كلية الهندسة بشبرا
FACULTY OF ENGINEERING AT SHOUBRA
ERJ
PRINT ISSN 3009-6049
ONLINE ISSN 3009-6022

ENGINEERING RESEARCH JOURNAL (ERJ)
Volume (54),Issue (2)
April 2025, pp:251-267
https://erjsh.journals.ekb.eg

Sustainable Regenerative Urban Design Standards for Coastal Areas: An Integrated Approach to Climate Change Adaptation and Environmental Development

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Abstract: Coastal areas are facing increasing risks due to climate change, such as sea level rise and shoreline erosion, which threaten their environmental, urban, social, and economic balance. Despite global efforts, there remains a clear gap in providing integrated design frameworks that combine sustainability, resilience, and ecological regeneration. This research adopts a comparative analytical methodology, beginning with a theoretical review of regenerative and sustainable design concepts, followed by an analysis of regional and international coastal case studies. It also draws on international standards and indicators to develop a measurable evaluation model. The study concludes with an integrated framework for sustainable regenerative urban design in coastal areas, focusing on ecosystem restoration, the development of resilient infrastructure, and the integration of smart technologies to support climate adaptation and long-term sustainable development.

Keywords: Sustainable Regenerative Design, Coastal Areas, Climate Change, Environmental.

1. Introduction

Coastal areas are among the most climate-sensitive ecosystems, with nearly 40% of the global population residing within 100 kilometres of coastlines. These zones host over 70% of the world's major cities and are increasingly threatened by urban expansion, population growth, shoreline erosion, sea level rise, and habitat degradation.

According to the IPCC, sea levels are expected to rise by 0.6 to 1.1 meters by 2100, endangering low-lying regions and displacing millions [1]. UNEP estimates that damages from coastal storms and flooding may exceed $1 trillion annually by 2050 without effective adaptation [2].

In response, sustainable regenerative design offers a progressive approach that not only mitigates environmental harm but also restores ecosystems, enhances natural balance, and promotes socio-economic well-being. This design paradigm is especially suited for coastal areas due to their complex needs in infrastructure, land use, energy, and water systems.

This study aims to identify standards of regenerative urban design tailored for coastal contexts by reviewing literature, analyzing global project case studies, and exploring theoretical and applied frameworks. Using a comparative analytical method, it seeks to develop a comprehensive model that supports climate adaptation and sustainable coastal development.

1.1 Research Problem:

Coastal areas are among the most vulnerable environments to climate change impacts such as sea level rise and shoreline erosion, threatening their environmental and urban stability. Despite the growing interest in sustainable design, there remains a lack of integrated frameworks that combine climate adaptation with ecological regeneration. This highlights the need for a design approach that merges sustainability, resilience, and technological and social innovation. Accordingly, this research addresses the challenge of identifying regenerative urban design standards that enable coastal areas to adapt and achieve effective environmental development.

1.2 Research Aim:

This research aims to identify and formulate sustainable regenerative urban design standards for coastal areas in a way that enhances their capacity to adapt to climate change while achieving an effective balance between environmental development and urban-social stability. The study aligns with the United Nations Sustainable Development Goals (SDGs), particularly Goal 11 (Sustainable Cities and Communities), and Goal 13 (Climate Action). It also supports Egypt's Vision 2030, which emphasizes sustainable urban growth, climate resilience, and the protection of natural resources, especially in vulnerable coastal zones. By integrating these global and national frameworks, the research aspires to provide a practical and context-sensitive design model that contributes to long-term environmental and societal well-being.

1.3 Research Methodology:

This research adopts an analytical, inductive, and deductive methodological approach aimed at developing comprehensive and integrated standards for sustainable regenerative urban design in coastal areas. The methodology follows a structured sequence beginning with an extensive literature review, aimed at establishing theoretical foundations through analyzing key definitions and concepts related to coastal regions, environmental sustainability, sustainable urban design, and climate change adaptation, particularly within the regenerative design framework.

Following this conceptual groundwork, the research delves deeper into identifying core principles and strategies of sustainable urban design and exploring adaptive measures specifically tailored for coastal areas facing climate change challenges. This review process culminates in formulating a preliminary set of theoretical criteria for sustainable regenerative urban design.

The methodology further includes a critical analysis of international sustainability standards and urban planning frameworks, including globally recognized certification systems such as LEED-ND, BREEAM, and ISO, as well as coastal adaptation guidelines issued by international organizations such as UNEP and IPCC. Through this critical review, measurable quantitative and qualitative indicators are derived to form a comprehensive criteria-based model.

To validate these derived criteria, the study employs a multi-criteria comparative analysis tool applied to selected international and regional case studies representing practical implementations of regenerative design principles in coastal contexts, specifically including the East Side Coastal Resiliency (ESCR) project in New York, and the El Max area in Alexandria. This analysis aims to evaluate consistency, identify common patterns, and assess the effectiveness of adopted strategies.

Finally, theoretical and empirical findings are integrated into a proposed normative framework, intended as a practical guideline for future planning and design initiatives, balancing climate adaptation strategies, environmental sustainability, and urban growth demands in coastal development projects.

2. Definitions:

2.1 Coastal Areas:

Coastal areas are dynamic and complex ecosystems that represent the intersection of land and ocean, influenced by both natural and human factors. Timothy Beatley described them as shifting zones where land, water, and atmosphere interact within a balanced system that can be altered by natural or human forces [3]. According to the "Protocol on Integrated Coastal Zone Management in the Mediterranean – Article 2", these are geomorphological areas where complex ecosystems are formed, in which biotic and abiotic elements interact with economic and social activities [4]. Furthermore, the Integrated Coastal Development Guide and the International Union for Conservation of Nature indicate that the geographic extent of coastal areas varies based on human uses and may include plains, reefs, and wetlands [5].

Coastal areas are increasingly exposed to climate change and rising sea levels, leading to the erosion and submersion of sandy beaches and the inland retreat of shorelines. These changes are accompanied by a rise in the frequency of storms that significantly impact coastal infrastructure. Low-lying areas are especially vulnerable to erosion and degradation, resulting in alterations to the environmental characteristics of water and marine life, and posing a serious threat of submersion to agricultural lands and urban areas.

2.2 Environmental Sustainability:

Environmental sustainability, as defined by the United Nations Environment Programme, requires the preservation of ecosystem functions and biodiversity, while minimizing the negative environmental impacts of human activity [2]. According to the International Union for Conservation of Nature, environmental sustainability is based on a balance between resource exploitation and environmental conservation, relying on conscious resource management to ensure their long-term and effective availability[5].

2.3 Climate change:

Climate change has been defined in various authoritative sources. According to The Oxford Dictionary, it refers to "changes in the earth's weather, including changes in temperature, wind patterns, and rainfall, especially the increase in the temperature of the earth's atmosphere that is caused by the increase of particular gases, especially carbon dioxide [6]." The United Nations Framework Convention on Climate Change defines it as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods [7]." Similarly, the Intergovernmental Panel on Climate Change describes it as "a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer, whether due to natural variability or as a result of human activity [8]."

