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Spatial Arrangement of Coastal Settlements from the Perspective of Slum Conditions: A Systematic Review

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Abstract.

This study is a systematic review focusing on the spatial arrangement of coastal settlements viewed from the perspective of slum conditions. It aims to analyze and synthesize previous research findings that discuss spatial dynamics, environmental challenges, and adaptive management strategies in coastal residential areas experiencing settlement degradation or slum formation. A total of 32 national and international journal articles were reviewed, selected from approximately 100 initial publications based on thematic relevance and methodological quality. The literature review process was conducted using the Google Scholar and SciSpace databases with the keyword "Coastal Settlements of the Slums." Each article was analyzed and categorized into five main thematic clusters: (1) spatial morphology and transformation, (2) environmental and climatic impacts, (3) physical and social characteristics of settlements, (4) management and adaptation strategies, and (5) governance and housing policy. The synthesis reveals that improving the spatial quality and resilience of coastal slum settlements requires more than physical interventions; it demands an evidence-based integrative approach that combines spatial planning, community empowerment, institutional collaboration, and adaptive, participatory governance. Therefore, this review strengthens the conceptual understanding of spatial–social relationships in coastal environments and emphasizes the importance of interdisciplinary approaches in achieving resilient, inclusive, and sustainable coastal settlements.

Keywords: coastal settlements; spatial arrangement; slum conditions; sustainable development

1 Introduction

Coastal settlements represent one of the most dynamic yet vulnerable urban typologies in the contemporary era. As the interface between terrestrial and marine environments, these areas are characterized by high population density, rapid informal urbanization, and increasing exposure to environmental hazards such as flooding, erosion, and sea-level rise. In many developing countries, particularly Indonesia, coastal zones have become concentrated spaces of socio-economic inequality and ecological degradation. These settlements often evolve informally, lacking adequate infrastructure, sanitation, and spatial planning, while their residents face persistent socio-economic marginalization and environmental risks.

The academic discourse on coastal settlements has expanded significantly in recent years, driven by the urgency of climate adaptation, sustainable development, and spatial justice. However, existing studies tend to focus on specific aspects such as environmental resilience, governance, or typological transformation without integrating them into a holistic analytical

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framework. To address this gap, this review aims to provide a comprehensive synthesis of contemporary research on coastal settlements and slum areas by examining their spatial typologies, environmental conditions, socio-cultural transformations, and governance mechanisms.

The review encompasses 32 journal articles published between 2014 and 2025, spanning cases from Indonesia, countries outside Indonesia, and other coastal regions. These studies collectively contribute to understanding how coastal communities adapt, transform, and negotiate their existence amid urban expansion and environmental change. The objective is to establish a comparative and conceptual foundation that can inform both academic theory and policy implementation toward sustainable coastal urbanism.

In general, the reviewed literature identifies five major domains that structure the analytical discussion: (1) typology and spatial patterns of coastal slum settlements, (2) strategies of transformation and physical upgrading, (3) environmental quality and adaptation to climate change, (4) social and cultural resilience within community systems, and (5) governance and policy frameworks. These interconnected themes provide a comprehensive framework for evaluating the dynamics of coastal settlements from physical, ecological, and socio-political perspectives.

This review contributes to the existing body of knowledge by bridging fragmented perspectives within coastal settlement studies. It integrates physical, social, and institutional analyses to elucidate how informal settlements evolve under the pressures of climate change and urbanization. Moreover, by situating Indonesian cases within global comparative contexts, the study highlights shared challenges and unique adaptive practices that can inspire more inclusive and contextually grounded policy interventions.

2 Method

This section outlines the methodological framework employed in reviewing the selected journals. The review process was conducted systematically to ensure academic rigor and analytical coherence. It involved three main stages: identification of sources, selection and screening, and thematic categorization and synthesis.

2.1 Research Design

This research employs “a systematic qualitative literature review” approach to synthesize existing knowledge on coastal slum settlements and their transformation within environmental, social, and policy frameworks. The review process was designed to identify thematic connections between coastal urbanization, informal settlement dynamics, and climate resilience. The analytical structure integrates both national and international studies to ensure comparative depth and contextual diversity.

2.2 Data Sources and Search Strategy

The data collection process was conducted using two primary academic databases: Google Scholar and Scispace. The keyword phrase *“Coastal Settlements of the Slums”* was applied to both databases to ensure a focused and comprehensive retrieval of relevant literature.

1) From Google Scholar, approximately 100 articles were initially found, later refined to 20 journals after applying inclusion criteria.

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2) From Scispace, 50 articles were identified, and 12 journals were retained after screening.

In total, 32 journals were selected for review, consisting of a balanced combination of national and international publications. These journals represent peer-reviewed studies addressing coastal settlement typology, governance, environmental vulnerability, and adaptive strategies.

2.3 Review Process and Analytical Stages

The review process was carried out in three sequential stages to ensure systematic analysis and conceptual saturation:

1) First Review Stage: An initial assessment of 12 journals was conducted to identify recurring themes, key variables, and conceptual frameworks.
2) Second Review Stage: The next 10 journals were analyzed to validate emerging patterns and expand coverage across different geographic and socio-environmental contexts.
3) Third Review Stage: The final 10 journals were examined to strengthen thematic synthesis and to ensure the inclusion of the most recent studies (up to 2025).

Each review stage contributed progressively to building an integrative understanding of coastal slum dynamics through a comparative, cross-contextual lens.

2.4 Inclusion and Exclusion Criteria

To maintain academic rigor and relevance, the following inclusion criteria were applied:

- Peer-reviewed journal articles published between 2014 - 2025.
- Studies focusing on coastal or waterfront settlements, particularly those categorized as slum or informal housing areas.
- Research addressing one or more of the following aspects: spatial typology, governance and policy, social conditions, infrastructure, or climate change adaptation.

Exclusion criteria included:

- Studies unrelated to coastal environments or focusing on inland urban slums.
- Non-peer-reviewed sources such as reports, theses, or conference proceedings.
- Articles lacking empirical evidence or direct relevance to the research focus.

2.5 Thematic Categorization

Following the analytical process, the 32 reviewed journals were grouped into five thematic clusters representing major dimensions of coastal slum settlement studies:

1) Analysis and Typology of Coastal Slum Settlements – exploring spatial and morphological characteristics.
2) Strategies for Slum Settlement Management and Revitalization – addressing planning and intervention frameworks.
3) Environment and Infrastructure Management in Coastal Slum Settlements – discussing environmental degradation, sanitation, and infrastructure issues.
4) Social Impacts and Climate Change Effects on Coastal Settlements – examining social vulnerability, livelihood, and climate resilience.

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5) Governance and Policy of Coastal Settlements – evaluating institutional frameworks, policy gaps, and community participation.

This thematic categorization provided a structured framework for synthesis, enabling the comparison of interrelated findings across spatial, social, and policy dimensions.

