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# Strengthening Coastal Cities and Building Climate Resilience Against Climate Change: Policy Pathways for the Global South

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Abstract

**Abstract:** In the face of escalating climate change impacts, improving resilience for coastal cities in the Global South is important to protect the lives and livelihoods of millions of people living in vulnerable urban areas. This research aims to provide a series of recommendations to enhance the resilience of coastal cities in the Global South against climate change. This study uses a comprehensive approach that combines case study analysis, literature review, and policy recommendations, focusing on coastal cities in the Global South, such as Alexandria, Cape Town, and Dakar, to examine the impacts of climate change, including sea level rise, flooding, and coastal erosion. The research also draws on existing climate policy frameworks, such as the Paris Agreement and regional initiatives, to formulate practical policy recommendations. The findings showed that increasing budgets and investment in urban resilience are critical to supporting the implementation of adaptation measures, including infrastructure upgrades, ecosystem restoration, and community resilience initiatives. Collaboration and the strengthening of governance capacities at the local and national levels are also essential for effective adaptation planning and implementation. In addition, building networks among coastal cities in the Global South is vital for sharing knowledge, exchanging best practices, and fostering solidarity among urban areas facing similar challenges.

## Introduction

Coastal cities are urban centers where terrestrial, marine, and human resources interact at high levels (Day et al., 2021) & (Griggs & Reguero, 2021). Coastal cities are important economic, social, and environmental hubs, contributing over 60% of the world's GDP and hosting over 40% of the global population within 100 kilometers of a coastline (Athanasiou et al., 2024). They serve as vital nodes in global trade networks, handling most international trade through their ports and offering diverse cultural and recreational opportunities. Coastal cities are also surrounded by diverse marine and coastal ecosystems, including mangroves, coral reefs, and estuaries. These ecosystems provide essential services such as coastal protection, carbon sequestration, and fishery resources. More than 40% of the world's population depends on coastal ecosystems for their livelihoods and food security (Dau et al., 2023). However, due to

their unique geographical characteristics, coastal cities also face significant challenges from the impacts of climate change.

Coastal cities globally face unprecedented challenges due to the impacts of climate change, posing significant threats to both human populations and critical infrastructure. Rising sea levels, intensified storms, and coastal erosion are the primary factors increasing these cities' vulnerability. According to the Intergovernmental Panel on Climate Change (IPCC), sea levels have risen by an average of about 8 inches (20 centimeters) since 1880, with projections indicating a further increase of up to several feet by the end of the century (O'Donoghue et al., 2021). Coastal cities in the Global South are particularly vulnerable due to socio-economic inequalities, environmental degradation, and geographic exposure to climate hazards. These cities often face additional challenges, including rapid population growth, inadequate infrastructure, poverty, and limited access to essential resources and services (Zanetti et al., 2016). According to the World Bank, approximately 70% of the world's urban population growth between 2015 and 2050 is expected to occur in Africa and Asia. A significant proportion of these new urban residents will settle in coastal regions, placing additional pressure on infrastructure, resources, and climate resilience efforts (World Bank Group, 2023).

Vulnerable populations face the greatest risks from severe climate impacts, particularly those in informal settlements within low- and middle-income nations, as well as in small and medium-sized urban centers. Cities and their inhabitants are increasingly threatened by flooding, extreme heat, water stress, degradation of urban ecosystems, and biodiversity loss (Global Commission on Adaptation, 2019). Flooding is a major threat to urban areas, with 21 of the world's 33 megacities situated in low-lying coastal regions. Nearly 700 million people reside in urban or peri-urban areas located less than 10 meters above sea level, placing them at heightened risk of coastal flooding and sea level rise (UN HABITAT, 2021).

