Accessibility and Infrastructure of Clean Water in Bagan Settlement (Case Study: Tanjung Piayu, Batam)

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Abstract
Coastal settlements are characterized by their unique geograpichal condition, where most houses are built above sea level, creating significant challenges in proving basic infrastructure, particulary clean water. In this research, we aim to look closely at the clean water infrastructure and how residents get their water in the Bagan area of Tanjung Piayu, Batam. We examine water access and infrastructure in Bagan, Tanjung Piayu, to uncover local challenges and check the actual water supply. Through field observation, we gathered qualitative data on water sources, strogae, and distribution networks. We found that most resident rely on rainwater haverseting, though some buy water from mobile vendors. Limited infrastructure also prevents connecenting the area to the piped water grid. Residents face high water costs, poor distribution, and a substantial depedence on seasonal rain. These problems hurt public health, disrupt daily routines, and lower the quality of life. Seawater leaks make groundwater too salty to drink, while poor filtering risk the safety of rainwater. Therefore, we highlight the need for better water management and infrastructure in coastal areas. We recommend decentralized solutions, like local desalination and subsidized water, to fix these issues. This helps lower costs for resident, improve water access, and build a reliable, long-term system.

Keywords: Water access; coastal settlements; infrastructure; rainwater haverseting; Tanjung Piayu

Introduction

Clean water is a basic need and an essential aspect of human life (Dinka, 2018). Clean water is defined as water that meets physical, chemical, and biological quality requirements, making it safe for domestic use such as drinking, cooking, bathing, and

washing. Clean water quality standards generally refer to specific parameters established by health institutions, such as colorless, odorless, and free from harmful microorganisms (Harmiyati et al., 2023) and hazardous substances. Water quality that does not meet standards can cause various health problems, including infections and stomach ailments (Santoso, 2025). Therefore, regular testing and monitoring are essential to ensure the safety of clean water used by the public.

In coastal areas, clean water cannot be implemented optimally due to limited environmental conditions and infrastructure (Stein et al., 2023; Astuti et al., 2021). One method commonly used by coastal communities is a rainwater harvesting system (Huwaina, Hasibuan, & Fatimah, 2022). This system utilizes rainwater collected from building roofs and stored in specific containers to be used as a source of clean water (Bañas et al., 2023). This method is quite effective in providing clean water in areas with limited water sources, but has a major weakness, namely dependence on rainfall (Rahman et al., 2019). In addition, several coastal communities rely on water supplied by private providers as an alternative source to fulfill their clean water needs. Nevertheless, this solution is not always sustainable because it requires relatively high costs for communities with limited economic capabilities (Ridwan et al., 2024). Rooftop rainwater harvesting has been widely recognized as an effective alternative strategy to address clean water scarcity, particularly in areas with limited access to conventional water sources. This system is relatively simple, cost-effective, and capable of supplying water for various domestic needs when properly managed. Therefore, effective and affordable clean water strategies are important to sustainable water availability in vulnerable regions (Aryal et al., 2022). The supply challenge is closely related to the often-inadequate physical condition of clean water infrastructure in coastal settlements. Coastal areas commonly experience limitations in water distribution systems due to environmental pressures, infrastructure vulnerability, and management constraints, which reduce service reliability and access to clean water. These conditions contribute to unequal water distribution and persistent supply issues in coastal communities (Putri et al., 2023). Previous studies have shown that limited environmental conditions and inadequate Infrastructure limitations in coastal areas restrict access to clean water, forcing communities to depend on alternative sources such as rainwater harvesting and purchased water, which are often costly and less sustainable World Bank (2021). According to previous studies, *bagan* (stilt houses) are often constructed independently using available materials, such as PVC pipes suspended beneath bridges, making the distribution system vulnerable to leaks caused by waves and tides (Hoque et al., 2016). In addition, limited land above water causes storage infrastructure such as rainwater tanks (PAH) to be placed on vulnerable structures, which if not taken into account can accelerate the structural damage of surrounding buildings (Mohamad et al., 2012)). The damage and lack of maintenance of water infrastructure are key factors limiting the equitable distribution of clean water in coastal areas. Aging systems, combined with harsh environmental conditions such as salinity and tidal forces, reduce the reliability of water distribution networks, leading to failures, leakage, and unequal access among coastal communities (Żywiec et al., 2024).

The *bagan* settlement in Tanjung Piayu, Batam City, is an example of a coastal area facing challenges with clean water. This area still experiences limitations in accessing clean water, particularly in coastal and low-income settlements where infrastructure and service coverage remain inadequate (WHO, 2021). Available infrastructure is uneven, and most residents still rely on rainwater as their primary source. This condition indicates a gap in the provision of basic services between coastal and inland areas (Yandri et al., 2020). Therefore, this study aims to analyze access to and the availability of clean water infrastructure in the Bagan settlement, Tanjung Piayu, Batam.