2.6 Data Extraction and Synthesis Method

Each selected journal was reviewed through structured content analysis. Key variables such as research objectives, methodological approaches, case study locations, and findings were extracted. These data were then coded according to the five thematic clusters. The synthesis followed a narrative integrative approach, emphasizing patterns, contrasts, and policy implications across studies.

2.7 Schematic Overview of the Review Process

The overall workflow of the journal selection and review process can be summarized as follows:

1) Keyword Search
   Literature searches were conducted using the main keyword "*Coastal Settlements of the Slums*".
2) Database Identification
   - Google Scholar yielded 100 articles, 20 of which were selected based on relevance.
   - Scispace generated 50 articles, with 12 selected after the screening process.
3) Total Selection (32 Journals)
   The final selection results from both databases were compiled into 32 journals for analysis.
4) Three-Stage Review Process
   The analysis was conducted in three stages of in-depth screening (12 + 10 + 10 journals) to ensure data quality and relevance.
5) Thematic Categorization
   Based on the review results, the journals were categorized into 5 analytical clusters for the thematic synthesis process.

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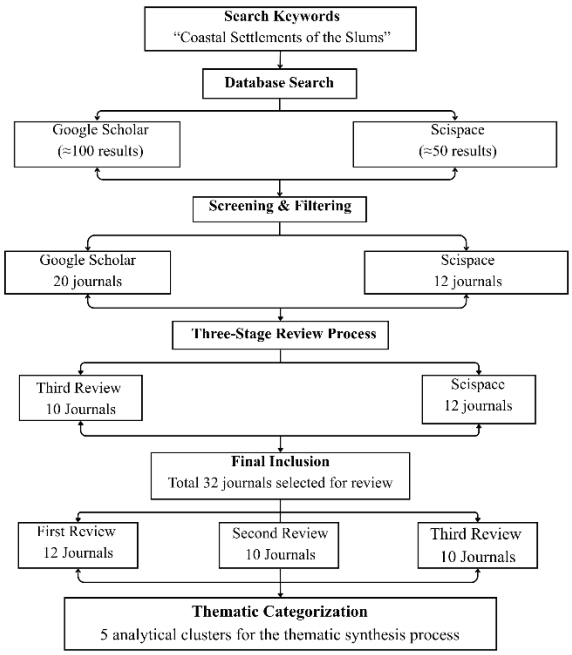

Figure 1. Flow diagram of journal identification and thematic review process.

3 Result and Discussion

3.1 Analysis and Typology of Coastal Slum Settlements

The typology of coastal slum settlements reflects the intersection of physical, spatial, and ecological conditions shaped by both local socio-economic dynamics and broader processes of urbanization. A series of studies reveals that these settlements evolve through a combination of morphological transformation, infrastructural decline, and environmental vulnerability, resulting in complex spatial typologies that vary across geographic contexts.

Elements of Integration and Spatial Morphology

The study *Elements That Shape Slum Integration: A Systematic Review* identifies nineteen key elements that shape the integration between slum settlements and formal urban areas. Eleven of these are physical elements such as road networks, accessibility, public open spaces, and infrastructure while eight are socio-economic factors, including local wisdom, social networks, and community empowerment. The results demonstrate that physical aspects play a more dominant role than socio-economic aspects in driving integration, with a ratio of 61 to 32. These elements collectively help reduce spatial segregation between slum and formal urban territories (Ekawati et al., 2023).

Complementarily, *Flood-related Challenges and Impacts within Coastal Informal Settlements: A Case from Lagos, Nigeria* provides a typological perspective based on flood vulnerability. The study shows that informal coastal settlements in Lagos are typically located in flood-prone zones, characterized by low-quality housing and inadequate infrastructure. Spatial analysis from 1990 to 2020 reveals an increase in built-up area from 27.5% to 70.6% and a significant decline in wetland coverage, exacerbating flood vulnerability (Adegun, 2023). Together, these findings demonstrate that coastal slum typologies are shaped by spatial-

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physical dynamics and ecological pressures, where land-use change and infrastructure quality serve as key indicators of vulnerability.

Physical and Environmental Degradation in Indonesian Coastal Settlements

Indonesian case studies reveal comparable patterns of degradation and typological complexity. *Analisis Permukiman Kumuh Kelurahan Buloa Kecamatan Tallo Kota Makassar* highlights poor physical conditions damaged wooden bridges, inadequate drainage, and limited sanitation access especially in RT 008 RW 002, categorized as severely slum. Around 12% of households lack toilets, leading to direct wastewater discharge into rivers and the sea (Sampebua et al., 2022).

Similarly, *Analisis Tingkat Kekumuhan Permukiman Pesisir di Kecamatan Abeli Kota Kendari* quantitatively measures slum intensity using national housing indicators, identifying moderate (index 2.5–3.4) and severe (index 3.5–4.4) slum classifications. Contributing factors include high building density, drainage blockage, and limited accessibility (Asyfa et al., 2021). Other studies further expand this perspective. *Concept Development of Housing and Settlement of Coastal Areas Based on Eco-Green* (Babelan and Tarumajaya Districts, Bekasi) identifies compact, unplanned fishing settlements with minimal green spaces, poor waste management, and groundwater dependency (Zefri, 2019). Similarly, *Coastal Settlement Resilience to Water-related Disasters in Semarang City* classifies Mangkang Kulon and Mangkang Wetan as less resilient areas, fulfilling only 6-8 of 13 physical resilience indicators such as construction quality, drainage, and sanitation (Zefri, 2019).

Collectively, these studies define two dominant categories: (1) physically and environmentally degraded coastal slums, characterized by dense, unplanned structures and low-quality infrastructure; and (2) ecologically vulnerable settlements, exhibiting exposure to floods and coastal hazards.

Local Typologies and Socio-Spatial Variation

The *Study of Patterns to Handling Slum Settlements in Bandar Rahmat Village, Batubara Regency* identifies seven physical indicators building conditions, drainage, water access, and waste management classifying the area as moderately to severely slum. The study attributes environmental degradation primarily to poor drainage and solid waste systems, with irregular spatial arrangements typical of fishing communities (Hidayat et al., 2021).

In *Typology of Slum Areas in Baubau City*, three major typologies are identified: traditional kampong, riverbank, and coastal settlements. Using Principal Component Analysis (PCA), the study concludes that management priorities vary by type, with riverbank areas requiring the highest intervention (Zain et al., 2018). Similarly, *Konawe Coastal Settlements* show encroachment along riverbanks, frequent flooding, poor sanitation, and inadequate infrastructure conditions that render the area unfit for habitation under current spatial plans (Anggraini et al., 2021). Coastal fishing communities such as those in Pohuwato further exhibit moderate slum conditions, where residents live below the poverty line amid insufficient infrastructure and environmental challenges (Wunarlan et al., 2020).

