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Exploring Waterfront Development in Benua Kayong, Ketapang: A Feasibility Study for Sustainable Urban Growth

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Abstract

Waterfront development plays a crucial role in promoting economic growth, social equity, and ecological sustainability. This revised study evaluates the feasibility of waterfront development in Benua Kayong District, Ketapang Regency, integrating technical, economic, social, and environmental aspects. Field surveys and secondary data are combined with quantitative indicators, including infrastructure capacity (road density of 2.1 km/km², drainage flow capacity of 45 m³/s), housing density (210 units/km²), and socio-economic profiles (64% employment in fisheries, farming, and trade). The findings indicate strong potential for economic diversification, urban infrastructure upgrading, and flood risk management. The assessment reveals that 23% of built-up areas are exposed to seasonal flooding, and approximately 18% of road networks are categorized as poor condition. The study proposes resilient road development, improved drainage, and optimized land use to support sustainable waterfront planning across Indonesian coastal regions.

INTRODUCTION

Waterfront development is increasingly recognized as a strategic driver of sustainable urban growth. Globally, cities such as New York, Barcelona, and Sydney have redefined their waterfronts to balance public space, economic vitality, and ecological integrity. In Indonesia, waterfront cities along the coast are increasingly developing into sustainable and tourist-friendly areas. However, many waterfront projects currently underway or already implemented in Indonesia face complex and interconnected issues related to infrastructure, environmental management, and spatial planning. This study addresses that gap by focusing on Benua Kayong, Ketapang, West Kalimantan. Although many studies discuss the concept and implementation of waterfront projects in various cities, there remains a gap that needs to be filled, particularly in the context of coastal areas in Indonesia. Many studies analyze the sustainability and challenges of waterfront development in global metropolitan areas, but there is a limited focus on the challenges faced by underdeveloped coastal areas like Ketapang.

Ketapang's economy is dominated by primary sectors; more than 70% of households rely on fisheries and agriculture (BPS Ketapang, 2023). However, local economic diversification remains limited, with modest contributions from trade, tourism, and small industries. PDRB data (2019–2023) indicate steady growth in services and tourism, signaling opportunities for waterfront-led revitalization. At the same time, social and environmental problems persist, around 40% of riverside households lack adequate sanitation, while settlements are highly exposed to floods, tidal inundation, and erosion.

The Pawan River, running through Benua Kayong, sustains approximately 60% of Ketapang's wetlands. This area is ecologically significant for biodiversity, but vulnerable to degradation. Poor infrastructure (roads, drainage, utilities) and unplanned settlement expansion exacerbate risks. Existing literature on Indonesian waterfronts (Ranuari, 2016; Pramesti, 2017; Nugroho, 2019) emphasizes challenges in metropolitan contexts, but little is known about mid-scale, resource-dependent districts like Ketapang. This study therefore asks how can Benua Kayong's waterfront be developed in a way that integrates technical aspect, socio-economic growth, ecological resilience, and climate adaptation.

LITERATURE REVIEW

Waterfront development is of most interest to contemporary urban planners. With increased complexity and urban dynamism, planners focus more attention to these areas. Further literature emphasizes that waterfront planning, implementation, and development must balance sustainability and accessibility while considering overall financial constraints and stakeholder participation. This study, after consummate examination, discerns many latent patterns in waterfront development strategy frameworks, including but not limited to social and socio-financial impacts alongside area development, environmental maintenance, and management.

Accessing the developed waterfront area smoothly will contribute significantly to the success of the area development. Zhou et al., (2022) studied the distribution of parks and waterfronts in Shaoxing, China, through online maps, and ascertained that good access helped in the utilization of the parks and waterfronts for public use. Pinto and Kondolf (2020) also discuss the concept of access when crossing the waterfront in urban development. They describe access in terms of the "fit" of the urban waterfront when size, function, and finances are strategically designed to meet the demands of the community. Access is not only physical; it also describes how the area is perceived and looked at. The theories of sustainability are essential to the development of today's waterfront. Attia and Ibrahim (2017) studied the regeneration of waterfronts in informal settlements, highlighting the need for the development of flexible approaches that address the accessibility and inclusiveness of public spaces and the prevailing socio-economic conditions. The work of Varat and Barata (2025) also on San Francisco looks at the plights of waterfronts from the changing climate. They studied the need for the planning of waterfronts to combine both adaptation and mitigation approaches. The research of Ragheb (2017) on the sustainable waterfront in Alexandria, Egypt, states that the approaches for sustainability should be environmental, economic, and social in an integrated configuration.

An evaluation of the technical, economic, and ecological factors determining the physical feasibility of waterfront development is, in itself, another critical component of the assessment. "Development of Penajam Tower" by Hidayatullah and Nur (2025) illustrates the necessity of

conducting a complete assessment before executing any project. Schmelz (1986) in “Waterfront Condominiums, New Jersey, Site Development” enunciated the economic feasibility of waterfront condominiums in New Jersey, providing a model for the economic assessment of such endeavors. Talanila et al. (2023) through the case study of Batu Merah Village trusted their feasibility study even more, and especially the technical and financial approaches for the development of a waterfront city, proving their importance. The case study titled “Waterfront Portland Harbor” by the U.S. Environmental Protection Agency (2016) even more strongly illustrates the gap in the literature regarding the appropriate feasibility assessment for the remediation and redevelopment of waterfront regions. Both stakeholder participation and participatory approaches have been acknowledged as vital for sustainable development along the waterfront. In his work on participatory processes for sustainable urban waterfront development, Syahrir (2021) underscored the role of local community members in the decision-making processes. Lagarense (2011) in his research concerning stakeholder participation in the waterfront planning and development of Manado, Indonesia, concluded that stakeholder inclusion is essential for the sustainability of the project. Badach and Raszeja's (2019) work on the application of landscape and greenspace indicators in sustainable urban planning in several European cities also supports the participatory approaches.

