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Research Article

Canal-Side Communities in Southeast Asia: Sustainable Urban Development and Environmental Remediation in Ho Chi Minh City

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Abstract: This study presents the living conditions of the residential community along the Xuyen Tam canal, an important waterway facing severe pollution and urbanization issues in Ho Chi Minh City (HCMC). The research focuses on key aspects such as housing types, average living area, domestic water sources, environmental sanitation, income, occupation, and residents' resettlement aspirations. Survey results indicate that most houses are semi-permanent or temporary (60%), living spaces are cramped (with 50% of households occupying 10-20 m² and 10% under 10 m²), clean water access is limited (only 60% use tap water, often unreliable), environmental sanitation is poor (50% lack adequate toilets), and incomes are unstable (70% earn less than 6 million VND/month). Water and air pollution negatively impact the physical and mental health of residents, contributing to respiratory and gastrointestinal diseases. The study also compares the situation at Xuyen Tam canal with canal-side areas in other major Southeast Asian cities like Bangkok, Jakarta, and Manila, highlighting common challenges such as inadequate infrastructure and environmental degradation. Based on the analysis, the paper proposes integrated solutions regarding urban planning (including infrastructure rehabilitation), environmental remediation (wastewater treatment, solid waste management), and improving residents' livelihoods (resettlement support, job creation), emphasizing the need for policies supporting sustainable urban development.

Keywords: Xuyen Tam Canal; canal-side housing; environmental pollution; living conditions; resettlement; urban planning; Ho Chi Minh City; Southeast Asia.

Highlights:

- Sustainable urban regeneration solutions for Ho Chi Minh City's Xuyen Tam Canal.
- Addressing pollution and housing issues in informal settlements along the canal.
- Proposing integrated solutions to improve water quality and public health.
- Comparing Xuyen Tam Canal with other Southeast Asian cities' urban challenges.
- Emphasizing community engagement in urban planning and regeneration efforts.

1. Introduction

1.1 Urban Development and Sustainable Challenges at Xuyen Tam Canal, Ho Chi Minh City

Ho Chi Minh City (HCMC), the largest and most economically significant urban center in Vietnam, continues to face rapid urbanization, which, while fostering economic growth, presents significant challenges for sustainable development. As of 2025, HCMC's population exceeds 10 million, with more than 30% of its inhabitants residing in informal settlements (HCMC Statistical Office, 2025). This massive influx of migrants, primarily from rural areas, has intensified pressure on the city's infrastructure, particularly on housing, water supply, sanitation, and waste management systems. Among the most pressing challenges is the development of informal settlements along the city's canal systems, which have become critical areas for both environmental and social reform.

One of the most impacted areas is Xuyen Tam Canal, which flows through the Binh Thanh and Go Vap districts (Figure 1). Once an important waterway for transportation and irrigation, the canal is now severely polluted, and the surrounding areas have become home to thousands of informal settlers. These settlements are characterized by inadequate housing, overcrowding, poor sanitation, and limited access to clean water, creating substantial health risks for the residents. The canal has also suffered from the discharge of untreated wastewater and waste from nearby industries, exacerbating the environmental degradation (Nguyen et al., 2024).

