

# Spatial Analysis and Development Dynamics of Kampung Kamal Muara via Coastal Mapping

**Denny Husin**

Architecture Study Program, Universitas Tarumanagara, Jakarta, Indonesia

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## Corresponding Author:

**Denny Husin**

Architecture Study Program, Universitas

Tarumanagara,

Jakarta, Indonesia

Email: [denny@ft.untar.ac.id](mailto:denny@ft.untar.ac.id)

## Abstract

This research aims to conduct a spatial mapping analysis for Kamal Muara Fisherman Kampung to understand the development dynamic of its housing fabric. It focuses on identifying and exploring the potential for spatial hybridity, a key factor in the transformation of the kampung's physical layout. The study identifies a critical issue in the current spatial aggregation, which lacks optimal development and coherence, thereby emphasizing its character for strategic planning and design intervention. A qualitative interpretive methodology is employed, utilizing a typo-morphological approach. The primary research instrument involves digital mapping techniques. The mapping process consists of three main stages: (1) map extraction, (2) morphological analysis, and (3) typological synthesis. The expected outcome of this research is the formulation of a spatial algorithm for model development, with a particular emphasis on generating a prototype for residential units that could serve as the structural core of the kampung's spatial network.

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## INTRODUCTION

*Kamal Muara* Fisherman Kampung is a historically significant coastal settlement located in North Jakarta, recognized for its proximity to mangrove forests and the river that flows into the Java Sea. Formerly an active fishing port until the 1970s within the *Penjaringan* sub-district, its prominence declined following the establishment of the more competitive *Muara Angke* port in 1977. The subsequent reduction in port activity at *Kamal Muara* coincided with the arrival of *Bugis* migrants from South *Sulawesi*, who settled along the coastal area. This migration contributed to the formation of a densely populated kampung characterized by cultural integration with *Betawi*, *Javanese*, and *Sundanese* communities, which is reflected in the varied configurations of residential building masses. *Kamal Muara* Fishermen Kampung, situated in North Jakarta, Indonesia, has traditionally depended on fisheries as its primary economic livelihood. In recent decades, however, the kampung has faced increasing socio-economic pressures due to rapid urbanization, coastal environmental degradation, and the impacts of climate change. Coastal spatial mapping emerges as a critical analytical tool to assess spatial patterns, environmental dynamics, and infrastructural capacities, thereby supporting sustainable development strategies in vulnerable coastal areas. This study seeks to assess the housing developmental trajectory of *Kamal Muara* through the application of integrated coastal mapping techniques, with the objective of informing sustainable coastal management and policymaking. Globally, coastal mapping has proven effective in monitoring environmental transformations, enhancing fisheries management, and informing infrastructure planning in coastal settlements. Existing literature highlights the strategic role of geospatial data in addressing issues such as coastal erosion, natural resource management, and livelihood enhancement. Despite its potential, the use of such integrative, data-driven approaches remains underutilized in Indonesia, particularly within Jakarta's coastal regions. This research addresses this gap by applying comprehensive coastal mapping methodologies tailored to the specific socio-environmental context of *Kamal Muara*.

