The Impact Of Blue Green Cities Implementation On Reducing Urban Flood In Yogyakarta City

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Abstract: Urban flooding is a frequent problem in many cities. Unfortunately, many mitigation efforts still rely on conventional, unsustainable methods. A more sustainable approach to reducing flood discharge in urban areas is the Blue Green Cities concept. This study demonstrates that implementing Blue Green Cities strategies—such as infiltration wells, porous drainage, and permeable pavements—can effectively reduce flood discharge in Tegalrejo District, Yogyakarta City.

INTRODUCTION

Yogyakarta City is among the fastest-growing cities in Indonesia in terms of development and population. This rapid growth has led to significant changes in land use, resulting in increased surface runoff. The rise in surface runoff and stormwater has contributed to multiple urban flooding hotspots within Yogyakarta City. Unfortunately, urban flood mitigation has so far relied solely on grey infrastructure by expanding and adding conventional drainage channels. While this approach provides temporary flood discharge reduction, it does not support sustainable development for the future.

One major drawback of grey infrastructure is the depletion of groundwater reserves, as conventional drainage channels divert stormwater without allowing it to infiltrate and recharge groundwater. Between 2013 and 2015, nearly all sub-districts in Yogyakarta experienced a decline in shallow groundwater levels, with drops of 0-2 meters (Nugroho, 2018). Similarly, deep groundwater levels decreased by 0-1.1 meters from 2011 to 2015 (Nuha, 2017).

To achieve sustainable flood mitigation, alternative measures are needed. The Blue Green Cities (BGC) concept, implemented in various developed countries, offers a sustainable approach to managing surface runoff and stormwater, addressing hydrological challenges through green infrastructure. Blue Green Cities is often integrated with the Sustainable Urban Drainage System (SUDS), Low Impact Development (LID), and

Water Sensitive Urban Design (WSUD) (BGC Team, 2016). This study examines the impact of implementing Blue-Green Cities on reducing urban flood discharge in Yogyakarta City.

RESEARCH METHODS

The study was conducted in Tegalrejo District, Yogyakarta City, which is characterized by 10 urban flood points. Flood discharge calculations were performed using the Rational Method (Triatmodjo, 2016), with rainfall data spanning 18 years (2001-2018). The area and runoff coefficient (C) were determined using remote sensing techniques.

The Blue Green Cities approach was adopted, incorporating infiltration wells, porous drainage systems, and permeable pavements. Flood discharge analysis for the application of infiltration wells and porous drainage was conducted using the standard formula outlined in SNI 8456:2017. For permeable pavements, the analysis was based on the equation commonly employed in relevant studies (Smith, 2006).

Additional data utilized in the study included information on the Yogyakarta City drainage network, topographic maps, rainfall inundation and urban flood maps, land use maps, housing characteristics, soil texture, and permeability data, all sourced from relevant government agencies.

RESULTS AND DISCUSSION

The first step in the analysis is to calculate the drainage channel capacity and initial urban flood discharge in Tegalrejo District, Yogyakarta City. The results of the subsequent analysis are presented in Table 1.

Table 1. Comparison of Q drainage capacity and Q initial flood discharge.

Area	Q drainage capacity m^3/s	Q initial flood discharge m^3/s	Explanation
Area 1	0,37	0,76	Flood
Area 2	0,83	1,11	Flood
Area 3	0,6	0,92	Flood
Area 4	0,8	1,1	Flood
Area 5	0,62	0,98	Flood
Area 6	0,09	0,13	Flood
Area 7	0,34	0,81	Flood

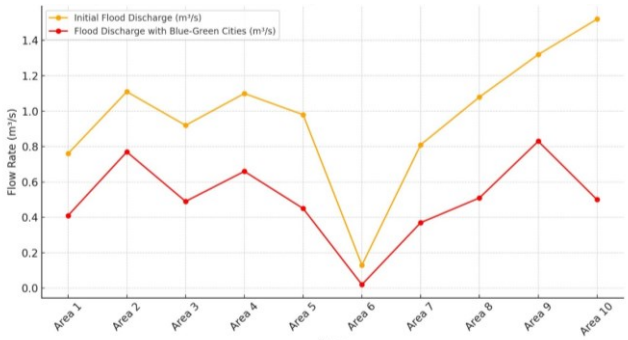
Area 8	0,94	1,08	Flood
Area 9	0,85	1,32	Flood
Area 10	0,97	1,52	Flood

The analysis revealed that the entire drainage channel was unable to accommodate the existing discharge, resulting in flood during periods of high rainfall intensity. Further analysis was conducted to calculate the flood discharge in Tegalrejo District, Yogyakarta City, with the application of the Blue Green Cities approach, which includes the three methods described above. The results are presented in Table 2.

Table 2. Q for the application of Blue Green Cities.

Area	Q After Blue Green Cities m^3/s
Area 1	0,41
Area 2	0,77
Area 3	0,49
Area 4	0,66
Area 5	0,45
Area 6	0,02
Area 7	0,37
Area 8	0,51
Area 9	0,83
Area 10	0,50

Furthermore, the two existing discharges are compared to assess the impact of implementing the Blue Green Cities approach on reducing urban flood discharge in Tegalrejo District, Yogyakarta City. The Blue Green Cities methods selected and analyzed are as follows: infiltration wells, porous drainage, and permeable pavement. The results are presented in Graph 1, as follows:



Graph 1. Comparison of initial flood discharge and Blue Green Cities flood discharge.

It is evident from Graph 1 that the implementation of the Blue Green Cities approach significantly reduces urban flood discharge in Tegalrejo District. In some areas, the reduction in discharge even reaches nearly 50%.

RESULTS AND DISCUSSION

The application of Blue Green Cities, using the infiltration well, porous drainage, and permeable pavement, effectively addresses urban flooding in Tegalrejo District, Yogyakarta City. This is evidenced by the significant reduction in flood discharge after the implementation, compared to the initial flood discharge.

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