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Spatial Evaluation of Urban Zoning and Green Open Space Provision in Moncongloe, Mamminasata New City, Indonesia

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ABSTRAK

Penataan zonasi perkotaan memiliki peran penting dalam mewujudkan pembangunan ruang yang berkelanjutan, khususnya pada kota baru yang sedang direncanakan. Penelitian ini mengevaluasi struktur spasial dan kesesuaian pengaturan tata guna lahan di Moncongloe, salah satu wilayah pengembangan strategis dalam Kawasan Kota Baru Mamminasata, Sulawesi Selatan, Indonesia. Dengan menggunakan pendekatan spasial deskriptif-evaluatif, analisis dilakukan untuk menilai kesesuaian Rencana Detail Tata Ruang (RDTR) dengan standar perencanaan nasional, terutama terkait distribusi tata guna lahan, penyediaan ruang terbuka hijau (RTH), dan keseimbangan zonasi. Hasil penelitian menunjukkan adanya ketidaksesuaian yang signifikan antara rencana tata guna lahan dengan ketentuan peraturan, di mana luas RTH hanya mencapai 0,35% dari total area, jauh di bawah ambang minimum 30% sebagaimana diamanatkan oleh Peraturan Menteri ATR/BPN Nomor 14 Tahun 2022. Zona permukiman mendominasi lebih dari 61% wilayah perencanaan, sementara zona lindung, pertanian, dan pelayanan publik masih sangat terbatas. Temuan ini menegaskan bahwa RDTR Moncongloe belum mampu mengoperasionalkan prinsip keseimbangan ekologis dan keadilan spasial, sehingga diperlukan penataan ulang zonasi, penguatan pengakuan terhadap zona agro-ekologis, dan pemanfaatan audit zonasi berbasis Sistem Informasi Geografis untuk meningkatkan kepatuhan dan ketahanan ekologis dalam pembangunan kota baru di Indonesia.

Keywords: Zonasi Perkotaan, Perencanaan Tata Ruang, Kepatuhan Tata Guna Lahan, Infrastruktur Hijau, Kota Baru Mamminasata

ABSTRACT

Urban zoning plays a crucial role in ensuring sustainable spatial development, especially in emerging planned cities. This study evaluates the spatial structure and regulatory compliance of land-use zoning in Moncongloe, a strategic development unit of the Mamminasata New City in South Sulawesi, Indonesia. Using a descriptive-evaluative spatial approach, the analysis examines the alignment of the Detailed Spatial Plan (RDTR) with national planning standards, particularly focusing on land-use distribution, urban green open space (GOS) provision, and zoning balance. Results show a significant mismatch between planned land use and regulatory requirements, with GOS accounting for only 0.35% of the total area, far below the 30% minimum threshold

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mandated by ATR/BPN Regulation No. 14/2022. Residential zones dominate over 61% of the planning area, while protected, agricultural, and public service zones remain underrepresented. These findings indicate that the Moncongloe RDTR has not yet operationalized ecological balance and spatial equity principles, highlighting the need for spatial reallocation, stronger recognition of agro-ecological zones, and the use of GIS-based zoning audits to improve compliance and ecological resilience in Indonesia's new city developments.

Keywords: Urban Zoning, Spatial Planning, Land-Use Compliance, Green Infrastructure, Mamminasata New City

INTRODUCTION

Urban expansion has become one of the most critical spatial and environmental transformations of the twenty-first century, particularly in developing regions across Asia and Africa [1]–[3]. The continuous conversion of agricultural and ecological land into residential, commercial, and infrastructural areas has intensified spatial fragmentation, degraded ecosystem functions, and generated governance conflicts over land allocation and sustainability [4]–[6]. Globally, peri-urban regions represent the frontlines of these transformations, where formal planning frameworks intersect with informal market dynamics, resulting in uneven land commodification and environmental degradation [7], [8].

