



Proportion and Potential of Open Space in Riverbank Settlements along the Musi River Palembang

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Abstract

Riverfront settlements along the Musi River in Palembang exhibit varied spatial characteristics in density and growth patterns. This study analyzes the proportion and potential of open spaces across four typologies: organic dense, organic sparse, planned dense, and planned sparse. Using GIS-based spatial analysis and digitized building data, the built-up area proportion is calculated to evaluate open-space availability and its socio-ecological potential. Results indicate that organic dense areas have the highest built-up proportion (59%), reflecting limited formal open space, whereas planned sparse areas show only 27%, indicating significant development potential. Settlement morphology influences the distribution and optimization of open spaces. The study recommends a typology-based approach: adaptive, community-driven strategies for dense organic areas and structured green space planning for low-density planned areas, supporting inclusive and resilient riverfront development.

Keywords: *open space; riverfront; settlements; spatial typology*

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1. INTRODUCTION

Riverbank settlements such as those along the Musi River in Palembang occupy areas with unique social and ecological characteristics, yet often face environmental degradation and inadequate infrastructure. Open spaces in riparian zones play a critical role as natural buffer zones: they reduce runoff, control erosion, and help maintain water quality and riparian biodiversity (Oktarini et al., 2021; Pahlewi & Rahman, 2023). From a social perspective, open space also functions as a communal space, facilitating daily interactions, informal economic activities, and recreation among residents (Oktarini et al.,

2021). In dense settlements such as Seberang Ulu and Seberang Ilir, access to public space is limited, yet the demand for context-sensitive open space is growing to help preserve and strengthen community cohesion. Open spaces are essential for daily activities such as gathering, playing, and socializing—functions that cannot be replaced by private indoor areas (Pahlewi & Rahman, 2023 ; Oktarini et al., 2021)

However, the spatial structure of riverbank settlements—ranging from formal housing developments to dense informal clusters—greatly influences the availability and quality of open space (Agustian & Utomo, 2023). In many

cases, buildings turn away from the river, disrupting human-water connectivity. Yet, informal spaces such as jetties, embankments, and traditional open house fronts still function as active public nodes with untapped ecological and social potential.

Formal open spaces—such as parks, promenades, and landscaped green corridors—play a pivotal role in riverbank settlements. In Palembang, planned spaces like riverfront promenades and waterfront parks near Ampera Bridge serve as structured venues for recreation, cultural events, and ecological buffering (Ta et al., 2024). These spaces often feature well-defined walkways, seating, shade trees, and maintained lawns, promoting accessibility and facilitating social cohesion. However, data from Ilir Barat I sub-district reveals that formal open space allocation is still far below Indonesia's minimum requirement—only around 0.51% of the area, compared to the mandated 20–30% (Rosianty, Waluyo, and Gunawan 2021).

Adjacent to formal areas, informal open spaces—comprising vacant lots, unpaved embankments, or riparian margins—emerge organically within riverbank settlements. Although unplanned and often overlooked by local governance, these spaces contribute significantly to biodiversity, habitat connectivity, and environmental resilience through spontaneous vegetation (Stanford et al., 2024). In Palembang, such areas are common in informal clusters like 3–4 Ulu: patches of unused land or embankments have high latent potential to become micro-habitats or community spaces if properly recognized and supported. (HIDAYAT & HIDAYAT, 2010 ; Alfatih et al., 2018)

Both formal and informal open space support critical socio-ecological functions, though in different ways. Formal parks and promenades offer curated environments for leisure, cultural events, and flood management, while informal green spaces foster biocultural diversity, locally rooted interactions, and adaptable uses. Research highlights how residents utilize vacant plots near riverbanks for social gatherings, gardening, or as flood spill zones—demonstrating how informal spaces effectively augment both urban biodiversity and community life. The dual existence of these open space types thereby

strengthens overall ecological connectivity and social vitality.

1.1. Typologies of Riverbank Settlements

Riverbank settlements along the Musi River in Palembang display varied spatial typologies—ranging from *high-density organized* (e.g., formal housing near Seberang Ilir), *high-density unorganized* (e.g., informal kampungs in 3–4 Ulu), to *medium- and low-density* settlements on the outskirts. Each typology reflects different levels of planning, accessibility, infrastructure, and consequently, availability and function of open spaces. Structured areas are more likely to allocate land for formal open space such as neighborhood parks and riverfront greenways, while unorganized dense zones rely heavily on informal open space such as leftover spaces, vacant lots, or vegetated riverbanks (Oktarini et al., 2022; Rosianty et al., 2020).

