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Spatial Upgrading of Riverbank Slums Towards Sustainability of Watershed Infrastructure

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Abstract

Due to limited land availability, riverbanks are frequently the preferred location for the establishment of slums or squatters. The expansion of these areas can diminish the capacity and sustainability of urban drainage system. It is envisaged that the upgrading of slum settlements on riverbanks will not only enhance livelihood levels but also contribute to the watershed's sustainability as primary drainage. The research study area is Kampong Mojo, a pilot project for slum upgrading along the Bengawan Solo River. This article seeks to determine how slum upgrading and infrastructure can contribute to the sustainability of the Bengawan Solo watershed's supporting infrastructure. In this study, qualitative and spatial analysis were utilized, with data support provided by field observations, interviews, and document research. Furthermore, data and information will be analyzed in three stages: (1) mapping the land use change of infrastructure and settlement along the river; (2). identification of settlement riverside upgrading models; and (3). analyzing the relevance of settlement planning on the sustainability of the watershed infrastructure. The findings of this study indicate that, for a river to function optimally as a primary drainage and flood control system, it is essential to promote the development of watershed-supporting infrastructure by strategically structuring land use along the river and enhancing the community's capacities. This study highlights the significance of an integrated approach to slum management, thereby facilitating the government's capacity to implement more inclusive and sustainable riverbank management.

1. Introduction

The urban population is increasing annually and is expected to reach 67.1% in 2045 (BPS, 2018). If rapid growth in urban areas is not properly managed, it will present a number of problems that hinder the achievement of existing development goals (Sagala et al., 2022). Limited land for proper settlements with infrastructure support is one of the problems that often arise. As a result, informal settlements have grown in critical urban areas, such as riverbanks. The emergence of informal settlements with the use of semi-permanent physical materials is also caused by social and economic factors and does not require land ownership (Pramantha et al., 2021). The riverbank area is one of the locations that people are interested in because the riverbank area is considered to provide economic and cultural value (Sultana & Alam, 2023), as a source of livelihood, and even as a recreational space (Hawa et al., 2023). Therefore, the implementation of land-use planning strategies in riparian areas is crucial to promote environmental sustainability (Buchori et al., 2015; Pihui et al., 2024).

On the other hand, slum settlements that develop along riverbanks can affect the river's capacity and function as part of the drainage system. The diminished capacity of rivers can increase the vulnerability of areas along riverbanks to flooding. The area along the watershed eventually lost the riparian areas that should have been used as a location for river infrastructure development, such as the construction of inspection roads and others. As part of the urban drainage system, river and their supporting drainage infrastructure (parapet embankments, water pumps, etc.) must be managed in a systematic and sustainable manner so that they can function optimally. With the state of riverbank slums, the vulnerability to floods rises. This is exacerbated by the lack of drainage, sanitation, and open space in slum areas. This vulnerability also increases when there is no attempt to mitigate flood conditions (Nasution et al., 2022).

Surakarta is a city that is intersected by tributaries of Bengawan Solo River. The historical development of residential along the riverbank has been significantly shaped by confluence of geographic advantages, including land availability, accessible to city center, and other socio-economic factors. Semanggi is a high-priority slum neighbourhood due to the fact that several sections of the slum area are located in critical areas along the banks of the Bengawan Solo and Premulung Rivers. The concept of structuring slum settlements in the Semanggi area, especially in Mojo Urban Village, with illegal land differs significantly from other slum upgrading locations (Meilasari-Sugiana et al., 2018; Bawole et al., 2020; Taylor, 2015; Widyaningsih & Van den Broeck, 2021) is labelled as the structuring without demolition.