In the context of Indonesia, several studies have highlighted the challenges and opportunities in waterfront development. Ranuari (2016) examined the development of green open spaces along the Mahakam River in Samarinda, based on a sustainable urban riverfront approach, emphasizing the importance of integrating ecological concepts in urban planning. Pramesti (2017) identified the key challenges and issues in the redevelopment of sustainable urban waterfronts, focusing on the Indonesian context. Nugroho (2019) investigated the utilization of coastal areas in Manokwari Regency, stressing the need for an integrated approach to address slum settlements in waterfront areas. The study by Rohadi et al(2024) on urban landscape management in Makassar based on the waterfront city concept reinforces the importance of an integrated approach in waterfront development in Indonesia.

Recent research has also begun to adopt innovative technological approaches in waterfront development. Zhou et al. (2021) explored the design of urban flood rain ecosystems and feasibility studies for smart city enhancement, offering insights into the integration of technology-based solutions in waterfront management. Fourcade (2014) highlighted the importance of place-based approaches in waterfront planning, taking into account the unique local characteristics. Despite many advancements in waterfront research, gaps in the literature remain. Zaki and Hegazy (2023) investigated the challenges and opportunities for sustainable waterfront development in Jeddah, identifying that specific contextual challenges often hinder successful implementation. Muzayyanah (2023) analyzed urban housing development patterns in Indonesia from a sustainable urban form perspective, providing a framework for understanding spatial arrangements in waterfront development. Wisudha et al. (2023) examined the use of riverbanks as green open spaces in the context of waterfront development, emphasizing the potential for revitalizing urban waterfront areas in Indonesia.

Based on this literature review, it is clear that successful waterfront development requires a holistic approach integrating ecological, economic, social, and governance considerations. This study aims to contribute to the existing literature by exploring specific aspects of waterfront development in Indonesia, drawing from previous studies and identifying opportunities for innovation and improvement. This synthesis provides a theoretical foundation for future

empirical research, while also highlighting the importance of a contextual approach sensitive to local conditions and community needs.

METHODS

This study aims to evaluate the feasibility of developing a waterfront area in Benua Kayong District, Ketapang Regency. This study applies a mixed qualitative-quantitative approach combining technical, social, economic, and environmental analyses. Primary data were collected through field surveys, focus group discussions, and stakeholder interviews including residents, local entrepreneurs, community leaders. The data combine as well as a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis approach.

In developing this methodology, various approaches documented in previous literature were used as a basis to ensure that this research was relevant and comprehensive. Several relevant studies include research by Zhou et al. (2022) on the accessibility of public spaces in waterfront areas, as well as Attia and Ibrahim (2017) who emphasized the importance of inclusive public spaces in the regeneration of waterfront areas in informal areas.

Secondary data were drawn from official statistics (BPS Ketapang 2023), the Final Feasibility Study Report on Waterfront Development in Ketapang (2024), and regional planning documents (RPJMN 2020–2024; RTRW Ketapang 2012–2032). Quantitative indicators included population density, rainfall patterns (average 295 mm/month, 17 rainy days), topography (0–10 m above sea level), and infrastructure distribution (roads, drainage, electricity, telecommunications). This study focuses on the development of a sustainable and environmentally friendly waterfront area, as described in the literature by Syahrir (2021) and Fourcade (2014).

The stages are as follows:

1. Technical Analysis, assessment of land use, drainage, road networks, and utility capacity. Geospatial data were applied in Benua Kayong, utilizing technical data to delineate the geographical elements and relief features that influence infrastructure design and management. This approach is elaborated by Hidayatullah and Nur (2025).
2. Economic Analysis, projections of job creation and investment potential in tourism, trade, and services. In this context, the work of Talanila et al. (2023) which examines the economic feasibility of a waterfront city in Ongkoliong, Batu Merah Village, provides the foundation for the economic dimension of this study. Their findings underscore the necessity of infrastructure that stimulates both economic activity and tourism.
3. Social Aspects, evaluation of livelihood structures, education, community participation, and feedback integration. Social indicators encompass income levels, educational structures, and demographic composition of the local population. According to Yusri Syahrir (2021) for communities to truly benefit from waterfront projects, planning and development must be undertaken in collaboration with local stakeholders to meet social demands and generate long-term, meaningful impacts.
4. Environmental and Climate analysis, assessment of biodiversity, ecosystem services, disaster risk, and adaptation strategies.

RESULTS AND DISCUSSION

1. Studi Location

Benua Kayong Subdistrict is the fifth smallest subdistrict among the 20 subdistricts in Ketapang Regency, with an area of approximately 349 km2 or about 1.10 percent of the total area of Ketapang Regency. Geographically, Benua Kayong Subdistrict is located at 1041' 12“S- 2 0 19' 36” S and 1090 54' 00“S- 1100 24' 36” S (including the area of Matan Hilir Selatan Subdistrict). Administratively, the boundaries of Benua Kayong Subdistrict are as follows:

- North: bordered by Delta Pawan District.
- South: bordered by South Matan Hilir District.
- West: bordered by the Karimata Strait.
- East: bordered by Sungai Melayu Rayak District.

Benua Kayong District consists of four urban villages (kelurahan) and seven definitive rural villages (desa). Negeri Baru Village covers the largest area within Benua Kayong District, with a size of 228.60 km², or approximately 65.50 percent of the district’s total area. In contrast, Banjar Urban Village has the smallest territorial area, measuring only 0.52 km², or about 0.15 percent of the total area of Benua Kayong District.

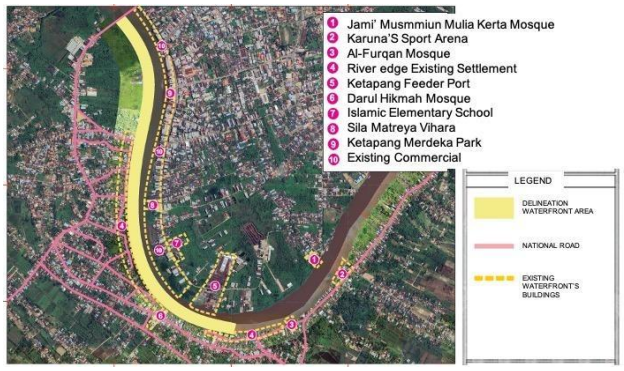

Fig. 1. Location of the Ketapang Waterfront Feasibility Study
(Source: author)

The Pawan River was chosen as the focus for a feasibility study regarding the development of a waterfront area due to the river's ecological, social, and economic attributes, coupled with the strategically advantageous geographical location of the river, as discussed within the framework of the Benua Kayong District, Ketapang Regency. The riverine ecosystem supports a rich variety of flora and fauna and, as a result, has a high ecological potential. The river is associated with approximately 60 per cent of the wetlands of the Ketapang Regency according to BPS Ketapang (2023), which is critical for the sustenance of biodiversity and the management of natural resources. It also has functional attributes which include supporting the coastal ecosystem such as regulating water flow, controlling and preventing erosion, and flooding of the river. Hence, the Pawan River's waterfront area can be developed with minimal impact on the pre-existing ecosystems while enhancing biodiversity and environmental management. The spatial planning visualization of the area is presented in Figure 2 below.