## LITERATURE REVIEW

### The Informality of Kampung Kamal Muara

*Kamal Muara* Fishermen's Kampung has drawn significant scholarly and policy attention due to its critical coastal environmental conditions for decades (Yonanda & Trisno, 2019). Geographically, the kampung is bounded by the *Seribu* Islands to the north, *Kamal* to the south, *Tangerang* Regency to the west, and the *Kapuk Muara* area to the east. As of 2020, the estimated population density in *Kamal Muara* was approximately 1,467 inhabitants per square kilometer, with a relatively balanced gender distribution and a diverse ethnic composition, including *Bugis*, *Minangkabau*, *Javanese*, *Sundanese*, *Betawi*, *Batak*, and *Chinese* communities (Firdausi, Malik, & Sururi, 2021). Kampung's socio-economic structure is predominantly shaped by its coastal topography and marine-oriented economy. Port operations, fishing, and trade are central to daily activities, visibly concentrated around the coastal zone (Prabowo, Afandi, Dewi, & Salve, 2021). Residential patterns reflect this economic focus, with settlements functioning as both housing and logistical support for maritime livelihoods (Wahyudi, Aprilia, & Setiawan, 2023). Settlement growth along the coastline has resulted in diverse vernacular housing types such as land-based houses, boat houses, stilt houses, and hybrid forms, demonstrating adaptive spatial strategies and a dynamic process of vernacular transformation (Yonanda & Trisno, 2019). However, the rapid and largely unregulated expansion of these settlements has led to concerns regarding informal development, inadequate infrastructure, and environmental degradation (Susiloningtyas, Chairunnisa, Siswantining, & Handayani, 2020). Issues such as reclamation, industrial encroachment, and construction activities have raised critical questions about spatial planning, especially in relation to ecological sustainability, fisheries, and natural habitat preservation (Sinaga, 2017); (Fajriyansyah, Handayani, & Nirawati, 2024). Additionally, the socio-cultural fabric of the community, including the fishing profession, gender roles in marine economies, and underdeveloped tourism potential in this historically significant area, requires further examination (Firdausi, Malik, & Sururi, 2021); (Setiani, Puspita, & Supriyanto, 2022). This study emphasizes the urgency of addressing these multifaceted issues through a deeper exploration of the area's latent potentials, including its rich traditions of vernacular architecture (Artiningrum & Sukmajati, 2017), the spatial hybridity of its built environment (Ayudya, Permana, Lakafin, & Wuryaningsih, 2019), and the complex marine network strategies observable in its spatial configuration (Gunawan & Poerbantanoë, 2021). These elements collectively inform the housing research agenda aimed at advancing sustainable and context-sensitive spatial development in *Kamal Muara*.

### Coastal Situation

The sea in the *Kamal Muara* area functions not merely as a scenic backdrop but serves as the terminus of the *Kamal* River estuary, constituting a critical ecosystem and habitat for both brackish and marine environments (Nugraha, Triharyuni, Suleman, & Hartati, 2020). This ecological role reflects a distinct spatial context that shapes the physical and cultural landscape of the region (Susiloningtyas, Chairunnisa, Siswantining, & Handayani, 2020). The sea operates as a spatial delimiter, differentiating terrestrial topography while simultaneously serving as a transitional zone that profoundly influences the form, function, and symbolic meanings embedded in coastal living spaces, particularly for the fishing community (Prabowo, Afandi, Dewi, & Salve, 2021)(Figure 1). Empirical observations reveal a dynamic transformation within the fishermen's living spaces, which maintain a close and multifaceted relationship with the marine environment. Rather than distancing themselves from the sea, the community's spatial organization can be delineated into three distinct phases: the land-based phase, characterized by settled houses on solid ground; a transitional phase, represented by stilted structures; and a marine phase, embodied by boat houses and vessels. The marine environment supports diverse functions, including service provision, operational activities, and production processes (Ulinata, Jura, & Simanjutak, 2022). Naval influences are discernible in the spatial configuration and architectural silhouettes, while cultural meanings of the sea manifest through local rituals, decorative elements, and ornamentation. This intricate integration of marine and terrestrial spaces distinguishes *Kamal Muara* Fishermen's Kampung from other fishing settlements (Artiningrum & Sukmajati, 2017). The kampung's vibrant physical expression is not only a source of communal identity but also represents a unique characteristic celebrated by its inhabitants (Lianto, Trisno, Husin, & Thedyardi, 2022). Notably, this distinctive spatial and cultural hybridity exposes a gap in existing research: while environmental issues have been extensively studied, there remains a lack of focus on spatial quality and the developmental potential embedded in the kampung's physical mass and layout.

