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## **LAYERED SPATIAL ADAPTATION IN INFORMAL COASTAL SETTLEMENTS TOWARD URBAN RESILIENCE**

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### **Abstract**

Rapid coastal urbanization in the Global South intensifies development pressures on informal settlements situated between metropolitan expansion and ecologically fragile coastal zones. Existing studies often frame adaptation as microscale housing modifications or climate responses, providing a limited understanding of how spatial change accumulates over time at the settlement scale. This study examines layered spatial adaptation in the informal coastal settlement of Tanjung Bunga, Makassar, Indonesia. Using a qualitative case study approach, it integrates spatial mapping (QField), morphological analysis, GIS-based reconstruction from satellite and topographic data, and qualitative coding (NVivo 12 Plus) to trace the transformation from the 1980s to 2024. The findings identify four overlapping phases: (1) vernacular ecological adaptation rooted in fishing livelihoods; (2) infrastructure-induced spatial reorientation following metropolitan road development; (3) tourism-driven economic consolidation through hybridization of domestic space; and (4) territorial negotiation characterized by access control and communal spatial claims. These phases coexist as layered spatial configurations that reorganize circulation networks, dwelling orientation, communal nodes, and coastal-edge use. The study conceptualizes informal coastal settlements as territorialized adaptive assemblages, where adaptation unfolds cumulatively under ecological and metropolitan pressures. Spatial plasticity enables communities to negotiate territorial agency and move toward resilience without erasing vernacular spatial logics.

**Keywords:** Coastal Settlements, Layered Spatial Adaptation, Territorialized, Adaptive, Urban Informality

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## **INTRODUCTION**

Coastal cities in the Global South are experiencing accelerated urban growth, which is increasingly placing informal coastal settlements in heightened vulnerability. Situated at the intersection of metropolitan expansion and ecologically sensitive environments, these settlements face overlapping pressures from urban development, environmental exposure, and socio-spatial marginalization. Historically, coastal areas have functioned as dense nodes of habitation, social interaction, and maritime-based economic exchange (Cain, 2014; Xie, 2023). However, adaptation is frequently framed as short-term or technical responses to environmental risks such as flooding and erosion, offering limited insight into how spatial transformation unfolds over time (Goyal & Lima, 2024; Iguait et al., 2023).

Contemporary urban theory positions informality as an active mode of spatial production shaped by self-organization and incremental adaptation (Dovey, 2012; Kamalipour, 2016). Informal morphologies persist and evolve despite formal interventions. Research on post-enhancement settlements demonstrates that transitions from stigmatized informal areas to recognized urban spaces reshape residents' perceptions of environmental quality and livability (Fidelista et al., 2025). However, studies of coastal informality often separate environmental adaptation from analyses of urban form and settlement morphology. While both indigenous strategies and modern coastal defenses reshape livelihoods and spatial configurations, few studies examine how these processes accumulate and interact over time within informal coastal settlements. Evidence from southeastern Ghana shows that hard-engineering defenses may reduce erosion but restrict coastal access and disrupt fishing livelihoods, revealing tensions between physical protection and socio-spatial sustainability (Loor, 2021). Adaptation thus remains conceptualized as discrete measures rather than as an evolving spatial process embedded in settlement structure.

Empirically, this study is situated in Indonesia, a maritime nation with one of the world's longest coastlines and a population heavily concentrated in coastal regions (Werich, 2015). Coastal communities, often low-income and socially vulnerable, develop adaptive strategies shaped by settlement history, tenure systems, and social solidarity (Dewi et al., 2021; Syarif et al., 2015). The research focuses on Makassar, a strategic coastal city in South Sulawesi and part of the Mamminasata Metropolitan Area, particularly the Tanjung Bunga coastal settlement. Originally a vernacular fishing settlement, Tanjung Bunga underwent significant transformation following the construction of the Metro Tanjung Bunga Road in the mid-1990s, which became a key axis of metropolitan expansion. This infrastructure triggered land conversion, commercial growth, and tourism development (Surya, Hadijah, et al., 2020), prompting local communities to occupy residual spaces and reorient livelihoods toward informal and

community-based tourism activities in Tanjung Bayang, Anging Mammiri, Pantai Biru, and Layar Putih.

These dynamics suggest that coastal informality in Tanjung Bunga is not merely a condition of marginality but a layered spatial system continuously reassembled through vernacular practices, infrastructural shifts, metropolitan political economy, and ongoing negotiations toward resilience amid rapid coastal transformation.

## **LITERATURE REVIEW**

### **Adaptation as spatial practice in informal settlements**

In settlement and architectural studies, adaptation is commonly understood as a response to environmental, social, and economic pressures through spatial adjustments and everyday dwelling practices (Nelson et al., 2007). Early environmental behavioral approaches framed adaptation as an effort to align spatial configurations with user needs and environmental constraints (Altman et al., 1980). Although foundational for explaining human-environment relations, these perspectives essentially positioned adaptation as a corrective, technical mechanism, paying insufficient attention to social negotiation, power relations, and the temporal dynamics shaping long-term spatial transformation.