According to the Global Climate Risk Index, seven of the ten countries most affected by weather-related disasters between 1999 and 2018 were located in the Global South, with small island nations and coastal communities being disproportionately affected (Eckstein et al., 2021). For instance, Bangladesh, where a significant portion of the population resides in low-lying coastal areas, could see the displacement of approximately 15 million people with just a one-meter rise in sea level. This would exacerbate existing social inequalities and place immense strain on disaster response and adaptation efforts (Nicholls et al., 2007). Additionally, coastal cities in the Global South are particularly vulnerable to intensified storms and hurricanes, which can cause widespread flooding (Liu et al., 2023) & (Adhikari et al., 2021).

Coastal erosion is a critical challenge for many cities, driven by a combination of natural processes and human activities that gradually erode coastlines. Approximately 70% of the world's sandy beaches are eroding faster than they can naturally replenish, posing risks to coastal communities and critical economic sectors, including tourism infrastructure (Luijendijk et al., 2018). Climate change further intensifies this issue by disrupting sediment transport patterns, accelerating erosion, and weakening coastal ecosystems that naturally protect shorelines from erosion (Santiago et al., 2021).

Climate Change Impacts on Coastal Cities in Global south: Coastal cities in the Global South are particularly vulnerable to climate change due to their geographical location, socio-economic conditions, and limited adaptive capacity. Sea level rise is one of the most urgent challenges facing coastal cities, driven by rising global temperatures, polar ice melt, and the thermal expansion of seawater. This phenomenon may result in permanent flooding, large-

scale displacement, and significant loss of coastal land. Additionally, sea level rise and strong wave action accelerate coastal erosion, which can damage infrastructure, alter ecosystems, and weaken natural barriers such as sand dunes and mangroves, thereby intensifying the effects of storms and flooding. Moreover, rising sea levels can cause saltwater intrusion into freshwater sources such as rivers and aquifers, contaminating drinking water and threatening agricultural productivity. This issue is particularly concerning regions with already scarce freshwater resources (Leichenko & Thomas, 2012).

Climate change is also causing heavier rainfall and more intense storms, increasing the risk of flooding. Many coastal cities have inadequate drainage systems, increasing their susceptibility to flood damage. Furthermore, the frequency and intensity of hurricanes and tornadoes are increasing due to climate change, causing widespread destruction in coastal regions. Additionally, coastal ecosystems—including coral reefs, mangroves, and salt marshes—are highly sensitive to climate change. Rising temperatures, ocean acidification, and sea level rise pose severe threats to these ecosystems, resulting in loss of biodiversity and negatively affecting fisheries and tourism industries (Seneviratne et al., 2023).

There are several coastal African cities suffering from these effects (Vousdoukas et al., 2022), some of the cities as follows: City of Alexandria, Egypt: Alexandria is situated on the Mediterranean coast of Egypt. It is one of the oldest and most historically significant cities in the region. Its coastal location, while beneficial for its port and economic activities, makes it highly susceptible to climate-related changes in sea levels. Alexandria is experiencing a significant threat from sea level rise, which could result in substantial parts of the city being submerged by the end of the 21st century. Studies suggest that sea levels could rise by as much as one meter by 2100, posing a direct threat to the city's infrastructure and residential areas. The inundation risk is compounded by the low-lying topography of the Nile Delta, which is subsiding due to both natural processes and human activities such as groundwater extraction. Alexandria is an economic hub due to its port, which is one of the busiest in Egypt. The potential flooding and increased salinity from sea level rise could severely impact port operations and the broader industrial activities in the city (Abou-Mahmoud, 2021) & (Hendy et al., 2021).

City of Cape Town, South Africa: The "Day Zero" water crisis that Cape Town, South Africa, experienced in 2018 was a significant and alarming event, highlighting the severe impacts of climate change on urban water management in coastal cities of the Global South. This crisis was a culmination of several factors, with climate change-induced drought playing a critical role (Ding et al., 2019). Cape Town experienced three consecutive years of drought, one of the worst in over a century. The drought significantly reduced water inflow into the city's main reservoirs, which are primarily dependent on rainfall. This was exacerbated by higher temperatures and decreased rainfall, patterns consistent with climate change projections for the region. The city's population had been growing rapidly, putting additional pressure on its water resources. The increased demand from residential, industrial, and agricultural sectors strained the existing water supply systems (Calverley & Walther, 2022).