2.4 Regenerative urban design:

Regenerative urban design is an advanced concept that goes beyond traditional preservation approaches adopted by sustainability. It focuses on resource renewal and reconstructing an integrated relationship between the built environment and nature, through a process-oriented design methodology. In doing so, it represents a higher goal rather than merely serving as a tool for achieving sustainability [9]. From a modern global perspective, regenerative design is defined as a process that respects urban fabric and local culture, producing designs that enhance neighbourhood connectivity and walkability, thereby supporting a resilient

and context-responsive urban environment [10]. Is a restoring and renewing process that integrates the social, economic and environmental aspects into the urban system in order to promote a more resilient living environment aligning with the social needs of all [11].

3. Discussions:

3.1 Principles and Strategies of Sustainable Regenerative Urban Design:

Sustainable regenerative urban design is based on a set of principles aimed at achieving a balance between environmental efficiency and human and economic needs. Key among these principles is energy efficiency, through the design of buildings and products that consume less energy, with a focus on renewable energy sources. It also involves reducing resource consumption by using sustainable and recycled construction materials to minimize reliance on non-renewable natural resources. In addition, sustainable design promotes health and well-being by improving indoor air quality, providing natural lighting, and creating healthy living environments. It includes reducing environmental impact by minimizing harmful emissions, efficiently managing water and waste, and preserving biodiversity through spatial designs that support natural habitats. This type of design is grounded in the principle of integration, balancing environmental, functional, and user needs, while ensuring flexibility and adaptability in space planning to allow for future reuse and functional modification. Moreover, technological innovation is a core component in enhancing sustainability and efficiency through smart, advanced solutions. Finally, continuous evaluation and improvement represent a supportive approach to ensuring optimal environmental performance and achieving long-term strategic goals for sustainable development **Diagram 1**.

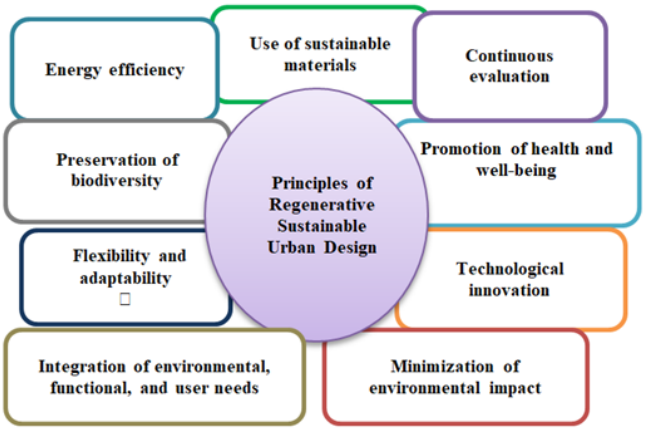


Diagram 1 Principles of Regenerative Sustainable Urban Design Source: By Author Based on source number [23] and [10]

And urban communities that respond to both present and future population needs. These strategies are grounded in principles of comprehensive and integrated planning, through the incorporation of diverse land uses within multifunctional urban environments that combine housing, work, and recreation **Diagram 2** .

A key pillar of these strategies is the development of sustainable transportation, through the creation of infrastructure that supports walking, cycling, and low-emission public transit systems. Increasing green spaces, such as parks and green roofs, contributes to improved air quality, quality of life, and environmental balance within the urban fabric. Furthermore, the strategies emphasize resource efficiency by adopting smart systems for energy and water conservation, along with sustainable waste management through recycling and source separation. They also support economic and social development by encouraging local projects and ensuring equitable access to essential services. Flexible and adaptive design is considered a core element in addressing the impacts of climate change, through resilient infrastructure and smart resource management systems. Lastly, technological innovation accelerates the transition toward sustainability by employing artificial intelligence and green construction technologies to reduce carbon footprints and achieve high-performance urban efficiency.

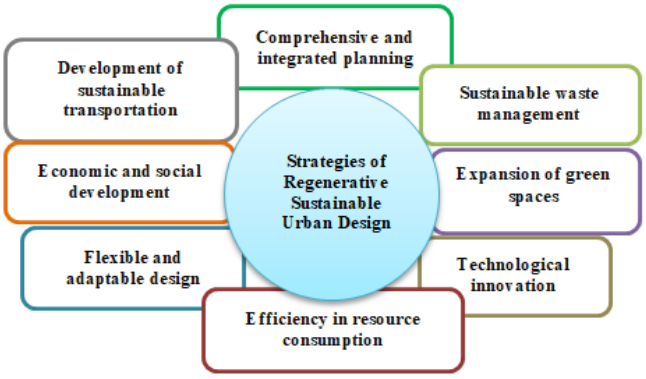


Diagram 2 Strategies of Regenerative Sustainable Urban Design Source: By Author Based on source number [23] and [10]

3.2 Elements of Sustainable Regenerative Urban Design:

Sustainable regenerative urban design is a holistic approach that balances environmental, social, and economic needs. It focuses on improving quality of life, reducing environmental impact, and enhancing climate resilience through green infrastructure, efficient resource use, and technological innovation. These elements are grounded in scientific principles that promote sustainable development and safeguard resources for future generations. The following diagram presents the key elements of regenerative urban design, along with a simplified explanation of the role each one plays in achieving this integrated approach. The following is a simplified explanation of the elements **Diagram 3**:

Site Selection & Land Protection: Careful environmental impact analysis leads to choosing resilient sites, using corrosion-resistant materials, and strengthening natural barriers like vegetation and breakwaters.

Transportation & Connectivity: Sustainable transport infrastructure prioritizes walking, cycling, public transit with

green energy, and reduces parking to lower carbon footprints.

Energy & Innovation: Renewable energy integration, smart lighting, and building materials that reduce emissions are combined with innovative construction technologies.

Water & Waste Management: Incorporate stormwater harvesting, greywater reuse, efficient irrigation, and advanced recycling technologies to conserve resources.

Diagram 3 Elements of Regenerative Sustainable Urban Design Source: By Author Based on source number [10]

3.3 Adaptation Strategy for Coastal Urban Areas to Climate Change:

Climate change is among the most significant challenges facing coastal cities, which are increasingly exposed to flooding, rising temperatures, and weather disruptions [7]. Adaptation strategies include the development of resilient infrastructure, sustainable design solutions, and the integration of community-driven and technological innovation [8]. According to the UNFCCC, adaptation is defined as the adjustment of human or natural systems to minimize harm or exploit beneficial opportunities. Reports from the World Bank and the Global Commission on Adaptation highlight the substantial economic impact of adaptation programs [12]. The IPCC emphasizes that the response to climate change involves four key pillars: planned retreat, adaptation, protection, and resilience, all of which are essential for enhancing the robustness of coastal cities [1]. The following **Table 1** presents a proposed operational framework for climate change adaptation programs in coastal urban areas;

3.4 Sustainable Regenerative Urban Design Standards for Coastal Areas:

This study aimed to analyses and understand the elements of regenerative sustainable design, its core principles, and strategies, as well as how these components integrate with environmental sustainability and adaptive approaches specific to coastal areas facing climate change. The culmination of this work is the development of a comprehensive evaluation framework — a reference tool designed to support the assessment and design of regenerative, sustainable projects in coastal regions in general, and those particularly vulnerable to climate change in particular. This framework represents a distilled synthesis of the research, merging theoretical and practical dimensions. It brings together essential design elements, foundational principles, and actionable strategies, while carefully considering the unique climatic and environmental contexts of coastal areas in **Table 2**. As such, it constitutes a step forward toward creating resilient, integrated, and adaptable environments capable of renewal over time.