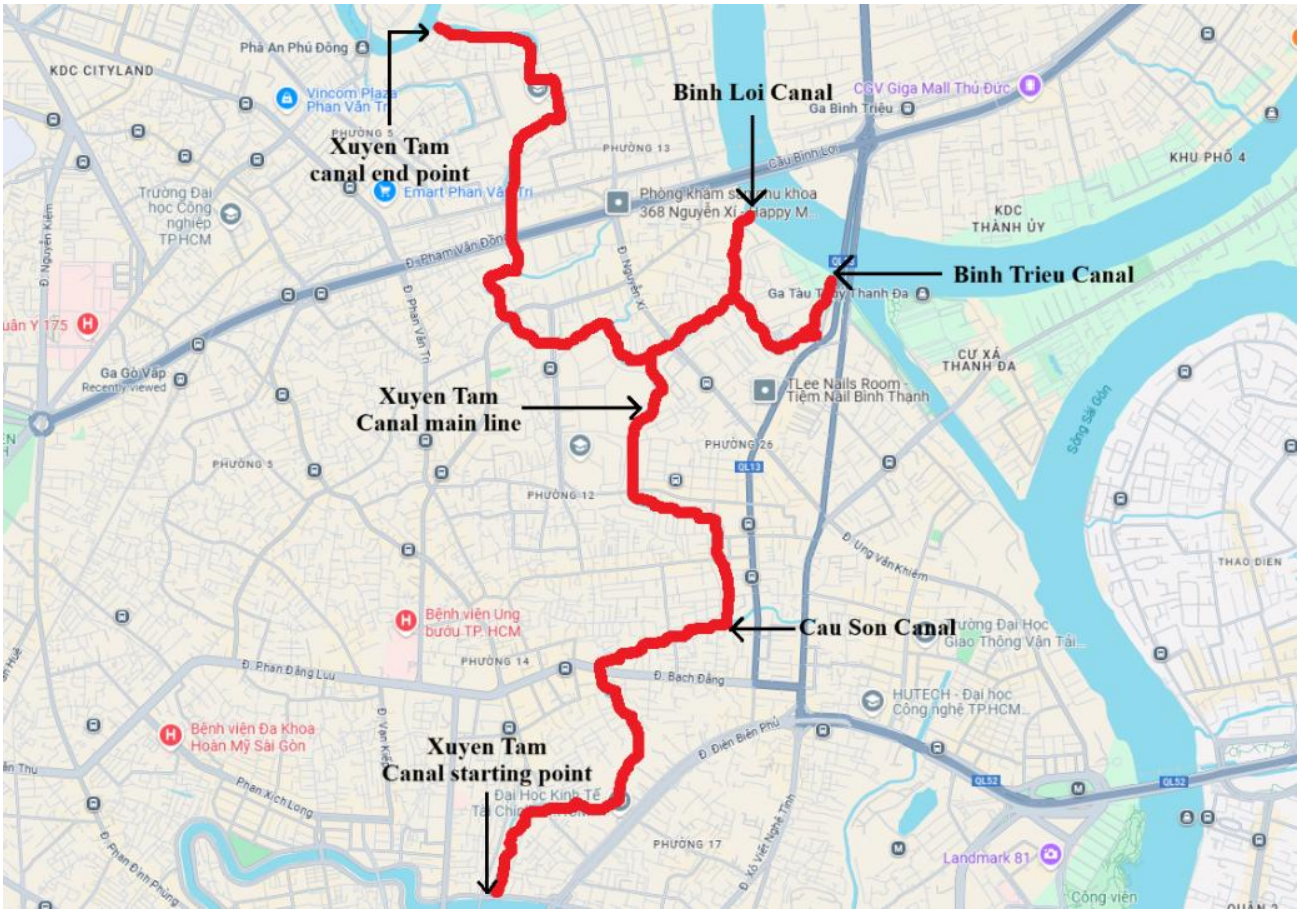

Figure 1. The location of the Xuyen Tam Canal in Ho Chi Minh City

The current state of Xuyen Tam Canal underscores a broader urban issue faced by many Southeast Asian cities, where rapid urban growth has outpaced the development of adequate infrastructure and environmental management. In cities such as Bangkok, Jakarta, and Manila, similar challenges exist, with informal settlements emerging along canals and waterways, facing environmental and social inequalities (World Bank, 2023). This paper aims to examine the situation at Xuyen Tam Canal, assess the living conditions of its residents, analyze

the environmental pollution affecting the area, and propose sustainable urban development strategies that can help restore the canal and improve the livelihoods of the people living nearby.

Xuyen Tam Canal, stretching through the Binh Thanh and Go Vap districts, is one of the most affected water bodies in HCMC. It serves as a primary drainage route for the city, but its condition has been seriously compromised by the unregulated discharge of domestic, industrial, and agricultural waste. In 2024, the Ministry of Natural Resources and Environment reported that the water quality in Xuyen Tam Canal had deteriorated significantly, with E. coli levels surpassing 1,000 CFU per 100 mL, far exceeding the permissible limit of 100 CFU per 100 mL for safe water (Ministry of Natural Resources and Environment, 2024). This pollution has adverse health effects, leading to respiratory and gastrointestinal diseases among the canal's residents.

The issue of informal settlements along canals is not unique to Ho Chi Minh City. Similar conditions can be found in other major cities across Southeast Asia. In Jakarta, informal kampung settlements along the city's rivers are plagued by high levels of pollution and inadequate infrastructure (World Bank, 2023). In Manila, the esteros (canal-side slums) suffer from similar environmental and social challenges, including inadequate waste management and the risk of flooding (UN-Habitat, 2021). These cities share common issues related to rapid urbanization and informal housing, where the need for housing and infrastructure often outpaces the ability of local governments to provide services and manage urban growth.

The research objectives of this study are to assess the living conditions of residents along Xuyen Tam Canal, focusing on housing quality, access to clean water, sanitation, health, and socio-economic conditions. It aims to evaluate the extent of environmental pollution in the canal, particularly the impact of untreated wastewater, solid waste disposal, and air pollution on residents' health and well-being. The study also seeks to compare the situation at Xuyen Tam Canal with similar informal settlements in Southeast Asian cities such as Bangkok, Jakarta, and Manila, to identify common challenges and successful strategies for urban regeneration. Finally, the research proposes integrated urban planning solutions that address the environmental, infrastructural, and social challenges faced by residents, with a focus on sustainable development, environmental remediation, and social inclusion.

1.2 Comparative Urban Challenges in Southeast Asia

Southeast Asian cities like Bangkok, Jakarta, and Manila provide relevant examples for understanding the challenges faced by informal settlements in Ho Chi Minh City. The rapid urbanization and lack of affordable housing in these cities have led to the expansion of informal settlements along waterways. These areas often suffer from overcrowding, inadequate sanitation, and environmental pollution, similar to the issues faced by Xuyen Tam Canal (see Table 1).

Table 1. Comparative Urban Challenges in Canal-Side Settlements

Issue	Ho Chi Minh City (Xuyen Tam Canal)	Bangkok (Khlongs)	Jakarta (Kampung)	Manila (Esteros)
Housing Quality	Informal, semi-permanent housing.	Informal, overcrowded.	Informal, prone to flooding.	Informal, high density.
Water Quality & Sanitation	Limited access to clean water, poor sanitation.	Inadequate water, poor sanitation.	Lack of clean water, poor sani-tation.	Severe water pollution, inadequate sanitation.
Pollution	High levels of water and air pollution.	Organic pollution, waste.	Heavy pollution from both domestic and industrial sources.	Severe pollution, solid waste.
Economic Stability	Low income, informal jobs.	High poverty in informal settlements.	Informal economy, low income.	Urban poverty, informal sector.

The development of informal settlements along the Xuyen Tam Canal represents a significant urban challenge for Ho Chi Minh City, one that mirrors the broader issues faced by other cities in Southeast Asia. These challenges—overcrowding, pollution, inadequate housing, and limited access to basic services—require urgent and integrated solutions that address both the environmental and social dimensions of urban development. The proposed urban planning strategies, which focus on infrastructure improvement, environmental remediation, and social inclusivity, are crucial for promoting sustainable urban development and improving the quality of life for residents of informal settlements along the canal.