This phenomenon also occurs in other cities in Indonesia such as Jakarta and Cagayan de Oro in Southeast Philippines. In Jakarta, providing land for the construction of apartments as a resettlement location is a challenge for the Jakarta provincial government during the resettlement of Kampung Pulo squatters. Not only are there substantial expenditures associated with providing this land, but there are also negotiations involved in picking a place that fits the qualities and interests of the community (Meilasari-Sugiana et al., 2018). If the site decision is inappropriate, it can frequently lead to numerous other issues. Several slums with eviction solutions (Jakarta, Indonesia and Cagayan de Oro in southern Philippines) frequently create new problems, with residents losing not only home possessions, but also their self-esteem, cultural identity, social networks, and place connections (Widyaningsih & Van den Broeck, 2021), failure of housing projects in terms of occupancy rates or abandonment of properties, destruction of livelihoods and community relationships, and fragmented settlements (Carrasco & Dangol, 2019). As was the case in Nanga Bulik, Kalimantan, Indonesia, the partial relocation of slum communities on riverbanks is also a viable solution. Those without land rights are relocated, while those with land rights can improve the quality of their houses and its environment (Purwanto et al., 2017).

The concept of structuring slum settlements without resorting to demolition but instead focusing on enhancing their infrastructure can serve as an all-inclusive solution. Following this concept, efforts to improve infrastructure aim to raise environmental quality and reduce flood risks (Michiani & Asano, 2019). This concept can be implemented if disaster risk can still be managed without complete or partial relocation (Dangol & Carrasco, 2019). Enhancing the quality of infrastructure and the surrounding environment can lessen the level of vulnerability to flooding (Nasution et al., 2022). The construction of inspection roads and long embankments on the riverbank is also considered capable of enhancing the environmental quality of slum settlements (Pusporini et al., 2021). In addition to improving the physical element, a social and economic approach is required through strengthening or empowering the community to ensure the sustainability of slum settlement (Hawa et al., 2023). Moreover, the participation and cooperation of each stakeholder can raise the level of social capital, reducing disaster risk (Buchori et al., 2022; Rustinsyah et al., 2021).

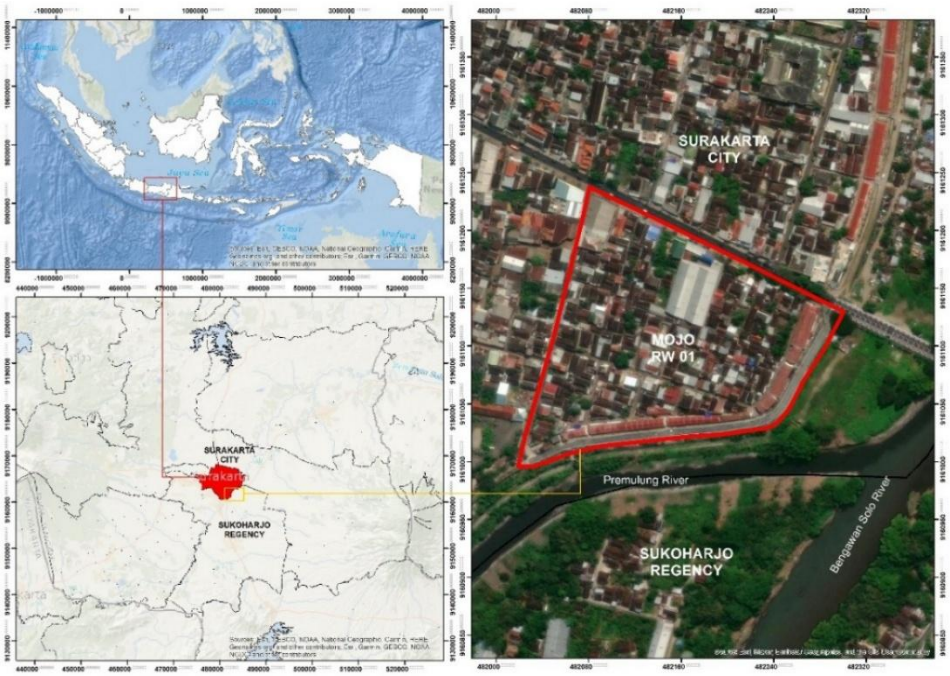
The case study of the concept of structuring slums in Kampong Mojo is an example of an integrative planning effort with a macro-drainage system in urban areas that is distinct from both the structuring of slums and the management of drainage systems in other locations (Dangol & Carrasco, 2019; Purwanto et al., 2017; Widyaningsih & Van den Broeck, 2021). It is envisaged that upgrading slum settlements on riverbanks will not only enhance livelihood levels but also contribute to the watershed's sustainability as primary drainage (Hawa et al., 2023; Pihui et al., 2024). Many strategies for addressing issues related to flood and watershed sustainability are community-based or community-initiated (Auliagisni et al., 2022). However, there has been limited discourse