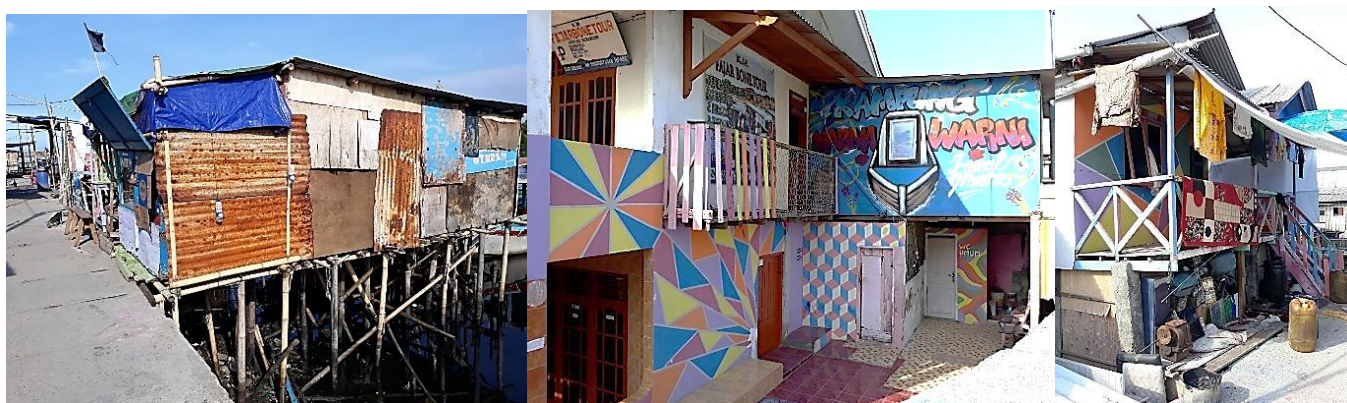


Figure 1. Kampung Kamal Muara Perspectives

## Socio-Economic Condition

The social, economic, and cultural dynamics within Kamal Muara significantly shape the kampung's formation and developmental trajectory (Firdausi, Malik, & Sururi, 2021). Kamal Muara can be characterized as a composite settlement comprised of both indigenous and migrant populations residing along the coastal zone (Artiningrum & Sukmajati, 2017). The kampung core is constituted by a cluster of residential units that function as both domestic spaces and centers of family-based economic activity (Setiani, Puspita, & Supriyanto, 2022). These residences are intricately embedded within extensive social networks that span diverse ethnic groups from across the Indonesian archipelago, as well as foreign cultural influences including Chinese, Arabic, Malaysian, and Filipino, resulting in a hybrid cultural milieu (Artiningrum & Sukmajati, 2017). Central to the kampung's social and spatial organization is the mosque, which serves as the focal point for ritual and spiritual life. The fish market operates as the economic hub, while communal spaces function as integrative social nodes (Figure 2). These socio-economic and cultural attributes are materially represented in the spatial configuration of the kampung, manifesting as residential aggregates and distinctive landmarks, interconnected through a network of pathways that facilitate accessibility and movement (Mulyasih & Suahya, 2022). In the broader environmental context, the kampung is geographically framed by the sea and traversed by rivers and estuaries, highlighting a continuous flow from terrestrial to marine domains. The kampung, thus occupies a transitional spatial position, mediating the interface between land and sea within its settlement structure.



Figure 2. Economic Nodes: Seafood Market, Shellfish Shucking House

Given the significant role of coastal area mapping in managing Muara Angke kampung, this study proposes a scaling-up strategy to address the integration of organically developed kampung growth with its surrounding environment, particularly within the urban context (Lianto, Trisno, Husin, & Thedyardi, 2022). The study employs a semi-parametric mapping approach derived from typo-morphological analysis to systematically illustrate, interpret, and decode the spatial structures that emerge intrinsically within the kampung. These structures evolve in accordance with the humanistic experiences and practices of the local inhabitants, allowing for their simulation and analysis (Lianto, Trisno, Choandi, & Husin, 2020). Deconstructing the kampung mapping into an examination of built space serves as a foundation for guiding future kampung planning by reflecting the inherent spatial knowledge embedded within the traditional kampung fabric (Husin, Prijotomo, & Sugiharto, 2021). This approach translates the spatial composition of the kampung into a scientific framework grounded in geometric algorithms such a framework

facilitates the simulation and potential reconstruction of the kampung through engineered interventions, aiming to futurize development while preserving the fundamental spatial essence and identity of the kampung environment.