In Indonesia, these dynamics are particularly evident in large-scale metropolitan development initiatives, such as the Mamminasata Metropolitan Area in South Sulawesi, which encompasses the Moncongloe-Pattalassang new city project. Empirical studies indicate that land-use conversion in this region has accelerated dramatically, transforming agricultural and ecological landscapes into built environments dominated by housing, commercial zones, and transportation infrastructure [9]–[12]. As a result, the area has experienced measurable declines in environmental quality including the reduction of green cover, deterioration of water quality, and heightened flood vulnerability typical consequences of unregulated peri-urban growth [13], [14]. These local findings echo broader global analyses indicating that unmanaged urban expansion erodes ecosystem services, weakens natural flood regulation, and exacerbates vulnerability to climatic and hydrological risks [1]–[3].

To regulate spatial development and ensure ecological balance, Indonesia employs statutory planning instruments such as the Rencana Detail Tata Ruang (RDTR) or Detailed Spatial Plan. RDTRs are legally binding spatial documents that define permitted land uses, including allocations for protection, cultivation, infrastructure, and Green Open Space (GOS) [15], [16]. In more detail, ATR/BPN Regulation No. 14 of 2022 stipulates that at least 30% of an urban area must be designated as GOS, of which a minimum of 20% must be provided as public open space that is accessible, evenly distributed, and functionally connected [17]–[19]. The regulation not only sets quantitative targets, but also outlines qualitative requirements related to ecological functions, disaster mitigation, and the social use of GOS,

including standards for park hierarchies and indicative service radii. In this study, the Moncongloe RDTR is explicitly evaluated against these regulatory standards, so that spatial deviations in GOS provision, protected zones, and supporting land uses can be systematically identified.

Several interrelated mechanisms underpin this failure. First, land monetization and speculative urban development have transformed land into a financial asset rather than a public resource, driving unsustainable conversion [2], [3]. Second, institutional fragmentation between municipal and sub-municipal levels produces inconsistent zoning enforcement and overlapping permits [4], [16]. Third, the lack of GIS-based monitoring and transparency mechanisms prevents the detection of illegal or premature land-use changes [20], [21]. Consequently, the Mamminasata case illustrates how metropolitan expansion, when inadequately governed, amplifies both ecological risks and socio-spatial inequities [12], [13].

To address such challenges, recent scholarship has adopted Production, Living, Ecological Space (PLES) frameworks and Spatial Conflict Index (SCI) methodologies to diagnose and visualize competing land-use pressures [6], [8], [22]. These tools allow planners to quantify spatial trade-offs and identify zones of conflict among productive, residential, and ecological functions, thereby supporting more adaptive and sustainable planning interventions (Surya et al., 2022; Bhakti et al., 2023). Their integration into RDTR analysis is particularly relevant in new urban areas such as Moncongloe, where land-use tension between economic growth and environmental conservation is acute (Rachmawati et al., 2024; Feola et al., 2019).

Nonetheless, there remains a critical empirical gap: few studies have conducted parcel-level or RDTR-specific audits to evaluate whether detailed spatial plans in Indonesia effectively operationalize national GOS mandates or integrate multifunctional land uses such as agro-ecological corridors and retention parks (Priyanta & Zulkarnain, 2024; Rachmawati et al., 2024). Moreover, the absence of standardized indicators linking planned and realized green-space coverage limits both policy accountability and the potential for evidence-based urban design reform (Cainie et al., 2023; Aryaguna et al., 2022).

Accordingly, this study aims to evaluate the spatial composition and regulatory compliance of the Mamminasata New City RDTR in Moncongloe District, focusing on three objectives: (1) assessing the adequacy of green open space allocation relative to the 30% national standard; (2) analyzing the spatial balance among residential, commercial, agricultural, and ecological zones; and (3) identifying planning and policy strategies to strengthen RDTR implementation through GIS-based auditing, PLES-informed spatial diagnosis, and ecological-network integration. By addressing these aims, the study contributes to the empirical understanding of how detailed spatial planning can be reoriented toward

sustainability, spatial equity, and ecological resilience in Indonesia's rapidly urbanizing metropolitan regions.