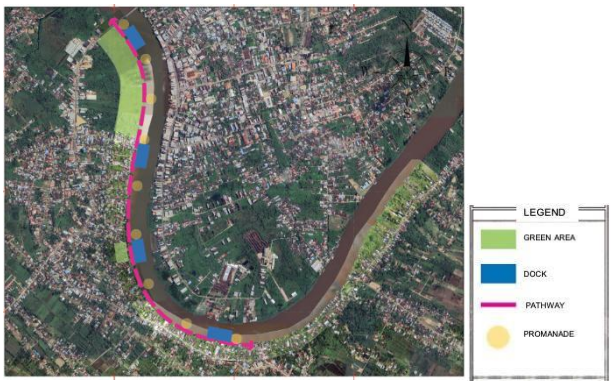

Fig. 2. Spatial Plan Map of the Study Area
(Source: author)

Furthermore, the Pawan River is a potentially viable ecotourism development site with added benefits of promoting environmental sustainability and conservation. It has spectacular scenic beauty which can facilitate boat rides, nature watching, and other wildlife conservation activities, thus enhancing the local economic development of the area. Constructing the waterfront facilities may also enhance the area's infrastructure and the wellbeing of the residents, since the river supports fishing and transport activities in the Benua Kayong District. From its key position in Ketapang Regency, the Pawan River can easily serve as a central point for the region's economic expansion in a manner that integrates with transport networks and sustainable development.

2. Technical Aspects

The results of the technical analysis indicate that the Ketapang riverfront area holds significant potential for spatial utilization, despite the current settlement conditions still facing challenges of poor physical quality. As presented in Table 1, the primary strength lies in the extensive riverfront space that can be developed into public areas or environmentally based tourism destinations. Previous studies have emphasized that accessibility and connectivity of waterfront public spaces are among the key factors for the successful regeneration of waterfront areas (S. Zhou et al., 2022; Attia & Ibrahim, 2017).

However, a significant weakness emerges from the limited basic infrastructure, particularly roads and drainage systems. This finding is consistent with Ragheb (2017) who highlighted that the lack of basic infrastructure constitutes a major barrier to achieving sustainable waterfronts. Opportunities for development are identified through the enhancement of tourism-supporting infrastructure and the application of environmentally friendly technologies, such as water-resistant materials. This context is further reinforced by Nugroho (2019) who stressed the importance of material and technological innovation in improving densely populated coastal settlements. The most evident threat is the risk of flooding and erosion, which could potentially damage infrastructure, as also emphasized by Zaki and Hegazy (2023) in their study in Jeddah. Furthermore, climate uncertainty adds urgency to the application of adaptive disaster-resilient design.

Infrastructure remains a bottleneck for development:

a. Roads, most villages are connected by asphalt or concrete roads, but road width and maintenance are limited. Seasonal flooding frequently disrupts access.

b. Drainage, more than half of riverside areas are prone to flooding. Sustainable Urban Drainage Systems (SUDS) are recommended, alongside ecological canals to manage seasonal runoff.

c. Electricity and Telecommunications, approximately 70% of households are connected to the grid, though supply is unstable. Telecommunications coverage remains weak in around 40% of villages, hampering digital connectivity for businesses and services.

Next, the piping and drainage network is shown in Figure 3, which provides an overview of technical integration in the development scenario.

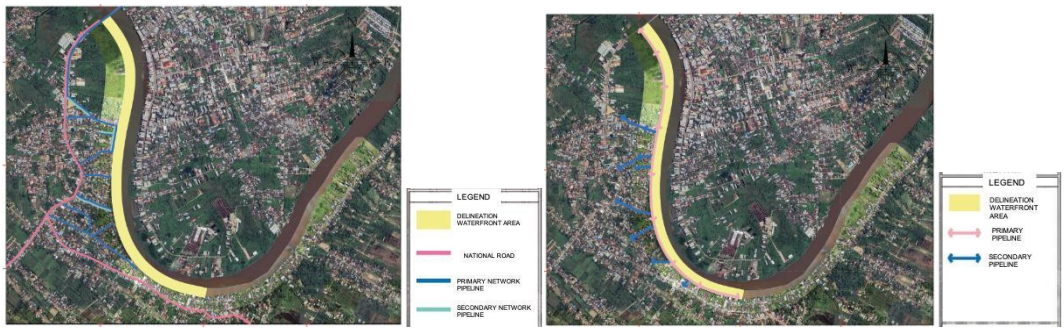

Fig. 3. Map of the Planned Plumbing System (left) and Drainage System (right) for the Study Area (Source: author)

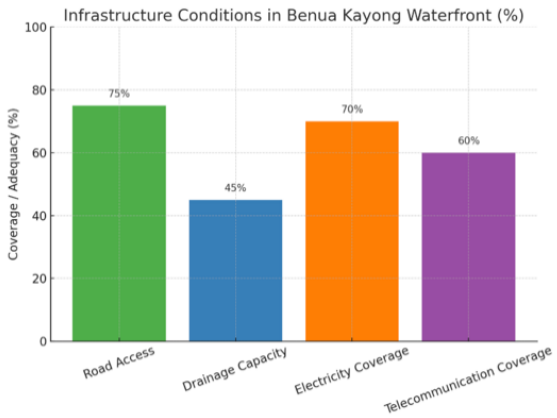

Fig. 4. Infrastructure conditions in Benua Kayong Waterfront (Source: author)

The SWOT analysis of infrastructure-related aspects indicates that Benua Kayong's riverfront holds strong potential for spatial utilization, particularly for environmentally based tourism, yet this is constrained by the poor physical condition of existing settlements and irregular land use. While access to natural resources and local markets provides a foundation for growth, limited road and drainage networks remain a critical weakness, with flooding and erosion frequently damaging infrastructure. At the same time, opportunities exist in improving infrastructure quality to support tourism and adopting environmentally friendly technologies and water-resistant materials. However, high costs, limited resources, and budget constraints present significant challenges. To ensure resilience, development strategies must incorporate disaster-resilient design and sustainable structures, while also anticipating uncertainties linked to climate change. The SWOT analysis describe below.