## METHODS

Kamal Muara Kampung, situated along Jakarta Bay, serves as the study area characterized by its proximity to urban infrastructure positions the kampung at the intersection of ecological vulnerability and developmental potential. Data collection employed a multi-method approach, including satellite imagery, calculation and field surveys comprising snapshot and sketching, as well as secondary data obtained from governmental agencies concerning coastal infrastructure and socio-economic indicators (Lianto, Trisno, Husin, & Thedyardi, 2022). Geographic Information System software was utilized to integrate multiple spatial data layers, encompassing infrastructure, and settlement distribution. The mapping efforts focused on delineating socio-economic zones, identifying areas suitable for development, and detecting infrastructural deficiencies. This study applies typological and morphological analyses within a semi-parametric mapping framework to evaluate spatial quality through descriptive and interpretative methods (Lianto, Trisno, Choandi, & Husin, 2020). Research activities were conducted from January to June 2025, encompassing a general assessment of Kamal Muara Kampung alongside a detailed examination of a specific network sample centered on key kampung landmarks the gate, mosque, and fish market. The methodological procedure involved: (1) extraction of satellite imagery and temporal snapshots, (2) cross-mapping studies to construct an integrated spatial representation of the kampung, and (3) spatial reconstruction utilizing a combination of QGIS, CAD, SketchUp, and other digital mapping applications. The mapping process was stratified into spatial layers to depict dynamic spatial phenomena, translating dimensional, geometric, and algorithmic characteristics of the kampung into modular units and typologies (Husin, Prijotomo, & Sugiharto, 2021).

## RESULTS AND DISCUSSION

### Spatial Distribution of Coastal Features

Coastal kampungs exhibit distinct characteristics that differentiate them from the predominantly informal urban sectors typically found in city centers. While sharing some attributes with suburban areas, coastal kampungs are uniquely positioned at the interface between terrestrial and marine environments, a transitional zone that significantly influences their spatial form and network configurations (Figure 3). Topographically, these kampungs are predominantly situated within lowland areas subject to maritime climatic conditions, prompting adaptive spatial arrangements responsive to surrounding aquatic environments. The physical quality of kampung includes the materiality of coastal kampung structures is closely linked to marine resources, with construction materials and spatial configurations often inspired by marine forms and complemented by elements derived from the aquatic ecosystem. Marine spatial mapping reveals a strong interrelation between local marine activities and climatic factors that dictate the orientation, position, and spatial organization within the kampung, reflecting 3 broader socio-economic and cultural patterns characteristic of coastal communities with a gradation from the land to the sea. Over time, these factors coalesce to form micro-community structures that reflect and replicate the surrounding environmental and social contexts: a coastal kampung-scape based on kampung physical layout.



**Figure 3.** Kamal Muara Aerial Perspectives Show 3 various morphological patterns

(Source: redrawn and rehighlighted using [https://cadmapper.com/pro/home/Kamal Muara, North Jakarta,JK, Indonesia/](https://cadmapper.com/pro/home/Kamal%20Muara,%20North%20Jakarta,%20Indonesia/) as a base, downloaded 20 June 2025)

## Infrastructure Development Needs

Spatial analysis further identified substantial degradation of mangrove forests in the southern sectors of Kamal Muara, which is associated with increased coastal erosion. The residential settlement pattern exhibits a predominantly gridded and linear configuration quality, particularly in proximity to fishing ports, where significant infrastructural shortcomings such as inadequate sanitation and limited transportation access are clearly observed. This location is prime as a sample as rarely mapped, strongly showing combination of naval and landed tendency, while having proximity to the kampung landmarks. Toward the inland periphery, the urban fabric becomes increasingly dispersed, while the central zone represents a transitional area that aggregates characteristics of both extremes (Figure 4). From an aerial or axonometric perspective, there is a distinct gradation in building scale: structures closer to the coastline are generally smaller, denser, and elongated, whereas those situated further inland tend to be larger and more spacious, with the central zone marked by increased spatial voids and subtractive forms. In terms of orientation, buildings near the shoreline predominantly face the sea in both longitudinal and transversal arrangements. In contrast, the central area exhibits a weaker orientation towards the sea, and the inland edge is characterized by a free-form orientation. This spatial organization results in a highly symmetrical and structured urban fabric near the coast, gradually transitioning into a more organic and irregular configuration toward the inland margin.