Architectural discourse later expanded this understanding through the concept of adaptability, emphasizing the capacity of built space to accommodate change without losing its core functions (Douglas, 2016; Kronenburg, 2007). By foregrounding flexibility and temporality, adaptability theory recognized buildings as evolving entities rather than static artifacts. However, it primarily treated buildings as discrete objects, overlooking settlements as socially negotiated spatial systems. Consequently, it often reduced adaptation to physical modification. At the same time, collective practices, urban pressures, and governance dynamics remained underexamined, an analytical limitation particularly evident in informal settlements where spatial change is inseparable from everyday survival strategies.

### **Layered and Incremental Spatial Adaptation**

To move beyond reductionist views of adaptation as merely technical adjustment, layered adaptation theories provide a broader analytical lens. Schmidt III & Austin (2016) conceptualize the built environment as a multilayered system in which urban context, infrastructure, spatial organization, and social practices evolve at different temporal rhythms. Adaptation thus unfolds through accumulation and coexistence rather than replacement. However, this framework has been applied mainly to formal settings, leaving informal and resource-constrained contexts underexplored.

Research on informal settlements supports incremental and layered perspectives. Turner (1977) and Dovey (2013) argue that spatial change emerges through localized decision-making and gradual adjustment, while Kamalipour (2016) frames informality as self-organized morphology capable of persisting despite eradication efforts. However, much of this scholarship remains focused on inland and micro-scale dynamics, offering limited insight into how incremental adaptations accumulate into long-term, settlement-scale transformation. Spatial plasticity is the capacity of space to be modified without losing function (Asikin, 2018; Marinovic, 2023). Extends this discussion but is often confined to individual housing units. In informal coastal contexts, adaptation is commonly framed as environmental risk response, such as stilt construction or coastal defenses (Goyal & Lima, 2024; Iguait et al., 2023; Widya et al., 2025). Evidence from Ghana highlights tensions between state interventions and local livelihoods (Loor, 2021). Under pressures of reclamation and large-scale development (Dodman et al., 2019; Liang et al., 2022), adaptation becomes negotiated. This study, therefore, conceptualizes informal coastal settlements as layered spatial systems that express territorial agency under metropolitan pressure.

## **RESEARCH METHODOLOGY**

Field observations were conducted systematically across segmented coastal units in Tanjung Bayang, Anging Mammiri, Pantai Biru, and Layar Putih (Figure 2). This segmentation served as an analytical framework for examining variations in incremental spatial adaptation at the settlement scale, including building patterns, residential clustering, household-based business groupings, and circulation networks linking dwellings to coastal and economic zones. The approach enabled tracing morphological transformation as a layered process of spatial addition, expansion, and reconfiguration. The researchers collected data through semi-structured in-depth interviews, field observation, and spatial analysis. Seven second-generation residents were selected through snowball sampling based on their long-term experience prior to the new town's development. Interviews (45–90 minutes) explored settlement phases, adaptation strategies, livelihood shifts, and public–private spatial changes. All interviews were conducted in Indonesian, recorded with consent, transcribed verbatim, and anonymized (I1–I7).

Temporal reconstruction employed field digitization (QField for QGIS, Global Mapper Mobile) combined with historical and satellite data: the 1991 Makassar Topographic Map (ANRI, 2025), Google Earth imagery (2000–2025), and Makassar satellite maps (2024). To ensure geometric consistency and cross-period comparison, we aligned all datasets in ArcMap 10.8. From these verified GIS outputs, we produced morphological diagrams and settlement distribution maps based on our field observations. The authors ensured reliability through multi-source triangulation and member checking. They cross-validated interview

data with satellite imagery and historical maps to verify shoreline shifts and changes in settlement patterns. Furthermore, the authors conducted qualitative analysis in NVivo 12 Plus using iterative inductive–deductive thematic coding grounded in layered spatial adaptation and adaptive assemblage as proposition theory.