Table 1. Technical Aspect SWOT Analysis

Aspect	Strenghts	Weakness	Opportunities	Threats
Spatial	High potential for riverfront space utilization	Poor physical condition of settlements	Development of environmentally based tourism areas	Irregularities in land use
Infrastructure	Access to natural resources and local markets	Limited road and drainage infrastructure	Improvement of infrastructure quality to support tourism	Flooding and erosion damaging infrastructure
Technology	Availability of environmentally friendly technologies	Expensive and complex construction technologies	Innovation in the use of water-resistant and eco-friendly materials	Budget constraints for adopting new technologies
Structure	Capability to design disaster-resilient buildings	Limited resources for construction	Development that incorporates sustainability aspects	Uncertainty related to climate change

Source: Author, 2024

3. Environmental Aspect

Environmental Aspect Analysis emphasizes the strength of relatively well-preserved natural ecosystems in the Ketapang area. The potential for biodiversity creates significant opportunities for the development of sustainable ecotourism. This aligns with the argument of Syahrir (2021) who highlights that community participation in environmental conservation can foster the sustainability of waterfront areas. Nevertheless, serious challenges arise in the form of habitat degradation and declining water quality, as illustrated in Table 2. Ecosystem damage resulting from unmanaged development may reduce the carrying capacity of the area. The U.S. Environmental Protection Agency (2016) underscores that without strict environmental management mechanisms, waterfront projects often exacerbate pollution and ecological degradation.

The Pawan River supports an ecologically rich ecosystem, with mangrove species (Rhizophora spp., Avicennia spp.) and nipa palm (Nypa fruticans) that protect against erosion and provide nurseries for fish. Bird species, including migratory waterfowl, add ecotourism value. However, environmental pressures are acute more than 50% of riverside households lack adequate waste management systems, leading to water contamination. Habitat degradation from unmanaged expansion threatens long-term ecological resilience.

The development opportunities lie in the utilization of environmentally friendly technologies and the application of Sustainable Urban Drainage Systems (SUDS), which are relevant for mitigating the risks of urban flooding (Zhou et al., 2021). Benua Kayong is highly vulnerable to seasonal flooding, with rainfall peaking at 448 mm in November. Low elevation (0–5 m above sea level) increases exposure to inundation.

Table 2. Environmental Indicators in Benua Kayong Waterfront

Indicator	Value/Status
Share of wetlands in Pawan River basin	60% of Ketapang wetlands
Dominant vegetation	Mangroves (Rhizophora, Avicennia), Nypa fruticans
Households with sanitation access	<60%
Flood risk areas	>50% riverside settlements

Source: Author, 2024

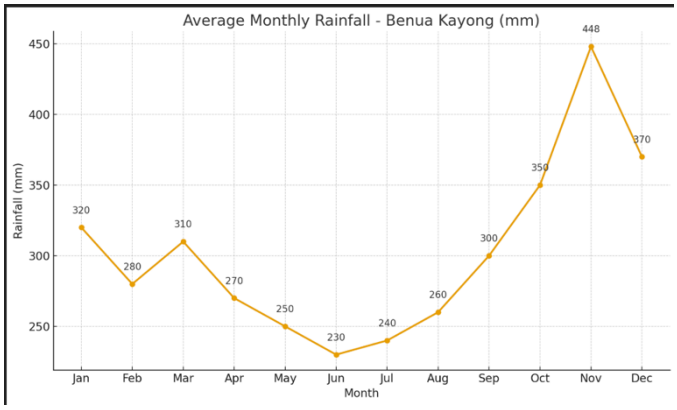

Fig. 5. Average monthly Rainfall in Benua Kayong
(Source: author)

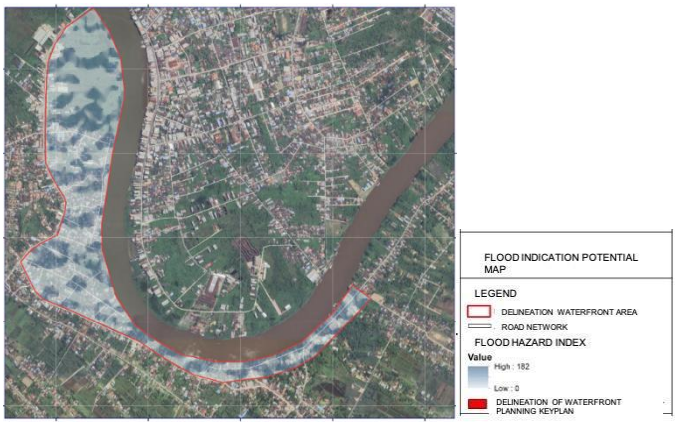

Fig. 6. Indicative Flood Potential Map of the Study Area
(Source: author)

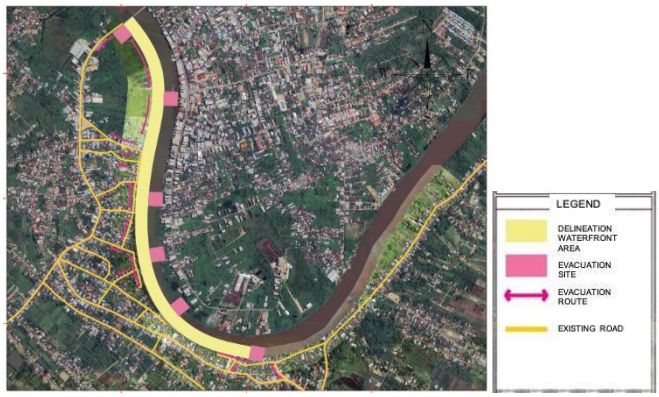

Fig. 7. Evacuation Route Plan Map of the Study Area
(Source: author)

SWOT analysis confirms strengths in biodiversity and eco-tourism potential but reveals weaknesses in water quality and habitat fragmentation. Opportunities include eco-tourism development and community-based conservation, while threats involve uncontrolled settlement growth and climate-induced habitat loss.