Before the crisis, Cape Town largely relied on surface water, with little investment in alternative water sources such as groundwater extraction, desalination, or water recycling. As dam levels dropped to critically low levels, the city imposed strict water restrictions, limiting residents to 50 liters of water per person per day. Residents faced penalties for exceeding usage limits, and water management devices were installed to enforce restrictions. The crisis affected businesses, particularly those in the agriculture and tourism sectors key drivers of

Cape Town's economy. There was also a significant social impact, with heightened anxiety and stress among residents over securing enough water for daily needs. The drought and subsequent water scarcity also had ecological impacts, affecting biodiversity and increasing the stress on local ecosystems, including increased fire risk in affected areas (Gittins et al., 2021).

Dar es Salaam, Tanzania: Rapid urbanization has led to the construction of many informal settlements, which are particularly vulnerable to flooding due to poor sanitation and proximity to waterways. Climate change is increasing the frequency and intensity of these flood events (John, 2020). Dar es Salaam is situated along the coast of the Indian Ocean and is subject to the influences of seasonal monsoons. The city has experienced explosive population growth, expanding from a modestly sized town to a mega-city in just a few decades. This rapid urbanization, driven by rural-to-urban migration and natural population growth, has led to the sprawling development of informal settlements (Mzava et al., 2021).

Climate change is contributing to more intense and less predictable rainfall during the rainy seasons. For Dar es Salaam, this means heavier downpours that the existing drainage infrastructure, often outdated and poorly maintained, cannot handle. The region is seeing a higher occurrence of cyclones and intense storms due to warmer ocean temperatures, which adds to the city's flood risks (Nyembo et al., 2022). Many informal settlements are in low-lying areas near rivers and the coastline, places inherently more susceptible to flooding. These areas are often the only options available to low-income residents. There is a significant lack of adequate infrastructure in these areas. Roads are unpaved, drainage systems are either non-existent or severely clogged, and housing structures are often built from materials that are not resilient to water damage (Mwalutolo, 2018).

City of Dakar, Senegal: Coastal erosion in Dakar not only threatens physical infrastructure but also affects local communities by reducing land available for housing and agriculture. The loss of beaches also affects tourism, an important source of income for the region (I. Pouye et al., 2024). Dakar, the capital and largest city of Senegal, is situated on the Cap-Vert peninsula on the Atlantic coast and is the westernmost city on the African mainland. Its coastal location makes it particularly vulnerable to the impacts of climate change, including coastal erosion, sea-level rise, and increased storm frequency. These factors pose significant threats to its infrastructure, economy, and community life. Coastal erosion in Dakar has direct implications for infrastructure and housing. As the shoreline recedes, properties located near the coast are increasingly at risk of damage or complete destruction. This not only leads to financial losses but also displaces communities, forcing them to relocate and rebuild their lives inland. The urban planning challenges are significant, as space in Dakar is already limited, and the competition for land increases housing prices, making affordable housing even scarcer (Aniel-Quiroga et al., 2021).

The encroachment of saline water into coastal soils as a result of rising sea levels further exacerbates the challenges faced by local agriculture. Salinity can severely diminish soil quality, making it unsuitable for traditional farming, which many local communities rely on for subsistence and income. This not only affects food security but also reduces economic independence, forcing many to abandon agriculture and seek work in other sectors, often under more precarious conditions. Tourism is a vital sector in Dakar, with its scenic beaches and vibrant cultural offerings drawing visitors from around the world. Coastal erosion, however, threatens this crucial industry by degrading the very attractions that lure tourists. The loss of beaches reduces the recreational space available for tourists and impacts facilities

and businesses that depend on beach-going clientele. This decline in tourism can have a ripple effect throughout the local economy, affecting everything from hotel occupancy rates to small businesses that cater to tourists (A. Pouye et al., 2023).