Environmental pollution in canals in urban Vietnam has been a significant concern. Studies by Nguyen and Tran (2021) and Tran (2022) have analyzed the environmental pollution in HCMC's canals and its negative effects on public health and the community's living conditions. The Ministry of Natural Resources and Environment (2020) reports alarming water quality in urban waterways. Recent research indicates high levels of organic and microbial contamination (e.g., E. coli, coliforms) in HCMC's canals, caused by untreated domestic and industrial wastewater. According to Pham et al. (2024), only about 15% of domestic wastewater in HCMC is treated centrally, with the remainder discharged directly into the environment, exacerbating pollution and increasing health risks related to digestive and respiratory diseases.

Internationally, large Southeast Asian cities such as Bangkok, Jakarta, and Manila face similar challenges regarding urban environmental management, canal-side communities, and pressures from climate change. Studies by UN-Habitat (2021) and the World Bank (2019) provide an overview of the infrastructure, water, and sanitation issues in developing cities. Douglas (2018) discusses urban ecology, while Wong and Brown (2018) focus on transitioning to water-sensitive cities. However, few studies have concentrated on the multidimensional living conditions (housing, economy, society, environment, health, aspirations) of canal-side communities in specific areas such as Xuyen Tam, while comparing this context with other Southeast Asian cities. This paper seeks to fill this gap by providing detailed analyses and feasible solutions for the rehabilitation of Xuyen Tam Canal and improving residents' livelihoods.

2. Literature Review

Urbanization in Southeast Asia has led to an increase in informal settlements, particularly along canals and waterways, which present challenges for both city planners and residents. The rapid pace of urban growth in cities like Ho Chi Minh City (HCMC), Bangkok, Jakarta, and Manila has resulted in the proliferation of informal settlements, characterized by overcrowding, inadequate infrastructure, and environmental pollution. These settlements often develop in areas with limited access to basic services such as clean water, sanitation, and waste management. This literature review synthesizes key research findings on urbanization, informal settlements, environmental pollution, and sustainable development strategies in Southeast Asia, with a particular focus on canal-side communities.

1.3 Informal Settlements and Urbanization in Southeast Asia

The phenomenon of informal settlements has become widespread in many rapidly urbanizing cities across Southeast Asia. In Ho Chi Minh City, informal settlements have grown as a response to the rising demand for affordable housing amidst rapid population growth. According to the HCMC Department of Planning and Architecture (2025), these settlements now account for nearly 30% of the city's population. They are often located in flood-prone areas, such as the banks of rivers and canals, where land is cheaper and more accessible. However, these settlements frequently suffer from inadequate housing quality, poor sanitation, and limited access to public services.

Similar trends are observed in other Southeast Asian cities. In Jakarta, informal kampung settlements are located along the city's rivers, with many residents living in makeshift homes made from low-quality materials (World Bank, 2023). Similarly, informal settlements along the Khlongs (canals) in Bangkok face challenges related to overcrowding, waste management, and environmental pollution (UN-Habitat, 2021). A study by Nguyen & Tran (2024) highlights that informal settlements, particularly those along urban waterways, are especially vulnerable to climate change impacts, such as flooding and rising sea levels, which further exacerbate the risks faced by residents.

In many cases, informal settlements are the result of the inadequacy of formal housing markets to meet the demand for affordable housing. This shortage is particularly severe in cities experiencing high levels of rural-

to-urban migration, where people seek jobs and better opportunities in urban areas but cannot afford formal housing options (Nguyen, 2024). The lack of affordable, legally recognized housing leads to the creation of informal settlements, where residents often lack legal rights to the land and face difficulties accessing financing or social services (Nguyen & Hoang, 2023).

1.4 Environmental Pollution in Canal-Side Settlements

Environmental pollution is a significant concern in informal settlements located along canals and rivers. In Ho Chi Minh City, the Xuyen Tam Canal, once a vital waterway for transportation and irrigation, has become highly polluted due to untreated wastewater, industrial waste, and solid waste (Ministry of Natural Resources and Environment, 2024). The water quality in Xuyen Tam Canal has deteriorated to hazardous levels, with E. coli concentrations exceeding 1,000 CFU per 100 mL, far above the permissible limit (Ministry of Natural Resources and Environment, 2024). This severe pollution poses serious health risks to the residents living along the canal, contributing to the prevalence of gastrointestinal and respiratory diseases.

Pollution is not unique to Ho Chi Minh City. In Bangkok, the Khlongs are similarly affected by untreated wastewater and waste runoff from informal settlements (UN-Habitat, 2021). Jakarta's kampung settlements face severe water pollution due to the discharge of both domestic and industrial waste into the city's rivers (World Bank, 2023). A study by Pham et al. (2024) reported that more than 80% of the water bodies in Jakarta are contaminated with harmful pollutants, including heavy metals and industrial chemicals. This pollution, combined with poor waste management systems, contributes to the degradation of urban environments and public health.

Environmental pollution in canal-side settlements is also driven by the lack of waste management infrastructure. In Ho Chi Minh City, many informal settlements along Xuyen Tam Canal lack proper waste disposal systems, and household waste is often dumped directly into the canal (Nguyen et al., 2024). Similarly, in Manila, waste from informal settlements along the esteros is a major source of water contamination, with untreated waste being discharged directly into the canals (UN-Habitat, 2021). These areas, which are also prone to flooding, often see an accumulation of waste and stagnant water, further exacerbating the environmental and public health risks.

1.5 Health Impacts of Pollution in Informal Settlements

The health impacts of environmental pollution in informal settlements are significant, particularly in areas with poor sanitation and contaminated water sources. Studies have shown that residents of canal-side settlements are at greater risk of waterborne diseases such as cholera, dysentery, and typhoid, as well as respiratory conditions caused by air pollution (Nguyen & Tran, 2024). In Ho Chi Minh City, the residents along Xuyen Tam Canal suffer from high rates of gastrointestinal illnesses due to contaminated drinking water, which is often sourced from the canal itself or from wells that are vulnerable to pollution (Nguyen et al., 2024).