on riverbank governance that integrates with the surrounding land use, particularly through a slum upgrading scheme that involves a more prominent role for the government. Consequently, the objective of this article is to introduce a novel concept for slum upgrading that encompasses enhancements in both spatial and social dimensions, can contribute to the sustainability of the Bengawan Solo watershed's supporting infrastructure.

2. Data and Methods

2.1. Study Area

The case study area is the location of the slum settlement along the banks of the Bengawan Solo River in Kampong Mojo, Surakarta City. This location is one of the locations identified as a slum area by the Decree of the Mayor of Surakarta Number 413.21/38.3/1/2016 in 2016 about the determination of the location of housing and slum environmental areas in the city of Surakarta. Since 2017, slum settlement arrangements have been carried out. The concept of structuring slum settlements in the Semanggi Area, especially in Kampong Mojo, with illegal land differs significantly from other slum upgrading locations (Meilasari-Sugiana et al., 2018; Bawole et al., 2020; Widyaningsih & Van den Broeck, 2021) and labelled as the structuring without demolition. It is expected that the case study can offer a novel approach to riverbank governance by incorporating the sustainability of watershed infrastructure and organizing land use along the river. Figure 1 displays the map of the research locations.



Source: CNES/Airbus Image Recording, 2023

Figure 1. The Map of Kampung Mojo as Research Area

2.2. Method

The case study method is employed to examine contextual conditions that are pertinent to the phenomenon of the study. Case studies cover the logic of design, data collection, and specific approaches to data analysis (Yin, 2009). This method was utilized due to its appropriateness in attaining the research objectives, specifically in the exploration of concepts through relevant and contextual case studies. Data collection was carried out using semi-structured interviews, Focused Group Discussion (FGD), field observations, and documentary reviews. Semi-structured interviews and FGD methods involved the key persons from the representatives of the slum upgrading project; KOTAKU (Cities Without Slums Organisation); Government

Unit of Housing and Settlement; Government Unit of Public Works, Head of Mojo Urban Village, and Head of Neighbourhood 01 (RW.01). The selection of respondents was determined based on their level of importance and influence in the management of watershed infrastructure and slum upgrading projects. The purpose of semi-structured interviews and FGD are to investigate the expansion and characteristics of settlement along the river, the vulnerability of settlement to flooding, and the historical process of watershed infrastructure and slum upgrading.

A documentary review and field observation method were conducted to review the implementation of slum upgrading planning, the spatial changes of riverbanks, and flood-related data. Spatial data is used to describe changes in land cover that occurred before and after the parapet was built and changes in the settlements around it. The spatial data utilized is obtained from satellite imagery (Copyright 2023 CNES/Airbus, image recording 2013 – 2023). The analysis techniques used are qualitative analysis and spatial analysis. Spatial analysis utilizes Geographic Information Systems (GIS) to discern alterations in land cover throughout a predefined temporal interval. There are three stages used in analyzing the data obtained: 1. mapping the land use change of infrastructure and settlement along the river; 2. identifying the process of settlement riverside upgrading models; and 3. analyzing the relevance of settlement planning on the sustainability of the watershed infrastructure. The research diagram can be seen on Figure 2. In the end, it can be seen how the slum upgrading and the infrastructure can contribute to the sustainability of the Bengawan Solo watershed's supporting infrastructure.