Maputo City, Mozambique: Mozambique is vulnerable to cyclones, which have become more intense in recent years. Cyclone Idai in 2019 was one of the worst disasters in the country's history, causing widespread flooding and widespread devastation in Maputo and beyond (Charrua et al., 2021). Mozambique, situated along the southeast coast of Africa, is highly vulnerable to the impacts of climate change, particularly cyclones, which are exacerbated by its extensive coastline along the Indian Ocean. Maputo, the capital city, although not the hardest hit by Cyclone Idai, still experiences significant challenges related to climate-related disasters (Morgado et al., 2021).

In March 2019, Cyclone Idai struck Mozambique and became one of the most devastating natural disasters in the country's history. While the central region, especially the city of Beira, bore the brunt of the disaster, the effects were felt nationwide, including in Maputo. The cyclone brought intense rainfall, leading to severe flooding across large areas. These floods destroyed homes, infrastructure, and farmland. The cyclone caused significant loss of life, with hundreds of people confirmed dead and many more missing. It also displaced tens of thousands of people, creating large populations of internally displaced people. The infrastructure damage was extensive, including the destruction of roads, bridges, and hundreds of thousands of homes, which complicated rescue and recovery efforts (Mester et al., 2023).

As a result of the above, the following main question arises: ***How can policy interventions enhance the resilience of coastal cities in the Global South against the impacts of climate change?*** This research will be conducted to address the escalating climate change threats to coastal cities in the Global South, which are disproportionately vulnerable due to socio-economic challenges, inadequate infrastructure, and rapid urbanization. Climate change-induced phenomena such as sea level rise, extreme weather events, coastal erosion, and flooding pose severe risks to both human populations and critical urban infrastructure. These cities, which host a significant portion of the global population, lack the necessary financial and institutional capacity to implement effective climate adaptation strategies. Thus, there is an urgent need for well-structured policies that enhance urban resilience and mitigate the risks associated with climate change.

The significance of this study lies in its focus on policy pathways that can strengthen the resilience of these cities through increased financial investment, improved governance frameworks, and enhanced international cooperation. By analyzing case studies from cities such as Alexandria, Cape Town, and Dakar, the research provides empirically grounded insights that inform policy recommendations. Furthermore, it aligns with global climate governance mechanisms, including the Paris Agreement and regional adaptation initiatives, ensuring its relevance to policymakers, urban planners, and international development organizations. The study is crucial not only in identifying the vulnerabilities of coastal cities but also in offering practical, evidence-based policy solutions that national and local governments, international agencies, and donor organizations can adopt to build long-term urban resilience.

This research fills a critical gap in existing literature by specifically focusing on policy-driven adaptation strategies for coastal cities in the Global South, a subject that has received limited scholarly attention compared to climate adaptation efforts in developed nations. While

previous studies have explored climate resilience broadly, few have examined targeted policy interventions designed to address the unique socio-economic and governance challenges of cities in the Global South. Given that these cities are at the forefront of climate change impacts, there is an urgent need for research that provides region-specific adaptation strategies rather than generalized approaches based on high-income countries' experiences.

The novelty of this research is evident in its comparative case study approach, which examines multiple coastal cities—Alexandria, Cape Town, and Dakar—allowing for a nuanced understanding of the diverse adaptation strategies implemented across different geographical and socio-political contexts. Additionally, this study distinguishes itself by focusing on governance structures, financial investment, and regional cooperation as key determinants of successful climate adaptation policies. Unlike many climate adaptation studies that primarily emphasize scientific modelling or climate impact assessments, this research is firmly rooted in policy analysis and practical implementation strategies. By addressing these gaps, this study contributes to the broader discourse on climate resilience and offers a unique perspective on how cities in the Global South can effectively enhance their adaptive capacity.

This research integrates international insights by contextualizing the resilience challenges of coastal cities in the Global South within the broader global climate governance framework. The study underscores how international agreements, such as the Paris Agreement and the Nationally Determined Contributions (NDCs), shape climate adaptation efforts in developing countries. By aligning the policy recommendations with these global climate commitments, this research ensures that findings are relevant not only at the local and national levels, but also within international climate policy discussions.