Global Comparisons and Universal Patterns

On a global scale, similar conditions are observed in megacities such as Mumbai, where over half the population resides in overcrowded, unsanitary slum settlements. Rapid urbanization combined with weak planning and ineffective housing policy has exacerbated

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these issues (O'Hare et al., 2014). In Indonesia, Tanjung Mas in Semarang exemplifies a dense coastal slum with substandard housing and inadequate infrastructure (Dewi et al., 2022). Coastal slums worldwide thus share common structural weaknesses limited infrastructure, poor environmental management, and low social welfare.

Consistent with this, Bagan Deli in Medan presents severe degradation, marked by substandard housing, limited clean water access, and significant waste accumulation along coastal zones (Putra, 2016). *Kampung Nelayan* in Makassar displays moderate-to-severe slum conditions with poor drainage and informal layouts (Agus et al., 2023), while *Batusitanduk* in Luwu demonstrates moderate typologies with unplanned building arrangements, high density, and poor roads (Baharuddin, 2023). In *Kampung Tua Tiangwangkang*, Batam, slum levels reach 39%, dominated by overcrowding and direct wastewater discharge into the sea (Rangkuty et al., 2023).

Other cases, such as Ternate City, report moderate slum levels (≈20%) due to insufficient fire protection, waste, and drainage systems (Ginting & Rarasati, 2025), while *Makalehi* in Sitaro is categorized as lightly slum (score 32), characterized by linear and clustered spatial forms due to limited land, poor drainage, and inadequate clean water (Amal et al., 2024). In contrast, *Telaga Tujuh Village* in Aceh exhibits severe slum conditions, including deteriorated housing, poor roads, weak drainage, and high fire risk (Puspita et al., 2025). Similarly, *Tanjungmas* in Semarang is marked by chronic flooding, limited space, and uncontrolled expansion (Ariaoktafiani, 2024).

Typological Transformation and "Slumification" Processes

Beyond Indonesia, *Varkala, India* illustrates unplanned urbanization driven by tourism, leading to land-use transformation and coastal fragility. Agricultural areas have been converted into tourism infrastructure, increasing construction density and uncontrolled development (Lakshmi & Shaji, 2016). In contrast, the concept of "slumification" explains the regressive transformation of previously improved informal settlements under neoliberal pressures and legal insecurity (Azhar et al., 2021). These frameworks collectively reveal both upward and downward trajectories of urban informality.

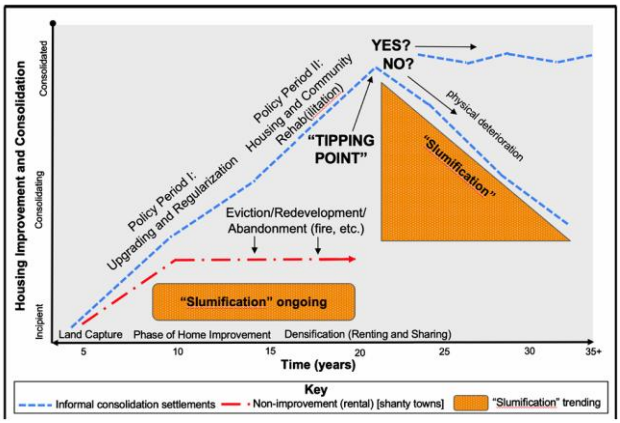

Figure 2. Trajectories of Consolidation and Possible Slumification in the Absence of Policies of Housing and Community Rehabilitation. (Diagram courtesy of Holly Buttrey and Sophie Morse).
(Azhar et al., 2021)

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Globally, slum formation has been interpreted as a byproduct of rapid rural urban migration and inadequate planning (Tahsina Taher & Ibrahim, 2014). Typical typological markers include overcrowding, unsanitary conditions, and poor housing quality. Informal settlements are globally prevalent, unplanned, and legally insecure environments housing over one billion people (Atkinson, 2024), often located in environmentally sensitive areas and lacking infrastructure, thus posing major challenges for sustainable urbanization.

Localized Typological Criteria and Spatial Heterogeneity

Within the Indonesian context, *Suryandari and Widyawati (2019)* introduce a typological classification based on seven physical criteria: building condition, road infrastructure, water supply, drainage, wastewater, solid waste, and fire protection (Suryandari & Widyawati, 2019). Findings in Muara Angke show that settlements range from moderately to highly degraded, illustrating spatial and infrastructural heterogeneity even within localized contexts. This micro-scale typological mapping underscores the multidimensional nature of slum formation along Indonesia's coastal zones.

Figure 3. Conditions connecting roads between houses
(Suryandari & Widyawati, 2019)

Synthesis and Conceptual Implications

Across all reviewed studies, coastal slum typologies emerge as dynamic outcomes of spatial inequality, infrastructural neglect, and ecological degradation. Whether viewed through the lens of integration, degradation, or transformation, coastal slums consistently reflect systemic vulnerabilities exacerbated by environmental and socio-economic pressures. The reviewed literature emphasizes the necessity of an integrative analytical framework linking urban morphology, environmental resilience, and spatial governance to develop effective strategies for sustainable coastal settlement management.

3.2 Strategies for Slum Settlement Management and Revitalization

The reviewed literature demonstrates that strategies for managing and revitalizing slum settlements particularly in coastal contexts require an integrative and context-sensitive approach that balances infrastructural improvement, ecological restoration, and community empowerment. These strategies evolve from both empirical and conceptual frameworks aimed at achieving sustainable urban resilience.

Integrated Physical and Social Revitalization

The study *Elements That Shape Slum Integration* provides a conceptual foundation for slum management through optimization of integration elements, highlighting the interrelation between spatial and social dimensions. The proposed strategies include strengthening physical connectivity, providing public spaces, and enhancing socio-economic empowerment to reduce spatial exclusion and foster social cohesion (Ekawati et al., 2023).

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Similarly, research in Lagos, Nigeria, emphasizes community-based adaptation and nature-based solutions, such as mangrove restoration and vegetation enhancement, to mitigate flood impacts and strengthen environmental resilience (Adegun, 2023). The participatory approach and integration of local knowledge are identified as key success factors in informal coastal settlement upgrading.

Urban Waterfront Development for Designing Coastal Cities broadens this framework by proposing three revitalization modes conservation, redevelopment, and development anchored on clear urban visions, inclusive public access, natural resource preservation, and alignment with local economic and tourism programs (Ragheb & EL-Ashmawy, 2020).

Infrastructure Enhancement and Environmental Management

Empirical research in Indonesian coastal cities has articulated practical strategies for slum rehabilitation. In Makassar, improvement measures include road upgrading, construction of closed drainage systems, implementation of 3R-based (reduce, reuse, recycle) waste management, and provision of communal sanitation facilities linked to shared septic tanks (Sampebua et al., 2022). In Kendari, slum index analysis serves as a policy instrument to prioritize infrastructure intervention, particularly in water supply and drainage systems (Asyfa et al., 2021).