**Figure 4.** Kamal Muara Undetected connections, Fabric Distributions and Research Sample  
(Source: [https://cadmapper.com/pro/home/Kamal Muara, North Jakarta, JK, Indonesia/](https://cadmapper.com/pro/home/Kamal%20Muara,%20North%20Jakarta,%20JK,%20Indonesia/) downloaded 20 June 2025)

## Fisherman Settlements and Housing

Kamal Muara, as a coastal area, exhibits distinct characteristics shaped by its historical and socio-cultural development. Originally established as a port and subsequently evolving into a hub for immigrant communities, Kamal Muara functions as more than a mere anchorage site. Historically, the area has been a settlement for the Betawi people for over six decades, who have traditionally centered their economic activities around fishing, with some engagement in fisheries processing industries. Additionally, immigrant groups from regions such as Java and Sunda have contributed to the emergence of new economic centers focused on food production, accommodation, and maritime-related services. The Chinese community played a significant role in accelerating maritime trade activities, while the Bugis people are recognized for enriching maritime practices and pioneering hybrid cultural formations within Kamal Muara. In light of these developments, Kamal Muara functions as a critical node and convergence point along the North Jakarta coast, serving as a focal magnet that integrates diverse networks across the Indonesian archipelago. This interconnectedness is also manifested in the shared communal spaces, which reflect collective interpretations and practices related to coastal defense configurations.

## Infrastructure Development Needs

Areas in closer proximity to the inland exhibit higher-quality infrastructure, characterized by wider, smoother, and more robust thoroughfares, along with a clearer hierarchy of circulation routes, albeit with fewer public facilities and identifiable landmarks. In contrast, the central zone features shorter boulevards supported by more prominent secondary and tertiary lanes, while the coastal edge is primarily accessible through narrower lanes and low-quality infrastructure. Despite these limitations, the coastal area benefits from the presence of strategic landmarks and a greater concentration of communal amenities within walking distance. Supplementing this socio-spatial analysis, Geographic Information System (GIS) assessments underscore critical infrastructural shortcomings, particularly in coastal zones, where there is a pressing need for enhanced coastal protection, improved sanitation, and upgraded transport connectivity to vital marketplaces. Additionally, the mapping data reveals overlooked or undocumented infrastructure, including unresolved circulation termini and poorly conceived routes that fail to adequately support local mobility such as dead-end or safety concern. Enhancing connectivity across these spatial zones is essential for unlocking the full potential of the neighbourhood and integrating it more effectively with the surrounding urban fabric.

## Socio-Economic Patterns

Kamal Muara Kampung exemplifies a hybrid coastal environment where the interplay between terrestrial and marine livelihoods is vividly reflected in the architectural typologies of residential structures, which incorporate diverse adaptations of traditional vernacular forms (Figure 5). Notably, stilt houses, raft houses, and boat houses are prevalent throughout the kampung landscape. The prominence of boat-shaped silhouettes within the built environment underscores a culturally embedded spatial comfort characteristic of coastal settlements. These dwellings are not isolated entities but are integrated within a cohesive infrastructural network that links open communal spaces with essential kampung amenities. Furthermore, materials associated with maritime activities frequently embellish the kampung environment, appearing as permanent installations, decorative elements, or temporary arrangements for cleaning, drying, and maintenance. Collectively, these form recognizable spatial patterns: points, lines, and planes that are well understood by the local community.



**Figure 5.** Kamal Muara Patterns: Urban Fabric, 3D, local connections, Socio-Economic Highlights.  
 (Source: <https://www.openstreetmap.org/#map=18/-6.091478/106.723809> downloaded 20 June 2025)