## Existing Adaptation Initiatives

Addressing the impacts of climate change, especially in coastal cities in the Global South, requires international and regional collaborative efforts. Various initiatives and policies aim to support adaptation measures to mitigate the harmful effects of climate change. There are several adaptation initiatives and policies at the international and regional levels:

1. **Paris Agreement's Nationally Determined Contributions (NDCs):** The Paris Agreement, a landmark in global climate agreements, requires countries to submit their own plans for reducing greenhouse gas emissions and adapting to climate changes. These are known as Nationally Determined Contributions (NDCs). Many coastal nations include specific adaptation strategies for their coastal areas, such as improving coastal defenses, managing coastal erosion, and enhancing ecosystem resilience. These commitments are critical as they outline specific targets and actions that countries intend to take, which also helps in attracting international support and funding (UNFCCC, 2021). Specifics for Coastal Adaptation: Coastal Defenses: Countries with vulnerable coastlines often prioritize measures such as strengthening sea walls and other physical barriers to protect against sea-level rise and extreme weather events. Erosion Management: Addressing coastal erosion involves techniques like beach nourishment, where sand is added to eroded beaches, and the construction of breakwaters to reduce wave energy reaching the shore. Ecosystem Resilience: Enhancing the resilience of coastal ecosystems often focuses on restoring mangroves and coral reefs, which act as natural buffers against storm surges and provide habitats for marine life. Global Impact and Funding: These commitments are essential for global efforts to tackle climate change. They also serve as a basis for receiving international

support and funding, as they demonstrate a country's dedication to addressing both mitigation and adaptation challenges.

2. Green Climate Fund (GCF) Initiatives: The GCF was established within the framework of the UNFCCC to assist developing countries in adaptation and mitigation practices to counter climate change. It is the world's largest dedicated fund for these purposes. The GCF funds projects directly related to coastal adaptation, such as improving flood defense systems, restoring coastal wetlands which act as natural barriers against sea-level rise, and implementing advanced saline intrusion prevention systems (Green Climate Fund, 2024). Key Projects: Flood Defense Systems: Projects include the development of advanced flood warning systems and the construction of flood barriers. Wetland Restoration: Restoring coastal wetlands which buffer against sea-level rise and storms while providing essential ecosystem services like water purification and biodiversity habitats. Saline Intrusion Prevention: Implementing technologies and methods to prevent saline water from intruding into freshwater systems, which is crucial for maintaining fresh water availability in coastal areas. For example, a project in the Maldives funded by the GCF aims to build resilience through integrated water management and coastal protection measures. The Maldives project involves comprehensive water management systems that combine freshwater conservation with robust coastal defenses to protect vital tourist infrastructures and local communities.
3. Global Environment Facility (GEF): The GEF supports a variety of environmental projects around the world, with a significant emphasis on biodiversity, climate change, and water resources. The GEF supports multiple projects focusing on coastal resilience, including sustainable fisheries, reduction of pollution, and protection of coastal habitats. These projects often incorporate climate adaptation measures, such as the construction of sea barriers and the rehabilitation of mangroves and other critical ecosystems (Protocol, 2009). Climate Adaptation Projects: Sustainable Fisheries: Projects aimed at creating sustainable fishing practices that do not deplete fish stocks and destroy habitats which are vital for coastal protection. Pollution Reduction: Initiatives to reduce water and air pollution that exacerbates climate impacts on coastal and marine ecosystems. Coastal Habitat Protection: Efforts include protecting and rehabilitating crucial coastal zones like mangroves, which are effective at carbon sequestration and act as storm buffers. Adaptation Techniques: Sea Barriers: Constructing barriers such as dikes and tide gates to protect against rising sea levels. Mangrove Restoration: Focus on restoring these critical ecosystems which are effective in soil stabilization and provide a nursery for many marine species. These international policies and initiatives are critical as they provide a structured approach to combat climate change effects. They facilitate the flow of financial, technical, and human resources necessary for comprehensive adaptation strategies in the most vulnerable regions, especially coastal cities that face immediate threats from rising sea levels and increased storm frequency. By aligning global goals with local needs, these efforts ensure that adaptation measures are both effective and sustainable, preserving not only the environment but also the economies and communities that rely on these coastal areas.
4. African Union's Program on Climate Change (AU-PACC): The AU-PACC aims to integrate climate change adaptation into the broader developmental strategies across Africa. Its focus is not only on tackling the present impacts but also on future-proofing the continent against adverse climate phenomena. For coastal cities, the AU-PACC focuses on enhancing adaptive