A holistic eco-green approach introduced in Bekasi integrates smart architectural design, environmentally friendly materials, energy efficiency, water conservation, and integrated waste management (Asyfa et al., 2021). This concept promotes a multidimensional framework that bridges environmental, social, and economic aspects for sustainable coastal settlements. In Semarang, coastal resilience improvement is linked to ecosystem rehabilitation through mangrove replanting and coastal defense structures (Dewi et al., 2021). Across these cases, four core strategies emerge:

1) improvement of basic infrastructure (roads, drainage, sanitation);
2) sustainable waste and wastewater management;
3) community capacity building for environmental stewardship; and
4) implementation of eco-green and nature-based solutions to enhance resilience.

Typology-Based and Contextual Management Approaches

Typological analyses provide a scientific basis for targeted intervention. In Bandar Rahmat Village, Batubara Regency, seven physical indicators such as building conditions, drainage, water access, and waste management classify the area as moderately to severely slum, primarily due to poor drainage and irregular spatial organization typical of fishing communities (Hidayat et al., 2021). *Baubau City* exhibits three typologies: traditional kampong, riverbank, and coastal settlements. Using Principal Component Analysis (PCA), it identifies varying management priorities, with riverbank areas requiring the highest intervention (Zain et al., 2018).

In *Konawe Coastal Settlements*, encroachment along rivers, recurrent flooding, poor sanitation, and inadequate infrastructure have rendered the area unfit for habitation under current spatial plans (Santi, Ratna Bachrun, 2017). Effective management must therefore balance the provision of basic needs with disaster risk reduction and socio-environmental sustainability (Wunarlan et al., 2020).

Technological and Community-Based Environmental Solutions

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Innovative wastewater and greywater management systems, such as horizontal flow treatment systems coupled with community-based awareness programs, are recommended to align with the environmental and socio-spatial contexts of coastal settlements (Asmal et al., 2022). A policy analysis from Mumbai shows a paradigm shift from state-funded housing toward market-based mechanisms, including public-private partnerships. However, these remain limited by affordability issues, unclear land ownership, and the exclusion of the urban poor from formal housing access (O'Hare et al., 2014). Hence, integrated adaptation strategies encompassing social, economic, and ecological dimensions are crucial to mitigate climate risks and enhance the sustainability of coastal communities (Dewi et al., 2022).

Localized Revitalization Models in Indonesia

Sustainable revitalization frameworks have been applied in several Indonesian cities. In *Bagan Deli*, strategies emphasize the construction of permanent housing, improved access to clean water, drainage systems, waste management, and mangrove planting, supported by community involvement for long-term sustainability (Putra, 2016). In *Kampung Nelayan*, Makassar, a SWOT analysis suggests coordinated management involving government, local communities, and private sectors to address urban pressures (Agus et al., 2023).

In *Batusitanduk*, revitalization integrates preventive community empowerment with rehabilitative infrastructure and environmental programs (Baharuddin, 2023). Similarly, *Kampung Tua Tiangwangkang* prioritizes urban infrastructure enhancement and spatial reorganization to achieve resilient coastal environments (Rangkuty et al., 2023).

Figure 4. Tanjung Uma (Left) and Tanjung Riau (Right) Old Villages Surrounded by Various Types of Waste (Rangkuty et al., 2023).

Ternate City adopts a pragmatic approach focusing on road widening for emergency and waste services, which can reduce slum severity by 16 points (Ginting & Rarasati, 2025). *Makalehi Island* requires comprehensive infrastructure development supported by data-driven planning (Amal et al., 2024). In *Telaga Tujuh Village*, on-site reconstruction combined with selective relocation is proposed, using a radial layout with central social-economic nodes (Puspita et al., 2025). *Tanjungmas* in Semarang employs community empowerment and government collaboration to enhance infrastructure, foster local economies, and build participatory governance (Ariaoktafiani, 2024).

Preventing Slumification and Promoting Sustainable Urbanism

The *Varkala* study in India underscores the need for sustainable tourism planning that balances economic growth with environmental and cultural preservation through stringent regulatory frameworks (Lakshmi & Shaji, 2016). Proactive interventions to prevent "slumification" include infrastructure upgrading, secure land tenure, and community-based rehabilitation (Azhar et al., 2021). Similarly, *Tahsina Taher and Ibrahim (2014)* emphasize successful self-help housing, in-situ upgrading, and microcredit schemes that prioritize affordability and cultural appropriateness (Tahsina Taher & Ibrahim, 2014). Despite contextual

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variations, all studies converge on the necessity of participatory and inclusive approaches that integrate local knowledge and multi-stakeholder collaboration to achieve long-term social inclusion and resilience.

Strategic Models and Policy Integration

Atkinson (2024) identifies four types of governmental responses to informal settlements neglect, eviction, upgrading, and integration arguing that coherent and inclusive strategies are essential for managing informal urban expansion (Atkinson, 2024). In parallel, *Suryandari and Widyawati (2019)* propose three operational models:

1) Restoration, focusing on improving existing housing and infrastructure;
2) Rejuvenation, emphasizing redevelopment of legally recognized land; and
3) Relocation, applied to illegal or high-risk riverbank areas.

The authors emphasize that interventions should remain humane, equitable, and environmentally responsive to ensure socio-economic stability, particularly within fishing-based coastal communities.

Synthesis

Overall, the reviewed studies reveal that effective slum management and revitalization require a multi-dimensional strategy that links spatial planning, environmental stewardship, and community empowerment. Physical upgrading alone is insufficient without parallel investment in socio-economic and institutional capacity. Coastal slum revitalization must therefore be guided by eco-social resilience frameworks, emphasizing participatory governance, adaptive design, and sustainable livelihood integration to foster inclusive and climate-resilient urban futures.

3.3 Environment and Infrastructure Management in Coastal Slum Settlements

Environmental degradation and infrastructural inadequacy represent the most persistent and interlinked challenges within coastal slum settlements. The reviewed studies collectively demonstrate that physical infrastructure deficiencies such as poor drainage, limited sanitation facilities, and weak environmental management directly exacerbate ecological vulnerability, health risks, and socio-spatial exclusion.

Infrastructure and Spatial Integration

The study *Elements That Shape Slum Integration* highlights that public infrastructure, accessibility, and topography are key determinants of spatial integration between slum areas and formal urban spaces (Ekawati et al., 2023). Similarly, *Flood-related Challenges and Impacts within Coastal Informal Settlements* in Lagos identifies poor drainage, inadequate waste management, and substandard building quality as the main factors increasing flood vulnerability. The study emphasizes ecosystem restoration and infrastructure upgrading as critical interventions for environmental resilience (Adegun, 2023).

Parallel findings are presented in *Waterfront and Its Relationship to the City of Surat*, which attributes environmental degradation to weak governance coordination and unregulated land use. Pollution, sedimentation, and spatial disconnection between the city and its waterfront accelerate ecological decline, underscoring the need for integrated environmental management and cross-sectoral planning (Vimawala, 2015).

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Figure 5. Transformation of waterfront: Early to intermediate
(Vimawala, 2015).