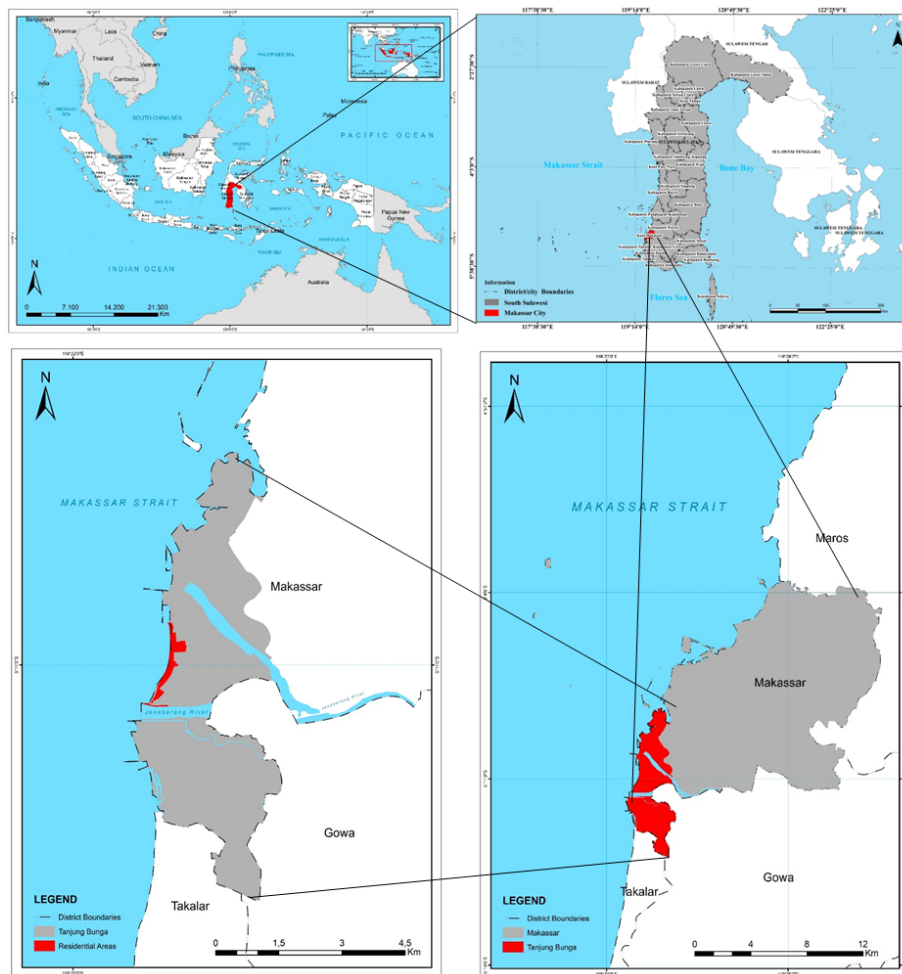


**Figure 1:** Location of study area, coastal settlement in Tanjung Bunga New Town, Makassar

*Source: Regional Spatial Plan of South Sulawesi Province (RTRW) 2009-2029; Makassar City RTRW 2015-2034; self-digitization by Author (2025)*

## RESULTS AND DISCUSSION

### Periodization of Spatial Adaptation in Tanjung Bunga

Periodization was used as an analytical framework to examine spatial adaptation in Tanjung Bunga coastal settlements, focusing on key spatial and infrastructure events. Based on spatial mapping, systematic field observations, and qualitative data coding, the transformation of the Tanjung Bunga coastal settlement can be classified into four main phases of spatial adaptation, as illustrated in Figure 4 (A-E). Each phase represents a distinct configuration of settlement morphology, spatial orientation, and functional organization, indicating that adaptation unfolded incrementally rather than through abrupt or comprehensive restructuring. Figure 3 traces the chronological evolution of key spatial elements from 1989 to 2024, highlighting changes in circulation systems, dwelling orientation, communal spaces, and the utilization of the coastal-edge zone.

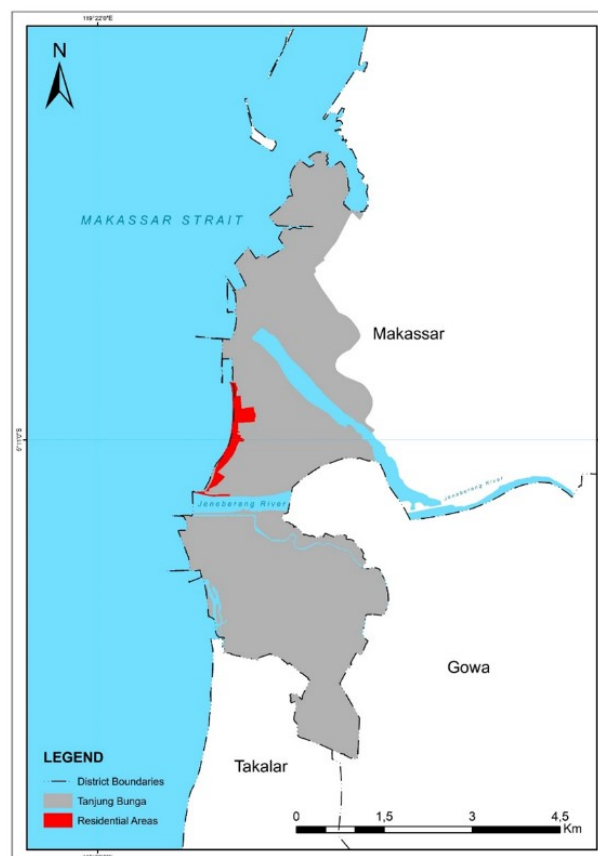


**Figure 2: Observation Point Location**

Source: Makassar City RTRW 2015-2034; self-digitization by Author (2025)

### **1. Vernacular Coastal Settlement Phase (Pre-1991)**

Prior to the development of Tanjung Bunga New City, the area was a traditional, fishery-based and agricultural settlement with strong ecological dependence and a water-oriented spatial organization. In the vernacular phase, morphology is formed from the need to inhabit the transition zone between the sea and wetlands. As seen in Figure 3 (1989), the spatial structure develops linearly along the pond (the pond divider), which functions as ecological infrastructure, a circulation route, and a central space organizer. *Pematang* connects clusters of stilt houses, ponds, rice fields, and coastal activity zones.