capacity through infrastructure resilience, promoting climate-resilient agricultural practices near coastal zones, and improving water resource management to deal with saltwater intrusion (Adaptation Committee, 2014). Key Areas of Focus: Infrastructure Resilience: Strengthening infrastructure to withstand climate-related events. This includes upgrading roads, bridges, and buildings to endure floods and storms, thus ensuring continuous connectivity and safety. Climate-Resilient Agriculture: Promoting agricultural practices that are adaptable to the changing climate, particularly near coastal zones. This could involve developing drought-tolerant crop varieties and improving irrigation systems to counter unpredictable rainfall patterns. Water Resource Management: Enhancing the management of water resources is crucial, especially in preventing saline intrusion into freshwater sources, a common issue in coastal areas. Techniques may include constructing desalination plants and improved watershed management.

5. South Asian Association for Regional Cooperation (SAARC): SAARC has undertaken initiatives to develop regional strategies for climate change, focusing on disaster management and adaptation strategies. This includes building cyclone-resistant structures, implementing early warning systems, and coastal zone management plans designed to protect vulnerable areas from the impacts of increased flooding and storm surges. SAARC focuses on creating a regional strategy to address the specific challenges posed by climate change, including the severe flooding affecting South Asia (Islam & Karim, 2022). Disaster Management and Adaptation Strategies: Cyclone-Resistant Structures: Building homes and community buildings that can withstand the high winds and heavy rains brought by cyclones. Early Warning Systems: Implementing advanced meteorological systems that provide early warnings to populations in the path of impending storms. Coastal Zone Management Plans: Developing comprehensive plans to manage and protect coastal zones, including regulations on land use, habitat protection, and disaster readiness.
6. Pacific Adaptation to Climate Change (PACC) Project: Supported by UNDP and operating in 14 island countries, this project focuses on three key areas: coastal management, food security, and water resources. The PACC operates across 14 Pacific island countries, addressing vulnerabilities unique to these island nations. This project supports the construction of climate-resilient infrastructures like seawalls and the implementation of sustainable land management practices (Palau, 2008). Primary Focus Areas: Coastal Management: Strategies include constructing seawalls and other physical barriers to protect from sea-level rise, as well as managing erosion through vegetation planting and other soil stabilization techniques. Food Security: Ensuring the sustainability of food resources by developing farming and fishing practices that can adapt to altered climatic conditions. Water Resources: Addressing the critical issue of water scarcity and quality which is exacerbated by climate change through initiatives like rainwater harvesting and the protection of freshwater sources from saltwater intrusion.

These regional initiatives, through their tailored approaches, seek to build resilience and adaptive capacity in coastal regions that are often on the front lines of climate change impacts. By focusing on infrastructure, agriculture, water management, and disaster preparedness, these programs aim to mitigate the adverse effects of climate change and secure a sustainable future for these vulnerable areas.

While these initiatives are extensive and ambitious, their effectiveness often depends on local implementation capabilities, political stability, and the availability of financial resources. One major challenge is ensuring that there is enough local capacity to plan, implement, and maintain the proposed adaptations. Additionally, while international funds are significant, they often come with stipulations that may not always align perfectly with local needs or priorities. Adaptation in coastal cities thus requires not just international and regional policy frameworks but also strong local governance that can integrate these policies into actionable and sustainable local actions. This holistic approach is necessary to effectively address the complex and interlinked issues caused by climate change in coastal regions.