Air quality in these informal settlements is also a concern, with studies indicating that pollution from waste burning and vehicle emissions contributes to respiratory diseases (World Bank, 2023). In Jakarta, for example, residents living along the kampung settlements are exposed to high levels of air pollution, which increases the incidence of asthma and other respiratory conditions (Nguyen & Hoang, 2023). The lack of proper sewage treatment in these areas also leads to the contamination of drinking water sources, further compromising public health.

The impact of pollution on mental health should not be overlooked. Living in environments characterized by poor air quality, constant exposure to waste, and the stress of overcrowded conditions can negatively affect residents' mental well-being. Research by Shaw et al. (2010) found that residents of informal settlements in Southeast Asia experience higher levels of stress and anxiety, partly due to the poor living conditions and the environmental hazards they face daily.

1.6 Sustainable Urban Development Strategies

Addressing the challenges posed by informal settlements and environmental pollution in canal-side areas requires a multi-faceted approach to sustainable urban development. Several international studies have emphasized the importance of integrating environmental, social, and economic considerations in urban planning. The United Nations (2021) advocates for the adoption of nature-based solutions to improve urban

water quality, such as wetland restoration and green infrastructure, which can help filter pollutants and improve the aesthetic and environmental quality of canal-side areas.

In terms of housing, the World Bank (2023) recommends the development of affordable housing schemes that integrate residents into the formal urban fabric, while also improving the quality of existing informal settlements through upgrading programs. In Jakarta, for example, the government has implemented a series of kampung improvement projects, which include the installation of basic infrastructure, such as water supply systems and sanitation facilities, as well as the construction of new housing in safer locations (World Bank, 2023). Similarly, in Bangkok, projects focused on revitalizing the Khlongs have aimed to reduce pollution and improve living conditions by introducing waste management systems and green spaces along the canals (UN-Habitat, 2021).

Moreover, enhancing the capacity of local governments to manage urban growth and ensure that infrastructure development keeps pace with population growth is critical for achieving sustainable urban development. The Vietnam Ministry of Construction (2023) has called for the implementation of more stringent regulations regarding land use and waste management in informal settlements, while also encouraging public-private partnerships to fund urban regeneration projects (Table 2).

Table 2. Sustainable Urban Development Strategies

Strategy	Ho Chi Minh City (Xuyen Tam Canal)	Bangkok (Khlongs)	Jakarta (Kampung)	Manila (Esteros)
Housing Improvements	Upgrading informal settlements, new housing projects.	Kampung improvement programs, housing relocation.	Affordable housing schemes, kampung regeneration.	Informal settlement improvement, housing relocation.
Pollution Control	Wastewater treatment plants, green infrastructure.	Waste management systems, green spaces.	Waste treatment, flood mitigation.	Canal cleanup, waste management systems.
Community Health	Public health initiatives, sanitation improvement.	Health programs, sanitation projects.	Public health campaigns, water quality improvement.	Health education, sanitation improvement.
Infrastructure Development	Road construction, water supply, sanitation systems	Green infrastructure, waste management.	Improved roads, water supply, sewage treatment.	Drainage improvement, waste disposal.

Source: Adapted from UN-Habitat (2021), World Bank (2023), Nguyen & Tran (2024).

The literature highlights the significant challenges faced by informal settlements along canals in Ho Chi Minh City, Bangkok, Jakarta, and Manila. These settlements, often plagued by inadequate housing, environmental pollution, and poor sanitation, represent a major obstacle to sustainable urban development. However, the international examples discussed demonstrate that comprehensive, multi-disciplinary approaches to urban regeneration, incorporating environmental, social, and economic considerations, can lead to significant improvements in the living conditions of residents and the overall urban environment.
In the following sections, we will present the results of our field study in Xuyen Tam Canal, discuss the impacts of pollution on the local community, and propose sustainable urban development strategies that can be implemented to address the pressing challenges facing this critical urban area.

3. Materials and Methods

This study employs a mixed-methods approach, combining quantitative surveys and qualitative interviews to assess the living conditions of residents along Xuyen Tam Canal in Ho Chi Minh City (HCMC). A survey was conducted with 50 households from Binh Thanh and Go Vap districts, where informal settlements along the canal are most prominent. The survey collected data on housing quality, access to clean water and sanitation, health conditions, income levels, and employment status. The survey was administered through

face-to-face interviews, allowing for the collection of demographic, socio-economic, and health-related data that reflect the challenges faced by the community.

In addition to the survey, qualitative interviews were conducted with 20 residents to gain deeper insights into their personal experiences and perceptions. These semi-structured interviews focused on residents' experiences with pollution, overcrowding, and their aspirations for resettlement or improvements in the area. Observations of the physical conditions of the housing and environmental quality were also made to support the findings from the interviews and survey. The combination of quantitative and qualitative data provides a more comprehensive understanding of the lived reality of residents along Xuyen Tam Canal.

Data analysis for the quantitative survey was performed using descriptive statistics, with the results being processed through Excel. The analysis focused on identifying patterns in housing conditions, water access, health issues, and income. For the qualitative data, thematic analysis was used to identify recurring themes such as pollution, health challenges, and economic instability, providing a richer understanding of the social and environmental context. Secondary data, including government reports on urban development and environmental health, were also reviewed to complement the primary data and place the findings in a broader context of urbanization trends in Ho Chi Minh City and Southeast Asia.

4. Results

4.1. Living Conditions Along Xuyen Tam Canal

The survey results revealed significant challenges regarding the living conditions of residents along Xuyen Tam Canal (See Figure 2 & Table 3). A majority of the households (40%) live in permanent but deteriorating homes, with the remaining 35% residing in semi-permanent homes that show signs of subsidence, and 25% in makeshift structures constructed with materials such as tin and wood. The average living space per household is approximately 18 square meters, with 50% of households reporting living spaces between 10-20 square meters. This overcrowding, particularly in larger families, exacerbates issues related to sanitation and access to basic services, contributing to poor quality of life. The small and deteriorating housing structures, combined with poor environmental conditions, create a high-risk environment for residents.