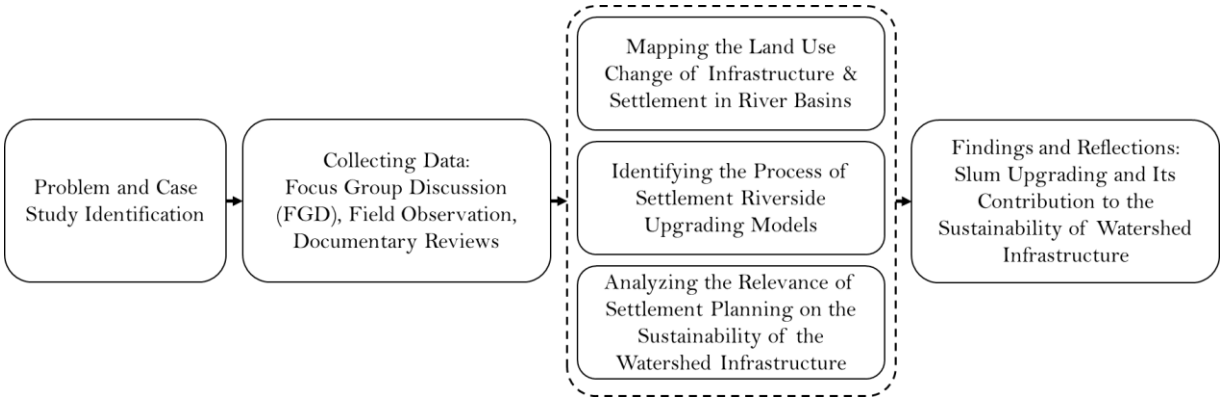


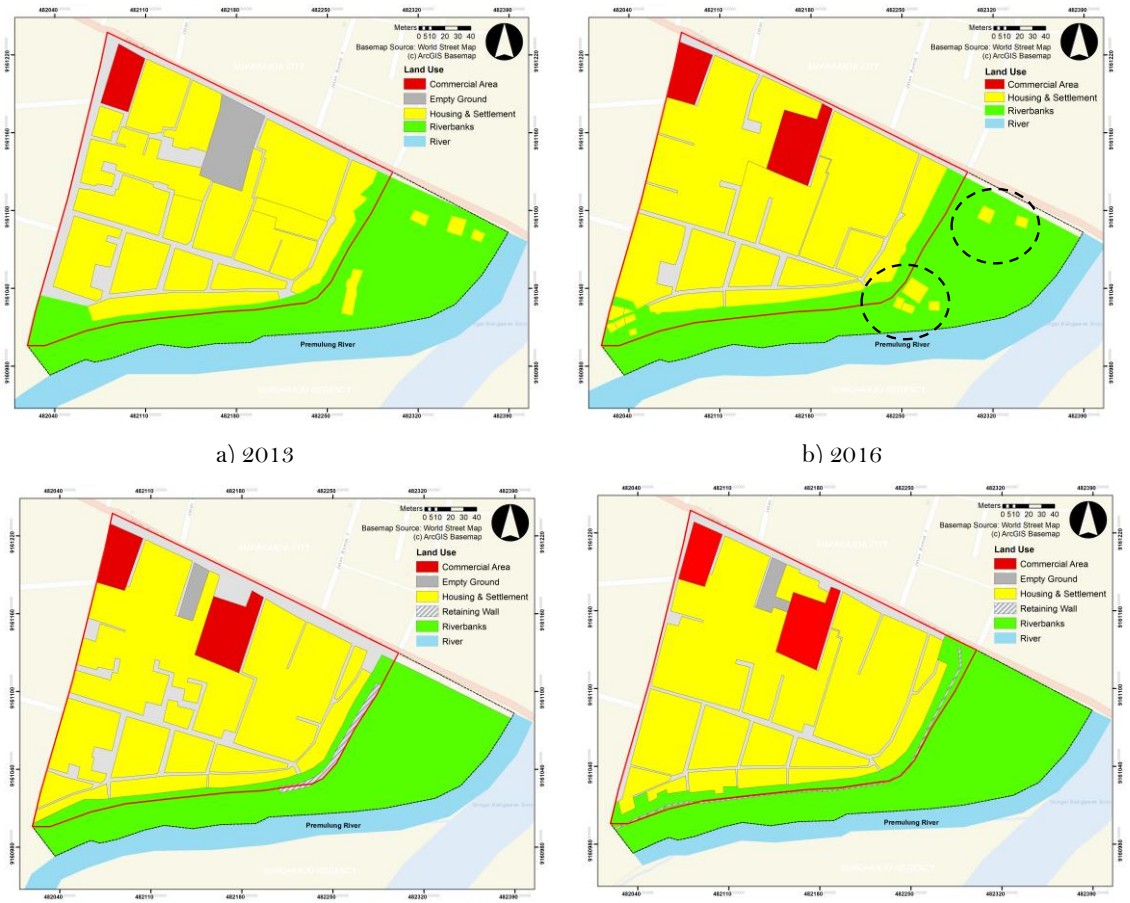
Figure 2. Research Method Diagram

3. Result and Discussion

The case study is discussed in three stages. First, we explain the vulnerability of watershed infrastructure and the expansion of settlement along it by mapping infrastructure and settlement land use changes along the river. Second, we outline the riverbank slum upgrading process. Finally, we examine the importance of riverside slum upgrading to the long-term viability of watershed infrastructure.

3.1. The Vulnerability of Watershed Infrastructure and Settlement Growth in Kampong Mojo

The case study area, Kampong Mojo, is located on the banks of the Bengawan Solo River and partially on the banks of the Premulung River. This area is included in the flood-prone category because its elevation is below the river's surface; consequently, it continues to experience flooding each year, particularly during the rainy season. Therefore, a 320-meter-long parapet was constructed in 2017 to prevent the overflow of river water into residential areas during the rainy season. Parapet construction is an enormous investment and is expected to have a service life of up to twenty years. In addition to constructing parapets, it is important to develop other supporting infrastructure such as inspection roads, drainage belts, and water pumps in order to maximize parapet function, control parapet quality, and regulate river capacity (Interview with KOTAKU, 2023).