Table 3. Environmental SWOT Analysis

Aspect	Strengths	Weakness	Opportunities	Threats
Ecosystem	Potential of natural ecosystems supporting biodiversity	Potential habitat degradation and declining water quality	Development of ecotourism and nature conservation	Ecosystem damage caused by unmanaged development
Socio-Cultural	Strong local traditions rooted in river-based livelihoods	Social changes that may threaten traditional lifestyles	Community empowerment through tourism and environmental education	Social tensions arising from changes in lifestyle and employment
Environmental Management	Adoption of sustainability principles and sustainable management practices	Limited resources for effective implementation	Application of environmentally friendly technologies and SUDS	Lack of consistent supervision and management
Monitoring	Community involvement in environmental monitoring	Limited funding and facilities for continuous monitoring	Development of training programs and environmental awareness initiatives	Risk of negligence in monitoring leading to greater environmental damage

Source: Author, 2024

Adaptation strategies proposed for SWOT Analysis include:

a. Nature-based solutions, rehabilitation of at least 20 hectares of mangroves and riparian vegetation to stabilize banks and absorb wave energy.

b. Infrastructure adaptation, implementation of SUDS, eco-drainage, and elevated pedestrian pathways.

c. Material innovation, promotion of flood-resilient construction materials, including environmentally friendly concrete and water-resistant wood.

d. Policy integration, alignment with national climate policies (RUED Kalbar 2020–2050, RPJMN 2020–2024) to ensure long-term funding and governance.

The strategies can be seen in figure below.

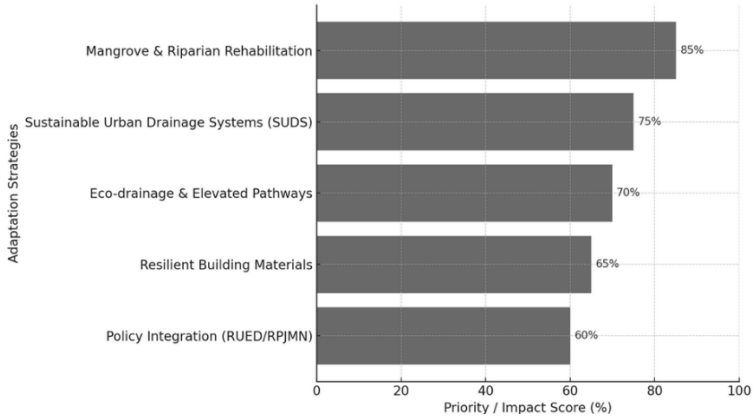

Fig. 8. Proposed Climate Adaptation Strategies for Benua Kayong Waterfront (Source: author)

The proposed climate adaptation strategies (Figure 8) strongly align with the environmental SWOT analysis of the Benua Kayong waterfront. The strength of rich biodiversity and mangrove ecosystems is reinforced by rehabilitation programs that restore riparian buffers and enhance ecological services. At the same time, weaknesses such as poor sanitation and water pollution can be mitigated through eco-drainage and SUDS that improve waste and runoff management. The opportunities for eco-tourism and community-based conservation are supported by the introduction of resilient building materials and sustainable infrastructure that reduce ecological pressures while attracting investment. Finally, the threats of habitat degradation, flooding, and climate change uncertainties are addressed by integrating adaptation strategies into regional and national policy frameworks. This synergy between SWOT findings and the proposed strategies underscores the necessity of combining ecological conservation with adaptive infrastructure to secure long-term sustainability for the waterfront.

4. Legal and Administrative Aspect

Legal and Administrative Aspects play a crucial role in guiding waterfront development. As shown in Table 3, the primary strength lies in the availability of spatial planning regulations and the clarity of land tenure between government and private ownership. The presence of formal regulations is considered an essential factor in ensuring that waterfront development adheres to the principles of sustainability (Pramesti, 2017) The main weakness identified is the rapid land-use conversion, particularly for plantations, as well as the existence of customary land and land under cultivation rights, which require special permits. This finding aligns with Lagarense (2011) who emphasized that the involvement of local stakeholders in the permitting process often becomes a critical issue in waterfront projects in Indonesia.

Opportunities are identified through land conversion policies that align with spatial planning, which can be directed towards tourism and commercial sectors. However, threats in the form of land-use conflicts remain, particularly given the lengthy and complex permitting process. The land-use plan is visualized in Figure 9, while the economic structure of Ketapang Regency from 2019–2023, which provides the development context for the area, is presented in Figure 10.

Table 4. SWOT Analysis of Legal and Administrative Aspects

Aspect	Strenghts	Weakness	Opportunities	Threats
Land use	Availability of land for area development	Rapid land-use conversion, particularly into plantations	Conversion of land for tourism and commercial development	Limited land that can be allocated for development
Land tenure	Clear status of land managed by government and private sectors	Many lands under *Hak Guna Usaha* (HGU) and customary rights requiring permits	Potential land conversion aligned with spatial planning policies	Lengthy and complex permitting processes
Spatial planning	Existence of clear spatial planning regulations governing land use	Land use that does not comply with existing spatial planning regulations	Coordinated development in line with spatial planning regulations to enhance sustainability	Conflicts in land utilization contradicting spatial planning regulations

Source: Author, 2024

Fig. 9. Proposed Land-use Plan of the Study Area
(Source: author)

