Urban Regeneration Interventions and Climate Change Responses in Coastal Areas

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Abstract

The aim of this analysis is to identify good practices and highlight international trends in waterfront redevelopment that can serve as examples for similar interventions aimed at improving sustainability in coastal areas. To this end, twelve (12) case studies (CSs) at coastal areas and cities worldwide that have implemented or intend to implement coastal zone regeneration projects are examined. In these CSs, a range of geographical contexts, population sizes, water body types (sea or river), levels of effectiveness and redevelopment timelines are included to identify recurring patterns, good practices and transferable principles in urban planning that support sustainability, despite the specific characteristics of each coastal area.

Building on these insights an assessment framework was proposed to evaluate based on various diverse criteria the impacts of a redevelopment project aiming at the regeneration of a coastal area. Each criterion is explicitly mapped to the relevant Sustainable Development Goals (SDGs) and organized under four pillars: a) Society, b) Economy, c) Environment and d) Urban Environment - Water Element.

The comparative analysis indicates that regeneration outcomes are strongly influenced by timing and each country's political and economic context, and not all interventions achieve full success. Economic design remains central, environmental aspects are increasingly prioritized, while social dimensions are often overlooked. Meanwhile, global trends show over-touristic exploitation, replication of standardized models, and growing homogenization of coastal identity. Overall, urban coastal regeneration can substantially support SDG 11 (Sustainable Cities and Communities), while also contributing to economic growth (SDG 8), infrastructure improvement (SDG 9), climate action (SDG 13), and enhanced public health and well-being (SDG 3). In the context of climate change, waterfront redevelopment is not only a tool for environmental and economic revitalization but also a key adaptation strategy against sea-level rise, coastal erosion, and extreme weather events. Equally important is the inclusion of informal development areas, often the most vulnerable to climate risks, through approaches that combine resilience-building with social equity.

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1 Introduction

1.1 Background

Urban planning plays a critical role in shaping pathways toward sustainable development, particularly under the accelerating pressures of climate change and interrelated environmental, social, and economic challenges. The adoption of the United Nations 2030 Agenda for Sustainable Development established a comprehensive global framework through the 17 Sustainable Development Goals (SDGs), aiming to promote inclusive, safe, resilient, and sustainable communities worldwide (United Nations, 2015). Within this framework, cities are recognized not only as drivers of economic growth but also as key arenas where climate mitigation and adaptation strategies must be effectively implemented. However, despite the political commitment of the SDGs, urban development and regeneration projects often continue to rely on legacy planning approaches that insufficiently integrate sustainability objectives and climate considerations into decision-making processes (Zokaei, Wernstedt, & Krueger, 2020).

Urban areas, frequently described as the natural habitat of contemporary societies (Rogers, 1997) and the future of humankind, remain powerful engines of growth, innovation, and social interaction. Their attractiveness is increasingly linked to their capacity to attract skilled human capital, foster creativity, and support inclusive development (UN-Habitat, 2020). However, this growth-oriented urban paradigm has also intensified environmental pressures, particularly in climate-sensitive areas, exposing structural weaknesses in conventional planning models that prioritize economic competitiveness over long-term resilience.

These challenges are most pronounced in coastal cities, which stand at the frontline of climate change impacts. Coastal urban areas face a convergence of pressures, including sea-level rise, coastal erosion, storm surges, and extreme weather events, alongside rapid urbanization, infrastructure concentration, and deepening social inequalities (Nicholls, et al., 2007).

Given this, urban coastal regeneration emerges as a critical lever for climate adaptation and sustainable transformation, rather than merely a tool for physical or economic renewal. Effective regeneration must integrate resilience-building, ecosystem protection, and social equity, aligning local interventions with the broader objectives of the SDGs. Embedding climate adaptation measures-such as nature-based solutions, flood-resilient design, and

inclusive governance into regeneration strategies is essential for ensuring long-term urban viability (Sharifi, 2021).

Despite increasing recognition of these challenges, a significant research gap remains regarding the systematic evaluation of urban regeneration projects through the lens of the SDGs, particularly at the local- and project-scale.