Source: Field Observation and CNES/Airbus Image Recording, 2013 - 2018

Figure 3. Growth of Riverbank's Settlement Before Slum Upgrading Program

Table 1. The Land Use Change of Kampong Mojo

Land Use	Year			
	2013	**2016**	**2017**	**2018**
Commercial Area	1,026.68	3,037.71	3,037.71	3,037.71
Housing & Settlement	32,685.11	32,919.06	32,446.29	31,696.85
Riverbanks	19,410.33	17,618.70	17,618.70	18,491.10
Retaining Wall	0	0	535.29	348.66
Empty Ground	1,026.68	0	510.81	574.48
Roads	1,454.20	1,454.20	1,454.20	1,454.2
Total Area	**55,603.00**	**55,029.67**	**55,603.00**	**55,603.00**

**Area in square meters*

Source: Field Observation and CNES/Airbus Image Recording 2013 – 2018

On the other hand, riverside settlements continue to expand and develop. This may be observed in Figure 3 and Table 1. Which depicts land use changes along the riverbank from 2013 to 2018 (before the arrangement of slum settlements). From 2013 to 2016, the number of settlements located along the riverbanks and occupying the remaining green open spaces increased. In 2017, construction of parapets began as part of annual flood mitigation. Nonetheless, there are a number of houses recognized as belonging to the river boundary zone that are prohibited from becoming housing or settlements. Because the land on the riverbanks belongs to the Bengawan Solo River Basin Center (Balai Besar Wilayah Sungai Bengawan Solo or BBWS Bengawan Solo)