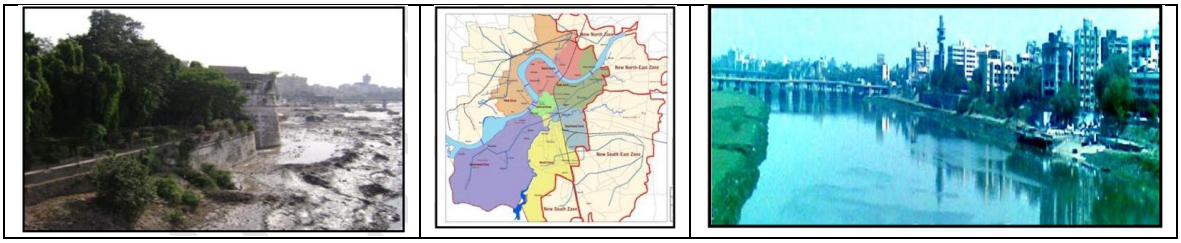

Figure 6. Transformation of waterfront in later stage: At Present
(Vimawala, 2015).

Urban Environmental Degradation and Basic Infrastructure Deficiencies

Consistent with these global findings, empirical studies from Indonesia reaffirm that poor environmental management and inadequate infrastructure remain the primary drivers of slum formation. Research in Buloa and Abeli identifies damaged road networks, clogged drainage, and insufficient household sanitation as key factors exacerbating urban decay (Sampebua et al., 2022).

In *Eco-Green Bekasi*, a new perspective is introduced through eco-efficient infrastructure management integrating energy efficiency, sustainable transportation, and water conservation to promote environmentally conscious settlement design (Zefri, 2019). Meanwhile, *Coastal Settlement Resilience in Semarang* highlights the necessity of disaster-resilient infrastructure such as evacuation routes, levees, and coastal buffer zones, with the absence of these systems correlating directly to flood and abrasion vulnerability (Dewi et al., 2021).

Overall, these studies conclude that physical infrastructure rehabilitation must be integrated with environmental management strategies encompassing clean water provision, waste and wastewater management, and coastal vegetation restoration to mitigate ecological degradation and enhance community resilience.

Technological and Analytical Approaches to Environmental Management

Several studies advance innovative analytical frameworks to address the multidimensional challenges of coastal slums. For instance, *Hidayat et al. (2021)* emphasizes physical revitalization through drainage and waste management improvement to enhance living conditions (Hidayat et al., 2021). *Zain et al. (2018)* employs fuzzy logic and Multi-Criteria Decision Making (MCDM) tools to generate spatial management priority maps, advocating

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regionally adaptive policies, community empowerment, and inclusive housing initiatives (Zain et al., 2018).

Asmal et al. (2022) proposes a comprehensive environmental strategy encompassing restoration, renovation, and relocation, emphasizing housing quality and infrastructure upgrading (Asmal et al., 2022). Similarly, *Sahin and Mohamed (2010)* introduce a decision-support system integrating System Dynamics and GIS to assess coastal vulnerability to sea-level rise and storm surges, thereby promoting adaptive, long-term infrastructure planning (Sahin & Mohamed, 2010).

In addition, a community-based solid waste management model developed for Cambaya Village in Makassar recommends on-site composting, waste banks, and recycling initiatives to reduce residual waste and improve local sanitation (Santi, Ratna Bachrun, 2017).

Environmental Sanitation and Public Health Risks

Environmental and infrastructural deficiencies pose severe implications for public health in coastal settlements. In *Pohuwato*, limited clean water access, poor sanitation, inadequate waste disposal, and the absence of fire protection facilities significantly degrade living quality (Wunarlan et al., 2020). Narrow access roads and inadequate drainage intensify flood risk and hinder emergency response. Similarly, in *Karama Village*, household greywater is discharged directly into coastal waters, contributing to pollution and health hazards (Asmal et al., 2022).

Tanjung Mas in Semarang experiences compound threats from limited infrastructure, poor waste management, and climate change impacts that exacerbate flooding and environmental decline (Dewi et al., 2022). In *Bagan Deli*, insufficient sanitation facilities and lack of solid waste disposal systems remain major environmental challenges (Putra, 2016), while *Kampung Nelayan* in Makassar suffers from recurrent flooding due to inadequate drainage (Agus et al., 2023).

Likewise, *Batusitanduk* lacks clean water supply systems and proper drainage (Baharuddin, 2023), and *Kampung Tua Tiangwangkang* experiences direct sewage discharge into coastal waters, causing marine pollution (Rangkuty et al., 2023). Revitalization programs in these areas frequently integrate mangrove planting, community awareness initiatives, and infrastructure improvement as holistic environmental responses (Rangkuty et al., 2023).

Disaster Risk Reduction and Infrastructure-Based Resilience

Environmental degradation and infrastructural inadequacy are directly linked to vulnerability in disaster-prone coastal areas. In *Ternate*, insufficient fire protection, poor waste management, and ineffective drainage remain major concerns. Infrastructure rehabilitation, particularly neighborhood road construction with integrated drainage and fire access, reduced slum prevalence by 2.87% (Ginting & Rarasati, 2025).

Makalehi Island faces deteriorating road conditions, limited clean water access, and lack of fire safety facilities (Amal et al., 2024), while *Telaga Tujuh* experiences direct wastewater discharge into the sea and limited private sanitation facilities (Puspita et al., 2025). Similarly, *Tanjungmas* in Semarang suffers from frequent flooding, poor drainage, and limited clean water supply (Ariaoktafiani, 2024). Collectively, these cases demonstrate that integrated infrastructure improvement coupled with disaster risk management is fundamental for sustainable slum revitalization.

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Figure 7. Drainage of the house on stilts directly throw to the kolong and the form of grey water disposal from the service area on stilt houses

(Amal et al., 2024)

Policy Neglect, Environmental Degradation, and Sustainable Design

Beyond physical deficiencies, environmental decline is also linked to policy neglect and unsustainable urban expansion. *Lakshmi and Shaji (2016)* highlight that unregulated tourism, waste accumulation, and land reclamation accelerate coastal erosion and habitat loss (Lakshmi & Shaji, 2016). *Azhar et al. (2021)* connect environmental hazards and infrastructure decay to insufficient policy intervention, warning that without targeted infrastructure investment, informal settlements will continue to deteriorate (Azhar et al., 2021).

Tahsina Taher and Ibrahim (2014) stress the importance of environmentally sensitive design, improved sanitation systems, and sustainable building materials in upgrading projects (Tahsina Taher & Ibrahim, 2014). The studies collectively reaffirm that the physical condition of the built environment is both a cause and a consequence of vulnerability in coastal slums.

Governance, Informality, and Urban Resilience

Governance perspectives further illuminate the structural roots of environmental challenges. *Atkinson (2024)* emphasizes that informal settlements exacerbate disaster risk and ecological vulnerability due to unplanned urban growth and fragmented infrastructure networks (Atkinson, 2024). Similarly, *Suryandari and Widyawati (2019)* document conditions in *Muara Angke*, where poor waste management, insufficient drainage, inadequate fire protection, and deteriorating housing quality compound urban inequality(Suryandari & Widyawati, 2019).