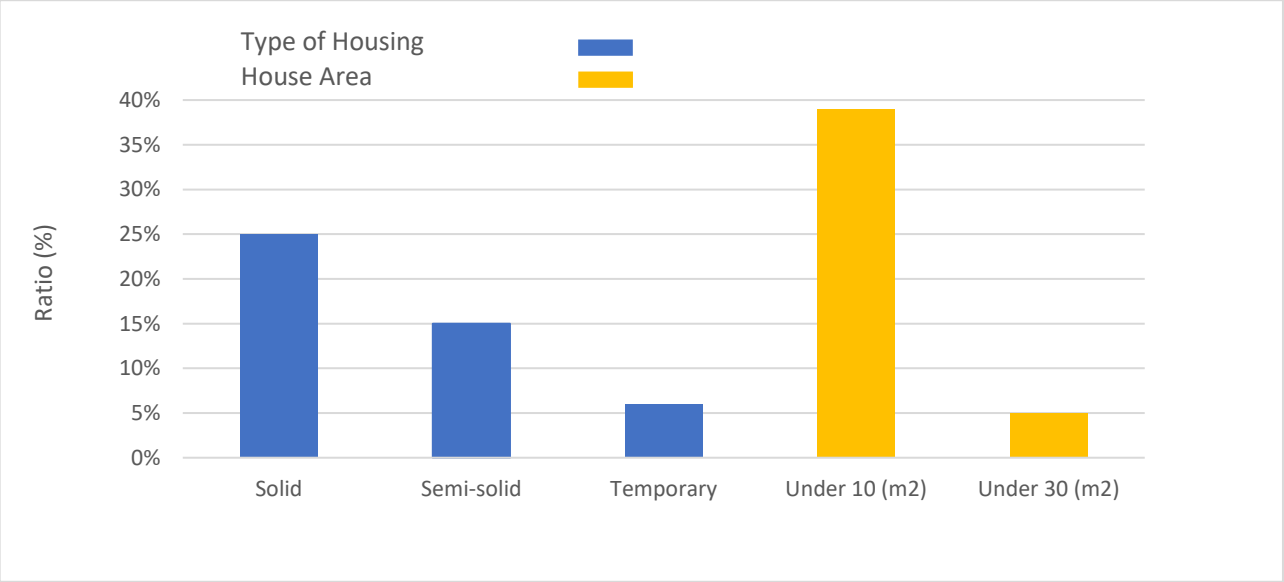

Figure 2. The type of housing and the living space of the residents

Table 3. Housing Conditions along Xuyen Tam Canal

Indicator	Category	Percentage (%) / Value

Housing Type	Temporary (tin/wood)	25%
	Semi-Permanent	35%
	Permanent (stable but old)	40%
Average Living Area	< 10 m²	10%
	10-20 m²	50%
	> 20 m²	40%
Key Issues	Built on unstable land	Common
	Informal construction	Prevalent
	Encroachment on canal	Widespread

In terms of water access and sanitation, the survey found that 60% of households rely on tap water, but the water pressure is frequently inadequate and unreliable (See Figure 3). Around 30% of residents still use well water, which is often contaminated and unsafe for consumption. Alarmingly, 50% of households lack proper sanitation, with many discharging waste directly into the canal. This lack of infrastructure significantly contributes to the contamination of the canal, which in turn affects residents' health. These conditions are consistent with those observed in other Southeast Asian cities, where informal settlements along canals often face similar challenges related to water quality and sanitation (World Bank, 2023; UN-Habitat, 2021).