1.2. Open Space in High-Density

Organized vs. Unorganized Areas

In high-density organized neighborhoods, open space often appears as linear parks, managed walkways, or community gardens built into the settlement layout. These green areas serve dual functions: enhancing flood resilience and providing structured social interaction spaces. In contrast, high-density unorganized settlements—typically informal and unplanned—lack designated open space. Yet, residents actively use informal spaces such as river edges, empty lots, and inter-house gaps for gardening, drying clothes, gathering, or even religious rituals. These spaces, though unofficial, serve vital ecological and social roles (Fitri & Wahyu, 2022; Kabisch & Haase, 2021).

1.3. Open Space Dynamics in Medium- and Low-Density Areas

Medium- and low-density riverbank settlements tend to offer more open land per household, increasing the potential for both formal and informal open space development. In these areas, riparian green belts or agricultural gardens are more visible and accessible. However, the challenge is often

underutilization or lack of integration into a wider ecological network (Aryaguna et al., 2022). Hence, open space potential in these areas lies not just in quantity but in strategic activation.

Riverbank settlements in cities of the Global South are experiencing increasing spatial pressure due to rapid densification, informal growth, and limited land availability. In the case of the Musi River, this pressure is reflected in the high proportion of built-up areas and the progressive reduction of accessible open space, particularly in organically developed settlements. Despite the recognized ecological and social importance of open space in riparian environments, its provision in riverbank settlements remains significantly below planning standards, and its spatial distribution is highly uneven.

Existing studies have primarily focused on formal green open space provision or city-scale planning targets, often overlooking the role of informal and residual spaces that emerge within dense settlements. While GIS-based approaches have been applied to identify priority areas for green space expansion, these methods typically assume relatively structured urban forms and do not adequately account for the fragmented and heterogeneous morphology of riverbank settlements. As a result, there is limited understanding of how open space potential varies across different settlement typologies, particularly in contexts where informal spatial structures dominate.

Moreover, previous research tends to treat open space as a static land-use category, rather than as a dynamic socio-ecological system that includes both formal and informal green spaces with varying functions. This creates a critical gap in linking spatial configuration, typology, and the multifunctional role of open space in supporting both ecological performance and social cohesion in riverfront environments.

This study aims to analyze the proportion and potential of open space in riverbank settlements along the Musi River, with emphasis on spatial variation across different urban typologies (formal, informal, dense, sparse). The goal is to identify how both formal open space and informal green spaces can support ecological functions (infiltration, biodiversity, flood

mitigation) and social cohesion (interaction, gathering, local economy). By combining GIS-based spatial mapping with typological analysis, the study evaluates both existing green coverage and underutilized residual spaces. Tools such as GIS-based suitability mapping have been successfully applied in contexts like West Jakarta to identify priority areas for green space expansion (Aryaguna et al., 2022). The research seeks to offer context-sensitive recommendations—such as developing micro-parks, enhancing riparian corridors, and integrating IGS into planning policy—to support inclusive and adaptive riverfront development in Palembang.

2. METHODS

This research applies a mixed methods approach with a sequential explanatory design, where quantitative methods serve as the primary stage followed by qualitative approaches to enrich the results. This approach was chosen because it can capture the complexity of the relationship between the spatial attributes of open space and the social characteristics of settlements along the Musi River holistically (Forrest & Kearns, 2001 ;Zain et al., 2022). Quantitative methods are used to identify the proportion of built space in various typologies of settlements, while qualitative methods serve to explore the community's perceptions of the use of open space and its social value.

At the quantitative stage, analysis was conducted using Geographic Information Systems (GIS) to calculate the total building area and plot area on 1,655 building units spread across four types of settlements: organic dense, planned dense, organic sparse, and planned sparse. The calculations showed that the organic dense area has the highest proportion of buildings at 59% of the total area of 101,252.37 m². In contrast, the planned sparse area has the lowest level of development at 27% of the total 102,587.30 m². Overall, from the study area of 394,441.26 m², the total building area is 183,510.92 m², which means the average built space reaches 46.5%.