Research Method

A qualitative method was chosen because this research aims to understand the phenomenon in depth, particularly regarding access to clean water, community behavior, and the obstacles faced in daily life (Creswell & Poth, 2018). Data collection was conducted through direct observation at the research location, namely the Bagan settlement in the Tanjung Piayu area, Batam (Figure. No 1). Observations were conducted to identify the ource of clean water used by the community, condition of infrastructure such as storage tanks and pipelines, water usage patterns by the community, and obstacles faced in obtaining clean water. After the data had been collected through observations, interviews, documentation, and literature reviews, the data were analyzed using qualitative data analysis techniques. The analysis process involved three stages: data reduction, data display, and conclusion drawing. Data reduction was conducted by selecting, focusing, and simplifying the information relevant to the research objectives. Subsequently, the data were organized and presented in a descriptive form to facilitate interpretation and understanding of the findings. The final stage, conclusion drawing, was carried out to identify patterns, relationships, and key findings in order to answer the research questions. For this coastal community, we focus on checking water access, inspecting infrastructure, and identifying main supply problems (Table 1).

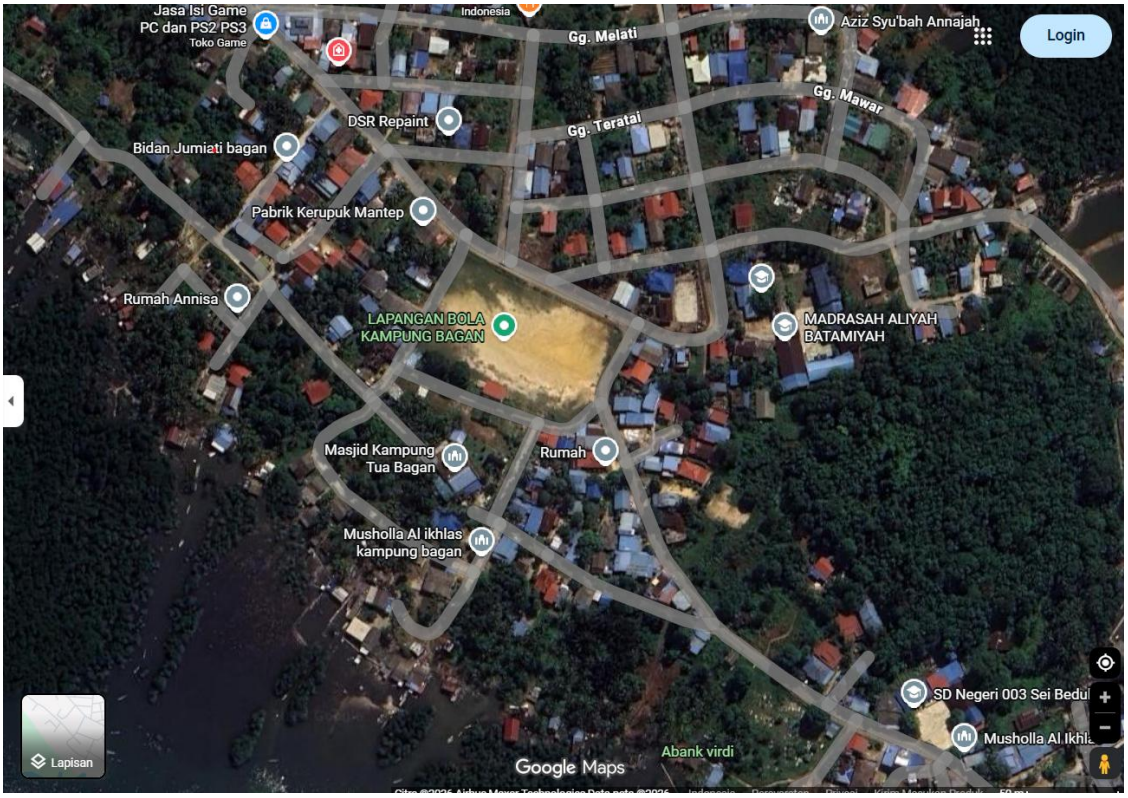


Figure 1. *Research Location Map*

Observation Aspect	Conditions in the Field	Impact
Water Sources	Using Rainwater	Depends on the season
Pipeline Infrastructure	Not evenly distributed	Not all homes have access
Storage Tank	Small capacity	Water runs out quickly
Water Purchase	From a traveling salesman	Adding to the community costs

Table 1. *Observation of Clean Water Accessibility in the field*

Results and Discussion

Our field data show that safe water in Bagan, Tanjung Piayu,is limited and unevenly distributed. As a result, most households rely on rainwater collected from their rooftops. Resident store this rainwater in tanks and container for daily use. Some households also buy water from mobile vendors for their additional need. Residents split their water use: they buy vendor water for drinking and cooking and use rainwater for washing and bathing. This happens because the city's water network doesn't reach every neighborhood, making water access highly unequal. Communities without proper toilets and clean water encounter a significantly elevated risk of contracting diarrhea and other infections (World Health Organization, 2023).