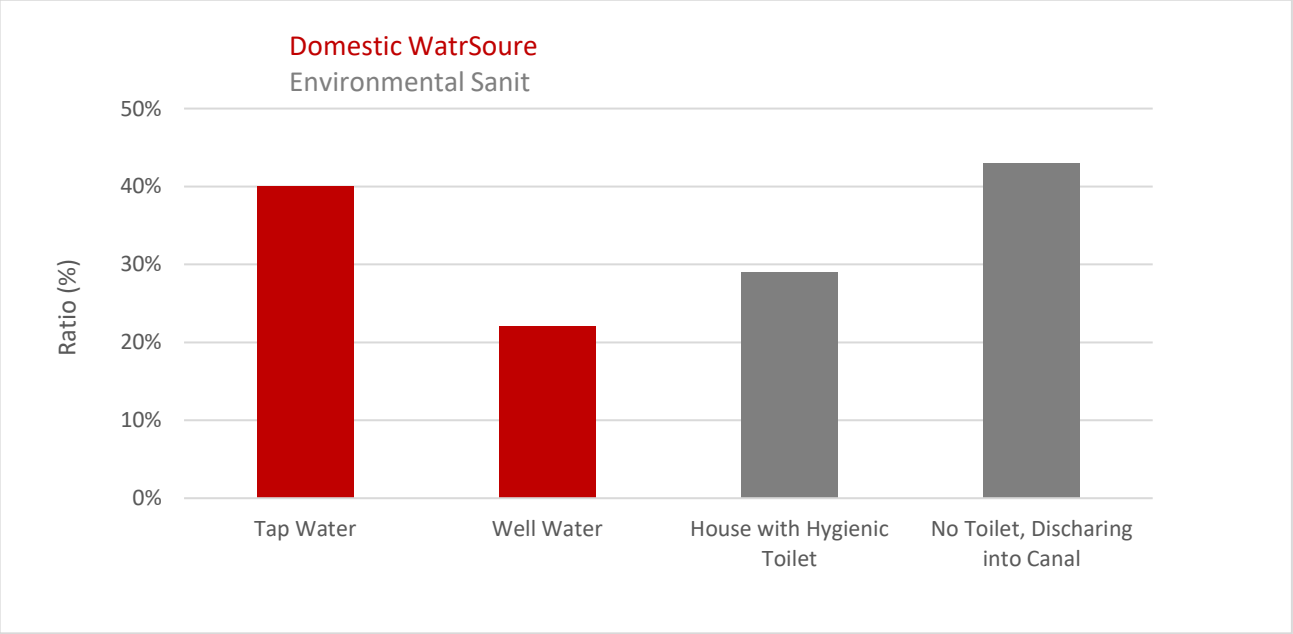

Figure 3. Water sources for daily use and environmental sanitation

4.2. Environmental Pollution and Its Impact

Environmental pollution is a major concern in the study area, with untreated wastewater, industrial effluents, and solid waste contributing to the poor water quality in Xuyen Tam Canal. According to the Ministry of Natural Resources and Environment (2024), E. coli levels in the canal exceed 1,000 CFU per 100 mL, far above

the permissible limit of 100 CFU per 100 mL for safe water. This high level of contamination poses significant health risks, particularly gastrointestinal and respiratory diseases. The poor sanitation systems in the area exacerbate the pollution problem, as household waste is frequently dumped into the canal, leading to blockages and further deterioration of water quality (See Table 4). Additionally, the canal's proximity to industrial zones means that industrial wastewater is often discharged without proper treatment, compounding the pollution issue. The residents' health, therefore, is directly impacted by these high pollution levels, contributing to the prevalence of waterborne diseases.

Table 4. Water Access and Sanitation along Xuyen Tam Canal

Indicator	Category	Percentage (%)	Source(s)
Primary Domestic Water Source	Tap Water (often unreliable)	60%	Survey Data
	Groundwater (poor quality)	30%	Survey Data
	Canal Water (unsafe)	10%	Survey Data
Sanitation Access	Lacks Adequate Toilet Facility	50%	Survey Data
Waste Disposal	Direct Discharge to Canal (Sewage)	High %	Survey Data, Pham et al. (2024)
	Direct Dumping in Canal (Solid Waste)	Common	Survey Data, Field Observation
Pollution Source	Untreated Domestic Wastewater	Major	Pham et al. (2024), MONRE (2020)
	Untreated Industrial Wastewater	Contributor	Survey Data, Field Observation

The environmental pollution in Xuyen Tam Canal mirrors similar issues faced by other cities in Southeast Asia (See Figure 4). In Jakarta, for example, kampung settlements along the rivers experience high levels of pollution from untreated wastewater and solid waste, which results in increased cases of waterborne diseases (World Bank, 2023). Similarly, in Bangkok, pollution in the Khlongs has led to significant health challenges, particularly respiratory issues caused by poor air quality and waterborne diseases (UN-Habitat, 2021). The comparison with these cities underscores the shared environmental struggles faced by informal settlements in Southeast Asia, where rapid urban growth and inadequate waste management systems contribute to widespread pollution and poor living conditions.

4.3. Health and Economic Impacts

The survey results indicate that health problems related to poor water quality and pollution are prevalent among the residents of Xuyen Tam Canal. Over 60% of respondents reported experiencing gastrointestinal issues, including diarrhea and dysentery, which they attributed to contaminated drinking water. Additionally, respiratory problems, such as asthma and bronchitis, were reported by 40% of households, likely due to both air pollution from nearby industrial zones and poor ventilation in overcrowded homes. These health issues

place a considerable burden on residents, both in terms of physical well-being and financial costs for medical treatment (Figure 5).

In terms of economic conditions, the survey found that 70% of households earn less than 6 million VND (approximately 260 USD) per month, with many relying on informal labor such as street vending, recycling, or working as motorbike taxi drivers (See Table 5). The lack of stable income sources and job insecurity further limits the residents' ability to invest in better housing or healthcare, contributing to the perpetuation of poverty. Moreover, the lack of legal property rights in informal settlements prevents residents from accessing financial support or loans to improve their living conditions. These economic challenges are consistent with findings in other Southeast Asian cities, where residents of informal settlements face similar economic insecurities due to a reliance on informal labor and limited access to financial resources (Nguyen & Tran, 2024; UN-Habitat, 2021).

Figure 4. The condition of waste and wastewater directly discharged into Xuyen Tam Canal from factories

Table 5. Socio-Economic Profile of Xuyen Tam Canal Residents

Indicator	Category	Percentage (%) / Value	Source(s)
Household Income	< 6 Million VND/Month	70%	Survey Data
Main Occupation Type	Informal Labor (vendor, waste collector, moto-taxi)	45%	Survey Data
	Factory/Service Worker	30%	Survey Data
	Small Business (stable income)	10%	Survey Data
	Unemployed	10%	Survey Data
Key Issues	Income Instability	High	Survey Data
	Lack of Formal Documentation (hinders credit)	Common	Survey Data, Xuan Nguyen & Tran (2023)