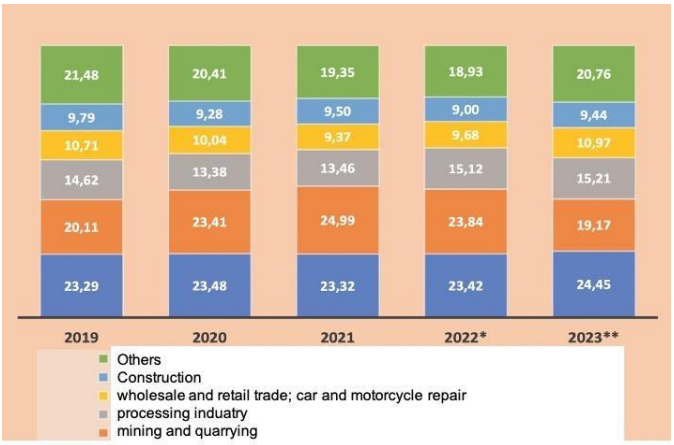

Fig. 10. Ketapang Regency Economic Structure, 2019-2023
(Source: author)

5. Social and Economic Aspects

Social and economic aspects show great potential for empowering communities through infrastructure development and tourism, as presented in Table 4. Studies by Fourcade (2014) and Varat & Barata (Lagarense, 2011; Varat & Barata, 2025) confirm that strengthening socio-cultural identity in waterfront areas can increase tourism appeal while strengthening social cohesion. Weaknesses arise in the form of social tensions due to changes in land use and shifts in livelihoods. According to Lagarense (2011) social tensions are a real risk in the waterfront regeneration process that does not involve inclusive community participation. On the other hand, opportunities for public space development can open up new jobs and support economic diversification. This is reinforced by Talanila et al. (2023) who found that waterfront city development encourages growth in the service and trade sector.

Benua Kayong's population (±35,000) is largely dependent on primary livelihoods like fisheries, farming, and small-scale trade. The waterfront project offers opportunities for diversification. Based on feasibility projections, waterfront development could create more than 500 new jobs across sectors such as river-based tourism, hospitality (homestays, restaurants), transport services, and cultural enterprises. Micro, small, and medium enterprises (UMKM) are expected to expand in food services, handicrafts, and local logistics.

Table 5. Employment Potential in Waterfront Development

Sector	Current Share	Potential Jobs Created
Fisheries & Farming	70%	+100 (processing, value-add)
Tourism & Hospitality	<10%	+250 (guides, hotels, restaurants)
Trade & Services	15%	+150 (markets, river transport)
Creative/Handicraft	<5%	+50

Source: Author, 2024

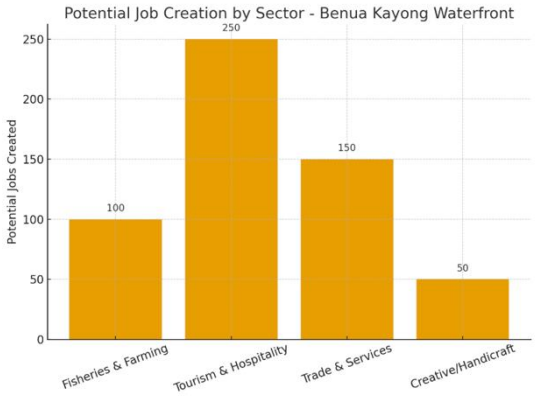

Fig. 11. Potential Job Creation by Sector in Benua Kayong Waterfront (Source: author)

Community feedback emphasized aspirations for improved access roads, sanitation facilities, and recreational spaces. Residents also highlighted the need for inclusive opportunities so that local workers not only outside investors benefit from waterfront development. This aligns with participatory waterfront models in Manado (Lagarense, 2011) and Makassar (Rohadi et al., 2024). The SWOT analysis of the socio-economic aspects highlights that waterfront development can empower local communities through tourism and infrastructure while diversifying the economy beyond mining. Opportunities arise from the creation of public spaces, social facilities, and new employment in tourism and commercial sectors, which can enhance local income. However, risks remain in the form of social tensions due to land-use changes, neglect of community needs, and persistent income inequality if economic benefits are not distributed inclusively. Therefore, active community engagement and inclusive policies are crucial to transform land-use change into shared social benefits and to ensure that diversification strengthens local resilience while reducing disparities.

Community participation in Benua Kayong's waterfront planning was facilitated through interviews, surveys, and village forums, involving around 50 respondents representing households (60%), UMKM actors (20%), community leaders (10%), and local officials (10%). Quantitative findings indicate that the majority of respondents prioritized road and transport access (70%) and sanitation and drainage facilities (65%), followed by opportunities in tourism and trade (55%), the provision of public open spaces (50%), and environmental conservation (40%). These figures highlight that while infrastructure and basic services remain urgent needs, there is also growing community awareness of economic diversification and ecological sustainability.

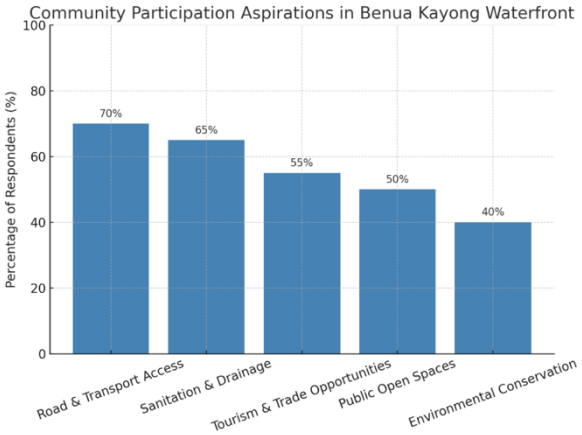

Fig. 12. Community Participation Aspirations in Benua Kayong Waterfront (Source: author)

From a SWOT perspective, the strength of community participation lies in its potential to empower local residents through tourism, UMKM growth, and infrastructure development. However, weaknesses are evident in the risk of uneven engagement, where some groups may feel excluded or underrepresented. Opportunities are clear in the alignment between community aspirations and the waterfront's potential for public spaces, eco-tourism, and diversified livelihoods. Yet, threats persist in the form of social tensions caused by land-use changes and the possibility that local needs might be neglected if decision-making is dominated by external investors. The integration of quantitative community feedback with SWOT analysis thus emphasizes that inclusive engagement is not only a social imperative but also a strategic requirement for ensuring that waterfront development enhances resilience, equity, and sustainability.