METHODS

This study used a descriptive and evaluative spatial approach to assess the conformity and adequacy of land-use planning in the Moncongloe District, as regulated in the Detailed Spatial Plan (RDTR) of the New City Area of Mamminasata, South Sulawesi, Indonesia. The evaluation focuses on the spatial structure, composition of functional zones, green open space (GOS) allocation, and regulatory compliance in line with national spatial planning standards (ATR/BPN Regulation No. 14/2022).

Data Description

The data used in this study consisted of both textual and spatial materials. Supporting data included zoning maps, hazard maps (for disaster-prone zones and river buffer zones), and references to national regulations such as ATR/BPN Regulation No. 11/2021 and No. 14/2022 [19], [23]. Additional spatial data such as administrative boundaries, river networks, and road layouts were used to support spatial analysis.

Methods of Analysis

The analytical process in this study was divided into two main stages. First, a regulatory compliance analysis was conducted to determine whether the proposed land-use plan meets the minimum standard for green open space (GOS) provision, as mandated by Ministry of ATR/BPN Regulation No. 14/2022 [19]. This regulation requires that at least 30% of the total planning area be allocated to green space, with a minimum of 20% designated for public use. The analysis involved calculating the total planned GOS area and comparing it to the required area based on the total land area of 2,165.90 hectares.

Second, a quantitative land-use composition analysis was carried out to identify the proportion of each functional zoning category such as residential, agricultural, commercial, public service, and green space relative to the total planning area. This process utilized land-use data extracted from the official RDTR tables, which were then verified for consistency. The analysis was conducted using Microsoft Excel to tabulate and compute the area (in hectares) and percentage share of each zoning class.

In addition to tabular analysis, spatial processing was conducted using Geographic Information System (GIS) software, specifically ArcMap 10.4.1. Official RDTR zoning maps were digitized and overlaid with key spatial layers, including administrative boundaries, river networks, road layouts, and hazard-prone areas. This GIS-based comparison enabled assessment of zoning distribution and identification of gaps between planned green open space networks, protected zones, and areas under development pressure, strengthening the evaluation of regulatory compliance.