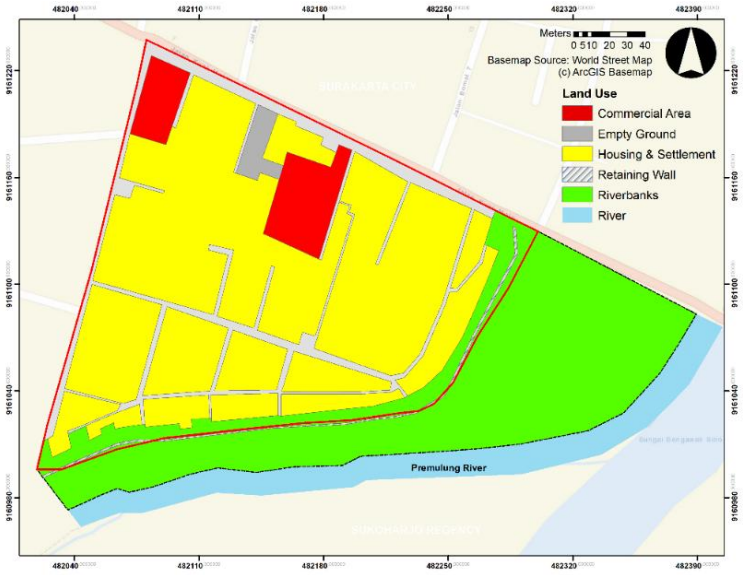
under the Ministry of Public Works, it is banned for the area to be developed for housing, as it could disrupt the sustainability or service life of the existing parapets. This is due to the fact that the buildings of these illegal settlements tend to utilize parapet walls as part of their dwellings.

In addition, inadequate facilities and infrastructure to support decent settlements, such as a lack of public space, might lead to the use of river banks as a place for interaction (Government unit of Settlement Surakarta, 2022). The development of supporting infrastructure for primary drainage is also necessary, including the construction of drainage belts or secondary drainage, the installation of water pumps, and the arrangement of drainage in the settlement area. However, the high housing density and existing road structures cause the situation challenging to construct the supporting infrastructure. A comprehensive arrangement of slum settlements should be carried out so that the overall development of the existing drainage system can operate and function optimally to reduce the flood risk.

3.2. Process of Riverbank's Slum Upgrading

Kampong Mojo is one of the five sections in the Semanggi slum area that lies in a total area of 3.72 hectares, concentrated in RW 01. This area is inhabited by 192 families occupying 178 residential units, 72 families of whom live in 63 building units on state-owned land or on the banks of the Premulung and Bengawan Solo Rivers. The inhabitants of the river's riparian area are local migrants from Surakarta and outside of the city. The process of structuring slum settlements is motivated by multiple issues, including the fact that these settlements are located in flood-prone areas, have limited facilities and infrastructure for proper settlements, have building irregularities, and have formed informal settlements that are expanding and occupying illegal land on riverbanks. Environmental conditions before an arrangement can be seen in Figure 4.

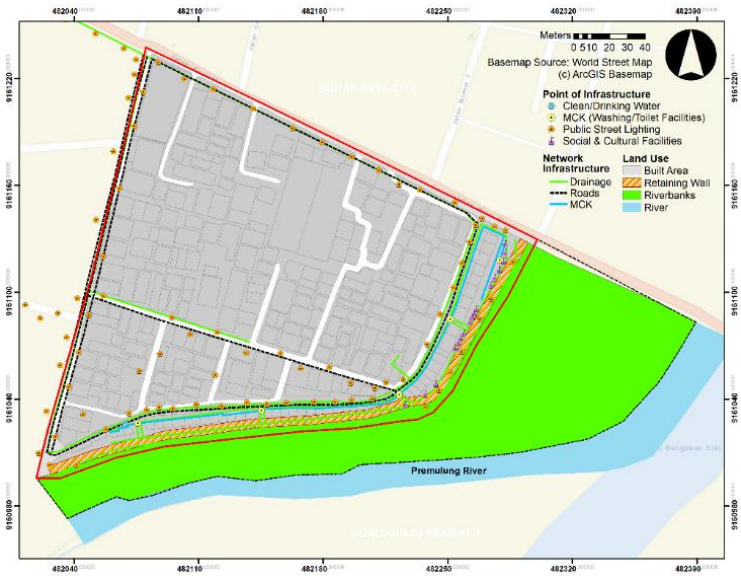
To address various existing issues, the focus of the arrangement includes four primary activities: 1) arrangement of illegal settlements along the border of the Premulung River and Bengawan Solo River; 2) the construction of roads and drainage along riverbanks; 3) the construction of parapets and flood pump houses; and 4) the improvement of the settlement environment's quality. The arrangement of illegal settlements began with outreach and determination by the affected residents; a total of 63 dwellings had to be demolished for realignment. In Kampung Mojo, unlike other slum settlement locations (such as in the Philippines and Nepal), an institution at the community level is formed as a representative to negotiate with the government (Carrasco & Dangol, 2019). Only 56 of the 72 household were able to re-occupy land in the area and later acquire land rights.