Table 1 Adaptation Strategy for Coastal Urban Areas to Climate Change Source: By Author Based on source number [7] and [24]

Main Objective	Proposed Executive Actions
Reducing climate change risks and associated disasters	- Develop Geographic Information Systems (GIS) for coastal areas. - Establish a national network to monitor sea level rise. - Enhance technical and scientific capacity to assess risks. - Prepare national models for climate forecasting and impact analysis. - Evaluate adaptation costs and produce risk maps. - Conduct studies and reinforce coastal protection structures. - Develop evacuation plans and flood barriers. - Study natural protection methods and sea intrusion. - Integrate smart and green infrastructure technologies.
Contributing to sustainable development and food security requirements	- Integrate disaster management into development policies. - Support national coordination among sectors. - Establish qualified technical bodies. - Promote urban agriculture and water-energy technologies. - Support desalination and smart irrigation projects.
Building Egypt's societal capacity to adapt to climate change	- Establish early warning systems. - Prioritize adaptation program stages. - Develop a national adaptation strategy. - Set flexible coastal development regulations. - Support human resources and capacity building. - Develop emergency plans and resilient health infrastructure.
Enhancing national partnership in climate crisis management	- Engage media and communities in awareness campaigns. - Foster partnerships among public, private, and civil sectors.

	- Disseminate understandable risk information. - Integrate climate concepts in curricula. - Promote citizen science for environmental monitoring.
Infrastructure resilience	- Construct drainage systems and dams. - Adopt green roofs and permeable pavements. - Integrate technology in resource management.
Urban planning and zoning	- Identify high-risk areas and restrict informal expansion. - Encourage vertical building and use of sustainable materials. - Integrate services to reduce travel and improve density.
Water management	- Enforce water-saving regulations. - Reuse greywater. - Promote solar-powered desalination.
Energy efficiency and renewable energy	- Support solar and wind energy initiatives. - Implement efficiency standards for buildings and appliances. - Develop distributed energy stations with simplified licensing.
Public health and safety	- Develop heat action plans and cooling centers. - Prevent diseases through vaccination and sanitation. - Prepare evacuation plans and sustainable shelters.
Environmental applications	- Establish urban forests and enforce protection laws. - Restore wetlands. - Protect biodiversity and ban harmful pesticides.
Community participation and education	- Launch awareness campaigns and community events. - Promote participatory planning and hold workshops. - Support citizen science projects for environmental monitoring.

Table 2 Sustainable Regenerative Urban Design Standards for Coastal Areas Source: By Author

Main Element	Sub-elements	Sustainable Regenerative Design	Adaptation Methods from Climate Change
Sustainable Site: Aims at selecting sites and environmentall y-friendly design strategies.	Site Selection	Environmental Impact Analysis: Study the surrounding environmental impacts, select appropriate materials and designs. Sustainability Guidelines: Choose sustainable sites that utilize renewable energy sources and reduce waste. Urban fabric characterized by streets and visual axes perpendicular to water bodies connecting water and city center directly. Inclusion of green spaces and parks to improve air quality and environment. Diverse urban space design concepts for visual and aesthetic differentiation in coastal areas.	1- Enhancing Climate-Resilient Infrastructure: *Constructing Natural Barriers: -Restoring mangrove forests, coral reefs, and wetlands to reduce wave impact and sea-level rise. -Reinforcing sand dunes as natural buffers against coastal flooding. *Strengthening Dikes and Urban Infrastructure: -Constructing protective seawalls in low-lying coastal areas. -Utilizing materials resistant to water and salinity in infrastructure development. 2-Sustainable Urban Design in Coastal Areas: *Elevating Land in Low-Lying Zones: -Raising buildings and homes in flood-prone areas. -Designing elevated structures to minimize flood-related damage. *Creating Buffer Zones: -Allocating green spaces and coastal parks as transitional buffers between urban zones and the shoreline. -Implementing permeable pavements to reduce surface runoff and enhance drainage efficiency. 3-Adaptive and Sustainable Urban Planning: *Risk Zone Identification: -Using digital mapping tools to identify areas vulnerable to flooding and erosion. -Zoning land use based on risk levels (e.g., residential, commercial, industrial). *Reducing Population Density in High-Risk Areas: -Relocating communities from the most
	Coastal Land Protection	Regulating Land Use: Designing buildings that respect coastal environments, maintain ecological balance, and address issues of soil salinity and rising groundwater levels. Using Corrosion-resistant Materials: Choose materials resistant to coastal corrosion like sulfate and chloride-resistant concrete and additives enhancing durability. Strengthening Natural Barriers: Employ coastal vegetation, breakwaters, and protective walls as barriers against erosion. Promoting Environmental Sustainability: Adopt regenerative designs respecting coastal ecosystems.	
	Community Services and Connectivity	Ensuring public connectivity with water bodies, addressing community needs and interests. Clear signage and guidance facilitating access to coastal areas. Reflecting visual identity and urban configuration of coastal areas with community's culture and behaviour.	
	Long-term Impact on Biodiversity	Development of Green Spaces: Communities ensuring parks and biodiversity support spaces, sports areas. Harmonious relationships	

		between blocks and open spaces enhancing visual comfort and diversity. Green Building Guidelines: Adopt green building principles and eco-friendly materials to minimize environmental impact. Consider coastal topography affecting visual axes and climate influencing building orientation and planting. Design standards for marine docks, wave barriers, and ship loading/unloading systems. Encourage Environmental Awareness: Organize environmental awareness campaigns emphasizing biodiversity conservation.	vulnerable zones to safer regions. -Designing emergency evacuation zones in proximity to coastal areas.
Transportation Management: Provide efficient, reliable, and environmentally-friendly public transportation.	Public Transportation Access	Provide public transport stations equipped with solar energy systems. Promote electric or hybrid public transport. Green spaces around transit stations improving air quality. Encourage cycling to access public transport.	-Providing shaded pedestrian pathways powered by solar energy. -Designing walkways surrounded by vegetation to enhance biodiversity. -Constructing parking areas covered with systems for collecting clean water. -Providing parking spaces equipped with electric vehicle (EV) charging stations. -Designing secure, covered bicycle parking facilities. -Promoting the use of electric bicycles as an alternative mode of transportation. -Encouraging the use of green vehicles by offering incentives and dedicated facilities. -Redirecting investments toward the development of alternative and green transportation systems.
	Main Roads	Appropriate road widths matching user numbers and intended uses. Roads designed for climate resilience. Proper planning separating pedestrian and vehicular traffic. Efficient rainwater drainage systems. Clear main roads leading to water bodies. Hierarchical road design (main, secondary, tertiary). Parallel roads along waterways to attract traffic.	
	Pedestrian Pathways	Sidewalks free from obstacles, non-slip rough surfaces, potentially recycled materials. Sidewalk width at least 2 meters. Shaded pedestrian paths using solar power. Sustainable lighting near traffic signs. Pedestrian paths surrounded by plants enhancing biodiversity, minimum width 1 meter. Smartphone and device charging points along paths.	
	Maximum Parking Capacity	Covered parking lots with water collection systems for irrigation. Parking spaces with electric car chargers. Eco-friendly construction materials for parking lots. Does not conflict with pedestrian pathways along water bodies. Trees and shrubs for aesthetics and separation. Parking positioning non-intrusive to water views.	
	Bicycle Facilities	Covered and secured bicycle parking. Safe bicycle paths not intersecting pedestrian or vehicle routes. Paths width minimum 8 feet per direction. Bike maintenance facilities promoting sustainability culture. Encourage electric bikes as alternative transport. Educational courses on bike safety and related traffic laws. Paths clear from visual obstructions like trees/signs.	
	Green Vehicles and Alternative Transport	Promote green vehicles like electric and hybrid cars by offering benefits and facilities. Integrated public transport networks supporting alternatives such as electric buses and trams. Facilitate electric bicycles and scooters through infrastructure. Investments targeting sustainable and healthy alternative transport.	
Water Management:	Water Consumption	Smart water meters monitoring and promoting water conservation. Promote eco-friendly	1. Enhancing Water Management Systems: *Developing Stormwater Drainage