Unlike the general pattern along the coastline, micro land lanes above the embankment path (*pematang*) form the spatial axis of Tanjung Bunga. These lanes provide higher access to inundation-prone land while maintaining pond productivity. Internal mobility relies on pedestrian movement across narrow embankments that remain accessible when flooded (Informant 1), connecting dwellings, ponds, rice fields, and communal spaces (Informant 2). River routes dominate external mobility; boats served as a link to markets, schools, and city centers along the Jeneberang River before the advent of formal roads (Informant 3; Informant 6).

Residents strategically place their homes to maintain dual land-water access and reduce the risk of high tide. They arrange the stilt houses in a linear, sea and circulation-path-oriented manner to respond to wind and mobility. Specifically, houses in Tanjung Alang Village (Anging Mammiri and Pantai Biru) face the sea; those in Lette Village (Layar Putih Beach) orient toward the moor, and residences in Kampung Bayang (Tanjung Bayang) follow the boundary of the pond. Communal elements such as *bale-bale* (fisherman shelter) function as social productive nodes for rest, repair nets, and coordination (Informant 3). Overall, this phase represents nature-based spatial adaptation, integrating ecology, livelihoods, mobility, and social organization into a permeable, flexible spatial system.

### **2. Infrastructure Transition Phase (1992-2010)**

The construction of the Tanjung Bunga Metro Road in 1996 became a turning point in the spatial organization of coastal settlements. This intervention triggered a gradual shift from a water-based, embankment system towards a land-oriented system structured by metropolitan corridors. As seen in Figures 4B and 5 (2000), Jalan Metro introduces a new mobility hierarchy, making land connectivity the primary reference for settlement growth and reorganization.

Prior to the presence of formal roads, spatial structures were formed through a network of embankments and dense soil paths, associated with kinship-based land cultivation and soil cultivation (Informant 4). Instead of removing these paths, the community gradually widens and integrates them, allowing the

vernacular configuration to remain alongside the new infrastructure. In the same period, the tourism industry emerged in Tanjung Bayang (1997) as residents constructed simple *bale-bale* (tourism shelter) on the beach. However, this phase does not yet reflect the consolidation of the tourism economy because access to the coast is not yet fully connected to the center of Makassar City via the Metro corridor; visitors still depend on the Barombong Bridge, so the flow of tourists remains local and limited.

In this context, Jalan Metro catalyzes selective adjustment rather than total replacement. Residents reoriented their residences and activity spaces towards the new road as a corridor to the city center (Informant 5), while still maintaining ponds and water-based access in daily practice. Locals gradually negotiate this shift from the water–terrestrial logic to the terrestrial system (Figure 5, 2000).

Adaptive responses differ between segments. In Tanjung Bayang, the community widened the dam and integrated it into the city's road network, which led to the emergence of initial tourism. In Anging Mammiri, adaptation occurs organically through incremental land access, and the northern sector (Tanjung Alang) is directly connected to the metropolitan corridor first. In Biru Beach, land acquisition triggered on-site relocation and a shift in kinship clusters to the coastline. In the White Screen, new access openings begin to form the initial territorial boundaries. Overall, this phase results in a hybrid configuration, suggesting that spatial adaptation occurs through layered accumulation rather than abrupt structural jumps.