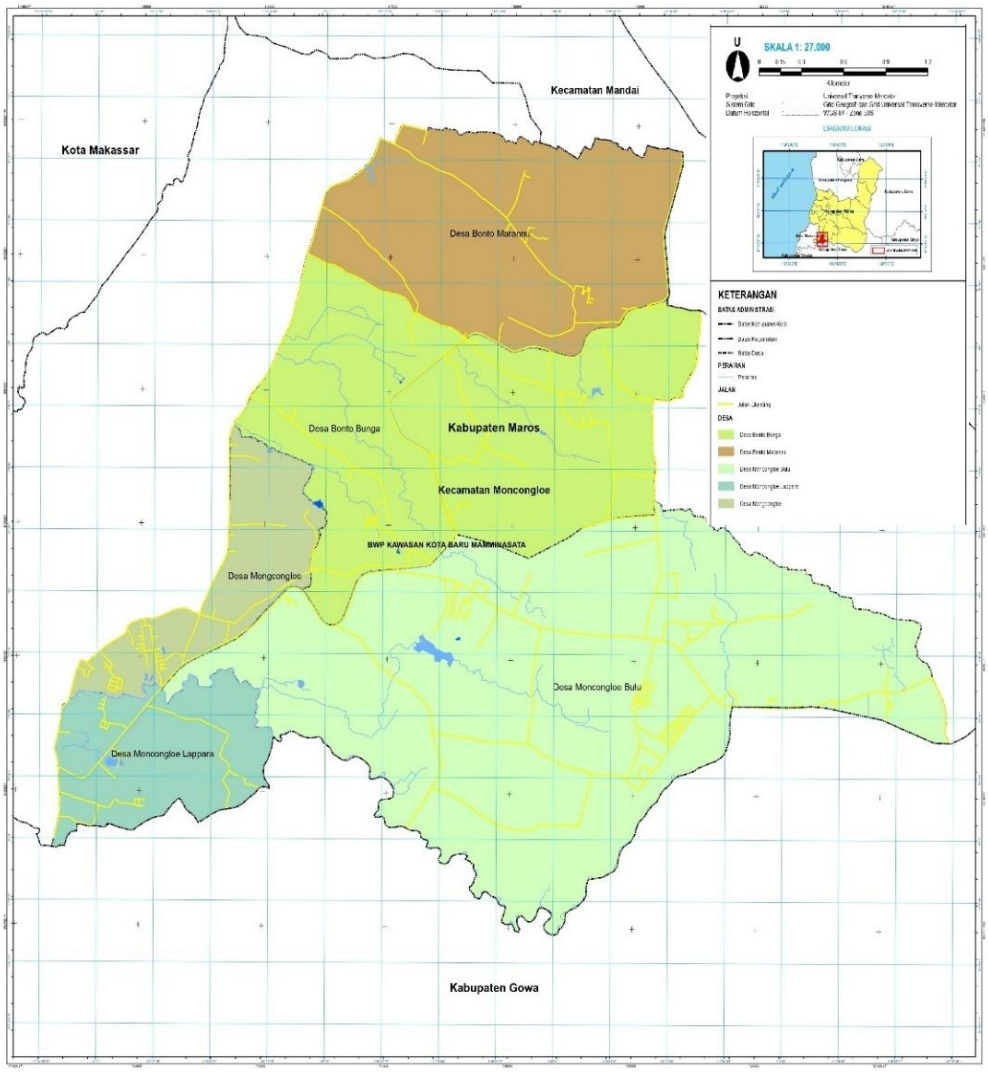

Figure 1. Delineation of the Moncongloe New City Area, Mamminasata Metropolitan Region
Source: Detailed Spatial Plan (RDTR) of Moncongloe Mamminasata (2024)

RESULTS AND DISCUSSION

Regulatory Standards and Evaluation Variables

The spatial evaluation in this study is based on a set of regulatory and planning standards that define minimum thresholds for key functional zones. First, green open space (GOS) provision is assessed against the 30% minimum requirement for urban areas, with at least 20% reserved as public GOS, as stipulated in ATR/BPN Regulation No. 14/2022 [17]–[19]. Second, the adequacy and distribution of public facilities (SPU) and protected zones are examined in relation to their role in supporting basic services, ecological buffers, and disaster risk mitigation, as emphasized in national spatial planning guidelines [23]. Third, the spatial balance between residential, commercial, agricultural, and ecological zones is evaluated to

identify excessive market-driven allocations that may undermine spatial equity and environmental resilience. For green space accessibility, indicative service-radius benchmarks (100 m for RT parks, 350 m for RW parks, and 700 m for kelurahan-level parks) are used as reference values from international and national guidelines. These standards provide the basis for interpreting the quantitative results presented in the following subsections.

Spatial Composition and Functional Allocation in Moncongloe Detailed Plan

The Moncongloe planning area, covering 2,165.90 hectares, exhibits a dominant orientation toward residential and commercial development. As shown in Table 1 and Figure 3, housing zones make up the majority land use, totaling 1,333.68 ha or 61.58% of the total planning area. This consists of medium-density (R-3) and low-density (R-4) housing zones. Meanwhile, zones allocated for green open space (RTH), which are vital for environmental services and public health, occupy only 7.61 ha or 0.35%.