Design local water reuse and efficient drainage systems, improve water quality and reduce emissions.	Monitoring	fixtures (low-flow taps/showers). Regular water consumption reporting. Water recycling technologies maximizing resources.	Systems: -Designing modern drainage networks to reduce the impact of flooding. -Utilizing constructed wetlands to treat stormwater before discharging it into the sea. -Implementing smart metering technologies to monitor and optimize water use. *Water Reuse Technologies: -Reusing treated water for irrigation or cleaning purposes in coastal areas.
	Outdoor Water Efficiency	Irrigation systems using treated wastewater, corrosion-resistant sewage systems suitable for saline water. Contests designing water-saving gardens. Community education on outdoor water conservation.	
	Stormwater Management	Rainwater harvesting for irrigation and cleaning, corrosion-resistant water systems suitable for stormwater management. Green permeable areas absorbing rainwater. Workshops on rainwater use. Sustainable flood emergency plans.	
Waste Management:	Waste Sorting and Recycling	Awareness programs promoting recycling. Investments in advanced recycling centres and innovative recycling technologies. Encourage using recycled materials in construction industries.	-Promoting recycling and the use of organic waste for energy production. -Developing infrastructure for the efficient collection and transportation of waste. -Enhancing the use of waste separation technologies and converting waste into reusable resources.
	Waste Storage and Sorting Spaces	Infrastructure for waste collection and sorting minimizing environmental impact in coastal urban areas. Advanced waste separation technologies transforming waste into energy or recyclable resources. Sustainable waste management projects for coastal urban areas.	
Energy Management: Encourage renewable energy sources and clean energy technologies.	Renewable Energy Use & Low-carbon Technologies	Install solar and wind systems for clean electricity. Buildings using eco-friendly materials minimizing carbon emissions. LED and smart street lighting saving energy. Smart lighting reducing unnecessary consumption. Promote various outdoor energy-efficient lighting (solar/kinetic). Policies reducing light pollution through regulation of excessive lighting.	1. Integration of Renewable Energy Sources: -Installing solar and wind energy systems for sustainable electricity generation. -Utilizing ocean thermal energy conversion (OTEC) technologies. -Integrating renewable energy into public infrastructure (e.g., solar-powered street lighting, coastal parks). -Encouraging the use of microgrids powered by renewable sources for local resilience. 2. Policy Incentives and Financial Mechanisms: -Offering tax incentives and subsidies for renewable energy projects. -Providing grants and low-interest loans for energy-efficient coastal developments. -Implementing feed-in tariffs to support decentralized renewable energy generation. 3. Energy-Efficient -Building Design: Promoting green building standards and Net Zero Energy Buildings (NZEBs). -Retrofitting existing coastal structures to improve thermal insulation and reduce energy demand. -Using passive design strategies to reduce reliance on mechanical cooling/heating. 4. Development of Smart and Resilient Energy Infrastructure: -Establishing smart grid systems to optimize energy distribution and reduce peak demand. -Integrating real-time monitoring and smart metering technologies for efficient energy use. -Developing energy storage facilities to ensure supply continuity during disruptions.
	Reducing Light and Noise Pollution	Noise reduction systems for transportation and industry in coastal areas. Acoustic insulation and architectural design minimizing noise.	

			5. Waste-to-Energy and Circular Energy Systems: -Promoting recycling and the conversion of organic waste into bioenergy. -Developing infrastructure for efficient waste collection and resource recovery. -Enhancing the use of waste separation technologies to support circular energy flows. 6. Community Awareness and Behavioral Change: -Launching public awareness campaigns on energy conservation and climate resilience. -Providing education and training programs on renewable energy technologies for coastal residents. -Engaging local communities in participatory energy planning. 7. Monitoring and Carbon Footprint Management.
Health and Well-being:	Visual Comfort	Green spaces, indoor and outdoor gardens for relaxation and connection to nature. Sustainable and organic materials in furniture/interiors providing ecological balance. Open natural views enhancing tranquillity in coastal zones.	-Providing indoor and outdoor green spaces and natural cooling facilities to improve air quality. Enhancing sanitation systems and promoting health awareness. -Developing a network of roads and pedestrian pathways designed to accommodate all ages and abilities. Installing advanced security systems in public spaces. -Designing dedicated areas for sports and social activities. -Creating relaxation and recreational zones connected to natural elements. -Implementing alarm and evacuation systems to enable rapid and effective disaster management and protect coastal residents. -Establishing updated and integrated disaster and emergency response plans to ensure effective action during natural emergencies. -Providing advanced monitoring and security systems in public and coastal areas to reduce crime, ensure safety, and enable early warning in the event of a disaster.
	Safe Accessibility	Road network and pedestrian pathways accessible for all ages/abilities. Bicycle and alternative transport parking promoting eco-friendly transit. Advanced monitoring/security systems enhancing public safety. Integrated disaster response plans. Effective evacuation and warning systems.	
	Private Space Availability	Outdoor areas serving various resident needs including green spaces, seating, entertainment areas. Social interaction and cultural event spaces fostering community bonds. Fitness and sports areas promoting health and well-being. Advanced security systems protecting public spaces.	
Materials and Resources: Use sustainable building materials with minimal lifecycle environmental impact.	Local Resource Use	Infrastructure developed using locally sourced coastal materials like rocks and sand ensuring durability/sustainability. Local resource projects creating jobs and enhancing local economy. Low-carbon local resources like sustainable wood and local stones minimizing carbon footprint. Traditional crafts preserving coastal heritage.	1- Use of Climate-Resistant and Suitable Materials: -Adopting materials resistant to corrosion, humidity, salinity, as well as flood- and UV-resistant construction materials. 2-Promoting Locally Sourced and Low-Carbon Materials: -Utilizing local and eco-friendly resources such as recycled aggregates and bamboo to reduce emissions and support the local economy. 3-Designing Flexible and Adaptable Material Systems: -Implementing modular and demountable building systems with envelopes that allow natural ventilation and adapt to changing climatic conditions.