Source: CNES/Airbus Image Recording, 2018

Figure 4. Kampong Mojo Before Slum Upgrading Program

The community must have a Surakarta City identity card and does not legally own a house in another location. The transfer of land ownership rights from BBWS Bengawan Solo to the community involves multiple stages including technical recommendations from the mayor of Surakarta. The process is conducted in accordance with the Ministry of Finance Regulation No. 111/PMK.06/2016 Article 93. The transfer of rights by grant from state-owned land to community ownership differs significantly from the case studies conducted in other locations. The arrangement of settlements is also accompanied by the construction and improvement of basic infrastructure, including the arrangement of roads and drainage. As observed in Figure 5, the road structure, drainage arrangements, construction of pump houses, and construction of sanitation channels have been modified. The provision of infrastructure, particularly drainage-related infrastructure, is a component of urban drainage system planning as a form of mitigation against the annual flooding that has occurred in this area in the past.



Source: Government unit of Settlement Surakarta, 2023

Figure 5. Kampong Mojo After Slum Upgrading Program

3.3. The Relevance of Riverbank's Slum Upgrading on the Sustainability of the Watershed Infrastructure

The solution to the challenge posed by slum settlements situated in riverbank areas with illegal land status across various locations is eviction rather than relocation (Cook et al., 2019). The relocation model is employed with the expectation that the affected community will secure a legal residence. However, upon implementation, following the relocation to the designated housing, the community faced challenges in covering the management costs associated with the area. This predicament arose from the absence of an accompanying economic and social capacity-building program (Khan, 2021). This top-down approach is necessitated by the fact that the land occupied by the community does not belong to them. Such situations frequently arise in strategically significant locations, including railway banks, riverbanks, and other pivotal areas within the urban center.

River banks are considered areas that may not be designated as settlements. The determination of river border lines in Indonesia refers to the Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia Number 28/PRT/M/2015 concerning the Determination of River Border Lines and Lake Border Lines. The boundary line of the river embankment in urban areas is determined to be at least 3 meters from the outer edge of the foot of the embankment along the river channel. Riverbanks are restricted to activities that do not interfere with the function of the river, such as the construction of facilities related to water resources, electricity, telecommunication lines, and others (Ministry of Public Works and Public Housing of the Republic

of Indonesia, 2015). The arrangement of slum settlements in Kampung Mojo is conducted beyond the delineated riverbank boundaries although the land is owned by the BBWS.

The arrangement of slum settlements in Kampung Mojo with the on-site upgrading model, particularly for the 63 houses that are on state-owned or illegal land, is a policy that the city government has never adopted before. The city government faces two options, the riverbank residents and those occupying state land can be relocated, or they can remain where they are. However, the city government decided to retain its 56 household's citizens despite the fact that they were located on state land.

> *"The city mayor stated that the community was present prior to the implementation of the current regulations. As a result, the mayor has opted to pursue a discretionary petition to facilitate their continued presence." (Interview with KOTAKU, 2023)*

This policy differs from those typically used by regional government, such as in Kalimantan, Indonesia, which opted for partial relocation (Purwanto et al., 2017). Flood control or the loss of livelihood is often considered an option in structuring slum settlements on riverbanks (Cook et al., 2019). It turns out that these two elements can be obtained with the support of all stakeholders, with political will from regional leaders or city governments being the most crucial factor. Furthermore, the successful implementation of improving the environment has been made possible through the cooperation of the government, local communities, and support from third parties, such as the private sector.

