in highly developed areas. Achieving these goals would require coordinated efforts from city planners, the local populace and the regional government. Immediate actions comprise incorporating UGS goals into the Regional Spatial Plan revision cycles, creating green space supervisory committees at the district level and pilot programmes for school and office rooftop gardens.

Building upon this work, policy simulation could explore varying green space configurations with different growth patterns and community-sourced participatory mapping frameworks to augment representation within these spaces. Incorporating AI-assisted remote-sensing tools could also enhance the precision of monitoring green coverage.

As much as this analysis speaks to Serang, the city's spatial approach and policy combinations were relevant for other fast-growing secondary cities in Southeast Asia. Through contextually-rooted and spatially-responsive planning, this work has potential to advance the conversation on sustainable urban change.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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Appendices

Appendix 1: Detailed identification matrix of existing and potential Urban Green Spaces (UGS) in Serang City, Indonesia, including typology, land use classification, spatial allocation, and estimated provision fulfilment

Nb.	Typology of Green Open Space	Standard				Identification (Ha)	Identification of UGS Provision Fulfillment (Ha)			
		Possession		Management			Existing UGS		Identification of Potential UGS of the Regional Spatial Plan	
		Public	Private	Public	Private		Public	Private	Public	Private
A	**UGS Area/Zone**									
1	Urban Forest	√	√	√	√					
	a. Urban Forest Park (Cipocok Jaya)					1.228				
	b. Kopassus Park Urban Forest (Taktakan)					141.650				
	Total Area of Urban Forest					**142.878**	**142.878**			
2	City Park	√		√	√					
	a. Curug					0.083				
	b. Walantaka					0.744				
	c. Cipocok Jaya					2.878				
	d. Serang					9.951				
	e. Taktakan					1.250				
	f. Kasemen					3.330				
	Total Park Area					**18.236**	**18.236**			
3	Cemetery (TPU)	√	√	√	√					
	Community TPU									
	a. Curug					72.336				
	b. Walantaka					38.957				

	c. Cipocok Jaya					47.256		
	d. Serang					39.426		
	e. Taktakan					24.322		
	f. Kasemen					19.733		
	Total Area of Community TPU					**242.030**		**242.030**
	Government TPU							
	a. Curug					0.240		
	b. Walantaka					2.926		
	c. Cipocok Jaya					8.871		
	d. Serang					6.979		
	e. Taktakan					0.000		
	f. Kasemen					3.084		
	Total Government TPU					**22.100**	**22.100**	
4	Green Lane	√	√	√	√			
	Street Median							
	a. Curug					1.678		
	b. Walantaka					3.411		
	c. Cipocok Jaya					0.000		
	d. Serang					0.000		
	e. Taktakan					8.871		
	f. Kasemen					2.160		
	Rail Boundaries							
	a. Walantaka					2.845		
	b. Cipocok Jaya					1.512		
	c. Serang					3.883		
	d. Kasemen					4.308		

	Total Green Lane Area (Road Median)					**28.668**	**28.668**
B	**Other Regions/ Zones**						
1	Areas/Zones that Provide Protection to Their Subordinate Areas	√	√	√	√	-	
2	Local Protection Area/Zone	√	√	√	√	-	
3	Conservation Area/ Zone	√	√	√	√	-	
4	Customary Forest Area/Zone	√	√	√	√	-	
5	Geological Protected Area/ Zone	√	√	√	√	-	
6	Cultural Heritage Area/Zone	√	√	√	√	-	
7	Mangrove Ecosystem Area/ Zone	√	√	√	√	-	
	a. Kasemen					24.935	24.935
8	Production Forest Area/Zone	√	√	√	√		
	Other Forests						
	a. Curug					971.206	
	b. Walantaka					0.000	
	c. Cipocok Jaya					0.000	
	d. Serang					0.000	

	e. Taktakan					607.428	
	f. Kasemen					0.000	
	Total Area of Other Forests					**1,603.569**	**1,603.569**
9	People's Plantation Area/Zone	√	√	√	√		
	Plantation						
	a. Curug					803.910	
	b. Walantaka					248.624	
	c. Cipocok Jaya					1,491.620	
	d. Serang					293.893	
	e. Taktakan					2,333.799	
	f. Kasemen					0.000	
	Total Plantation Area					**5,171.846**	**5,171.846**
10	Agricultural Area/ Zone	√	√	√	√		
	Rice Field Area						
	a. Curug					677.629	
	b. Walantaka					1,444.659	
	c. Cipocok Jaya					1,005.830	
	d. Serang					489.908	
	e. Taktakan					469.485	
	f. Kasemen					4,446.843	
	Total Rice Field Area					**8,534.354**	**8,534.354**

C	**UGS Function Objects**					
1	UGS Functional Objects in Buildings					
	Roof Garden	√	√	√	√	-
	Podium Garden	√	√	√	√	-
	Balcony Garden	√	√	√	√	-
	Corridor Garden	√	√	√	√	-
	Vertical Garden	√	√	√	√	-
	Planter Box Garden	√	√	√	√	-
	Container Garden	√	√	√	√	-
2	UGS Function Object on Kaveling					
	Persil in Residential Areas/Zones	√	√	√	√	-
	Persil in Trade and Service Zones/ Zones	√	√	√	√	-
	Provisions in Office Areas/Zones	√	√	√	√	-
	Persil in Industrial Areas/Zones	√	√	√	√	-
3	House Yard		√		√	-
4	RTB	√	√	√	√	-
5	Danau	√	√	√	√	
	a. Curug					4.761
	b. Walantaka					7.612
	c. Cipocok Jaya					0.844
	d. Serang					0.000

	e. Taktakan				0.407				
	f. Kasemen				4.747				
	Lake				**18.371**				**18.371**
6	Reservoirs	√	√	√	-				
7	River	√	√	√	-				
	a. Curug				13.224				
	b. Walantaka				19.491				
	c. Cipocok Jaya				12.299				
	d. Serang				10.873				
	e. Taktakan				12.184				
	f. Kasemen				64.659				
	Total River Area				**132.730**			**132.730**	
8	Embung	√	√	√	-				
9	Situ	√	√	√	-				
10	Spring	√	√	√	-				
11	Rawa	√	√	√	-				
12	Biopores	√	√	√	-				
13	Infiltration Wells	√	√	√	-				
14	Bioswale	√	√	√	-				
15	Rain Garden	√	√	√	-				
16	Retention Pond	√	√	√	-				
17	Artificial Swamp	√	√	√	-				
		Sum			**15,914.782**	**183.214**	**242.030**	**15,471.167**	**18.371**
		Overall Total UGS Identification				**425.244**		**15,489.538**	