### Kampung's Sample Algorithm

The spatial mapping reveals a diverse range of residential modules and dimensional variations located adjacent to prominent Muara Kamal landmarks namely, the seafood market and the mosque; both serving as focal points of the local fishing community's cultural and economic activities (Figure 6). A sample of 100 housing units demonstrates a broad spectrum of typologies, indicative of socioeconomic stratification and perceived property value (Table 1). Module's range from 2 to 16 meters, with floors areas spanning approximately 10 m<sup>2</sup> to nearly 200 m<sup>2</sup>. Despite this variation, the majority of units share a consistent vertical profile of two to three stories and predominantly adopt a rectangular form. Most are classified as irregular rectangles, lacking standardized dimensions. The sample includes units ranging from single-room studios to dwellings with more than three bedrooms, with some units approaching the spatial configuration typical of formal residential estates. All observed dwellings are oriented perpendicularly to the coastline and the main kampung corridor, with the longitudinal axis being the prevailing alignment; however, a minority displays a less regulated, transverse orientation. Interstitial spaces are uniformly present between structures, with the widest separations occurring near key landmarks. These gaps are variably utilized as alleys, yards, gardens, communal areas, or simply left vacant for potential future use. The spatial organization of the settlement exhibits an organic and irregular rhythm, characterized by alternating odd and even intervals, suggesting an underlying pattern akin to a prime number sequence. That is why, the map visually presents a semi parametric order, a combination of formal informal configuration as a result of regular geometric aggregate built in a semi-irregular manner.