Table 1. Land Use Composition in Moncongloe the Detailed Spatial Plan (RDTR)

Category	Area (ha)	Proportion (%)
Medium-density Housing	762.07	35.18
Low-density Housing	571.61	26.40
Agriculture	371.27	17.14
Commercial	353.22	16.31
Public Services	21.56	1.00
Green Open Space	7.61	0.35
Infrastructure & Others	78.56	3.63
Total	**2,165.90**	**100.00**

Source: Data Analysis (2024)

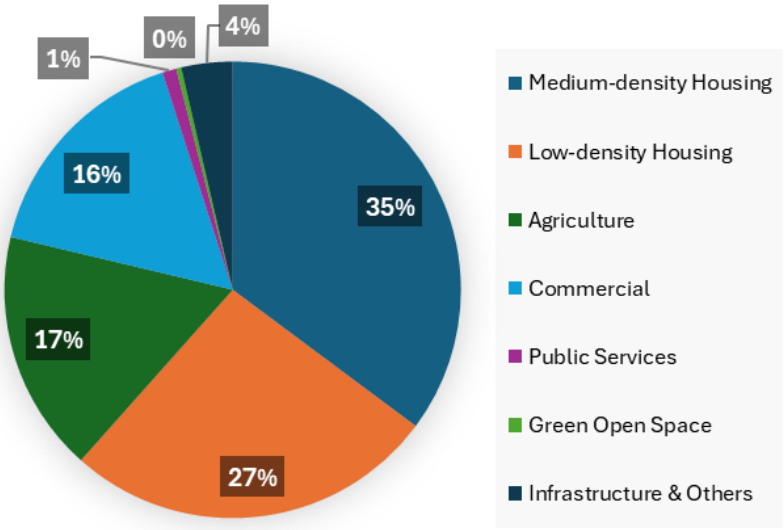

Figure 2. Land Use Composition in the Detailed Spatial Plan (RDTR) of Moncongloe
Source: Data Analysis (2024)

Such a spatial imbalance reflects broader urbanization trends in peri-urban areas, where rapid expansion tends to prioritize real estate and infrastructure at the expense of ecological functionality [1], [3]. This underscores a critical misalignment between statutory planning goals and operational outcomes especially given the ecological and social imperatives of equitable spatial planning [2].