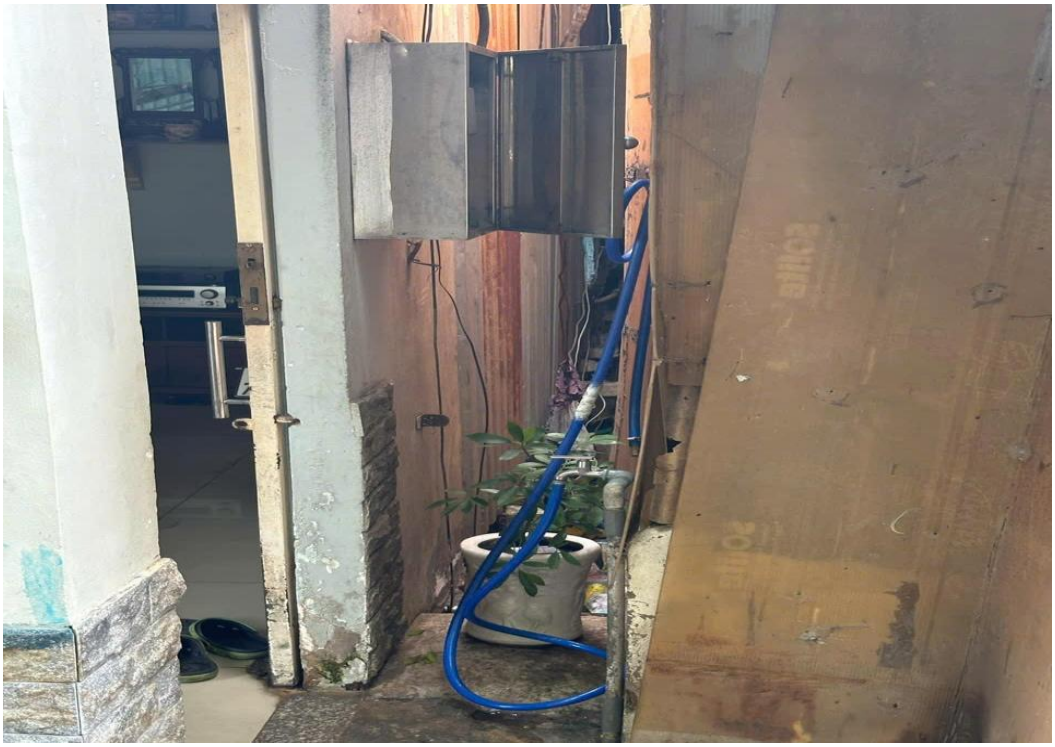

Figure 5. The water supply system for residents living along Xuyen Tam Canal.

4.4. Comparative Analysis with Other Southeast Asian Cities

The findings from Xuyen Tam Canal are consistent with challenges faced by informal settlements in other rapidly urbanizing cities in Southeast Asia, such as Jakarta, Manila, and Bangkok. In Jakarta, informal settlements along the rivers experience severe flooding, poor sanitation, and water pollution, which similarly impact residents' health and quality of life (World Bank, 2023). Manila's esteros, or canal-side slums, face the same issues of poor waste management and water contamination, with many residents living in overcrowded and unsafe conditions (UN-Habitat, 2021). Similarly, Bangkok's Khlongs suffer from high levels of organic pollution and inadequate waste treatment, creating health and environmental risks for those living nearby (UN-Habitat, 2021).

The comparison with other cities highlights several common issues: inadequate infrastructure, poor sanitation, environmental pollution, and economic vulnerability in informal settlements. However, each city also has unique characteristics that influence the extent and severity of these challenges. For instance, Jakarta's kampung settlements face additional challenges related to flooding due to the city's location and topography, while in Manila, informal settlements are highly vulnerable to the impacts of typhoons and extreme weather events. These comparisons provide valuable insights into the shared and unique challenges faced by urban populations in Southeast Asia and inform potential solutions for improving living conditions in informal settlements.

The results from this study highlight the urgent need for comprehensive urban regeneration efforts in Xuyen Tam Canal and similar informal settlements in Ho Chi Minh City. The combination of poor housing, inadequate sanitation, environmental pollution, and economic insecurity creates a challenging living environment for residents, significantly affecting their health and quality of life. The comparison with other Southeast Asian cities demonstrates that these issues are not unique to HCMC, and similar urban areas face comparable challenges in terms of pollution and informal housing. Addressing these challenges requires integrated solutions that focus on improving infrastructure, ensuring better waste management, promoting sustainable urban planning, and providing economic support for vulnerable communities.

5. Discussions

The findings from this study shed light on the multiple urban challenges faced by residents along Xuyen Tam Canal in Ho Chi Minh City, offering important insights into housing, sanitation, environmental pollution, and socio-economic conditions. These results are consistent with urbanization trends seen across Southeast Asia, where informal settlements along water bodies such as rivers and canals often struggle with inadequate infrastructure, environmental degradation, and health issues. The outcomes of this study also offer significant implications for urban planning and policy-making in rapidly growing cities, particularly in regions facing similar challenges.

5.1. Housing Quality and Overcrowding

One of the primary findings of this study is the poor housing quality in the informal settlements along Xuyen Tam Canal. With 25% of households living in makeshift structures, 35% in semi-permanent homes, and only 40% in permanent but deteriorating houses, the majority of residents face substandard living conditions. This aligns with previous studies that highlight the prevalence of informal settlements in Southeast Asia and their association with overcrowding and inadequate housing quality. For instance, Nguyen and Tran (2024) report similar findings in informal settlements along the rivers in Jakarta, where overcrowding and lack of permanent housing are pervasive.

These findings suggest a significant gap between the demand for affordable housing and the availability of sustainable options in rapidly urbanizing cities. The overcrowding observed in this study, with many households living in cramped spaces of less than 20m², mirrors patterns found in other cities, such as Manila and Bangkok, where informal settlements are similarly prone to overcrowding and lack of infrastructure (World Bank, 2023). From the perspective of urban theory, this reinforces the importance of integrating affordable housing solutions in urban planning, with an emphasis on resilience and adaptability to local environmental conditions. Future research could explore innovative solutions for affordable housing, such as modular construction and the role of community-driven housing initiatives, which have been successfully implemented in other cities in Asia.

5.2. Environmental Pollution and Public Health

The results also highlight the severe environmental pollution in Xuyen Tam Canal, with untreated wastewater, solid waste, and industrial discharges contributing to poor water quality and elevated health risks for residents. The findings that 60% of households rely on contaminated well water or water directly from the canal align with the conclusions of previous studies, such as those by Pham et al. (2024), which demonstrate the significant health risks posed by polluted water sources in Southeast Asian cities. Moreover, the high levels of E. coli contamination in the canal observed in this study reflect broader regional trends of water pollution, as seen in Bangkok's Khlongs and Jakarta's rivers (UN-Habitat, 2021; World Bank, 2023).

