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Provision of a Green Infrastructure Network in the Summarecon Bandung Residential Area for Sustainable Urban Development in East Bandung

Ilhamdaniah [1], Fahmyddin A'raaf Tauhid [2]*

[1] Universitas Pendidikan Indonesia, Bandung, Indonesia
[2] Universitas Islam Negeri Alauddin Makassar, Gowa, Indonesia
*Correspondence: E-mail: ilhamdaniah@upi.edu

A B S T R A C T

The provision of green infrastructure on a neighborhood scale for flood mitigation and the provision of green open space in the area are important issues in the development of large-scale housing areas. This paper discusses the green infrastructure network on a neighborhood scale in the housing area in Summarecon Bandung which is located in the flood-prone area of Gedebage, East Bandung. Using a descriptive method, this article explains the green infrastructure network map, including the role and function of the drainage network, several retention ponds, and parks equipped with biopore holes, in overcoming the problem of waterlogging in this housing area of Summarecon Bandung. In addition to functioning to mitigate flooding in the housing area, these elements of green infrastructure also function as green open spaces that can be used by residents for recreational and sports activities. The application of green infrastructure in this area is not only aimed at reducing the risk of flooding, but also to improve the quality of the environment and support the sustainability of the local ecosystem around this housing area. Through good management, the green infrastructure network in Summarecon Bandung is expected to create a balance between physical housing development and environmental preservation. This is also an effort for sustainable urban development in East Bandung. This study emphasizes the importance of integrating physical and social environmental aspects in designing more environmentally friendly housing areas.

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1. INTRODUCTION

The development of formal and planned housing in urban areas is an effort to meet the growing demand for housing driven by population growth and urbanization. However, meeting this demand often leads to changes in land use, converting undeveloped areas into built-up ones. If not planned sustainably, this can reduce environmental quality—for example, by decreasing the land's water absorption capacity and increasing rainwater runoff. To achieve urban development that meets social, economic, and environmental standards, a sustainable approach to urban infrastructure planning and design is essential, particularly in housing development.

Housing development in the Bandung city area is predominantly expanding toward the east, specifically in the Gedebage area. According to the Rencana Tata Ruang (spatial plan), this area is designated to become the main new growth center of Bandung City. In addition to its development potential, the Gedebage Primary Center is also vulnerable to flooding due to its geographical condition as a floodplain area (Anwar, 2017). This area is a lowland that forms part of the Cinambo River basin. Located in Gedebage, East Bandung, it has a drainage channel that flows into a tributary of the Cinambo River, which crosses the study area. The flow and runoff of water to the river are very slow due to the relatively flat land elevation, making the area prone to river overflows from upstream and to local rainwater runoff. The development of the Gedebage Primary Center must therefore consider planning and design approaches that can mitigate potential flooding in order to achieve social, economic, and environmental sustainability. Such an approach should be based on an analysis of the area's characteristics—particularly the housing zones in Gedebage, which are situated in the lowest floodplain area of Bandung City and have relatively flat terrain.

Urban flood disasters are natural phenomena that are becoming increasingly widespread and have devastating impacts (CRED, 2019). Managing urban flooding has become a growing priority due to several contributing factors, including ongoing urbanization, unplanned urban development, climate change, and the rising operational and maintenance costs of urban infrastructure (Bae et al., 2020; Price et.al., 2008). Urban flood disaster mitigation is still largely carried out using conventional approaches that rely solely on physical, structural, or construction-based infrastructure (Elisa, 2018; Johns, 2019). However, gray infrastructure alone has not been effective in significantly reducing the frequency and severity of flooding in urban areas, particularly in Indonesia (Saptoyo, 2021). Therefore, a more sustainable approach to urban flood disaster management is needed—one that incorporates green infrastructure into city planning.

The development of green infrastructure not only plays a significant role in mitigating and reducing flood risks but also contributes to overall quality improvements across various aspects of urban life. Research on green architecture and its application in residential area design has been actively conducted as an alternative solution for flood mitigation in urban housing developments (Tauhid, 2018; Tauhid 2019), particularly in response to climate change impacts in low-income housing environments (Tauhid dan Zawani, 2018). Studies also indicate that the provision of green spaces—such as parks and vegetation—can help reduce the urban heat island effect and improve air quality (Alfakihuddin et al., 2024).