Table 6. SWOT Analysis of Social and Economic Aspects

Aspect	Strengths	Weakness	Opportunities	Threats
Social	Potential for community empowerment through tourism and infrastructure	Social tensions due to land-use changes	Development of public spaces and social facilities for the community	Neglect of local community needs
Economic	Economic diversification through tourism and commercial sectors	High dependence on the mining sector	Creation of new employment opportunities and enhancement of local income	Persistent income inequality and social disparities

Source: Author, 2024

Social inequality and disparity still present sizable challenges. Pinto and Kondolf (2020) point out the need to deal with the equitable allocation of the economic gains so that the enhancement of waterfront development should not be tilted to the advantage of a few. Therefore, in planning the Ketapang area, the socio-economic aspect has to be integrated. Based on the SWOT analysis, an investment program has been formulated for the housing, trade and service, and green open space (GOS) sectors.

This program is illustrated in Table 5 and has been set for a five-year implementation phase. In the housing sector, the program comprises construction and landscaping, coupling of green corridors, parking area development, and basic services improvement. This is in line with the findings of Rohadi et al. (2024) which highlight the need for the integration of utility and public facility systems for the development of waterfront city concepts.
In the trade and services sector, development focuses on the planning of building construction and the design of the area's entry points for vehicles and pedestrians, which enhance the district's identity. This approach is in line with the inclusive design of public space advocated by Attia and Ibrahim (2017) At this point in time, in the GOS sector, investment programmes seek to build riverwalk trails, green belts, docks, deltas, and promenade embankments. Badach and Raszeja (2019) suggest that the development of these public green spaces supports the principles of urban eco-sustainability.

Table 7. Investment Program Plan for Waterfront Development

No	Block	Program	Year					Implementing Agency
			1	2	3	4	5	
1	Housing	Spatial and environmental restructuring						District Government, Community
		Green corridor development						District Government, Community
		Provision of parking facilities						District Government
		Road and basic utility infrastructure development						District Government
2	Trade and Services	Spatial arrangement of commercial buildings and environment						District Government, Private Sector, Community
		District gateway (for vehicles and pedestrians)						District Government, Private Sector, Community
3	Green Open Space	Green corridor development						District Government, Private Sector, Community
		Riverwalk development (including inspection path and green belt)						District Government, Private Sector, Community
		Promenade embankment construction						District Government, Private Sector, Community
		Dock development						District Government, Private Sector, Community

6. Discussion

The development of the waterfront area in Benua Kayong District, Ketapang Regency presents both significant opportunities and challenges in the pursuit of sustainable and inclusive urban planning. Based on the findings, various elements can support the success of this project; however, several challenges must also be addressed. One of the main challenges concerns the management of flood risk and coastal abrasion, which are common issues in many coastal cities. As highlighted by Varat and Barata (2025) enhancing the resilience of waterfronts in low-lying coastal regions requires adopting an ecosystem-based approach, such as mangrove rehabilitation and environmentally friendly drainage systems. Nature-based stormwater management solutions are therefore crucial to ensure infrastructure sustainability while mitigating negative impacts on coastal ecosystems.

In addition, the development of infrastructure including roads, drainage networks, and ports must consider both the physical capacity of the site and its potential impacts on surrounding ecosystems. Waterfront projects that disregard environmental considerations often result in severe ecological degradation, as evidenced in other waterfront cases (Zhou et al., 2021). Thus, this project must integrate physical infrastructure with nature-based solutions for disaster risk mitigation. From an economic perspective, the tourism sector offers substantial potential to stimulate local economic growth in Ketapang. With its natural assets, such as coastal landscapes and local cultural sites, the area could emerge as a prime tourism destination in West Kalimantan. However, the greatest challenge lies in the limited basic infrastructure supporting the tourism sector, including hotels, restaurants, and transport access. Syahrir (2021) argues that accessibility constraints represent a major obstacle to sustainable tourism development, particularly in remote coastal areas. Accordingly, the waterfront project in Ketapang must prioritize the development of essential infrastructure that supports tourism and other local industries.

Moreover, the success of tourism is also dependent on the availability of environmentally friendly public spaces and facilities that can attract visitors, such as green open spaces and recreational areas. Attia and Ibrahim (2017) emphasize that inclusive and well-designed public spaces not only enhance tourism appeal but also provide social benefits to local communities. Therefore, the creation of an environmentally responsible waterfront with adequate public facilities can simultaneously increase tourism attractiveness and social well-being. From a social perspective, the study underscores the importance of community involvement at every stage of waterfront planning and development. As noted by Syahrir (2021) active community participation is essential to ensure that the project aligns with local social and cultural needs. Findings show that residents in Benua Kayong require improvements in basic infrastructure, such as upgraded roads and adequate sanitation facilities. Community engagement is also vital to ensure that they can harness the economic opportunities generated by the waterfront development. Nevertheless, the dependence of local communities on traditional fisheries and agriculture presents challenges in adapting to the transformations brought by the project. Consequently, the project must incorporate skill training and community empowerment programs to help residents adjust to these changes. Furthermore, the planning of inclusive public spaces accessible to all segments of society—including those living in informal settlements—represents a key step in fostering a socially sustainable waterfront.

The environmental dimension plays an equally critical role in sustainable waterfront planning. Coastal ecosystem management, particularly mangrove rehabilitation and fish habitat conservation, is indispensable for maintaining ecological balance. Zhou et al. (2021) stress that nature-based solutions, such as mangrove rehabilitation and infiltration-based stormwater management, can reduce adverse environmental impacts while preserving coastal biodiversity. However, sustainable environmental management requires collaboration between government, the private sector, and local communities to ensure that the project does not degrade existing ecosystems. A major constraint in implementing this waterfront project lies in the substantial investment required, as well as the high risks associated with climate change. Managing natural disaster risks, such as floods and abrasion, demands investment in infrastructure capable of addressing these hazards. Thus, the project calls for a comprehensive risk mitigation plan encompassing technical, social, and environmental dimensions. As noted by Schmelz (1986) in-depth risk analysis is essential to ensure that waterfront projects achieve their objectives successfully without undermining environmental integrity or community welfare.