These findings demonstrate that environmental neglect and infrastructural decay are symptomatic of broader governance failures. Effective intervention therefore requires integrated urban management, institutional coordination, and community engagement to promote ecologically resilient coastal settlements.

Synthesis

Across all reviewed studies, it becomes evident that infrastructure quality and environmental management are inseparable components of sustainable coastal slum revitalization. Effective interventions must move beyond isolated physical upgrading toward integrated frameworks encompassing water resource management, sanitation improvement, coastal ecosystem restoration, and participatory governance. Sustainable revitalization, therefore, hinges on balancing physical infrastructure enhancement with ecological resilience and community-based environmental stewardship.

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3.4 Social Impacts and Climate Change Effects on Coastal Settlements

The social dimensions of coastal slum settlements reflect a complex interaction between environmental degradation, economic precarity, and climate-related hazards. The reviewed studies reveal how social segregation, health vulnerability, and adaptive capacity are shaped by both physical infrastructure and ecological instability.

Social Segregation and Community Integration

The study *Elements That Shape Slum Integration* identifies persistent social segregation as a core issue within urban informal settlements. Limited access to education, healthcare, and economic resources reinforces marginalization, while negative social stigma restricts upward mobility. The research proposes strengthening local social networks and community empowerment as mechanisms to enhance inclusivity and spatial integration (Ekawati et al., 2023).

In Lagos, Nigeria, the study *Flood-related Challenges and Impacts within Coastal Informal Settlements* confirms that recurring floods not only damage property but also disrupt livelihoods, increase school dropout rates, and exacerbate poverty cycles (Adegun, 2023). These findings demonstrate how physical and environmental vulnerabilities translate directly into social inequality.

Conversely, *Urban Waterfront Development for Designing Coastal Cities* emphasizes the potential of well-planned waterfront revitalization to serve as inclusive social spaces that enhance public interaction and urban quality of life (Ragheb & EL-Ashmawy, 2020). Yet, these benefits are often limited by poor environmental governance in informal settlements.

Public Health, Sanitation, and Social Well-being

Poor environmental conditions in coastal slums significantly affect public health. Studies in Makassar and Bekasi reveal that limited sanitation infrastructure and low hygiene awareness contribute to disease spread and community health risks (Zefri, 2019). High population density, shared housing arrangements, and restricted living space further exacerbate social tensions and reduce overall well-being.

Research from Semarang links climate-induced hazards such as flooding, land subsidence, and erosion with deteriorating public health and declining local economies, particularly among fishing communities (Dewi et al., 2021). In *Bandar Rahmat Village*, poor drainage and unmanaged waste are identified as direct causes of environmental degradation that intensify social and health burdens (Hidayat et al., 2021).

Similar findings in *Karama Village* show that improper wastewater disposal leads to soil and groundwater contamination exceeding safety thresholds, resulting in increased waterborne disease incidence (Asmal et al., 2022). The interplay between physical decay and social vulnerability is further emphasized by *Anggraini 2021,*who propose integrated waste management and local participation as critical tools to mitigate pollution and enhance social resilience (Anggraini et al., 2021).

Climate Change, Gendered Vulnerability, and Adaptive Capacity

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Climate change amplifies the existing inequalities within coastal slum communities. *Sahin & Mohamed (2010)* emphasize that rising sea levels (SLR) and storm surges increasingly threaten critical infrastructure and housing assets, requiring adaptive design standards for long-term protection (Sahin & Mohamed, 2010). Global demographic projections indicate that *Low Elevation Coastal Zones (LECZ)* especially in Asia and Africa will face heightened exposure to such hazards (Neumann et al., 2015).

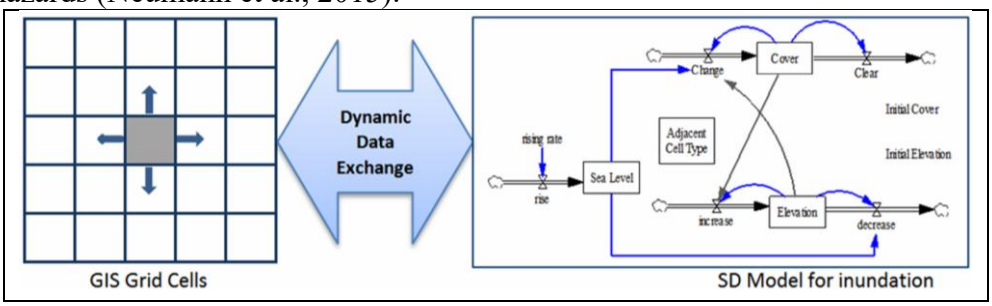

Figure 8. Coupling SD-GIS for Modeling Coastal Inundation

(Sahin & Mohamed, 2010)

In Vijayawada, India, gender-based vulnerabilities are particularly severe. Women face increased mortality and injury risks during disasters due to restrictive clothing, caregiving responsibilities, and unsafe housing structures (Kantamaneni et al., 2022). These social and cultural factors compound environmental hazards, highlighting the need for gender-sensitive adaptation strategies.

Case studies from Ternate, Makalehi, Telaga Tujuh, and Tanjungmas demonstrate varying degrees of adaptation. In Ternate, socio-economic resistance to relocation underscores the necessity of participatory planning and sufficient financial support to build acceptance (Ginting & Rarasati, 2025). Makalehi focuses on improving quality of life through environmental rehabilitation (Amal et al., 2024), while Telaga Tujuh emphasizes disaster resilience and social inclusion (Puspita et al., 2025). In Tanjungmas, rapid urbanization and recurrent flooding demand adaptive urban strategies for inclusive and sustainable living environments (Ariaoktafiani, 2024).

Socio-Cultural Transformation and Community Resilience

Beyond immediate environmental and health impacts, coastal settlements also experience socio-cultural transformations. The *Varkala study* documents a transition toward nuclear families, shifting income structures, and the erosion of traditional coastal identities. *Azhar et al. (2021)* further argue that environmental hazards and climate-induced displacement cause tenure insecurity and community fragmentation, leading to urban regression (Azhar et al., 2021).

Relocation policies, while addressing physical risks, may inadvertently weaken community cohesion and create new forms of social exclusion. *Tahsina Taher & Ibrahim (2014)* highlight that sustainable upgrading should prioritize social cohesion and collective agency to maintain community resilience (Tahsina Taher & Ibrahim, 2014).

At a global analytical level, *Atkinson (2024)* integrates discussions of urban inequality, climate adaptation, and resilience, emphasizing that informal settlements remain disproportionately affected by climate hazards (Atkinson, 2024). The socio-economic diversity of *Muara Angke*, consisting of native and migrant fishers living in low-lying reclaimed zones,

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illustrates how livelihood dependency and environmental exposure reinforce cycles of vulnerability (Suryandari & Widyawati, 2019).