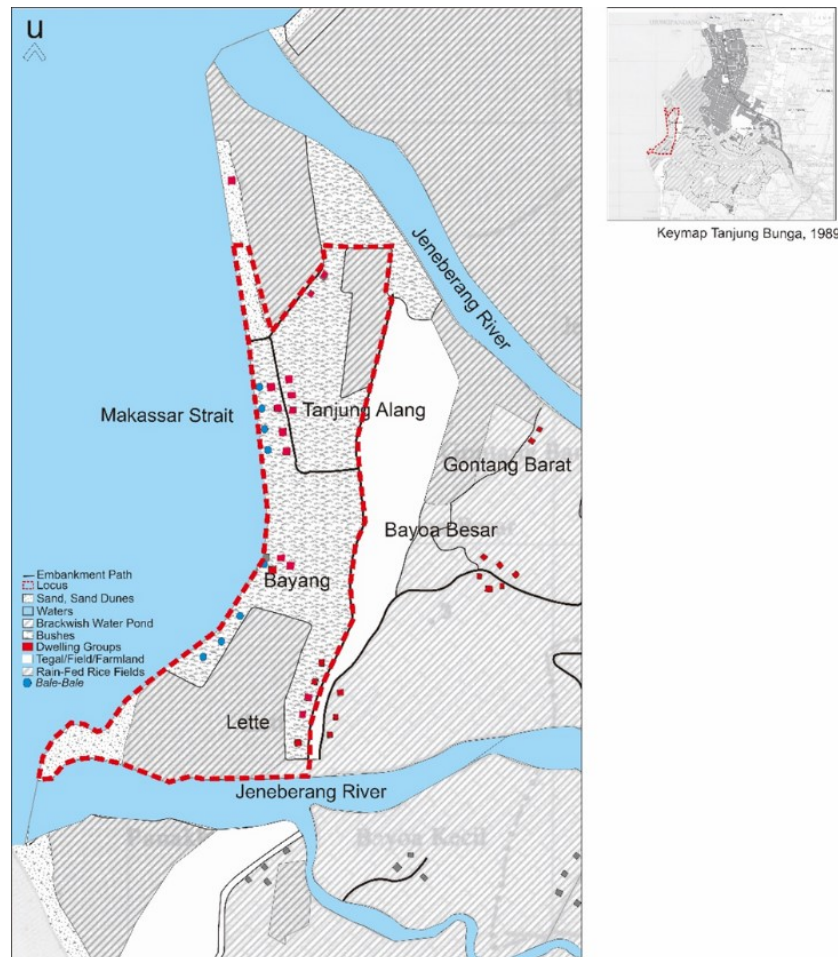


**Figure 3:** Distribution of Dwelling Groups Vernacular Settlement Phase (1989)  
*Source: Derived from Ujung Pandang Topographic Map (1991); Field Note (2024); Field Interview Interpretation (2024)*

In the late 1990s, the city's infrastructure did not fully connect Tanjung Bayang Beach to Makassar's urban core. Because the Metro corridor remained incomplete despite ongoing road development, access depended primarily on the southern route via Barombong Bridge. As a result, visitor flows remained local and limited. As shown in Figure 5A (1989) and Figure 5B (2000), the settlement structure was still predominantly residential, with tourism facilities emerging sporadically and linearly along the shoreline. The early bale-bale followed the coastal edge, reflecting a community-based tourism logic rather than corridor-driven urban growth. Thus, 1997 represents a proto-tourism phase.

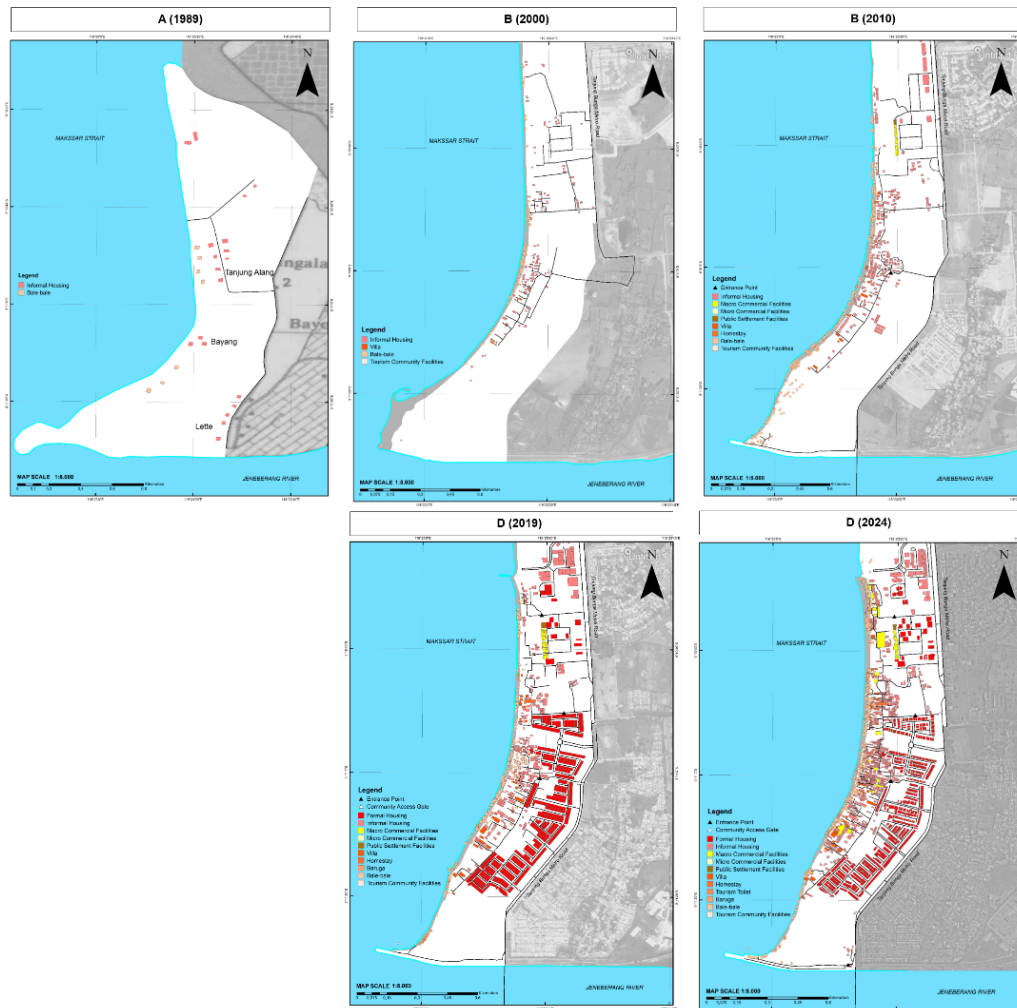


**Figure 4:** Spatial Key Elements of Morphological Coastal Settlement in Tanjung Bunga During the Years of (A) 1980, (B) 2000, (C) 2010, (D) 2019, and (E) 2024