1.2 Objectives of the Study

In this context, the present study examines the sustainable development of coastal urban areas through the lens of urban regeneration and waterfront redevelopment projects. It investigates the extent to which regeneration interventions with differing spatial, socio-economic, and governance characteristics succeed in advancing the principles and targets of the Sustainable Development Goals (SDGs), while balancing the social, economic, and environmental dimensions of sustainability. By analyzing real-world examples, the study aims to identify transferable good practices in the redevelopment of urban coastal fronts and to formulate an assessment framework that can be applied across multiple contexts as guidance for achieving sustainable coastal development.

Urban regeneration in coastal areas has become a strategic priority for cities worldwide as they confront the combined pressures of rapid urbanization, accelerating climate change, and structural economic transformation. In this setting, sustainable coastal regeneration is no longer a discretionary urban upgrade but a prerequisite for long-term climate resilience, social inclusion, and economic competitiveness.

Within this agenda, the SDGs provide a shared operational framework and a common language for aligning local interventions with global sustainability objectives. In the context of coastal regeneration:

- SDG 6 (Clean Water and Sanitation) guides investments in wastewater treatment, stormwater management, nature-based solutions, and bathing-water quality;
- SDG 8 (Decent Work and Economic Growth) supports diversification beyond mono-sector tourism toward blue-economy activities, creative industries, and local employment;
- SDG 9 (Industry, Innovation and Infrastructure) frames resilient transport systems, ports, logistics, and digital infrastructure;
- SDG 11 (Sustainable Cities and Communities) anchors inclusive planning, accessible public waterfronts, affordable housing, and risk-informed land use;
- SDG 13 (Climate Action) drives adaptation pathways, mitigation strategies, and climate-resilient urban design;
- SDG 14 (Life Below Water) prioritizes the protection of marine ecosystems, wetland restoration, and the reduction of coastal and marine pollution;

- SDG 15 (Life on Land) supports the conservation and reconnection of dunes, riparian zones, and peri-urban biodiversity;

while SDG 1 (No Poverty), SDG 3 (Good Health and Well-being), and SDG 16 (Peace, Justice and Strong Institutions) underpin social equity, public health, and participatory, transparent governance processes. Interpreting coastal regeneration through SDG lens transforms isolated redevelopment projects into a coherent portfolio of place-based climate and sustainability interventions.

Building on this framework, this analysis assesses how selected coastal urban regeneration projects align with the SDGs and evaluates their combined environmental, social, and economic impacts. Drawing on a comparative analysis of the twelve case studies, the research identifies cities that have successfully localized the SDGs, translating high-level goals into site-specific design guidelines, procurement criteria, governance mechanisms, and measurable performance indicators. Particular attention is given to governance arrangements (e.g. cross-departmental coordination, port–city partnerships), financing models (public-private partnerships, impact investment, green bonds), and implementation tools such as blue–green infrastructure, nature-based solutions, circular construction practices, climate-adaptive waterfront mobility, and year-round cultural programming.

2 Methodology

To systematically evaluate the contribution of coastal regeneration to the SDGs, this study adopts a multi-level analytical framework (Figure 1). This framework bridges the alignment of top-down policies, rooted in global and European sustainability agendas, with bottom-up assessments of local implementation practices. This dual approach offers a comprehensive evaluation of urban regeneration interventions, placing local projects within the context of broader sustainability and climate transition processes (European Commission, 2020; UN-Habitat, 2022).

The analytical framework operates across three interconnected levels:

- *Policy coherence* - how well national, regional, and local strategies align with the SDGs and EU sustainability and climate goals.
- *Implementation performance* - how regeneration projects turn these policies into real actions through planning, governance, funding, and day-to-day operation.
- *Impact assessment* - how these projects affect the environment, society, and the economy over time, using both numbers and qualitative evidence.