Research on the development of the Gedebage area, including the Summarecon Housing complex, generally focuses on flood vulnerability and urban development through the provision of public open spaces that incorporate water-sensitive urban design (Anwar, 2018; Rasika et al., 2023). Water-sensitive urban design is also an approach used in the development of sustainable areas located near water bodies or traversed by rivers (Ramadhani & Indradjati, n.d.). Applying this approach through the integration of green infrastructure in the

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Summarecon housing area represents a planning and design strategy suited for flood-prone regions such as Summarecon Gedebage in Bandung. The urban development undertaken by the Summarecon Bandung developer covers a 300-hectare residential area integrated with comprehensive, city-scale facilities. As part of efforts to enhance environmental quality, the developer has built a park and six lakes covering 27 hectares, and planted more than 2,000 trees to preserve local wildlife habitats and support ecological sustainability (Summarecon, 2024).

Based on the background and characteristics of the area, the Summarecon Bandung housing area is an important and worthy case study for demonstrating the application of green infrastructure in urban housing, with the following considerations: 1) The Summarecon Bandung area is a large urban development designated mostly as formal housing, covering approximately 300 hectares in East Bandung; 2) The area is located within the floodplain of the Citarum River Basin (Daerah Aliran Sungai Citarum); 3) Prior to development, this area was known as a water retention zone and was prone to flooding in Gedebage; 4) Land use changes from undeveloped areas (such as rice fields and floodplains) to built-up areas have significantly impacted flood levels in the surrounding region; 5) The housing area incorporates planned green infrastructure in its master plan and has implemented it in its development to mitigate flooding.

The purpose of this article is to describe the principles of Green Infrastructure in urban areas as planned and designed in the Master Plan, and their implementation in the landscape design of the Summarecon Bandung housing area. The problem formulation addressed in this article is how the principles and provision of various Green Infrastructure components in the Summarecon Bandung Housing Area Master Plan are used to mitigate the impact of flooding in the area.

2. LITERATURE REVIEW

Green Infrastructure (GI) is defined as the development of a network that connects green spaces—such as parks, greenways, retention ponds, and other components—to preserve natural ecosystems while providing various social, economic, and environmental benefits. Several studies have demonstrated the benefits of its implementation, including habitat preservation and maintenance of natural services (US Environmental Protection Agency/USEPA (2010), reduction of urban heat effects (Debbage et al., 2015), improvement of air quality (Bereitschaft et al., 2013), flood control, enhancement of water quality, climate change adaptation, and maintenance of the water cycle (American Rivers, 2018; Dhakal et al., 2016). Green Infrastructure employs the principle of connecting and integrating natural and man-made elements to achieve sustainability (Serra-Llobet et al., 2017).

Green Infrastructure can contribute to urban flood mitigation by minimizing surface runoff and increasing the natural flood storage capacity for excess stormwater runoff, while being more cost-effective. Large-scale physical urban development has increased runoff rates beyond the city's natural surface absorption capacity. A study by Gill (2007) concluded that the cost of green infrastructure is 15–64% lower than that of gray infrastructure. At the macro scale, green infrastructure elements such as urban forests, wetlands, and floodplains act as effective barriers during peak runoff events and also help purify water by removing pollutants (Ellis, 2012). Urban green areas, as components of green infrastructure, can reduce runoff by 77–88% (District, 2012). At the micro scale, green roofs can reduce runoff by 65–85%, depending on the structure, local climate, and rainfall amount (Mentens et al., 2006).

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Green Infrastructure (GI) can be categorized at regional, urban, neighborhood, and site scales (Gambar 1). At the regional scale, it consists of networks of land conservation elements and ecological corridors. At the urban scale, GI includes urban forests, city parks, parkways, and boulevards. At the neighborhood scale, GI comprises local parks, constructed wetlands, and greenways, while at the site scale, it includes stormwater planters, rain gardens, green roofs, and vertical gardens (Mark, 2006). In principle, GI elements aim to maintain natural hydrological functions by absorbing, infiltrating, and storing water. According to a study by the Ontario Coalition (2024) GI components can include urban forests and woodlots; bioswales, engineered wetlands, and stormwater ponds; green roofs and green walls; natural systems such as interconnected meadows, wetlands, ravines, waterways, and riparian zones; and urban agriculture (Figure 2).