Synthesis

Across these studies, the convergence of social segregation, environmental degradation, and climate exposure underscores that physical and ecological upgrading alone is insufficient. Social resilience embodied in inclusive governance, gender-sensitive adaptation, community-based management, and cultural continuity must be integrated within coastal revitalization strategies. Only through such holistic frameworks can coastal slum communities transition toward sustainable, equitable, and climate-resilient urban futures.

3.5 Governance and Policy of Coastal Settlements

Governance emerges as a pivotal determinant in shaping the resilience, inclusivity, and sustainability of coastal settlements. Across the reviewed studies, governance-related weaknesses ranging from fragmented policy frameworks to limited institutional coordination are identified as core drivers of spatial segregation, environmental degradation, and persistent socio-economic inequities.

Governance Deficiencies and Policy Fragmentation

Governance deficiencies are consistently identified as core structural problems shaping the vulnerability of coastal settlements. The *Elements That Shape Slum Integration* study reveals that spatial segregation and slum persistence largely stem from the absence of integrated policy frameworks and poor institutional coordination (Ekawati et al., 2023). In Lagos, *Adegun (2023)* highlights the state's limited engagement in addressing informal settlement growth and flood risks, stressing the need for inter-agency collaboration and the inclusion of ecosystem-based adaptive policies. Similarly, *Zefri (2019)* in *Waterfront and Its Relationship to the City of Surat* underscores policy fragmentation and weak regulation as principal causes of the disconnection between cities and their waterfronts (Zefri, 2019).

These governance failures are not isolated but systemic. *Vimawala (2015)* attributes waterfront degradation to uncontrolled urban expansion and the lack of clear regulatory guidance. *O'Hare et al. (2014)* further demonstrate how the shift from public-sector housing provision toward market-oriented policies in Mumbai entrenched inequality and informal growth. Such fragmented governance and neoliberal tendencies contribute to unregulated urbanization and spatial inequality in coastal zones.

Adaptive and Collaborative Governance Approaches

A second cluster of studies focuses on the shift toward adaptive and collaborative governance as a pathway for resilience. *Asyfa et al. (2021)* emphasize that successful urban waterfront development depends on strong public leadership and multi-sectoral collaboration involving both government and private stakeholders. Likewise, *Ragheb & El-Ashmawy (2020)* reinforce the importance of visionary public authority in driving sustainable waterfront transformation.

In *Bekasi* and *Semarang*, adaptive governance frameworks integrating local participation, private-sector involvement, and environmental awareness are shown to enhance the sustainability of settlement upgrading (Dewi et al., 2021). *Adegun (2023)* further suggests embedding local ecological knowledge into flood adaptation policies to strengthen resilience.

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Empirical evidence from *Makassar* highlights that limited community engagement and weak coordination across institutions undermine environmental programs. Conversely, integrated planning and inclusive participation have been proven essential for the continuity of slum improvement initiatives (Asyfa et al., 2021).

Local Policy Implementation and Institutional Roles

Local governments emerge as key agents of transformation. Studies show that municipalities play a crucial role in shaping settlement quality through infrastructure investment, environmental health initiatives, and community-based policy interventions (Wunarlan et al., 2020; Asmal et al., 2022). *Putra (2016)* demonstrates that integrated physical infrastructure and land-use control in *Bagan Deli* can enhance urban sustainability, while *Agus et al. (2023)* identify multi-sector coordination among government, private, and community actors in *Makassar* as vital for sustainable management.

Case studies from *Ternate*, *Makalehi*, *Telaga Tujuh*, and *Tanjungmas* reflect diverse governance dynamics. In *Ternate*, *Ginting & Rarasati (2025)* identify policy gaps, poor coordination, and dependency on central government funding (DAK) as constraints, advocating for integrated and participatory local governance. *Amal et al. (2024)* in *Makalehi* propose data-based planning for precise policy interventions, while *Puspita et al. (2025)* use the Analytic Hierarchy Process (AHP) to prioritize sustainable settlement strategies. Meanwhile, *Ariaoktafiani (2024)* applies SWOT analysis to reveal that although government support remains a key strength, limited financing capacity poses major barriers to implementation prompting the development of joint public-private-community governance models (Ariaoktafiani, 2024).

Equity, Participation, and Social Justice in Governance

Beyond administrative and technical dimensions, governance in coastal settlements must integrate equity and inclusivity principles. *Kantamaneni et al. (2022)* stress gender-sensitive disaster governance, emphasizing that women in urban slum communities face disproportionate vulnerability due to social and cultural inequalities (Kantamaneni et al., 2022). Similarly, *Azhar et al. (2021)* critique fragmented policy responses, neoliberal neglect, and insecure tenure rights as drivers of "slumification," urging for participatory frameworks that protect marginalized groups (Azhar et al., 2021).

Tahsina Taher & Ibrahim (2014) advocate secure land tenure, participatory decision-making, and equitable housing frameworks to counter market-driven displacement (Tahsina Taher & Ibrahim, 2014). The *Varkala* study adds that enforceable coastal zoning and integrated tourism governance are critical to preventing ecological imbalance and social dislocation. Together, these findings underscore that governance must move beyond infrastructure management to include dimensions of justice, inclusion, and empowerment.

Toward Integrated and Resilient Governance Frameworks

A growing number of studies argue that sustainable transformation of coastal settlements requires governance that is adaptive, multi-scalar, and evidence-based. *Atkinson (2024)* highlights that government responses to informality range from neglect to proactive integration, advocating for multi-level, data-informed governance frameworks (Atkinson, 2024). *Neumann et al. (2015)* emphasize the importance of demographic projections to guide long-term policy design, especially as coastal population growth heightens exposure to sea-level rise and urban expansion pressures (Neumann et al., 2015).

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Baharuddin (2023) reinforces that comprehensive and continuous government interventions are essential for improving environmental quality and community well-being. Similarly, *Suryandari & Widyawati (2019)* link governance with land legality, proposing differentiated strategies: legal areas for revitalization and illegal ones for humane relocation, supported by culturally sensitive frameworks (Suryandari & Widyawati, 2019).

Synthesis

Synthesizing across these studies, governance emerges as both a structural condition and a transformative mechanism. Effective coastal settlement governance integrates:

- Evidence-based and data-driven planning for targeted intervention;
- Inclusive and participatory mechanisms to empower local communities;
- Cross-sectoral coordination between state, market, and community actors;
- Legal and regulatory clarity that balances development and social equity; and
- Adaptive frameworks to respond to dynamic environmental and climatic challenges.

Collectively, these insights affirm that the sustainability of coastal settlements cannot rely solely on physical interventions or market solutions. Rather, it requires a coherent governance architecture that unites institutional coordination, local participation, and socio-environmental justice as the foundation of resilient coastal urban futures.

3.6 Synthesis of Strengths, Limitations, and Thematic Classification of the Reviewed Literature

A comprehensive review of the 32 selected studies reveals distinct strengths and weaknesses that collectively shape current scholarly understanding of coastal slum settlements, while also allowing for the formulation of a broader thematic classification. These insights are essential for developing a more holistic and comparative framework for analyzing coastal slum morphology, environmental vulnerability, socio-spatial integration, and revitalization strategies across diverse geographic contexts.