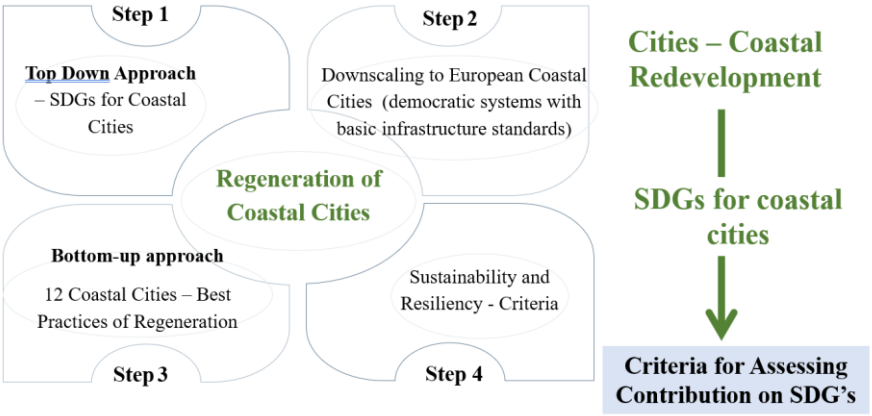

Figure 1. Methodological Framework for Assessing Contribution on SDG's

This methodology draws on international best practices derived from twelve coastal cities globally, selected for their geographical diversity, policy maturity, and relevance to SDG-driven urban regeneration. The case studies span Europe, North America, Australia, Asia, Africa, and South America. This geographical diversity provides valuable comparative insights across different governance structures, coastal types, and development trajectories.

Based on the literature review and the case study analysis, a total of thirty-two (32) sustainability criteria were identified and organized into four interdependent pillars:

- Social inclusion, encompassing accessibility, community participation, social equity, public health, and cultural integration (7 Criteria);
- Economic vitality, focusing on local employment generation, economic diversification, innovation ecosystems, and the development of the blue economy (5 Criteria);
- Environmental sustainability, addressing climate adaptation and mitigation, biodiversity conservation and restoration, circular resource use, and ecosystem-based approaches (9 Criteria);
- Urban spatial quality, examining design excellence, connectivity, mobility integration, enhancement of the public realm, and landscape and waterfront integration (11 Criteria).

Together, these pillars create a cohesive assessment framework that allows for a thorough evaluation of how coastal urban regeneration projects contribute to sustainable development across various dimensions.

Figure 2 illustrates the number of criteria that align with each of the SDGs, and it confirms key insights from the analysis. SDG 11 (Sustainable Cities and Communities) is the most comprehensively addressed goal, with 26 criteria meeting its targets, which is reflected by the tallest bar in the graph. Significant alignment is also seen with SDGs 8 (Decent Work and

Economic Growth) and 9 (Industry, Innovation and Infrastructure), with 9 and 6 criteria, respectively. However, SDGs 6 (Clean Water), 10 (Reduced Inequalities), 13 (Climate Action), and 14 (Life Below Water) show less consistent integration, as evidenced by the lower bars in the diagram for these goals. This fragmentation highlights a gap in multi-SDG planning and emphasizes the need for integrated coastal management approaches that connect land, sea, and community systems, as noted in the text (UN-Habitat, 2017).