			4-Enhancing Resource Management and Circular Economy Practices: -Recycling construction waste, designing for reuse, and focusing on minimizing waste and maximizing resource sustainability. 5-Adopting Technological Innovation and Supporting Sustainable Policies: -Using smart and advanced corrosion-resistant materials, aligning material selection with green building standards, and encouraging supportive policies.
Innovation: Creative design and innovative environmental solutions.	Innovative Techniques and Design	3D technologies for precise coastal project design and analysis. Innovative construction methods (prefab, modular) reducing waste and speeding up construction. Projects enhancing coastal biodiversity and ecosystem protection. Integrated water and waste management improving marine environment quality.	• Adopting advanced technologies such as floating or adaptable buildings. • Supporting research and utilizing artificial intelligence for climate risk analysis and smart design. • Establishing early warning systems: • Installing alert systems to warn residents of floods or storms. • Monitoring sea levels and climatic conditions using satellite technologies. • Developing smart buildings: • Utilizing renewable energy sources in buildings. • Designing building façades to resist wind and waves. • Developing "sponge cities" to cope with climate change impacts.
	Advanced Environmental Technologies and Sustainable Materials	Flexible designs adaptable to climate/environmental changes in coastal areas. Community and expert collaboration in sustainable design processes. Advanced environmental technologies (solar energy, clean technology) in coastal buildings. Sustainable building materials (green concrete, environmental thermal insulation) enhancing energy efficiency and reducing environmental footprint.	

3.5 Analysis of Similar Projects in Coastal Areas Affected by Climate Change Through Regenerative Design Elements and Adaptation Strategies to Climate Impacts:

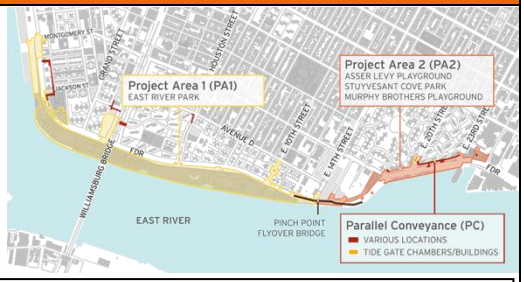
Coastal areas are sensitive ecosystems increasingly threatened by climate change, including rising sea levels, increased flooding, and coastal erosion—challenges that call for design interventions combining sustainability and resilience. This study presents diverse examples of adaptation strategies, ranging from engineered protection to nature-based solutions such as mangrove restoration and the planting of native vegetation. Among these examples are the ESCR project in New York, and the El-Max area project in Alexandria. These projects demonstrate the importance of integrating environmental and social approaches, improving urban infrastructure, and engaging local communities. Such experiences offer practical insights that can inform the design and implementation of more climate-resilient coastal projects

3.5.1 East Side Coastal Resiliency (ESCR) Project for the Coasts of New York City:

3.5.1.1 Analysis of the "East Side Coastal Resiliency (ESCR)" Project: Table 3

3.5.1.2 Analysis of the "East Side Coastal Resiliency (ESCR)" Project in Terms of Regenerative Sustainable Urban Design Standards and Climate Change Adaptation Methods: (Table 4)

Table 3 Analysis of the "East Side Coastal Resiliency (ESCR)" Project Source: By Author Based on source number [15]

Axis	Details
Location	The "East Side Coastal Resiliency (ESCR)" project is a coastal protection initiative funded in collaboration between New York City and the federal government, aimed at reducing flood risks from coastal storms and sea level rise. It is located in New York City, USA, on the east side of Manhattan Island from East 25th Street to Montgomery Street, covering an area of 72 acres.  **Figure 1-1 Illustrates the location of (ESCR) project. Source:** About - ESCR
Reason for Project	The project demonstrates innovative ways to protect the East Coast from flooding and erosion through the design of resilient infrastructure and environmental sensing technologies, while enhancing green spaces and

Selection	biodiversity, making it a model of urban coastal sustainability.
Climate Change	1. Coastal Flooding: The area was severely flooded during Hurricane Sandy (2012), causing significant damage to infrastructure and residential communities. 2. Severe Storms: Increased intensity and frequency of coastal storms. 3. Rising Temperatures: Heatwaves affecting local communities.
Impact on Urban Design	1. Redesign of Public Spaces: Integration of green spaces to improve air quality and reduce temperatures. 2. Infrastructure Improvement: Creation of modern drainage systems and flexible coastal protection walls. 3. Community Connectivity: Improvement of walkways and public facilities. 4. Focus on Sustainability: Use of environmentally friendly building materials.
Adaptation Methods Used	1. Resilient Infrastructure: Construction of flexible flood protection walls. 2. Green Urban Design: Creation of water retention gardens and use of green spaces. 3. Water Management: Systems for collecting and reusing rainwater. 4. Smart Technologies: Integration of IoT systems to monitor water levels. 5. Community Participation: Involving residents in planning and implementation stages.
Positive Impact	1. Flood Risk Reduction: Protection from significant damage. 2. Improved Quality of Life: Enhancing green spaces and public health. 3. Sustainability Promotion: Increased energy efficiency and reduced reliance on non-renewable resources. 4. Increased Climate Awareness: Educating the community on how to deal with climate disasters.

Table 4 Analysis of the "East Side Coastal Resiliency (ESCR)" Project in Terms of Regenerative Sustainable Urban Design Standards and Climate Change Adaptation Methods Source: By Author

Main Elements	Sub-elements	Details	Adaptation Methods from Climate Change
Sustainable Site	Site Selection	The project is located on the eastern coast of Lower Manhattan, a strategic choice to mitigate the impacts of frequent storms and rising sea levels.	The project area extends from 25th Street to Montgomery Street, covering the most storm-prone areas.
	Coastal Land Protection	The project design relies on the creation of protective systems such as levees and retention basins to safeguard coastal neighborhoods and reduce environmental damage.	Construction of a 4-kilometer-long wall along the waterfront to protect adjacent residential areas.
	Community Services and Connectivity	Enhancements to public infrastructure to improve quality of life in the local community, including public spaces, green areas, and better access to the waterfront.	Creation of new public parks and sports fields to serve residents and improve their quality of life.
	Long-term Impact on Biodiversity	Plans to improve local biodiversity by planting native vegetation and creating green spaces to improve air quality and the local environment.	Planting flood-resistant species such as coastal grass to enhance soil stability and support wildlife.
Transportation Management	Access to Public Transportation	Improving access to public transportation by providing nearby stations equipped with renewable energy systems such as subway and bus stations.	Creating project entrances next to subway stations like East Broadway Station.
	Pedestrian Paths	Designing pedestrian pathways connecting neighborhoods to coastal areas, shaded by solar canopies and surrounded by native plants to improve air quality and reduce temperatures.	Constructing shaded paths with native trees offering direct views of the river.
	Maximizing Parking Capacity	The project focuses on reducing car usage and promoting alternative transportation rather than expanding parking, with limited green parking lots equipped with EV chargers.	Providing small parking areas integrated under elevated gardens while preserving green spaces.
	Bike Facilities	Dedicated paths and facilities for bicycles are provided within the design to promote sustainable transportation, along with bike maintenance services.	Installing bike rental stations and connecting paths to the "Manhattan Waterfront Greenway."
	Green Vehicles and Alternative Transport	No direct information on green vehicles, but there is an emphasis on the use of electric or hybrid public transport and electric buses to reduce reliance on private cars.	Installing EV charging stations at project entrances to support electric vehicles.
Water Management	Monitoring Water Consumption	Developing systems to monitor water consumption and encourage conservation through the installation of smart water meters.	Installing smart meters to monitor water use in irrigation and public facilities.
	Outdoor Water Use Efficiency	Designing irrigation systems for gardens and green areas using treated wastewater and rainwater.	Installing drip irrigation systems based on soil moisture data to reduce waste.