Strengths of the Reviewed Studies

Across the literature, several strengths become evident. First, the studies demonstrate *methodological diversity*, ranging from quantitative approaches such as slum index calculations, Principal Component Analysis (PCA), spatial vulnerability mapping, and longitudinal land-use analysis to qualitative and mixed-method frameworks involving observations, interviews, and community-based assessments. This plurality of methods enriches the evidence base and enables multi-scalar insights, combining physical, social, and ecological dimensions.

Second, the literature provides a *broad geographical representation*, encompassing both Indonesian coastal settlements (Makassar, Kendari, Semarang, Batam, Aceh, Medan, Pohuwato, Bekasi, Ternate, Luwu, and others) and cases from global contexts including Nigeria, India, and Mumbai. This geographical variation strengthens the generalizability of the findings and reveals universal characteristics of coastal slums such as dense unplanned housing, inadequate infrastructure, environmental degradation, and exposure to coastal hazards.

Third, a consistent strength lies in the *clear identification of slum typologies*. Across studies, typological patterns emerge, including compact fishing settlements, flood-prone

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riverbank clusters, ecologically vulnerable coastal strips, and deteriorated inner-city kampongs. These recurring typologies demonstrate structural similarities across contexts and reinforce the notion of slum formation as a product of intertwined socio-ecological pressures.

Finally, many studies offer *applicable strategies for revitalization*, ranging from eco-green housing concepts and nature-based solutions (e.g., mangrove restoration, green buffers) to infrastructural upgrading (drainage, sanitation, roads), community empowerment, and integrated governance frameworks. The inclusion of both conceptual and empirical components strengthens the practical relevance of the literature for policy design and urban planning.

Limitations and Gaps in the Existing Scholarship

Despite these strengths, several notable limitations persist across the body of literature. The most prominent limitation is the *dominance of physical-centric assessments*. While drainage systems, road conditions, housing structures, and waste management are extensively studied, socio-economic, political, and cultural dimensions such as livelihood strategies, mobility patterns, land-tenure insecurity, and power relations receive comparatively little analytical depth.

Second, many studies lack a *strong theoretical grounding*, with several relying heavily on descriptive assessments based on national slum indicators. Few integrate broader theoretical frameworks from urban informality, coastal resilience, socio-ecological systems, or political ecology. This gap reduces the ability of the studies to contribute to theory-building or comparative urbanism.

Third, the literature is limited by *short-term or cross-sectional data*, restricting the understanding of long-term settlement dynamics, including historical transformation, consolidation, or slumification processes. Only a small number of studies (e.g., Lagos, Varkala, Mumbai) offer longitudinal insights into land-use change, infrastructure decline, or socio-economic transformation.

Fourth, *governance and institutional analysis* remains weak. Few studies systematically examine the role of municipal authorities, regulatory frameworks, land administration, or multi-level governance in shaping slum formation or revitalization. As a result, the institutional drivers of slum persistence remain understudied.

Lastly, methodological repetition especially the use of uniform national indicators limits innovation. While useful for baseline assessment, these approaches often reduce complex socio-spatial realities into standardized scores, offering limited explanatory power regarding causal mechanisms.

Thematic Classification of the Reviewed Literature

To synthesize the diverse findings, the 32 studies can be grouped into five thematic clusters reflecting distinct analytical orientations:

- **Physical and Spatial Typologies of Coastal Slums**
  This cluster includes studies focusing on physical conditions, environmental degradation, housing quality, road networks, sanitation systems, and settlement morphology (e.g., Makassar, Kendari, Bekasi, Batam, Baubau, Luwu, Medan). These works form the empirical backbone of slum diagnosis and provide baseline assessments for policy intervention.
- **Environmental Vulnerability and Disaster Risk**

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Studies in this category highlight coastal and hydrological risks flooding, sea-level rise, land subsidence, wetland loss, and ecological fragility. Examples include Lagos flood risk, Semarang resilience studies, and environmental deterioration in Bekasi and Konawe. These works underscore the pressing need for climate-adaptive planning.

- **Socio-Spatial Integration, Governance, and Community-Based Approaches**
  This group explores social networks, community empowerment, local wisdom, and governance mechanisms influencing urban informality. It includes works on slum integration, Mumbai housing politics, participatory coastal management, and community-driven revitalization models.
- **Revitalization Strategies and Policy-Oriented Frameworks**
  These studies propose structured interventions such as eco-green settlement design, infrastructure upgrading, mangrove restoration, relocation-rejuvenation-restoration models, and data-driven planning. Cases from Semarang, Batam, Tanjungmas, and Ternate illustrate context-sensitive approaches tailored to coastal conditions.
- **Transformation Processes, Urban Informality, and Slumification**
  The final cluster captures dynamic processes of urban transformation, including land-use conversion driven by tourism (Varkala), neoliberal policymaking (Mumbai), rural urban migration pressures, and slumification as a regressive trajectory of informal settlements. This theme emphasizes long-term urban dynamics shaping coastal settlements.

Synthesis

Overall, the literature reveals that coastal slum settlements are shaped by a multidimensional convergence of spatial inequality, infrastructural deficit, environmental degradation, and governance challenges. While existing studies provide substantial empirical evidence on physical and environmental conditions, greater theoretical integration and deeper socio-political analysis are still needed. The thematic classification offered here establishes a foundation for future comparative studies and underscores the importance of integrative frameworks that bridge morphology, vulnerability, governance, and community resilience.

4 Conclusion

The reviewed body of literature provides a comprehensive and multidimensional understanding of coastal slum settlements encompassing typology, management strategies, environmental conditions, social implications, and governance structures. Collectively, the studies demonstrate that coastal slums represent complex socio-spatial systems shaped by the interaction of physical degradation, ecological vulnerability, and institutional weaknesses. The main contribution of this review lies in integrating diverse perspectives ranging from morphological analyses to governance frameworks into a cohesive understanding of how informal coastal settlements evolve and respond to environmental and socio-economic pressures.

From a critical standpoint, the strength of the reviewed research lies in its extensive empirical grounding, particularly in Indonesian and global contexts, offering robust typological classifications and practical revitalization strategies. However, most studies remain limited in cross-scale integration and longitudinal analysis, often focusing on physical upgrading without sufficiently addressing systemic governance or socio-cultural adaptation. Additionally, the lack of standardized indicators for measuring resilience and sustainability across contexts constrains comparative evaluation.

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Future research should advance toward developing integrative frameworks that combine spatial analytics, ecological modeling, and participatory governance mechanisms. Such approaches can bridge the gap between physical intervention and social transformation, enabling data-driven, inclusive, and climate-resilient models of coastal settlement revitalization. In essence, sustainable progress for coastal slum communities depends not merely on infrastructural improvement, but on embedding environmental stewardship, social equity, and adaptive governance as interdependent pillars of resilient urban futures.

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