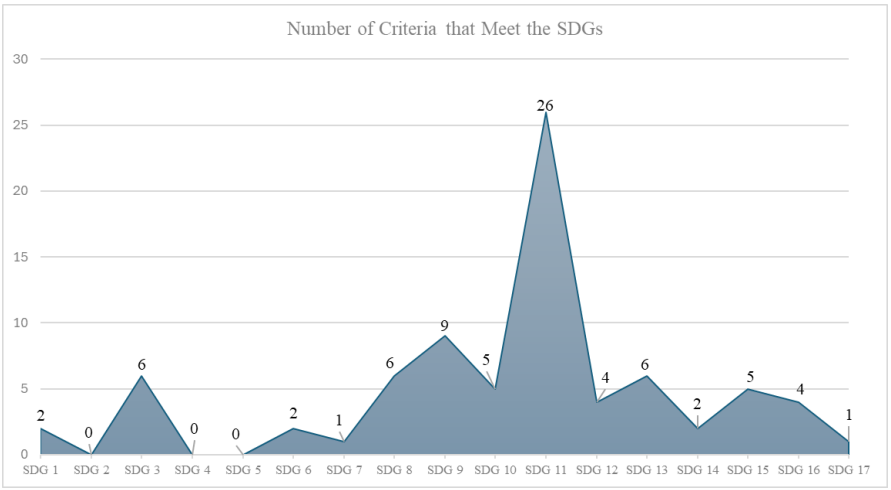

Figure 2. Criteria that meet SDGs, Source: (Giachou, 2025)

The research utilizes a qualitative multiple-case study approach (Yin, 2018), which provides both in-depth contextual analysis and comparative insights. The selected cases reflect a range of coastal environments and regeneration models, ensuring analytical diversity and the ability to transfer lessons across contexts. Each case is analyzed using an SDG alignment matrix, which maps project goals, design approaches, and governance structures against relevant SDG targets and indicators, specifically SDGs 6, 8, 9, 11, 13, 14, and 15 (Giachou, 2025).

A cross-case analysis was conducted to identify key success factors, implementation challenges, and transferable strategies for effectively integrating SDGs into coastal regeneration. Special attention was given to how governance innovation, participatory planning, and nature-based solutions intersect to generate measurable sustainability outcomes. The findings underscore the critical role of context-specific, inclusive, and data-driven strategies in advancing meaningful progress toward the SDGs at the local level (UN-Habitat, 2016).

The proposed methodological framework developed in this study serves as both an evaluative and prescriptive tool-capable of assessing ongoing regeneration projects and guiding future initiatives. It aids decision-makers and urban planners in balancing environmental sustainability, social inclusion, and economic resilience, ensuring that coastal regeneration becomes a key strategy for sustainable urban transformation in alignment with global and European sustainability goals.

3 Application to Coastal Regeneration Systems

This section applies the methodological framework proposed in Section 2 to twelve international coastal and river-adjacent cities (Hamburg, Marseille, Genoa, Lisbon, Heraklion, Prà (Genoa), London, Port Said, Sydney, Baltimore, Buenos Aires, and Seoul) in order to evaluate contemporary waterfront regeneration. Rather than treating the case studies as isolated examples, the analysis operationalizes a structured set of thirty-two sustainability indicators, grouped into four interdependent pillars: social inclusion and justice, economic vitality, environmental sustainability, and quality of urban public space, to reveal patterns, gaps, and systemic tendencies in waterfront redevelopment globally.

Data were collected through multiple sources, including scientific literature, planning documents, municipal reports, sustainability assessments, and international spatial and urban databases. Each case was evaluated using a consistent binary scoring system (0/1), recording the presence or absence of each criterion and translating qualitative and quantitative evidence into comparable sustainability performance measures.

The methodological strength of this framework lies in its ability to translate the abstract logic of the SDGs into spatially and institutionally measurable urban processes. Across highly diverse geographic, economic, and governance contexts, the comparative matrix enables consistent cross-case evaluation of how regeneration projects perform not only as physical interventions but as sustainability and resilience strategies. The results demonstrate that waterfront redevelopment has become one of the primary laboratories in which cities test their capacity to integrate climate adaptation, economic restructuring, environmental restoration, and social inclusion within a single spatial system.

Across all cases, SDG alignment is strongest for goals linked to infrastructure, economic development, and climate adaptation (SDGs 8, 9, 11, and 13). These goals align with dominant investment and planning logics, real estate development, transport, tourism, and innovation districts and are therefore systematically embedded into regeneration projects. In contrast, SDG 10 (Reduced Inequalities) and SDG 14 (Life Below Water) show weak and inconsistent performance, indicating that social justice and marine ecosystem protection are not structurally integrated into most redevelopment frameworks.