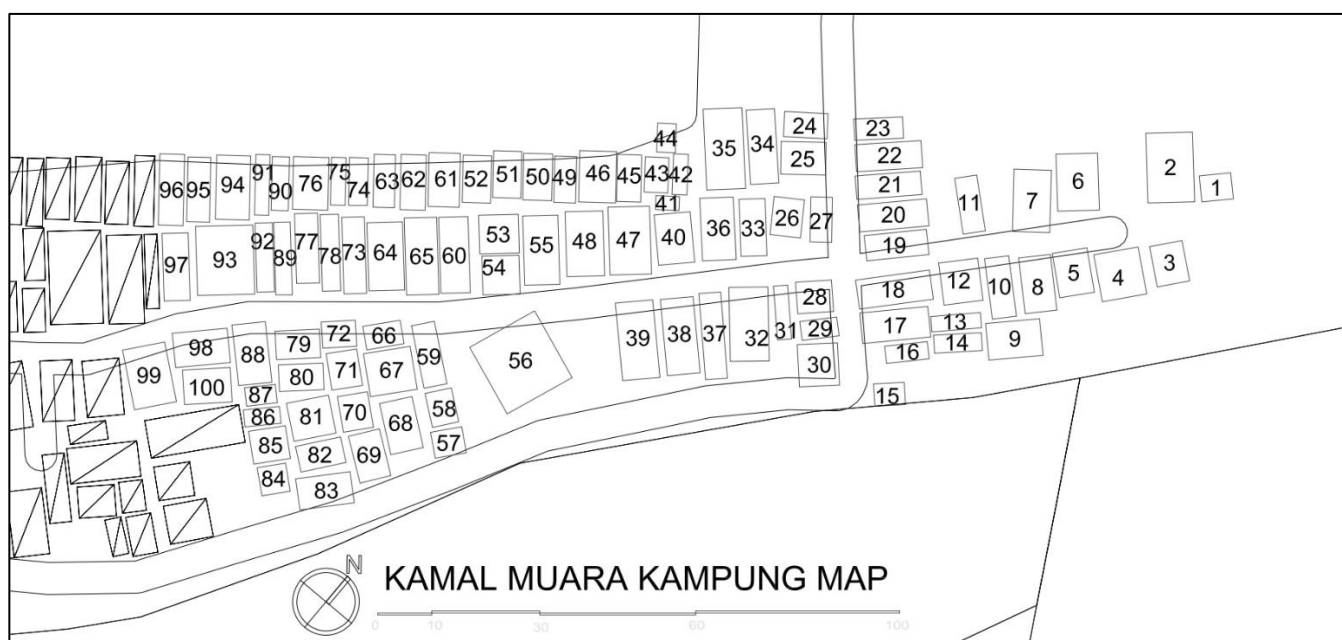


Figure 6. Kamal Muara Fisherman Kampung Sample Map

Table 1. Kamal Muara Fisherman Kampung Algorithm

No	Length (m)	Width (m)	Tall (fl)	Coverage area (m <sup>2</sup> )	Type
1	5.93	4.9	2-3 floors	29.057	rectangular
2	13.07	8.75	2-3 floors	114.3625	rectangular
3	7.67	6.18	2-3 floors	47.4006	rectangular
4	8.95	8.46	2-3 floors	75.717	rectangular
5	8.42	6.58	2-3 floors	55.4036	rectangular
6	10.67	7.82	2-3 floors	83.4394	rectangular
7	11.69	7.01	2-3 floors	81.9469	rectangular
8	10.49	5.98	2-3 floors	62.7302	rectangular
9	10.16	6.87	2-3 floors	69.7992	rectangular
10	11.41	4.57	2-3 floors	52.1437	rectangular
11	10.56	4.2	2-3 floors	44.352	rectangular
12	7.95	7.37	2-3 floors	58.5915	rectangular
13	9.33	2.87	2-3 floors	26.7771	rectangular
14	8.98	3.35	2-3 floors	30.083	rectangular
15	5.76	4.19	2-3 floors	24.1344	rectangular

16	8.04	3.23	2-3 floors	25.9692	rectangular
17	12.8	5.74	2-3 floors	73.472	rectangular
18	13.97	5.5	2-3 floors	76.835	rectangular
19	11.71	4.74	2-3 floors	55.5054	rectangular
20	13	5.07	2-3 floors	65.91	rectangular
21	12.26	4.42	2-3 floors	54.1892	rectangular
22	12.41	5.09	2-3 floors	63.1669	rectangular
23	9.16	3.99	2-3 floors	36.5484	rectangular
24	8.15	4.72	2-3 floors	38.468	rectangular
25	8.43	6.12	2-3 floors	51.5916	rectangular
26	7.17	5.36	2-3 floors	38.4312	rectangular
27	8.47	4.04	2-3 floors	34.2188	rectangular
28	6.75	5.9	2-3 floors	39.825	rectangular
29	6.97	3.55	2-3 floors	24.7435	rectangular
30	7.93	7.54	2-3 floors	59.7922	rectangular
31	10.11	2.65	2-3 floors	26.7915	rectangular
32	13.86	7.31	2-3 floors	101.3166	rectangular
33	10.70	4.87	2-3 floors	52.109	rectangular
34	13.93	5.30	2-3 floors	73.829	rectangular
35	15.14	7.30	2-3 floors	110.522	rectangular
36	11.51	6.29	2-3 floors	72.3979	rectangular
37	16.19	4.11	2-3 floors	66.5409	rectangular
38	14.32	6.16	2-3 floors	88.2112	rectangular
39	14.59	7.03	2-3 floors	102.5677	rectangular
40	9.47	6.80	2-3 floors	64.396	rectangular
41	4.42	2.6	2-3 floors	11.492	rectangular
42	7.61	2.8	2-3 floors	21.308	rectangular
43	6.61	4.42	2-3 floors	29.2162	rectangular
44	5.41	3.51	2-3 floors	18.9891	rectangular
45	8.79	4.54	2-3 floors	39.9066	rectangular
46	9.61	6.91	2-3 floors	66.4051	rectangular
47	12.7	7.79	2-3 floors	98.933	rectangular
48	12.17	7.08	2-3 floors	86.1636	rectangular
49	8.68	4.09	2-3 floors	35.5012	rectangular
50	8.77	5.43	2-3 floors	47.6211	rectangular
51	8.77	5.28	2-3 floors	46.3056	rectangular
52	8.86	5.33	2-3 floors	47.2238	rectangular
53	7.44	7.27	2-3 floors	54.0888	rectangular
54	7.43	6.97	2-3 floors	51.7871	rectangular
55	12.97	6.59	2-3 floors	85.4723	rectangular
56	14.33	13.95	2-3 floors	199.9035	rectangular
57	5.94	4.95	2-3 floors	29.403	rectangular
58	6.51	5.05	2-3 floors	32.8755	rectangular
59	11.91	4.37	2-3 floors	52.0467	rectangular
60	14.34	5.5	2-3 floors	78.87	rectangular
61	10.11	5.86	2-3 floors	59.2446	rectangular
62	10.34	4.74	2-3 floors	49.0116	rectangular
63	9.9	4.01	2-3 floors	39.699	rectangular
64	12.76	6.69	2-3 floors	85.3644	rectangular
65	14.45	6.08	2-3 floors	87.856	rectangular
66	7.08	4.45	2-3 floors	31.506	rectangular
67	8.15	8.87	2-3 floors	72.2905	rectangular
68	9.97	6.22	2-3 floors	62.0134	rectangular
69	9.02	5.95	2-3 floors	53.669	rectangular
70	6.75	5.70	2-3 floors	38.475	rectangular
71	6.91	5.8	2-3 floors	40.078	rectangular
72	6.39	4.9	2-3 floors	31.311	rectangular
73	14.35	4.25	2-3 floors	60.9875	rectangular
74	8.87	3.53	2-3 floors	31.3111	rectangular
75	8.93	2.76	2-3 floors	24.6468	rectangular