Considering the research above, a case study is needed on the application of Green Infrastructure principles in the Master Plan, their implementation in the landscape design, and the provision of these components in the Summarecon Bandung housing area to mitigate the impact of flood disasters. Among the various scales of Green Infrastructure services discussed, this article will focus on the application of Green Infrastructure at the neighborhood scale within the housing area.

Figure 1. Provision of Green Infrastructure at various service scales
(Source: The Conservation Fund, 1999)

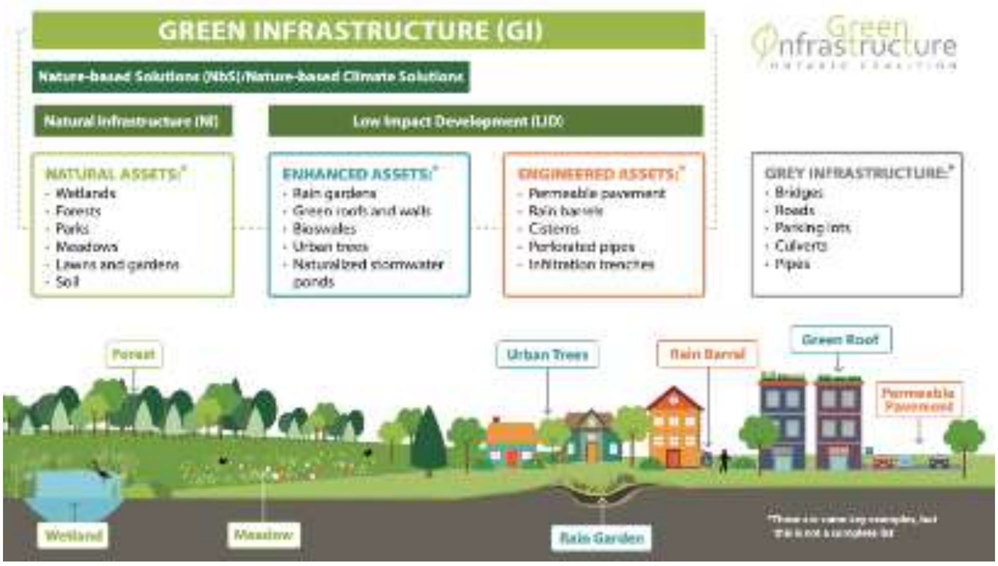

Figure 2. Green Infrastructure Components
(Source: Green Infrastructure Coalition Ontario, 2024)

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3. RESEARCH METHODS

This study uses a descriptive case study method. It qualitatively describes the principles of Green Infrastructure in urban areas and explains their application in the Master Plan and implementation in the landscape design of the Summarecon Bandung housing area. The case study focuses on the Summarecon Bandung housing area, based on the considerations outlined in the introduction.

Primary data were collected through area observations. Additionally, secondary data were gathered to compare the observational results with Green Infrastructure (GI) principles and theories obtained from secondary sources, including scientific articles, websites, and other literature. The literature review focuses on recent studies about urban green infrastructure, its benefits in reducing urban flooding, and the practical implementation of GI in urban residential areas.

4. RESULT AND DISSCUSSIONS

4.1. Result

The provision of green open space in housing is a prerequisite, with 30% of the area required to be allocated as green open space. Of the total 300 hectares, 30% is designated for interconnected open spaces. Various green infrastructure components are applied within the open space network in the Summarecon area.

Table 1

Green Infrastructure Components (Green infrastructure - Nature-based Solution)	Implementation in the Masterplan
Natural Infrastructure (NI)	
Wetlands	There are wetlands and retention ponds
Forest	There is no urban forest
Parks	There are spread across the region and connected
Meadows	There is no meadows
Lawns, Gardens	There are various open space parks
Soil	There is open land that has not been built on
Low Impact Development – Enhanced Assets	
Rain gardens	There are rain gardens and retention ponds
Green roofs and walls	There are green walls, no green roofs
Bioswales	There are bioswales
Urban trees	There are many and varied urban trees
Naturalized Stormwater Ponds	There are many and varied
Low Impact Development – Engineered Assets	
Permeable Pavement	There are many and varied
Rain barrels	There isn't any
Cisterns	
Perforated pipes	
Infiltration trenches	

Source: Green Infrastructure Coalition Ontario, 2024

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Figure 3. Green Infrastructure Network in Summarecon Housing Estate Masterplan
(Source: Website Summarecon, 2024)

GI Components: *Wetlands and retention ponds*

North retention pond in Summarecon Bandung

Key Plan

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Retention Pond next to Sumringah Park

Key Plan

Retention pond in cluster park

Key Plan

Retention pond at Tilu Lake

Blekok Bird Conservation Retention Pond

Figure 4. Retention pond in Park Open Space
(Source: Observation and Summarecon's Website, 2024)

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Green parks and six interconnected lakes covering 27 hectares help improve environmental quality, mitigate flooding in the area, and contribute to better air quality. Additionally, green open spaces with more than 2,000 trees are provided to maintain local wildlife habitats and support ecological sustainability (Summarecon, 2024).