This divergence highlights a critical methodological insight: the SDGs that are easiest to spatialize and monetize are the ones most likely to be implemented, while those that require redistributive policies, governance reform, or ecosystem-based regulation face greater institutional and political resistance. The framework therefore reveals not only what cities do, but what their planning systems are structurally able or unable to deliver.

4 Results

In General, the comparative analysis of the twelve coastal cities reveals varying degrees of integration between urban regeneration strategies and the SDGs. Despite their differing geographic, institutional, and economic contexts, these cities face a common challenge:

balancing coastal resilience with social equity, environmental quality, and economic vitality. The findings reaffirm that the success of SDG localization depends more on institutional coherence, political commitment, and civic engagement rather than on a city's size or wealth (Satterthwaite, 2011). The results show strong disparities across cities (Figure 3).

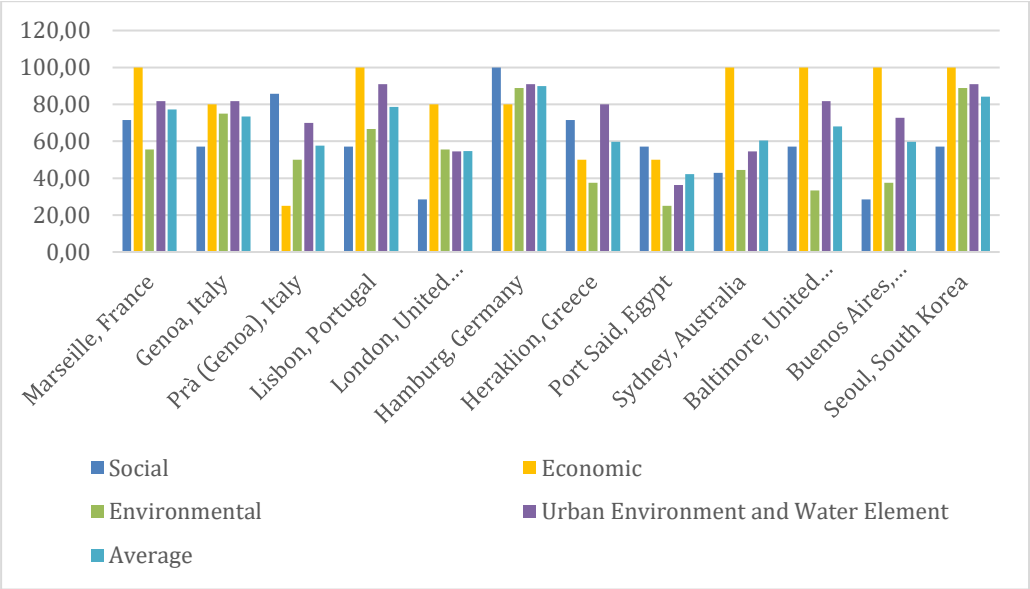

Figure 3. City Comparison Based on Average Evaluation

Hamburg and Seoul lead with balanced performance across all pillars, while Lisbon and Marseille follow, driven mainly by economic and urban-quality strengths. Genoa and Baltimore perform moderately, and London, Buenos Aires, Sydney, Heraklion, and Prà show mixed results with clear environmental and inclusion gaps. Port Said scores lowest. Overall, while economic objectives are widely achieved, environmental sustainability and social equity remain the weakest dimensions, underscoring the need for more integrated and resilient governance in waterfront regeneration.

The comparative analysis also uncovers three key lessons:

- Sustainability must be context-specific: coastal morphology, climate exposure, economic structure, and community priorities should inform regeneration strategies, rather than relying on one-size-fits-all solutions.
- Inclusive processes are essential: early and ongoing engagement with residents, local businesses, and vulnerable groups enhances legitimacy, social acceptance, and long-term stewardship.
- Decision-making should be data-driven, supported by baseline diagnostics, climate-risk modeling (including sea-level rise and heat scenarios), and clear performance indicators-such as water quality indices, habitat extent, affordable housing provision, sustainable mobility modal share, and local green employment to ensure accountability and promote learning.