The health impacts reported by residents, including gastrointestinal diseases and respiratory issues, are a direct consequence of these environmental conditions. The prevalence of such health issues has been documented in previous studies, which underscore the importance of improving water treatment systems and waste management infrastructure. For example, Shaw et al. (2010) highlighted the link between water pollution in informal settlements and the incidence of waterborne diseases. The findings from this study, combined with the literature, emphasize the need for urgent intervention to address water quality and pollution in informal settlements. Future research could explore the effectiveness of different wastewater treatment technologies, particularly low-cost and nature-based solutions such as biofilters and constructed wetlands, which have shown promise in other regions.

5.3. Socio-Economic Vulnerability and Informal Labor

The study found that 70% of households in Xuyen Tam Canal earn less than 6 million VND (approximately 260 USD) per month, with the majority relying on informal labor, such as street vending or recycling. These findings are consistent with other studies on informal settlements, where economic instability and a reliance on low-wage, informal jobs limit opportunities for upward mobility. In Jakarta, similar patterns of economic

insecurity were found in kampung settlements, where residents are primarily engaged in the informal sector and face low job security and limited access to social benefits (World Bank, 2023).

This economic vulnerability, combined with inadequate housing and environmental hazards, reinforces the importance of addressing both economic and social issues in urban regeneration efforts. Previous research, such as that by Nguyen & Hoang (2023), suggests that improving job opportunities and providing vocational training can be an effective way to help residents transition out of poverty. The findings from this study, coupled with these insights, suggest that future regeneration projects should not only focus on physical infrastructure but also integrate economic empowerment initiatives, such as microfinance programs, skill-building workshops, and local business development.

5.4. Implications for Urban Planning and Policy

The results of this study have broad implications for urban planning and policy in Ho Chi Minh City and similar cities across Southeast Asia. The need for comprehensive urban regeneration strategies that address both environmental and social dimensions is clear. The findings highlight the necessity of integrated policies that combine housing improvement, environmental remediation, and social services. Drawing from international examples, such as Jakarta's kampung improvement programs and Manila's estero cleanup projects, HCMC can develop policies that foster sustainable urban development and improve the living conditions of informal settlements (World Bank, 2023; UN-Habitat, 2021).

The proposed policy recommendations, including the regulation of industrial waste and the promotion of community-led initiatives, are supported by the results of this study. They reflect a growing recognition of the need for collaborative, multi-stakeholder approaches to urban regeneration, where local communities, businesses, and the government work together to create sustainable and resilient urban environments.

5.5. Future Research Directions

While this study provides valuable insights into the challenges and potential solutions for informal settlements along Xuyen Tam Canal, several areas require further research. Future studies could explore the long-term health outcomes of living in polluted environments, particularly focusing on the cumulative effects of waterborne diseases and respiratory conditions. Additionally, research on the economic impacts of urban regeneration on informal communities is needed to better understand how infrastructure improvements and economic empowerment programs can lead to sustainable livelihoods. Investigating the effectiveness of specific wastewater treatment technologies and their applicability to informal settlements in Ho Chi Minh City and other Southeast Asian cities could also contribute to more targeted environmental interventions.

Furthermore, research on the role of technology and innovation in informal settlement regeneration, such as the use of smart infrastructure and low-cost environmental solutions, could provide new avenues for improving urban resilience. By integrating digital technologies and community participation, future regeneration efforts could be more efficient, inclusive, and adaptable to the needs of rapidly urbanizing cities.

6. Conclusion

The living conditions of residents along Xuyen Tam Canal in Ho Chi Minh City are a reflection of the broader urban challenges faced by rapidly growing Southeast Asian cities. The canal, once a vital waterway for transportation and irrigation, has become a symbol of the environmental and social issues that arise when urbanization outpaces infrastructure development. The findings of this study reveal that the residents of Xuyen Tam Canal face severe challenges, including inadequate housing, poor sanitation, environmental pollution, and limited access to essential services like clean water and healthcare. These conditions not only compromise the health and well-being of the community but also hinder the city's broader goals for sustainable urban growth.

The comparative analysis with other cities in Southeast Asia, such as Jakarta, Bangkok, and Manila, highlights that the challenges in Xuyen Tam Canal are not unique but rather part of a broader regional issue. Informal settlements along waterways in these cities face similar problems of overcrowding, inadequate waste management, and environmental degradation. However, the strategies used in these cities to address these issues—ranging from infrastructure improvements to community-based solutions—provide valuable lessons for Ho Chi Minh City.

To address the issues along Xuyen Tam Canal, this paper proposes a comprehensive set of solutions that prioritize urban regeneration, environmental remediation, and socio-economic empowerment. These solutions include improving housing quality, enhancing water and sanitation infrastructure, treating wastewater, implementing solid waste management systems, and promoting job creation and skills development for local residents. Furthermore, the proposed urban planning strategies emphasize the importance of community engagement and ensuring that residents are included in the decision-making process. By taking a holistic approach that integrates environmental, social, and economic dimensions, Ho Chi Minh City can create a more resilient and inclusive urban environment for all its residents.

In conclusion, the regeneration of Xuyen Tam Canal offers an opportunity to transform a neglected urban area into a model for sustainable development. With the active involvement of the local government, businesses, and residents, this regeneration can serve as a stepping stone toward a more livable, environmentally sustainable, and socially inclusive city. The solutions proposed in this paper offer practical, actionable steps that can be implemented in the short to medium term, paving the way for a brighter future for the communities living along Xuyen Tam Canal. The key to success lies in collaborative efforts, long-term planning, and a commitment to ensuring that the voices of those most affected by urbanization are heard and acted upon.

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