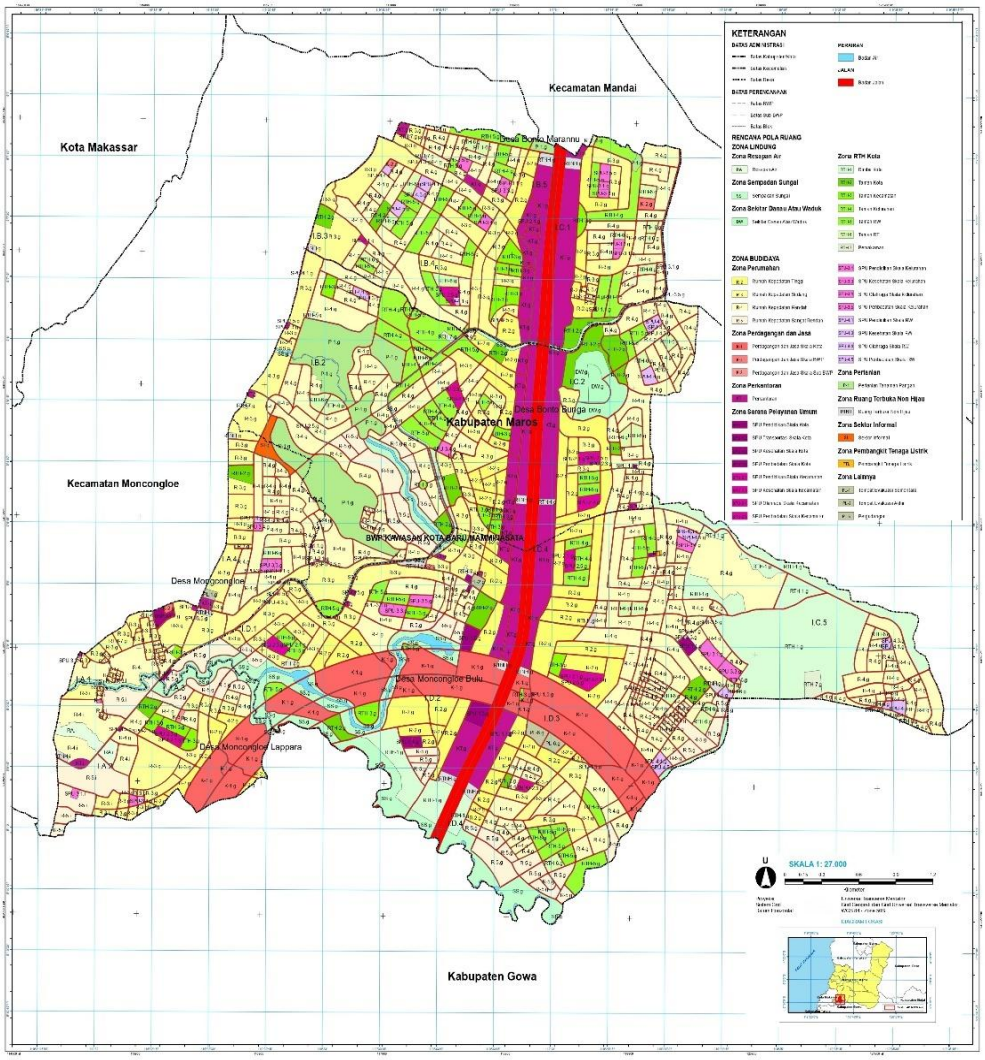

Figure 3. Zoning Composition Map of the Spatial Structure Plan in Moncongloe, Mamminasata New City
Source: Detailed Spatial Plan (RDTR) of Moncongloe Mamminasata (2024)

Regulatory Compliance and Green Open Space Deficit

According to Ministry of ATR/BPN Regulation No. 14/2022, urban planning areas must allocate at least 30% of total area for green open space (GOS), with at least 20% for public access. For Moncongloe's planning area, this would require 649.77 ha of total GOS.

However, the Detailed Spatial Plan (RDTR) for the New City Area of Mamminasata in Moncongloe District only designates 7.61 ha, or just 1.17% of the required minimum. This significant shortfall indicates a major compliance gap and undermines the ecological resilience of the new city area. As seen in Table 2, the green open space is fragmented into small pockets of kelurahan parks, neighborhood parks (RW and RT), and cemeteries without integrated green networks or ecological corridors.

Table 2. Allocation of Green Open Space in the Detailed Spatial Plan (RDTR) for the Moncongloe District of Mamminasata New City

Sub-Zone	Code	Area (ha)	Block Location
Kelurahan Park	GOS-4	1.88	IC.1, ID.4
RW Park	GOS-5	0.79	IA.2, ID.2, ID.3
RT Park	GOS-6	0.23	IA.2, ID.1, ID.3
Cemetery	GOS-7	4.70	IB.5, ID.2
	Total GOS	**7.61**	

Source: Data Analysis (2024)

This spatial mismatch has been similarly observed in other Indonesian cities where green space provisions exist nominally in the Detailed Spatial Plan (RDTR) for the New City Area of Mamminasata in Moncongloe District but fall short in implementation [15], [16]. The absence of ecological buffers, riparian corridors, and linear parks further exacerbates the environmental vulnerability of the urban fabric [8], [22].

Ecological Function and Accessibility of Protected Zones

The the Detailed Spatial Plan (RDTR) for the New City Area of Mamminasata in Moncongloe District designates only 21.93 ha (1.01%) for protected zones, consisting of water bodies and localized protection areas. These allocations are insufficient when compared to the scale of built-up development and their ecological buffering needs. Moreover, the distribution of public green spaces is spatially uneven, creating significant accessibility gaps. For instance, medium-density housing zones (R-3) are largely disconnected from kelurahan-level parks, which should ideally be within a 700-meter radius of all residential units [17].