CONCLUSION

This study demonstrates that waterfront development in Benua Kayong, Ketapang, is feasible under conditions that prioritize socio-economic diversification, ecological resilience, and adaptive infrastructure. Key findings include: a) strong potential for job creation in tourism, hospitality, and UMKM's, reducing reliance on fisheries and farming; b) high ecological value of the Pawan River, which supports 60% of Ketapang's wetlands but requires strict conservation measures; c) infrastructure gaps, particularly in roads, drainage, electricity, and telecommunications, which must be addressed for inclusive growth; d) community participation as a cornerstone for planning, ensuring that development reflects local needs and aspirations; e) climate adaptation strategies (SUDS, mangrove rehabilitation, resilient materials) are essential to mitigate risks from flooding and erosion.

The contribution of this research lies in integrating quantitative data with qualitative community insights, offering a model for mid-scale waterfront development in Indonesia. Future research should incorporate hydrodynamic modeling of sea-level rise and flood scenarios to strengthen long-term adaptation strategies. By combining ecological, economic, and social priorities, Benua Kayong's waterfront has the potential to become a showcase for sustainable and inclusive development in coastal Indonesia.

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REFERENCES

Attia, S., & Ibrahim, A. A. A. M. (2017). Accessible and Inclusive Public Space: The Regeneration of Waterfront in Informal Areas. Urban Research & Practice, 11(4), 314–337.

Badach, J., & Raszeja, E. (2019). Developing a Framework for the Implementation of Landscape and Greenspace Indicators in Sustainable Urban Planning. Waterfront Landscape Management: Case Studies in Gdansk, Poznan and Bristol. Journal MDPI Sustainability , 11(2291).

BPS Ketapang. (2023). Kabupaten Ketapang Dalam Angka 2024.

Fourcade, L. (2014). Waterfront Considerations Toscolano Maderno. Politecnico Di Milano.

Hidayatullah, A. I., & Nur, A. (2025). Penajam Tower Development Location Feasibility Study. 1st International Conference on Civil, Architecture, Environmental Engineering, and Technology (ICCAEET 2024), 6–15.

Lagarense, B. E. S. (2011). Stakeholder Involvement in Waterfront Planning and Development in Manado, Indonesia. University of Waterloo, Canada.

Muzayyanah. (2023). Pola Pembangunan Perumahan Perkotaan di Indonesia dari Perspektif Sustainable Urban Form : Pengantar pada Studi Pengaturan Ruang dan Space Syntax. Selaras Media Kreasindo.

Nugroho, A. D. (2019). Kajian pemanfaatan ruang kawasan pesisir studi kasus kawasan permukiman kumuh Kelurahan Padarni Kabupaten Manokwari. CASSOWARY, 2(2), 128–146.

P P Rohadi, N Qisthina, R Aulia, H S Arifin, & R L Kaswanto. (2024). Urban Landscape Management of Makassar City Based on Waterfront City Concept. The 7th International Symposium of Sustainable Landscape Development (ISSLD) , 012029.

Pinto, P. J., & Kondolf, G. M. (2020). The Fit of Urban Waterfront Interventions: Matters of Size, Money and Function. Journal MDPI Sustainability , 4079.

Pramesti, R. E. (2017). Sustainable Urban Waterfront Redevelopment: Challenge and Key Issues. Media Matrasain, 14, 41–55.

Ragheb, R. A. (2017). Sustainable Waterfront Development—A Case Study of Bahary in Alexandria, Egypt. Journal of Civil Engineering and Architecture , 11, 380–394.

Ranuari, A. (2016). Penataan Ruang Terbuka Hijau Kawasan Tepi Sungai Mahakam Kota Samarinda Berbasis Sustainable Urban Riverfront [Program Magister Bidang Keahlian Perancangan Kota]. Institut Teknologi Sepuluh Nopember Surabaya.

Schmelz, D. D. (1986). The Palace At Port Imperial: Financial Feasibility Analysis of a Waterfront Condominium Development in West New York, New Jersey. MIT Libraries Document Services.

Syahrir, Y. (2021). Towards an effective participatory process for a sustainable urban waterfront development. Communications in Humanities and Social Sciences , 1(1), 1–6.

Talanila, G. C., Sri Pare Eni, & Margareta Maria Sudarwani. (2023). Analisis Kelayakan Waterfront City (Studi Kasus Daerah Ongkoliong Desa Batu Merah). Jurnal Lingkungan Binaan Indonesia, 12(4), 205–221.

U.S Environmetal Protection Agency. (2016). PORTLAND HARBOR RI/FS FEASIBILITY STUDY.

Varat, A., & Barata, L. (2025). San Francisco Waterfront Resilience Program Draft Plan. In Waterfront Regeneration in a Time of Climate Change (1st ed., Vol. 1). Taylor and Francis.

Wisudha, F., Suryadjaja, R., Santoso, S., & Wipranata, B. I. (2023). Pemanfaatan Sempadan Sungai Sebagai Ruang Terbuka Hijau Dengan Konsep Waterfront Development. Jurnal Stupa Sains, Teknologi, Urban, Perancangan, Arsitektur, 5(2), 1933–1944.

Zaki, S. K., & Hegazy, I. R. (2023). Investigating the challenges and opportunities for sustainable waterfront development in Jeddah City. International Journal of Low-Carbon Technologies , 18, 809–819.

Zhou, S., Fei Chen, & Zhen Xu. (2022). Evaluating the accessibility of urban parks and waterfronts through online map services: A case study of Shaoxing, China. Urban Forestry & Urban Greening, 77, 127731.

Zhou, Y., Sharma, A., Masud, M., Gaba, G. S., Dhiman, G., Ghafoor, K. Z., & AlZain, M. A. (2021). Urban Rain Flood Ecosystem Design Planning and Feasibility Study for the Enrichment of Smart Cities. Journal MDPI Sustainability , 5205.