Qualitative data were obtained through field observations and semi-structured interviews with residents. Observations were conducted to

identify the actual conditions of open spaces, both formal and informal, including aspects of accessibility and the activities that occur. Meanwhile, interviews explored how residents interpret these spaces, the barriers to their use, and the forms of social ties that are established. This approach supports a deeper understanding of statistical results and highlights dynamics that are not captured by quantitative data (Zain et al., 2022).

The research stages began with: (1) mapping the study location based on the spatial typology of settlements using spatial imagery and field data; (2) calculating the proportion of built land with GIS; (3) collecting observational data about the physical condition of open spaces and their usage; and (4) conducting interviews with residents, local leaders, and neighborhood heads. The results from both approaches are then cross-validated to ensure data integration and strengthen recommendations.

Thus, the integration of spatial analysis and social exploration allows this study to formulate adaptive open space strategies that align with the spatial characteristics and community needs. This approach confirms that in organically dense settlements, revitalization of community-based micro spaces is needed, while in sparsely planned areas, there are opportunities for sustainable formal open space development (Hair et al., 2019 ; Oktarini et al., 2021)

The spatial characteristics of each riverbank typology is key to formulating effective, localized strategies for open space enhancement. In high-density areas, the focus should be on optimizing small-scale informal green spaces through community design and regulatory recognition. In lower-density areas, efforts should be directed toward ecological restoration and the integration of green corridors along the river. This typology-based approach can ensure that open space development is context-sensitive, equitable, and aligned with both ecological performance and social need (Oktarini et al. 2022).

This study uses a mixed methods approach with a primary explanatory sequential design, where the quantitative approach serves as the main phase, which is then complemented and deepened with qualitative data. The choice of

mixed methods strategy is based on the complexity of the phenomena studied—namely the relationship between the physical attributes of public open space which requires strong quantitative evidence as well as rich contextual understanding to capture the social and spatial dynamics in riverside settlements in their entirety. The aim is to confirm and enrich quantitative findings with qualitative insights (Tashakkori 2010).

The quantitative approach will be conducted using survey methods and statistical analysis, while supporting qualitative data will be collected through observation and interviews. The quantitative approach allows the research to obtain objective and generalizable data using data collection techniques such as structured questionnaires (Chih-Pei and Chang, 2017; Ishtiaq, 2019). Statistical analysis is used to identify the relationships between the studied variables, thereby providing empirical evidence regarding the extent to which the physical attributes of public open space contribute to the increase or decrease of social cohesion in the local community (Hair et al., 2019). Furthermore, qualitative supporting data that will be collected through observation and interviews will be useful in providing a deeper understanding of the results obtained from the statistical analysis. Observations are used to assess the physical conditions of RTP directly, while interviews with local residents help to understand how they utilize the space in their daily social interactions (Patton 2002).

The study area covers several riverbank neighborhoods along the Musi River in Palembang, including both the northern (Seberang Ilir) and southern (Seberang Ulu) segments. These areas were selected to represent a range of urban morphologies—from dense informal settlements such as 3–5 Ulu, characterized by organic, unplanned growth, to more structured zones like 14 Ulu and 16 Ilir, which feature planned layouts and formal infrastructure. The study sites include a combination of high-density and low-density areas, both formally planned and organically developed, allowing for comparative spatial analysis of open space distribution and potential. The diverse physical and social characteristics of these riverbank neighborhoods make them ideal for evaluating

how different settlement typologies affect open space availability, accessibility, and multifunctional use (see Figure 1).

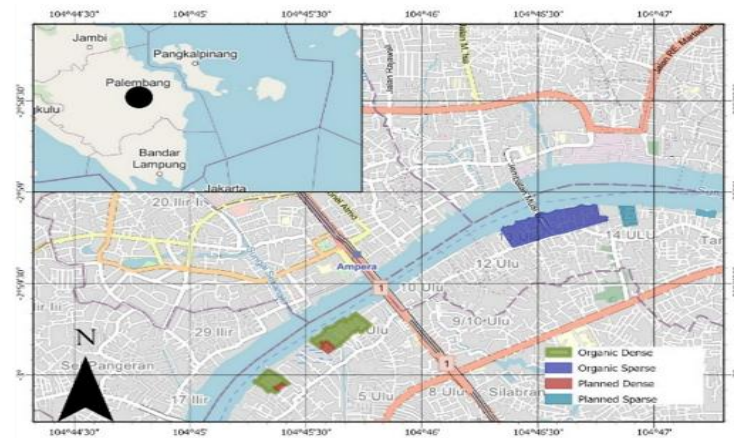


Figure 1. Study Location

3. RESULTS AND DISCUSSION

The results of the spatial analysis of 1,655 building units spread across four types of riverbank settlements show a striking difference in the proportion of built space (building area) to the total area (see Table 1). **The organic dense type** recorded the highest number of building units with 793 units, with a total building area of 59,626.28 m² from a total

area of 101,252.37 m², resulting in a built space proportion of 59%. This indicates that the organic dense area is heavily occupied by buildings, with relatively limited remaining open space. This condition is commonly found in traditional settlements that have developed naturally without structured spatial planning, resulting in narrow inter-building spaces that do not function optimally as open space.