Figure 2. *Typical Housing Structure Found in the Bagan Settlement Area of Tanjung Piayu*

Most families here rely on small tanks and plastic containers because proper water storage is severely lacking. Unfortunately, these small tanks simply cannot hold enough water when the water shortage drags on for weeks. Building a settlement directly on coastal water makes it technically difficult to construct standard clean water infrastructure. Cramped spaces and unstable housing conditions make it incredibly difficult to build water pipeline networks. Because of these unstable housing conditions, both the pipeline costs and engineering challenges skyrocket (Figure 2).



Figure 3. *Rainwater Harvesting Facilities in Bagan Settlement*

This image highlights the rainwater systems in the Bagan area, showing how Bagan residents rely on rainwater harvesting for daily survival. In this setup, storage containers are placed on a simple wooden frame to gather water. These basic containers rely entirely on the wooden frame for structural support. The community built this system out of necessity, proving that when fresh water is scarce, the community will find its own ways to secure water. Because of harsh coastal conditions and bad water distribution, coastal residents must hunt for any alternative water sources available around them.

Despite its small capacity and substantial depedence on local rainfall, the setup significantly helps secure the household's daily water supply. This basic setup highlights the community's capacity to adaptively respond to both environmental challenges and severe infrastructure shortages.



Figure 4. *River Conditions Around the Bagan Settlement*

The investigation shows that limited local water sources and weak infrastructure are the ultimate bottlenecks to safe water access in Bagan. This substantial depedence on rainwater proves that the local infrastructure cannot support long-term water distribution. Because rainwater depends on seasonal weather, stored water levels fluctuate constantly; heavy rain temporarily secures family needs, but dry seasons end in severe water shortages. This weak infrastructure creates a massive gap where getting water is easy for some households but incredibly tough for others. This water disparity clearly stems from bad utility planning, which directly lowers the quality of life for many residents. On top of that, the water crisis triggers major financial strains. Families outside the official network must buy from alternative water channels, raising their daily costs. Over time, these extra costs heavily burden household economics and wipe out the financial coping mechanisms of underprivileged families. Ultimately, bad infrastructure is the main reason these areas lack clean water. When public infrastructure is this weak, getting safe water becomes nearly impossible for coastal communities (Yandri et al., 2020). Field data shows that the clean water network is highly fractured, meaning only a few areas get piped water. This broken network is a direct result of Bagan's geography, where houses over the sea stop the network from expanding. To make matters worse, how residents manage their water storage lowers the quality of the water. Because this water storage lacks proper filters, the stored water easily catches dust and dirt, leading to real health risks. Ultimately, fixing this water crisis means looking beyond the pipes; it requires treating water insecurity as a deeply rooted problem tied to technology, economics, and society. Earlier studies prove that poor water access directly damages community welfare. When clean water is hard to find, the welfare of the entire neighborhood suffers (Exposto et al., 2021). This evidence confirms that securing daily water remains a complex struggle for Bagan residents, who must constantly ration water and alter their habits. This reality proves that water scarcity isn't just a technical issue, but a social and economic one too.

Therefore, finding real solutions cannot depend on standalone projects; instead, these solutions require teamwork between the government and the local community. Only by involving the community in an integrated plan can we build a water supply system that genuinely lasts.

Conclusion

The result shows a clear imbalance in clean water access across the Bagan community in Tanjung Piayu, where rainwater is the cornerstone of local supply. This reliance leaves households vulnerable to water insecurity, a problem that peaks during dry seasons. Ultimately, this unstable water supply is tied to the settlement's coastal location, lagging infrastructure, and small storage capacities. This paper delivers a grounded assessment of these conditions, mapping out how infrastructure and social factors govern coastal water access. To move forward, we must design water frameworks that are both adaptive and sustainable. Future research must prioritize technical solutions and wider strategies for seaside communities. Upgrading water infrastructure demands long-term planning and direct community engagement in governance. This focus ensures the system satisfies immediate water demands while remaining viable for decades. Consequently, a localized approach is vital to building clean water architectures that fit the actual realities of the Bagan community.

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Competing Interest

No potential conflict of interest was reported by the authors.