Source: Derived from Ujung Pandang Topographic Map (1991); Google Earth Imagery of Tanjung Bunga (2025); and Tanjung Bunga Satellite Imagery (2024);  
 Author's Field-Based Digitization Mapping (2023–2024)

A decisive shift occurred in 2010 (Figure 5C), when infrastructure became functionally integrated, improving accessibility and intensifying urban flows. Tourism growth in Pantai Akkarena and Tanjung Bayang generated spillover effects, prompting residents in Anging Mammiri to replicate the beach-tourism model. Figure 5C shows the emergence of villas, lodgings, and beach-oriented dwelling clusters, indicating a more systematic and economically

integrated adaptation. Rising visitor numbers led to incremental functional hybridization of domestic spaces. Residents maintained residential continuity in their homes while incorporating food stalls, homestays, public toilets, and rental facilities along the front-layer plots facing the shoreline. They repurposed the underfloor spaces of their stilt houses for parking and tourist services. Furthermore, the community redefined *bale-bale*, formerly fishermen's shelters (Figure 5A), as semi-public tourism shelters (Figure 5C), reflecting a shift toward economic logic and blurred public-private boundaries. As noted by Informant 3, these changes were perceived not as a loss of domestic meaning but as partial adjustments, illustrating layered spatial adaptation rather than wholesale transformation.

### **3. Territorial Intensification Phase (Post-2019)**

The post-2019 phase shows a shift from economic-functional adaptation to territorial intensification, encompassing spatial, symbolic, and economic expansion. This process is not uniform, but manifests differently in each case unit. In the Tanjung Bayang Beach Settlement, a random and high-density fishing village, intensification is marked by the strengthening of residential-based tourism. On a micro scale (footprint), residents transform their stilt houses into homestays, adding *bale-bale*, gazebos, and tourist toilets, while repurposing the underside of the houses for parking and tourist services. Adaptation takes place incrementally; residential sites become spaces for economic negotiation as well as symbols of the community's claim to coastal space as sustainable.

In the Pantai Biru Coast Settlement, intensification occurs through kinship mechanisms and access controls. On a meso scale, negotiations with developers resulted in access restrictions, the establishment of an inlet, and the strengthening of family-based controls. Territorial strengthening is achieved through access regulation and social legitimacy, not just densification. Therefore, the spatial pattern is more structured along the coastline, with a linear composition of residential, parking, and business space. A very prominent mechanism is kinship-based zoning. The community organizes spatial order along family clans to secure control over land and coastal access. They use physical elements such as entrance gates and guard posts as symbols of spatial control over the outside.

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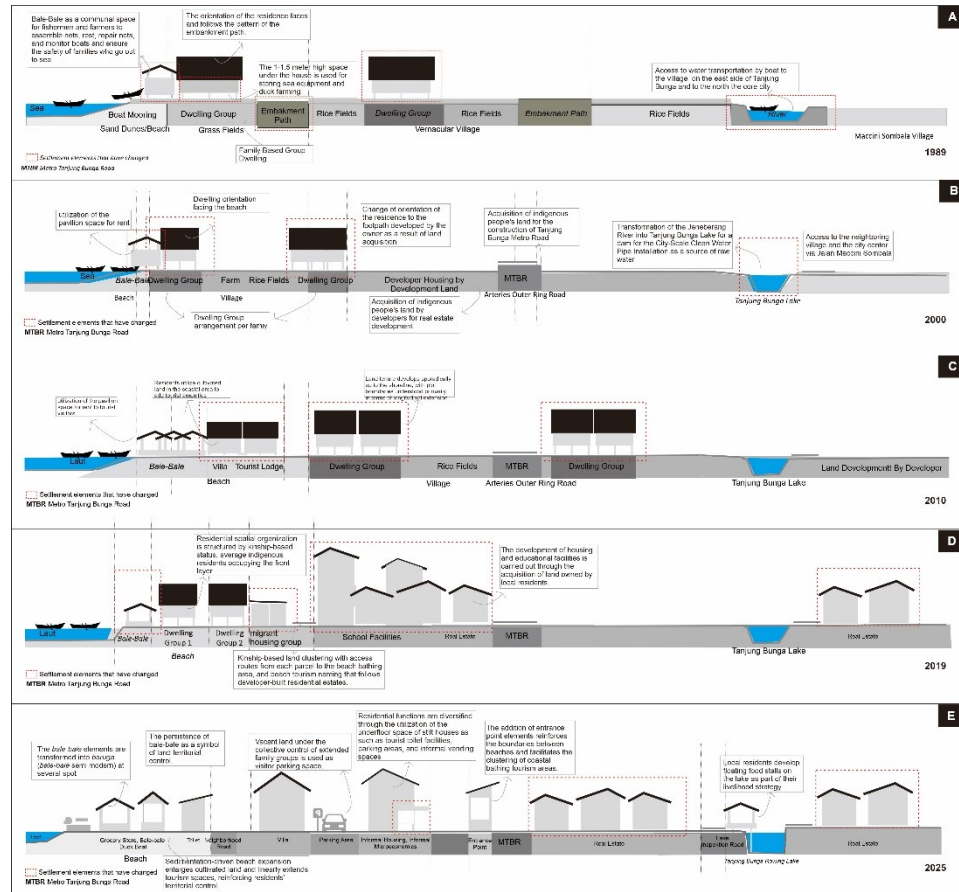