Table 1. Characteristics of Buildings and Land Area by Settlement Typology

Type	Amount	Building Area (m ²)	Average Building Area	Area Size(m ²)	Proportion
Organic Dense	793	59.626,28	75,19	101.252,37	59%
Regular Dense	82	6.739,02	82,18	12.406,77	54%
Organic Sparse	631	89.679,89	142,12	178.194,83	50%
Regular Sparse	149	27.465,73	184,33	102.587,30	27%
Grand Total	1.655,00	183.510,92		394.441,26	

The densely organized area, although it has far fewer buildings (82 units), shows an almost equivalent proportion of built space, namely 54%. This indicates that the efficiency of land use in this area is quite high. The planned arrangement of blocks results in a consistently high density even though the number of units is relatively few, possibly through multi-unit buildings or compact designs.

In contrast to the organic sparse area, which has 631 building units with a total building area of 89,679.89 m² on an area of 178,194.83 m². The built space proportion is recorded at 50%, indicating that although the buildings are

irregularly distributed, the remaining space between buildings is quite large. However, the potential of this open space may not necessarily be utilized optimally, considering that the organic pattern tends to produce unstructured leftover spaces.

The type with the lowest built space proportion is the regular spaced type, with 149 building units and a proportion of only 27% of the total area. This indicates the presence of very vast open spaces in this area, both in the form of yards, parks, and undeveloped riverbanks. The high availability of open space in this type indicates a great potential for the development of both ecological and social functions.

Overall, from a total area of 394,441.26 m², the total recorded building area is 183,510.92 m², with an average proportion of built-up space of 46.5%. This finding indicates that half of the riverside area remains open space, but its distribution and utilization are significantly influenced by the characteristics of the settlements. Organic characteristics tend to have high density with inefficient spatial planning, while organized characteristics offer opportunities for optimal land use, especially in the management of open spaces.

The analysis of the average building area across the four settlement typologies reveals significant spatial differences. Regular Sparse areas exhibit the highest average building area, at 184.33 m², indicating that although the number of buildings is relatively low (149 units), each unit occupies a large plot. This reflects a more planned residential pattern, allowing greater spacing between buildings and providing better potential for adjacent open spaces. In contrast, Organic Dense settlements have the smallest average building area, at just 75.19 m², despite having the highest number of buildings (793 units). This suggests a high-

density environment where each unit occupies limited space, and buildings are tightly packed.

Such patterns are typically found in informal or organically developed areas, where land constraints lead to compact living conditions with minimal private or communal open space. Organic Sparse and Regular Dense settlements fall in between, with average building areas of 142.12 m² and 82.18 m² respectively. Organic Sparse areas, while unplanned in structure, benefit from lower density, allowing for more space per unit. Regular Dense areas are more structured but still feature moderately sized buildings. These patterns demonstrate that the average building area is a valuable indicator for identifying the spatial potential and needs for open space development and targeted planning interventions in riverbank settlements.

Spatial analysis of the Musi Riverbank settlement map reveals significant differences in open space potential based on area typology (see Figure 2). In the organic dense area, which is generally located in older regions such as 3–5 Ulu, buildings are very close together and their growth does not follow a formal planning pattern.



Figure 2. Spatial analysis of the Musi Riverbank settlement map

The limitations of open space are very evident in this area, where only leftover spaces between buildings or narrow alleys can be optimized as public spaces. Nevertheless, these narrow spaces hold potential to be revitalized into micro-scale parks or green corridors along the

riverbank with a participatory approach. Meanwhile, the organic sparse area has a greater distance between buildings, although its spatial pattern remains irregular. This condition offers better opportunities for the creation of informal communal open spaces, especially

with a focus on strengthening local capacities and utilizing underutilized inter-plot spaces.