	Stormwater Management	Designing systems to collect and use rainwater for irrigating plants and green spaces, with improved stormwater drainage and recycling technologies.	Constructing underground tanks with high capacity for rainwater collection to reduce reliance on potable water.
Waste Management	Sorting and Recycling Waste	Developing infrastructure for efficient and safe waste collection and transport, encouraging the use of waste separation and conversion into valuable resources.	Placing recycling bins for plastic and metal waste at every project entry and exit point.
	Waste Storage and Separation	Designing dedicated areas for waste storage and separation within coastal urban communities.	Creating small waste storage areas under elevated structures to avoid impacting open spaces.
Energy Management	Use of Renewable Energy Sources	Installing solar and wind energy systems to generate clean, sustainable electricity.	Placing solar panels on elevated rooftops to produce electricity for public lighting.
	Low and Zero Carbon Technologies	Promoting the use of green construction techniques and eco-friendly materials to reduce carbon emissions.	Using recyclable concrete in building barriers and roads.
	Energy-efficient Outdoor Lighting	Adopting smart lighting technologies with sensors to minimize energy use when lighting is not needed.	Using solar-powered lighting poles along public pathways.
	Reducing Light and Noise Pollution	Developing systems to reduce noise from transportation and industries in coastal urban areas.	Installing light fixtures designed to limit light spread beyond necessary boundaries.
Health and Well-being	Visual Comfort	Harmonious coordination of buildings and green spaces to create an aesthetically pleasing and relaxing environment.	Integrating fountains and green spaces to add visual beauty to the site.
	Safe Access	Providing an integrated network of safe paths and routes for pedestrians and cyclists to ensure safe access to buildings and public areas.	Creating wide ramps and elevators to facilitate mobility in elevated areas.
	Private Spaces	Designing diverse outdoor spaces to meet residents' needs such as green zones, seating areas, and spaces for community and recreational activities.	Installing benches and canopies in secluded corners away from crowded areas.
Materials and Resources	Use of Local Resources	Using low-carbon local resources such as local stones and eco-friendly materials to reduce the carbon footprint.	Relying on local stone for constructing protective walls.
Innovation	New Techniques in Design and Construction	Adopting innovative construction methods such as prefabrication and 3D printing to reduce waste and accelerate execution. The project also includes integrated levees and water management systems.	Testing 3D models of the project before construction begins.
	Positive Environmental Impact Projects	Designing projects that preserve biodiversity and enhance the protection of coastal ecosystems.	Creating gardens that absorb carbon dioxide and reduce heat.
	Innovative and Flexible Designs	Implementing designs that encourage innovation and sustainability through community participation and expert input, with flexibility for future modifications based on community needs and climate changes.	Designing facilities to be expandable or to add new services when needed.
	Advanced Environmental Tech & Sustainable Materials	Using advanced technologies like solar energy systems and clean technology in coastal building operations, along with sustainable materials such as green concrete and eco-insulation.	Applying glass facades that reduce heat and provide high-efficiency thermal insulation.

3.5.1.3 Findings and Recommendations:

The project demonstrated remarkable excellence across several key dimensions related to sustainability and urban design. It particularly excelled in the area of sustainable site development, with a strategic site selection, effective coastal land protection, community service enhancements, and long-term positive environmental impacts. In terms of transportation management, the project succeeded in enhancing public transportation access, providing safe pedestrian walkways, integrated bicycle facilities, and promoting green vehicle usage — all contributing to a significant reduction in carbon emissions. Regarding water management, the implementation of advanced systems for monitoring consumption and reusing stormwater and treated wastewater was a notable achievement. The project's energy management also showed outstanding performance through the adoption of renewable energy sources, low-carbon technologies, and energy-efficient lighting solutions, reinforcing its commitment to sustainability. Finally, the project displayed a high level of innovation through the

application of new design and construction techniques and the development of projects with tangible positive environmental impact.

Based on these findings, the following recommendations are proposed:

1. Expand green spaces to enhance biodiversity and improve the urban environmental quality.
2. Increase the use of renewable energy by raising the project's reliance on clean energy sources.
3. Improve waste management by upgrading recycling infrastructure and allocating adequate spaces for waste sorting and storage.
4. Encourage community engagement in planning and implementation phases to ensure alignment with local needs.
5. Establish a continuous environmental performance monitoring system to ensure the long-term achievement of sustainability goals.

3.5.2 Coastal Development Project in Alexandria – El-Max Area:

3.5.2.1 Analysis of the Alexandria – El-Max Area Project: (Table 5)

3.5.2.2 Analysis of the Alexandria – El-Max Area Project in Terms of Regenerative Sustainable Urban Design Standards and Climate Change Adaptation Methods(Table 6):

Table 5 Analysis of the El-Max Area Project Source: By Author Based on source number [16]

Axis	Details
Location	Alexandria, Egypt. The project is located along the northern coasts of Alexandria, with a particular focus on the El-Max area situated on the city's western shoreline.  **Figure 2** Illustrates the location of El-Max Area project. Source: Google Earth
Reason for Project Selection	El-Max is characterized by its strategic location that combines industrial facilities, a port, and residential areas serving a large population. It is bordered by the Dhekelia Port on one side and low-rise residential neighborhoods on the other. El-Max is one of the areas most vulnerable to climate change, facing rapidly rising sea levels and coastal erosion, which threaten both infrastructure and local communities.
Climate Change Effects	1. Rising sea levels impact both residential and industrial zones. 2. Coastal erosion threatens vital infrastructure and facilities. 3. Recurrent storms affect the quality of life for local communities.
Impact on Urban Design	1. Construction of concrete barriers and sand dunes along the shoreline. 2. Design of public spaces including community facilities and pedestrian pathways. 3. Improvement of drainage systems to prevent flooding.
Adaptation Methods Used	1. Use of concrete barriers: providing protection for the shoreline from waves and sea level rise. 2. Water management: installing systems for rainwater drainage and reuse. 3. Environmental techniques: planting coastal vegetation to stabilize the soil and reduce salinity impact.
Positive Impact	1. Reduced flood risks: protecting coastal facilities and residential communities. 2. Boost to tourism: enhancing beaches and public spaces. 3. Improved quality of life: providing healthy green spaces for residents. 4. Increased local awareness: educating the community on how to respond to climate-related disasters.

Table 6 Analysis of the El-Max Area Project in Terms of Regenerative Sustainable Urban Design Standards and Climate Change Adaptation Methods Source: By Author

Elements	Description	Details	Adaptation Methods from Climate Change
Sustainable Site	Site Selection	Environmental impact analysis: The project includes a comprehensive study of the surrounding environment, including climatic and environmental conditions and the expected impacts of climate change on the coastal area. Sustainability directives: The site allows the use of renewable energy sources such as solar and wind energy, and waste reduction through improvements in the sewage system and the use of corrosion-resistant construction materials.	Selecting the El-Max area to protect it from flooding risks due to its low elevation and proximity to the port, which serves as a vital economic hub.