Table 3. Distribution of Park Services

Park Type	Number of Locations	Block Location
Kelurahan Park	2	IC.1, ID.4
RW Park	3	IA.2, ID.2, ID.3
RT Park	3	IA.2, ID.1, ID.3

Source: Data Analysis (2024)

These findings align with studies emphasizing the link between urban green coverage and social equity. Inadequate and poorly distributed green space has been associated with reduced

physical activity, higher vulnerability to heatwaves, and lower social cohesion [18], [24]–[26].

Agricultural Land: Protection Potential and Minapadi Innovation

The planning area maintains 371.27 ha (17.14%) of land for agriculture, divided among staple food crops, horticulture, and plantations. This presents an opportunity to reinforce multifunctional land use by integrating minapadi a dual-function system combining aquaculture and rice cultivation.

This approach not only supports food security but contributes to green infrastructure, serving as an ecological buffer and educational tourism site [27], [28]. Nevertheless, there is a need for formal protection through the Detailed Spatial Plan (RDTR) zonation to safeguard these areas from speculative conversion.

Table 4. Agricultural Zoning Breakdown

Sub-Zone	Code	Area (ha)
Food Crops	P-1	118.88
Horticulture	P-2	167.58
Plantation	P-3	84.81
	Total	**371.27**

Source: Data Analysis (2024)

Public Service Deficits vs. Commercial Surplus

The the Detailed Spatial Plan (RDTR) for the New City Area of Mamminasata in Moncongloe District designates only 21.56 ha (1.00%) for public service facilities—significantly under-serving a population expected to grow alongside housing development. By contrast, commercial zones are allocated 353.22 ha (16.31%), suggesting a market-driven prioritization.

Table 5. Public Facility and Commercial Allocation

Public Services		
Scale	**Code**	**Area (ha)**
District-level	SPU-2	17.83
Sub-district	SPU-3	3.32
RW level	SPU-4	0.41
	Total SPU	**21.56**
Commercial Zones		
Scale	**Code**	**Area (ha)**
City Scale	K-1	313.49
SWP Scale	K-3	39.73
	Total	**353.22**

Source: Data Analysis (2024)

This spatial imbalance threatens to exacerbate inequality in access to education, health, and community facilities, a dynamic also found in comparative studies on peri-urban development in Southeast Asia [2], [16], [29].

Policy Implications and Planning Recommendations

The preceding analysis reveals significant deficiencies in the spatial planning logic of the Moncongloe the Detailed Spatial Plan (RDTR), particularly concerning ecological provision, spatial equity, and service delivery. The findings suggest that while the plan responds to urban growth pressures, it fails to integrate core sustainability principles such as green space provision, disaster risk reduction, and inclusive public services which are fundamental to resilient urban planning [22], [26], [30]–[34].

To further illustrate the magnitude of the identified gaps, the following table summarizes the key compliance deficits and their associated spatial and policy implications:

Table 6. Summary of Compliance Gaps and Policy Implications

Issue	Observed Condition	Policy Implication
Green Open Space (RTH)	0.35% provided vs. 30% required (7.61 ha vs 649.77 ha)	Urgent zoning reallocation; major compliance issue with ATR/BPN Regulation No. 14/2022 [19]
Ecological Protection Zones	1.01% of WP; lacks spatial buffers	Inadequate for mitigating environmental risks and disaster impacts
Public Facilities (SPU)	Only 1.00% vs. 61.58% for housing	Risk of service inaccessibility; needs rebalancing
Commercial Zones	16.31% of WP	Market-driven growth; lacks support for public infrastructure
Agricultural Land	17.14% but unprotected legally	Needs minapadi integration into RTH framework
Spatial Data Infrastructure	Only one map provided (figure 1)	Limits spatial diagnostics; calls for GIS layers and service radius visualization

The disproportionate allocation of space to commercial and residential zones at the expense of ecological and social infrastructure indicates a market-driven planning orientation, consistent with critiques of peri-urban land commodification in Southeast Asia [16], [29], [35]–[41]. Without corrective spatial interventions, the plan risks reinforcing socio-spatial inequality, environmental degradation, and infrastructural vulnerability [2], [42]–[44].