76	9.87	6.63	2-3 floors	65.4381	rectangular
77	13.08	4.31	2-3 floors	56.3748	rectangular
78	14.34	3.44	2-3 floors	49.3296	rectangular
79	8.32	5.34	2-3 floors	44.4288	rectangular
80	8.1	4.99	2-3 floors	40.419	rectangular
81	7.97	6.98	2-3 floors	55.6306	rectangular
82	8.62	4.89	2-3 floors	42.1518	rectangular
83	10.29	5.88	2-3 floors	60.5052	rectangular
84	5.39	5.33	2-3 floors	28.7287	rectangular
85	6.97	6.2	2-3 floors	43.214	rectangular
86	6.70	3.19	2-3 floors	21.373	rectangular
87	5.8	3.45	2-3 floors	20.01	rectangular
88	11.41	6.27	2-3 floors	71.5407	rectangular
89	13.58	3.09	2-3 floors	41.9622	rectangular
90	10.07	3.23	2-3 floors	32.5261	rectangular
91	11.34	2.66	2-3 floors	30.1644	rectangular
92	12.93	3.27	2-3 floors	42.2811	rectangular
93	12.94	10.73	2-3 floors	138.8462	rectangular
94	12.01	6.36	2-3 floors	76.3836	rectangular
95	12.11	4.27	2-3 floors	51.7097	rectangular
96	13.34	4.65	2-3 floors	62.031	rectangular
97	12.64	4.88	2-3 floors	61.6832	rectangular
98	10.34	6.46	2-3 floors	66.7964	rectangular
99	11.38	8.02	2-3 floors	91.2676	rectangular
100	8.95	6.47	2-3 floors	57.9065	rectangular

## Coastal Development

Economically, the fishermen face income volatility attributable to declining fish stocks and environmental degradation. While there is demonstrable community interest in pursuing ecotourism and sustainable fisheries development, progress is constrained by limited technical expertise and financial capacity. The integration of coastal area mapping into the development planning of Kamal Muara Kampung underscores the spatial complexities inherent in addressing both environmental and social challenges. Sustainable development strategies must prioritize initiatives such as mangrove restoration and infrastructural enhancements to bolster community resilience. Moreover, participatory approaches that actively involve local fishermen are essential to ensure that development plans are responsive to the community's needs and socio-economic realities.

## CONCLUSION

This study emphasizes the critical role of coastal area mapping as a foundational instrument for comprehending and directing the development of fishing communities such as Kamal Muara. Within this context, mapping serves as a critical tool to visualize the kampung's spatial organization comprehensively, while facilitating the regulation and management of kampung architectural forms. The methodology involves decomposing the kampung into spatial layers, enabling the systematic categorization and design of architectural typologies through simulation and model projection. This approach advances the conceptualization of the kampung beyond the house as an isolated core, positioning Kamal Muara within a broader urban network situated in a coastal context. Consequently, the generated projections and simulations represent an extrapolation grounded in empirical spatial data rather than a mere imposition, thereby supporting informed planning and sustainable transformation of future kampung spaces. Algorithm holds key recommendations include the implementation of systematic coastal monitoring through Geographic Information Systems (GIS) to track environmental dynamics; the reinforcement of community-led kampung restoration initiatives; the development of infrastructure projects targeting improvements in sanitation and transportation; the promotion of multi-stakeholder cooperation involving governmental agencies, non-governmental organizations, and local residents; and the exploration of alternative livelihood opportunities based on suggested structural types to stimulate novelty, such as ecotourism, to enhance income diversification. However, effective coastal management still necessitates interdisciplinary collaboration and active community participation to facilitate sustainable livelihoods while ensuring ecological conservation.

## ACKNOWLEDGEMENT

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