The government and local communities contribute significantly to fostering dialogue within the slum upgrading planning process, facilitating the formulation of actionable plans for implementation. The private sector is also integral, particularly in financing housing development through Corporate Social Responsibility (CSR) initiatives. This involvement is necessitated by the fact that housing development occurs concurrently with the land transfer process, while municipal government funds are restricted from being allocated for revitalization efforts in the area, given that the land transfer process remains incomplete. This has been achieved without the necessity of resettlement programs (Wahyuni et al., 2021). Slum upgrading initiatives, founded on robust collaborations between the community and local government, combined with proactive measures to anticipate future risks, render this case a prime example of comprehensive community-led upgrading with a focus on resilience (Satterthwaite et al., 2020).

Concerning watershed infrastructure, these slum settlements not only affect the quality of the housing environment but also pose a risk to the durability of the existing drainage infrastructure (parapet) and impede the establishment of a secondary drainage system in riverfront residential areas. Integration between the arrangement of slum settlements, including community empowerment, can simultaneously be an effort to maintain the sustainability of the constructed drainage infrastructure. Communities have a sense of belonging to their area and anticipate being able to participate in the operation and maintenance of existing drainage infrastructure. Economically, the utilization of empowered communities enhances the cost-effectiveness and efficiency of infrastructure development (Sedyowati et al., 2020).

The Surakarta City Government could have evicted the slum dwellers, but instead it improved the infrastructure and utilized these empowered communities to transform the watershed into a tourism and cultural destination. In addition to physical upgrading, social and economic factors are required to strengthen community institution capacity in order to increase commercial business productivity and can further contribute to the sustainability of settlements so that they don't revert to slums (Hawa et al., 2023). The following step is to provide shared space and facilities as a complement that can form an identity and reveal the visual charm of the location (Michiani & Asano, 2019). This arrangement can also be utilized as a means of generating collective action from all stakeholders, particularly the community, in order to maintain the revitalized urban environment (Meilasari-Sugiana et al., 2018), in this case the infrastructure along the riverbanks.

4. Conclusion

This study aims to propose a novel concept for slum upgrading that encompasses enhancements in both spatial and social dimensions, contributing to the sustainability of the Bengawan Solo watershed's supporting infrastructure. Kampong Mojo is situated along the banks of the river, with its terrain positioned at a lower elevation than both the Bengawan Solo River and the Premulung River. As a result, this area is susceptible to flooding, particularly during the rainy season. To mitigate flooding, the government constructed embankments and enhanced the drainage system in settlements along the river. Improvement of the drainage system in slum settlements is carried out comprehensively with the concept of slum upgrading, including in slum areas that occupy state land. The city government elected to arrange residential areas on site, including the transfer of housing land ownership from the state to affected communities. This case study indicates that for a river to function optimally as a primary drainage and flood control system, it is essential to promote the development of watershed-supporting infrastructure through the regulation of land use along the river and the enhancement of community capacity.

The arrangement of illegal slum settlements by on site upgrading is not a well-liked strategy. City governments and urban planners frequently face challenging decisions regarding flood management and the arrangement of slum settlements. The adoption of an appropriate settlement strategy can effectively address both issues concurrently and sustainably. The approach implemented in Kampung Mojo, which integrates physical enhancements with the reinforcement of land ownership security, significantly contributes to the sustainability of drainage infrastructure while improving the quality of life and fostering a sense of ownership among residents. The proximity of residences to the river boundary facilitates community involvement in the maintenance of the drainage support infrastructure, thereby mitigating the risk of new illegal settlements emerging along the riverbank. This engagement is driven by the community's awareness that suboptimal functioning of the drainage system could lead to flooding that directly impacts their homes.

Initiatives that were undertaken to transform the watershed, which was formerly a slum, into a destination for tourism and culture aligned with the area's potential through spatial or physical improvement and community empowerment. In practice, the findings of this research highlight the importance of an inclusive approach to addressing the riverbank slum problem. Implementing on-site upgrading instead of eviction or relocation requires a long-term commitment from the local government. Policies that focus on land tenure security, long-term infrastructure investment, and leveraging community capacity can foster the development of a more resilient and equitable urban environment. Further research is required to evaluate the sustainability of the area following the implementation of slum upgrading initiatives

5. Acknowledgement

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