Furthermore, the absence of transitional green buffers, no-build disaster-sensitive zones, and service radius analysis suggests that spatial equity and climate adaptation principles have yet to be meaningfully operationalized [6], [45]–[48]. The lack of ecological corridors or connective green networks undermines the potential for biodiversity support, urban cooling, and flood mitigation, which are increasingly central to sustainable urban agendas [27], [31], [48]–[51].

To address these deficiencies, a series of strategic policy and spatial planning interventions are recommended.

1. Conduct a retroactive spatial audit using GIS overlays with hazard zones, GOS thresholds, and ecological corridors to diagnose inconsistencies and identify opportunities for functional land use realignment.
2. Designate multifunctional green networks that interconnect parks, agricultural lands, and water bodies to foster ecological connectivity and climate resilience.
3. Reallocate low-density residential zones and fringe commercial blocks as transitional green spaces or community-managed open space, especially in R-4 zones with low utilization intensity.
4. Implement service radius buffers for all public green spaces, ensuring equitable access based on standards: 100 m (RT), 350 m (RW), and 700 m (Kelurahan), following WHO and UN-Habitat benchmarks.
5. Formalize the inclusion of agricultural zones under minapadi systems as counted contributions to the 30% GOS quota, supported by local ordinances and participatory monitoring mechanisms.
6. Update the RDTR document with multi-thematic spatial maps including disaster-prone areas, river corridors, park service coverage, and land conversion trends to enable better visualization, policy enforcement, and spatial justice assessments.

In conclusion, this study underscores the necessity for urban spatial plans to move beyond conventional functional zoning by integrating principles of resilience, spatial equity, and ecological sustainability. For Moncongloe and similar peri-urban regions, achieving inclusive, sustainable, and climate-resilient development will require a strategic realignment of zoning priorities, firmly grounded in national regulatory frameworks and strengthened through participatory and evidence-based spatial governance.

CONCLUSION

This study demonstrates that the Detailed Spatial Plan (RDTR) for the Mamminasata New City Area in Moncongloe District does not yet reflect the principles of sustainable and spatially equitable urban planning as mandated by national regulations. In quantitative terms, the zoning composition is heavily skewed toward residential and commercial functions, while the allocation for green open space (GOS) remains critically low only 0.35% of the total area far below the 30% minimum threshold stipulated in ATR/BPN Regulation No. 14/2022. This severe GOS deficit is accompanied by limited protected zones and the absence of continuous ecological corridors, indicating that ecological considerations have not been systematically integrated into the spatial structure of the plan.

Beyond GOS, the analysis also reveals a marked imbalance between public facilities and market-oriented zones. Public service facilities account for only 1.00% of the planning area compared to 16.31% for commercial zones, raising concerns about future inequalities in access to basic services and the potential overconcentration of economic activities without adequate social and environmental infrastructure. Agricultural land, while still covering 17.14% of the area, is not firmly protected in the zoning regulations, leaving its ecological and food-security functions vulnerable to speculative conversion. A key contribution of this study is to highlight the opportunity to reframe existing agricultural areas and scattered green spaces as multifunctional GOS through systems such as minapadi, which combine aquaculture and agriculture while delivering ecological, economic, and educational benefits. However, realizing this potential requires explicit recognition in the RDTR, alignment with the 30% GOS standard, and the use of GIS-based audits to monitor compliance and visualize service coverage.

Overall, the findings underscore the urgency of reforming spatial policy and zoning practice in Moncongloe by: (1) reallocating portions of low-density residential and commercial zones to meet minimum GOS and protection standards; (2) expanding and better distributing public facilities to strengthen spatial equity; and (3) embedding climate resilience and disaster risk reduction into the spatial structure through ecological buffers and connected green networks. Such adjustments are essential for transforming the Moncongloe RDTR from a growth-oriented blueprint into a spatial plan that genuinely supports livable, inclusive, and ecologically robust new city development in Indonesia.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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