**Figure 5:** Longitudinal cross-sectional evolution of informal coastal settlements showing the adaptation of dwelling groups, micro-economic spaces, and public-private interfaces over three decades (1989, 2000, 2010, 2019, 2025)  
 Source: Field Interview Interpretation (2024); Google Earth (2000-2025)

In contrast to other cases, in Biru Beach, the adaptation mechanism involves symbolic reinforcement through the White Screen Monument. This structure predates the development of the Tanjung Bunga New City Area. The intensification was then marked by the addition of baruga and bale-bale as business spaces for settlers as well as land cultivators who play a role in protecting the developer's land. Fishing tourism activities and sunset views from Layar Putih are the main selling points of the area, which is directly adjacent to the river mouth and managed by the Kampung Lette fishermen's group. This configuration serves as a visual statement of the community's presence and their claim to the estuary area bordering government and developer land. The land

guard community consists of land guards from developers and the river area authority, who then move to the mainland due to abrasion and build guard houses near the entrance post to consolidate their presence and spatial control.

## DISCUSSION

This study again reflects the tendency of the still-dominant adaptation literature to position spatial adaptation as a technical response to environmental risks or as a partial economic adjustment. Although incremental adaptations have been recognized (Turner, 1977; Dovey, 2012), how these changes accumulate and are organized at the settlement scale, especially in informal coastal contexts, remains relatively limited. The findings in Tanjung Bunga show that adaptation occurs as a layered spatial accumulation rather than a series of disconnected changes.

As shown in Figure 5A-5E and formulated in Figure 6, the four phases, namely vernacular, infrastructure transition, tourism, and territorial intensification, do not replace each other, but coexist in one configuration of settlement morphology. The vernacular phase forms the ecological foundation through maturation, sea orientation, and communal *bale-bale*. The infrastructure transition phase reorients circulation to the Metro corridor without removing the old network, resulting in hybrid mobility. The tourism phase presents a mixed residential-economic function through incremental domestic refunctionalization. Since 2019, adaptation has shifted toward territorial intensification through kinship clustering, access arrangements, entry gates, and the transformation of *bale-bale* into *baruga* as a semi-permanent communal-economic node (Figure 5D).