By embedding the SDGs in local governance, infrastructure development, economic strategies, and social programs, coastal cities can drive meaningful, place-based change while remaining aligned with global sustainability and climate goals.

A critical but often overlooked aspect of sustainable coastal regeneration is the role of land governance and geospatial ecosystems. Issues such as informal construction, unregulated land use, and fragmented data frequently undermine sustainability, especially in Southern Europe and the Global South. Implementing fit-for-purpose land administration and integrating geospatial tools can significantly enhance planning efficiency, equity, and SDG monitoring at the neighborhood level. The HafenCity case illustrates how geospatial intelligence and land value capture mechanisms can align land policy with sustainability objectives, while Heraklion and Marseille highlight the risks posed by weak land governance frameworks (World Bank, 2017).

Ultimately, the localization of the SDGs in coastal regeneration depends on the integration of institutional capacity, participatory governance, and spatially informed decision-making. When these elements converge, waterfronts can become powerful laboratories for implementing the 2030 Agenda and advancing truly sustainable urban transformation.

5 Discussion

Comparative assessment indicates significant differences in the ways urban regeneration processes are structured around the Sustainable Development Goals (SDGs) and principles of climate resilience and sustainability. The findings show that waterfront regeneration is increasingly used by cities to combine environmental protection, economic development, and social inclusion within complex institutional and governance settings.

One of the most significant insights from the cross-case comparison is the variability in how cities integrate the SDGs into their regeneration strategies. While Hamburg and Seoul emerge as front-runners with high overall scores in social, environmental, and urban-water criteria, other cities such as London, Buenos Aires, and Sydney show moderate performance. These variations suggest that SDG localization is highly context-dependent, with factors such as governance capacity, political will, and institutional coherence playing pivotal roles in driving successful outcomes. The evidence reinforces the notion that the success of SDG integration in coastal regeneration projects is not necessarily tied to the wealth or size of the city, but rather to the robustness of local governance structures and the level of civic engagement in the planning process (Ansell, Sørensen, & Torfing, 2022).

A critical challenge that emerges from the analysis is the tension between economic development and environmental sustainability. Cities like Hamburg and Lisbon have managed to strike a balance by prioritizing both resilience and economic growth, integrating green infrastructure and climate-adaptive design into their waterfront developments. However, in other cities, particularly those with strong real estate-driven regeneration models (e.g., Marseille, Buenos Aires), environmental and social objectives often take a backseat to

economic growth, leading to inequitable distribution of benefits. This highlights the need for a more holistic approach that incorporates environmental sustainability and social inclusion as core objectives, rather than as secondary considerations.

This analysis also reveals a recurring gap in the integration of marine and coastal ecosystem sustainability (SDG 14). While cities like Genoa and Lisbon have incorporated blue-green infrastructure and ecosystem restoration into their regeneration plans, many others, such as Sydney and Port Said, show limited attention to marine biodiversity and the protection of coastal habitats. This indicates a missed opportunity to strengthen the environmental dimensions of coastal regeneration, which is particularly crucial given the increasing threats of sea-level rise and coastal erosion.

Another important lesson is the centrality of participatory governance. Cities that actively engaged residents, local businesses, and vulnerable groups in the planning and decision-making processes, such as Hamburg and Marseille, were able to foster greater social acceptance and long-term commitment to regeneration projects. In contrast, projects with limited or delayed community engagement often faced resistance, highlighting the need for transparent, inclusive, and accountable governance models. As UN-Habitat argues, inclusive governance ensures that regeneration projects are not only efficient but also socially legitimate and beneficial to all stakeholders (UN-Habitat, 2022).

Moreover, the analysis highlights the central role of data-driven decision-making and long-term monitoring. Successful cases such as Hamburg's HafenCity show how geospatial intelligence, climate-risk modeling, and performance indicators allow cities to evaluate outcomes, adapt to emerging challenges, and keep regeneration aligned with the SDGs over time. By contrast, cities with weak monitoring capacity, such as Heraklion, struggle to track progress and adjust policies, undermining long-term resilience (Sharifi, 2021; Füssel, 2009).

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