	Coastal Land Protection	Construction regulation and development: Applying policies and regulations that protect coastal lands from floods and storms, including the construction of natural and artificial barriers to prevent marine erosion. Use of corrosion-resistant materials: Selecting durable building materials resistant to marine erosion to enhance the project's long-term sustainability.	Constructing 4 kilometers of concrete barriers along the western coast to prevent water infiltration into inland areas.
	Community Services and Connectivity	The project includes improvements in public infrastructure to enhance the quality of life in the local community, including enhancements to public and green spaces, and improved access to the waterfront.	Creating a pedestrian area connecting Dekheila Port with residential areas, with seating areas for families and bicycle lanes.
	Long-Term Impact on Biodiversity	The project includes plans to improve local biodiversity by planting native vegetation and establishing green areas to improve air quality and the local environment.	Planting mangroves along the coast to protect the marine environment and improve habitats for marine life.
Transportation Management	Access to Public Transport	Improving access to public transportation by providing nearby stations equipped with renewable energy systems such as solar energy, reducing dependency on private vehicles and limiting carbon emissions.	Improving El-Max Road to connect with nearby bus routes that transport workers to the port and residents to their neighborhoods.
	Pedestrian Paths	Designing shaded pedestrian paths using solar energy, surrounded by native plants to improve air quality and reduce urban temperatures.	Creating a pedestrian path along the concrete barriers with direct sea views and shaded seating areas.
	Maximum Parking Capacity	Providing covered parking equipped with electric vehicle chargers to promote the use of green vehicles and reduce carbon emissions.	Allocating small parking areas at residential entrances with improved internal roads to regulate vehicle movement.
	Bicycle Facilities	Providing safe and covered bicycle parking in central, accessible locations to encourage cycling as a mode of transportation, along with bicycle maintenance services.	Constructing a 2-kilometer dedicated bicycle path with rental and storage stations.
	Green Vehicles and Alternative Transport	Encouraging the use of electric or hybrid public transportation and electric buses to reduce reliance on private cars.	Installing electric charging stations near Dekheila Port to support electric vehicles serving the industrial area.
Water Management	Monitoring Water Consumption	Developing systems to monitor water consumption and encourage conservation through the installation of smart water meters.	Installing smart systems in public parks to accurately measure and reduce water consumption.
	Water Efficiency in Outdoor Spaces	Designing irrigation systems for parks and green spaces using treated wastewater and rainwater.	Using treated rainwater to irrigate coastal plants in gardens.
	Stormwater Management	Designing systems to collect and use rainwater for irrigation of plants and green spaces, with improved drainage and recycling techniques.	Constructing underground tanks with a capacity of 500 cubic meters to collect and reuse rainwater.
Waste Management	Waste Sorting and Recycling	Developing infrastructure for the effective and environmentally safe collection and transport of waste, while promoting separation and conversion of waste into valuable resources.	Placing recycling bins for plastic and glass at the entrances of parks and public spaces.
	Waste Storage and Separation Spaces	Designing designated areas for waste storage and separation within coastal urban communities.	Creating underground temporary storage rooms in the port area for safe waste collection.
Energy Management	Use of Renewable Energy Sources	Installing solar and wind energy systems to generate clean and sustainable electricity.	Installing solar panels on concrete barrier rooftops to power lighting for walkways.
	Use of Low and Zero Carbon Technologies	Promoting the use of green building techniques and eco-friendly materials to reduce carbon emissions.	Using eco-friendly, salt-resistant concrete for marine barriers.

	Use of Energy-Efficient Outdoor Lighting	Adopting smart lighting technologies with sensors to reduce energy consumption when lighting is not needed.	Installing LED lamps along pedestrian paths powered by solar energy.
	Reducing Light and Noise Pollution	Developing systems to reduce noise caused by transportation and industry in coastal urban areas.	Using shielded lighting poles to prevent light dispersion into the sky and reduce light pollution.
Health and Well-being	Visual Comfort	Harmoniously coordinating buildings and green spaces to create a visually appealing and comfortable environment.	Integrating coastal gardens and vegetation with the barrier design to offer a pleasant natural view.
	Safe Access	Providing a comprehensive network of safe walkways and paths for pedestrians and cyclists to ensure safe access to buildings and public areas.	Creating sloped ramps for people with disabilities at walkway entrances.
	Provision of Private Spaces	Designing diverse outdoor spaces that meet residents' needs such as green areas, seating, and recreational zones.	Creating dedicated family zones with shaded benches and small green spaces.
Materials and Resources	Use of Local Resources	Using low-carbon local materials such as local stone and eco-friendly building resources to reduce the carbon footprint.	Using local rocks to build sand dunes and concrete barriers.
Innovation	Application of New Design and Construction Techniques	Adopting innovative building methods such as prefabrication and 3D printing to reduce waste and accelerate construction processes.	Testing 3D models of concrete barriers before construction begins.
	Development of Projects with Positive Environmental Impact	Designing projects that preserve biodiversity and support the protection of coastal ecosystems.	Planting seagrass and wave-resistant plants along the coast.
	Adoption of Innovative Design and Implementation Approaches	Implementing designs that promote innovation and sustainability through community and expert involvement in the design process.	Designing multi-use barriers that include protection functions and pedestrian walkways.
	Use of Advanced Environmental Technologies and Sustainable Materials	Using advanced technologies like solar systems and clean tech in coastal building operations, and adopting sustainable building materials such as green concrete and eco-friendly insulation.	Installing sensors to monitor the performance of concrete barriers and their resistance to high waves.

3.5.2.3 Findings and Recommendations:

The El-Max development project demonstrated solid performance across several key areas. It showed notable strength in the **sustainable site** category, focusing on coastal land protection and enhancing community infrastructure. The project also achieved **moderate improvements in transportation**, providing public transit access and pedestrian pathways, though there is room for strengthening bicycle facilities and promoting green vehicles. In terms of **water management**, the application of systems for monitoring consumption and managing stormwater was effective, but further efficiency gains are possible. Regarding **energy management**, renewable energy sources were utilized well, yet there remains potential to enhance low-carbon technologies and energy-saving lighting. Additionally, the project displayed a **moderate level of innovation**, with some forward-thinking features, though broader integration of advanced environmental technologies could be improved.

Based on these findings, the following recommendations are proposed:

1. **Enhance bicycle facilities** by providing safe, covered parking and encouraging cycling as a sustainable transport option.
2. **Improve water management efficiency** by applying advanced irrigation technologies and increasing the use of treated rainwater.
3. **Increase innovation** through the adoption of new design and construction technologies that enhance environmental performance.
4. **Promote community participation** by engaging local residents in planning and implementation processes to improve sustainability outcomes.
5. **Expand renewable energy use** by increasing reliance on solar and wind energy across the project systems.

3.5.3 Evaluation of Previous Projects:

Previous projects were evaluated to analyze the extent to which they incorporated elements of regenerative sustainable urban design in coastal areas, in order to assess their alignment with environmental, social, and economic objectives. A three-level scoring system was adopted to assess the presence of each design element within the project, as follows: **(1)** if the element is clearly and fully

present, **(0.5)** if the element is partially or incompletely present, and **(0)** if the element is not present at all. These values were assigned based on a thorough analysis of project documents and design outputs. The following section outlines the evaluation methodology and the scoring tables used to assess the integration of key design elements.