On the other hand, the planned dense areas, clearly visible in regions like 14 Ulu in the southern part, show a regular but very dense block structure of buildings. Formal open spaces are limited, yet there are still circulation paths or neighborhood roads that can be functionally repurposed as green corridors and spaces for social interaction if rearranged. In this area, the integration of open spaces needs to be done vertically, such as rooftop gardens or community-based green spaces in multi-story buildings. Zones with a planned sparse typology, such as seen in 16 Ulu, show the highest potential for open space. The distance between buildings is wide and the layout pattern follows a measured block planning.

Overall, the spatial characteristics of each typology of settlements determine the most suitable approach for open space intervention. Dense and organic areas require adaptive community-based strategies, while planned areas, especially those that are sparse, provide ample opportunities for more structured and sustainable open space development. The findings of this study highlight that open space planning in urban riverbank areas must be tailored to the specific spatial characteristics of each settlement. Variations in building density, layout, and land use patterns significantly influence the availability and potential of open spaces. High-density areas may require strategies focused on activating small, informal spaces, while lower-density areas offer greater opportunities for planned open space development. Therefore, a typology-based approach is essential to ensure that open space policies are responsive, equitable, and capable of supporting both environmental sustainability and community well-being allowing for the development of neighborhood parks, community fields, and integrated green corridors. This area is ideal for multifunctional public open space development programs, both for social activities and ecological mitigation such as flood control and microclimate cooling.

Across the four settlement typologies, a clear spatial pattern emerges linking built-up proportion, settlement morphology, and open space potential. High-density typologies,

particularly organic dense areas, exhibit limited open space not only in quantity but also in spatial continuity, resulting in fragmented and less accessible residual spaces. In contrast, lower-density typologies, especially planned sparse areas, provide significantly larger open spaces with more coherent spatial structure, allowing greater flexibility for ecological and social functions. However, the findings also indicate that the availability of open space alone does not guarantee its effective use. In organically developed areas, even where spatial gaps exist, their irregular configuration often limits usability, while in planned areas, structured layouts enhance accessibility and integration of open space into daily activities.

These differences highlight that the role of open space in riverbank settlements is strongly determined by typological conditions rather than by area proportion alone. In dense and organic settlements, the potential of open space lies in the activation of small-scale, informal, and residual spaces that support everyday social interaction and localized ecological functions. Conversely, in planned and lower-density areas, open space can be developed more systematically to support broader ecological services such as flood mitigation, biodiversity support, and microclimate regulation. This suggests that open space planning in riverbank environments should move beyond uniform standards and instead adopt a typology-based approach that recognizes both formal and informal green spaces as integral components of the urban socio-ecological system.

4. CONCLUSION

The study reveals that open space management in riverbank settlements must be adapted to the unique spatial character of each neighborhood. A one-size-fits-all approach is insufficient, as variations in density, planning structure, and access influence both the quantity and quality of available open space. The proportion and distribution of open spaces are closely tied to the type of settlement: organic areas often lack clear zoning or planned provision for open spaces, while planned areas are typically more structured and allow better integration of public space into the urban fabric.

In dense organic settlements, building coverage is high and formal open spaces are scarce. Here, the strategy should center on activating residual spaces like alleys, courtyards, or river edges as multifunctional communal spaces. Organic sparse areas, although still unplanned, offer more room for informal green spaces and public functions. Through community engagement, these underutilized spaces can support micro-economies, shared gardening, and social interaction, enhancing both ecological and social resilience.

In contrast, planned settlements, particularly those with lower density, present greater potential for structured open space development. Planned dense areas can benefit from the integration of open spaces into public infrastructure, such as walkways and shared plazas. Planned sparse neighborhoods are ideal for developing parks, ecological corridors, and designated recreation areas. Overall, a typology-based approach, whether it involves activation, restoration, or function enhancement, ensures that open spaces are not only available, but also meaningful and adaptive to local ecological and community needs.

AUTHOR CONTRIBUTIONS

Endang Sri Lestari: Conceptualization, data collection, spatial mapping, and initial manuscript drafting. Maya Fitri Oktarini: Research design, methodology development, supervision, data analysis, and manuscript review and editing. Fadzli Irwan Bahrudin: Comparative analysis and critical revision of the manuscript. Saldi Yulistian: Field investigation, data validation, and visualization support. Viata Viriezky: Data processing, literature review, and manuscript formatting.

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