GI Compotent: Culverts and Pipes

Implementation in Summarecon Bandung

Key Plan

Figure 5. Drainage channels of the area
(Source: Observation and Summarecon's Website, 2024)

The porous drainage channel network is designed to direct and absorb rainwater into the ground. The retention lake collects rainwater and runoff from the drainage system. Green open spaces with rainwater-absorbing landscapes around the retention pond also help absorb rainwater. This illustration of a green infrastructure network—implemented as a park in the Summarecon Housing Area—also serves as a green open space with social and recreational functions, utilized by the community for social interaction and outdoor sports.

GI Components: *Lawns and Parks*

Sumringah Park

Key Plan

Sumringah Park

GI Component: Permeable pavement

Permeable pavement on pedestrian way

Key Plan

GI Components: Rain garden and Bioswales

Implementation in Summarecon Bandung

Key Plan

Figure 6. Open space with rain garden and water-absorbing bioswales
(Source: Observation, 2024)

4.2. Disscussions

This study examines the implementation of green infrastructure in the Summarecon Bandung housing complex, analyzed in the context of flood mitigation, environmental quality improvement, and the provision of interconnected public spaces. The discussion highlights the relevance of the study's findings to previous research on green infrastructure and urban sustainability.

In line with research by Gill et al. (2007) and Ellis (2012), which demonstrated that green infrastructure can reduce stormwater runoff in urban areas by 77–88%, this study finds that features such as retention ponds and infiltration gardens in Summarecon Bandung play a significant role in managing rainwater and mitigating flooding. A study by the Capitol Region Watershed District (2012) also confirmed that retention ponds and permeable surfaces are effective in reducing excess water flow in floodplain areas. This is particularly relevant to the Gedebage area, which is situated in a low-lying region and is prone to waterlogging.

The use of green infrastructure to improve air quality and mitigate urban heat effects is supported by research from Bereitschaft and Debbage (2013) and Debbage and Shepherd (2015). In the Summarecon Bandung area, urban vegetation and green open spaces offer additional environmental benefits, including enhanced air quality and the provision of local habitats. As concluded by Dhakal and Chevalier (2016), well-managed green spaces

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contribute to climate change adaptation by sequestering carbon and lowering ambient temperatures.

This study also aligns with the findings of Matthews et al. (2015) who revealed that green infrastructure provides not only environmental benefits but also enhances the social and economic value of an area. In Summarecon Bandung, green open spaces are utilized as accessible public areas that support recreational and sports activities. This approach is consistent with Johns' (2019) research, which emphasizes the importance of integrating public spaces with green infrastructure to foster social engagement and improve urban quality of life.

This study reinforces the concepts presented by Serra-Llobet and Hermida (2017) regarding the need for collaboration between spatial design and environmental conservation to achieve long-term sustainability. Summarecon Bandung, which integrates green elements into its housing and public space planning, aims to create a balance between physical development and environmental preservation, aligning with the goals of urban sustainability outlined in previous studies. Overall, this study supports and expands the existing understanding of the multifunctional benefits of green infrastructure in promoting a more sustainable urban environment.

5. CONCLUSION

The green infrastructure network in Summarecon Bandung serves both ecological and social functions, providing solutions to environmental challenges such as water management while also offering spaces for community recreation and social interaction. This aligns with the goal of developing a sustainable and environmentally friendly area. The riverside green infrastructure in Summarecon Bandung reflects efforts to create a healthy and sustainable urban environment. Emphasizing green open spaces, flood control, and habitat preservation, the area functions not only as a residential zone but also as a model for environmentally conscious urban development. With effective management, Summarecon Bandung’s green infrastructure can serve as an example of residential development that balances physical growth with environmental conservation in East Bandung. This initiative also contributes to the broader goals of sustainable urban development in East Bandung.

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