3.5.3.1 Evaluation of Previous Projects (ESCR Project – New York & El-Max Area – Alexandria):

This **(Table 7) and (Chart 1)** presents the evaluation of the two projects in percentage terms for each element, providing a clear and direct understanding of the extent to which each project meets the specified criteria.

Table 7 Evaluation of Previous Projects (ESCR Project – New York & El-Max Area – Alexandria) Source: By Author

Elements	Description	ESCR Project	El-Max Area Project
Sustainable Site	Site Selection	1	1
	Coastal Land Protection	1	0.5
	Provision of Community Services and Connectivity	1	1
	Long-Term Impact on Biodiversity	1	1
Total		**4**	**3.5**
Transport Management	Access to Public Transportation	1	1
	Pedestrian Paths	1	0.5
	Maximum Parking Capacity	0.5	0.5
	Bicycle Facilities	1	0.5
	Green Vehicles and Alternative Transport	0	0
Total		**3.5**	**2.5**
Water Management	Water Consumption Monitoring	1	0.5
	Water Efficiency in Outdoor Spaces	1	0.5
	Stormwater Management	1	0
Total		**3**	**1**
Waste Management	Waste Sorting and Recycling	0.5	0
	Space Allocation for Waste Storage and Separation	0.5	0
Total		**1**	**0**
Energy Management	Use of Renewable Energy Sources	1	0.5
	Low/Zero Carbon Technologies	0.5	0
	Use of Energy-Efficient Outdoor Lighting	1	1
	Reduction of Light and Noise Pollution	1	1
Total		**3.5**	**2.5**
Health and Well-being	Visual Comfort	1	1
	Safe Access	1	1
	Provision of Private Spaces	1	1
Total		**3**	**3**
Materials and Resources	Use of Local Resources	1	0.5
Total		**1**	**0.5**
Innovation	Application of New Design and Construction Techniques	1	0.5
	Development of Environmentally Positive Projects	1	1
	Adoption of Innovative Design Approaches	1	0.5
	Application of Advanced Environmental Technologies and Materials	1	0.5
Total		**4**	**2.5**
Total All of Standards		**23**	**15.5**

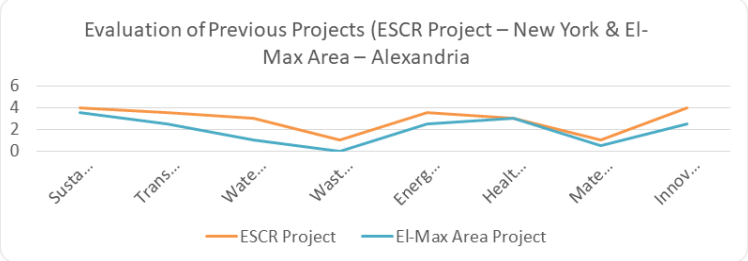


Chart 1 Evaluation of Previous Projects (ESCR Project – New York & El-Max Area – Alexandria) Source: By Author

3.5.3.2 Results and Recommendations of the Analytical Study:

The analysis of the two projects revealed a significant disparity in adherence to sustainable regenerative urban design criteria. The ESCR project in New York achieved a high compliance rate of 23 points, reflecting robust integration of sustainability and climate adaptation elements, particularly in the domains of health and well-being, sustainable site selection, and innovation. In contrast, the El-Max area project scored only 15.5 points, highlighting evident gaps in water, energy, and waste management components, as well as limited incorporation of smart technologies and green transportation systems. Consequently, this research recommends the development of a comprehensive design framework for coastal projects in Egypt, incorporating advanced environmental strategies such as greywater reuse and solar energy systems, alongside fostering local innovation and community engagement in public space planning. Furthermore, establishing a dedicated regenerative urban planning unit within official bodies and adopting a national design guideline inspired by global best practices, such as the ESCR project, are proposed to effectively balance environmental sustainability and quality of life in coastal cities.

4. Findings and Recommendations :

The research concluded that regenerative sustainable urban design is a strategic and effective tool in enhancing the adaptive capacity of coastal areas to climate change while achieving a balance between environmental sustainability and urban development. The theoretical studies and analysis of practical projects revealed a set of criteria for sustainable regenerative urban design in coastal areas has been identified, consisting of six (6) main elements and eighteen (18) sub-elements, as follows: **Sustainable Site**(Site Selection- Coastal Land Protection- Community Services and Connectivity- Long-Term Impact on Biodiversity)**Transportation Management**(Access to Public Transport- Pedestrian Paths- Maximum Parking Capacity- Bicycle Facilities- Green Vehicles and Alternative Transport)**Water Management**(Water Consumption Monitoring- Water Efficiency in Outdoor Spaces- Stormwater Management)**Waste Management**(Waste Sorting and Recycling- Waste Storage and Separation Spaces)**Energy Management**(Use of Renewable Energy Sources- Use of Low and Zero Carbon Technologies- Use of Energy-Efficient Outdoor Lighting- Reducing Light and Noise Pollution)**Health and Well-being**(Visual Comfort- Safe Access- Provision of Private Spaces)**Materials and Resources**(Use of Local Resources)**Innovation**(Application of New Design and Construction Techniques- Development of Environmentally Positive Projects- Adoption of Innovative Design Approaches- Application of Advanced Environmental Technologies and Materials)

The analysis also showed that the implementation of these criteria largely depends on the integration of global environmental codes, such as green building standards (LEED, BREEAM), coastal zone planning codes, and local urban planning regulations, which contribute to providing a practical implementation framework These findings align with the United Nations Sustainable Development Goals (SDGs),

They also directly support Egypt Vision 2030, which aims to promote sustainable urban environments, modern infrastructure, and climate-resilient development, especially in vulnerable coastal zones.

Based on the above, the research recommends the following:

1. Adopting a national regulatory framework for coastal project design grounded in principles of regeneration and environmental sustainability, aligned with Egypt Vision 2030.
2. Integrating environmental and planning codes into all phases of urban design and implementation to ensure resilient and smart infrastructure.
3. Utilizing leading international models in coastal projects and adapting them to suit the geographic and social contexts of local communities.
4. Enhancing community and stakeholder engagement in the planning and execution of coastal projects to ensure community acceptance and long-term sustainability.
5. Updating urban planning legislation to include climate adaptation standards and carbon footprint
6. Integrating environmental and sustainability standards into urban policies and master plans for coastal cities, while directing investments toward resilient infrastructure projects.
7. Enhancing collaboration between academic institutions, government bodies, and the private sector to develop applicable regenerative design models tailored to the specific characteristics of each coastal region in Egypt and the Arab world.
8. Embedding climate adaptation strategies into university curricula and urban planning accreditation standards to ensure the development of a new generation of designers and planners capable of addressing environmental challenges.
9. Developing measurable performance indicators to evaluate future projects based on their compliance with regenerative environmental design standards, and linking these indicators to green financing and incentive mechanisms.
10. Supporting scientific and experimental research in the field of regenerative coastal design, while promoting pilot applications and urban living labs to create localized and innovative solutions.

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