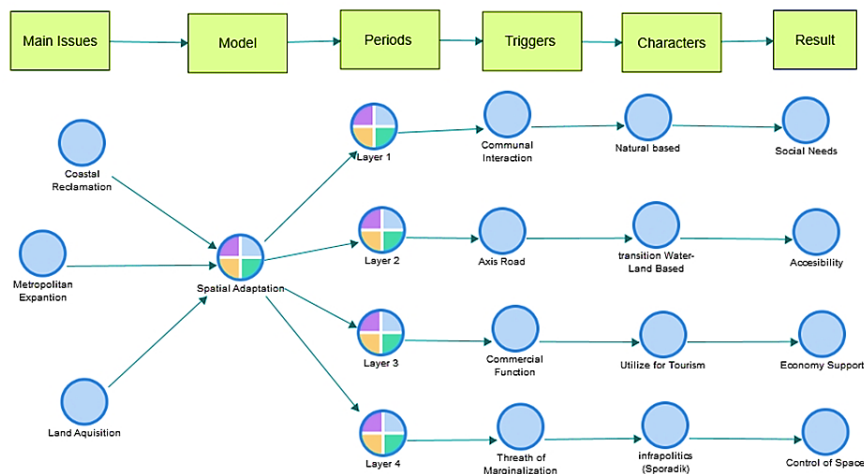


**Figure 6:** The Four Phases of Adaptation Forming Spatial Layers in Tanjung Bunga Coastal Settlement

Beyond the spatial and economic mechanisms identified above, the findings reveal a dimension of social practice that operates continuously across all four phases: what this study terms "Everyday Play." This concept refers to the informal, recurrent, and non-instrumental social activities enacted in shared communal spaces, including collective net repair and conversation at *bale-bale* nodes, children's Play along the coastal edge, informal social exchange among residents at beachfront gathering areas, and communal leisure practices at Tanjung Bayang, Anging Mammiri, Pantai Biru, and Layar Putih. These activities are not peripheral to the settlement's adaptive logic; rather, they constitute a form of everyday social practice that reproduces interpersonal bonds, reinforces collective identity, and sustains the social capital necessary for coordinated territorial action (Nelson et al., 2007). Critically, Everyday Play persists across shifting economic and infrastructural conditions: *bale-bale*, which once hosted fishermen's rest and net repair (Phase 1), later accommodated tourist interaction and communal tourism coordination (Phase 3), yet the underlying social logic of shared, informal gathering endured. This continuity signals that Everyday Play functions not merely as cultural residue but as an active social resilience mechanism, one that maintains community cohesion and reproduces the relational infrastructure upon which collective adaptive responses depend. As such, it constitutes a qualitative indicator of social resilience that complements the spatial and territorial indicators identified in the morphological analysis.

In contrast to the Dovey adaptive cycle model (growth, conservation, release, reorganization), the Tanjung Bunga case does not show a gradual change in spatial structures that cancel each other out. Instead, ecological, infrastructural, economic, and territorial pressures form a new morphological layer that integrates the previous layers (see Table 1). Key mechanisms of adaptation include the reorientation of the circulation network, the plasticity of residential functions, kinship-based access control, and the strategic occupation of the seaside as an expression of collective territorial agency. Thus, we define this long-term negotiation and layered morphological accumulation under sustained metropolitan pressures as a process toward spatial resilience in settlements. Theoretically, these findings expand the adaptive assemblage framework by formulating territorial adaptive assemblage as a collective spatial system that reassembles circulation networks, residential clusters, communal nodes, and coastal interfaces to strengthen the legitimacy, access control, and sustainability of space without erasing pre-formed spatial logic.

**Table 1:** Adaptive Cycle and Layered Spatial Adaptation under Multi-Salar Pressure

| Dovey Phase<br>(Theoretical)                  | Informal Coastal Settlement in Tanjung Bunga (Empirical) |                                           |                                                                      |
|-----------------------------------------------|----------------------------------------------------------|-------------------------------------------|----------------------------------------------------------------------|
|                                               | Phase                                                    | Dominant Pressure                         | Key Spatial Mechanism                                                |
| <b>Growth</b>                                 | Vernacular                                               | Tides, wetlands, and fishing livelihood   | Linear embankments; sea-oriented houses; bale-bale nodes             |
| Informal expansion; occupation of interstices |                                                          |                                           |                                                                      |
| <b>Conservation</b>                           | Infrastructure Transition                                | Metropolitan road, land acquisition       | Reorientation to Metro Road; hybrid circulation                      |
| Structural stabilization                      |                                                          |                                           |                                                                      |
| <b>Release</b>                                | Tourism                                                  | Tourism economy; rising land value        | Hybrid dwelling functions; mixed-use frontage                        |
| External disruption                           |                                                          |                                           |                                                                      |
| <b>Reorganisation</b>                         | Territorial Intensification                              | Developer expansion; spatial contestation | Entrance gates; kinship clustering; <i>bale-bale</i> → <i>baruga</i> |
| Reassembly; new territorial configuration     |                                                          |                                           |                                                                      |

## CONCLUSION

This study demonstrates that informal coastal settlements evolve through layered, cumulative spatial adaptations rather than as a linear response to urban expansion. The case of Tanjung Bunga identifies four overlapping phases: vernacular ecological adaptation, transition due to infrastructure, tourism-based consolidation, and territorial negotiation, which coexist in a single settlement morphology, reorganizing circulation, residential orientation, communal nodes, and waterfront utilization while maintaining the initial spatial logic. Theoretically, this study formulates the concept of Territorialized Adaptive Assemblage, which expands on the Dovey adaptive assemblage framework by emphasizing the spatial-territorial dimension of adaptation through access arrangements, kinship-based zoning, and coastal frontage management. The transformation of bale-bales into baruga shows how architectural elements evolved into territorial instruments that sustain the economy and strengthen the claim to collective space. Although these adaptation trajectories are contextual and influenced by kinship networks, local norms, and tenure systems, they offer a relevant analytical framework for understanding how community-based spatial adaptation contributes to resilience in metropolitan coastal areas. Future cross-urban comparative studies should further test this framework.

Beyond territorial and economic dimensions, this study explicitly identifies "Everyday Play", the informal, recurrent social practices enacted in communal spaces such as *bale-bale*, beachfront gathering nodes, and waterfront

promenades, as a qualitative indicator of social resilience. The persistence of these quotidian practices across all four adaptive phases, from vernacular fishing communities gathering at *bale-bale* to residents and tourists co-inhabiting the same spaces in the territorial intensification phase, demonstrates that social cohesion is continuously reproduced through non-instrumental, shared activities. Everyday Play thus serves as a connective tissue between the settlement's ecological, economic, and territorial adaptive layers, sustaining the interpersonal bonds and collective identity that underpin the community's capacity for long-term spatial negotiation under metropolitan pressure.

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