## Case Studies

There are several case studies highlighting successful adaptation projects or initiatives implemented in coastal cities in the Global South. These examples demonstrate diverse approaches from infrastructure developments to community-based adaptations that effectively mitigate climate risks:

1. Integrated Urban Water Management in Beira, Mozambique: Project Overview: Beira, a major coastal city in Mozambique, is highly vulnerable to cyclones and flooding due to its low-lying geography. The city implemented an Integrated Urban Water Management (IUWM) project with support from international donors, including the World Bank and the Netherlands government (van Berchum et al., 2020). Strategies Used: Flood Management Infrastructure: Construction of a new drainage system designed to cope with increased rainfall and storm surge events. Wetland Restoration: Rehabilitation of local wetlands to improve natural water absorption and reduce the speed and volume of runoff. Community Engagement and Capacity Building: Local communities were involved in the project planning and execution, enhancing local knowledge and ownership of flood risk management. Effectiveness and Impact: The project significantly reduced the incidence and severity of flooding in Beira, protecting thousands of homes and critical infrastructure. By restoring wetlands, the project also helped to enhance biodiversity and the local microclimate, contributing to longer-term environmental sustainability. Challenges Overcome: Coordinating multiple stakeholders, including local government, international donors, and the community, was initially challenging but ultimately key to the project's success. Continuous maintenance and monitoring of the new infrastructure and restored ecosystems are required to ensure lasting benefits.
2. Climate Resilient Coastal Protection in Cartagena, Colombia: Project Overview: Cartagena faces significant threats from sea-level rise and tropical storms. The city, with support from the Inter-American Development Bank, developed a comprehensive coastal management plan that includes both hard and soft adaptation measures (Orejarena-Rondón et al., 2019). Strategies Used: Sea Walls and Revetments: Installation of reinforced sea walls to protect against storm surges. Mangrove Restoration: Strategic reforestation of mangrove areas that had been lost to urban expansion, providing a natural buffer against coastal erosion. Early Warning Systems: Development of sophisticated meteorological systems to provide advance notice of tropical storms and high tides. Effectiveness and Impact: The combination of engineered and natural defenses has enhanced Cartagena's resilience, significantly reducing economic losses from coastal flooding. The mangrove restoration not only protects against erosion but also supports fisheries and carbon sequestration, promoting ecological and economic benefits. Challenges Overcome: Balancing the

construction of hard infrastructure with the preservation and restoration of natural ecosystems was complex and required innovative engineering solutions. Ensuring adequate funding for both immediate construction and long-term maintenance of diverse measures required strong commitment from both local authorities and international partners.

3. Community-Based Adaptation in Khulna, Bangladesh: Project Overview: Khulna, located in the delta region of Bangladesh, is susceptible to cyclones, sea-level rise, and salinity intrusion. The city implemented a community-based adaptation project focusing on enhancing local resilience through diversified livelihoods and improved infrastructure (Haque, 2017). Strategies Used: Salinity Management: Installation of community-operated desalination units to provide fresh water. Livelihood Diversification: Training programs for alternative livelihoods such as crab farming and handicrafts, reducing dependence on traditional agriculture and fishing. Storm-Resilient Housing: Construction of elevated homes designed to withstand flooding and storms. Effectiveness and Impact: The project has successfully reduced the vulnerability of communities to climate impacts, ensuring access to safe water and more stable income sources. Community engagement in planning and implementation has led to a high level of local buy-in and sustainability of adopting measures. Challenges Overcome: Addressing diverse and complex community needs required tailored interventions, which demanded extensive local knowledge and flexible project design. Mobilizing sufficient funding for community-level initiatives involved demonstrating clear benefits and outcomes to secure continued support.
4. Green Infrastructure and Flood Resilience Project in Santo Domingo, Dominican Republic: Project Overview: Santo Domingo, the capital of the Dominican Republic, faces severe risks from hurricanes and tropical storms that can lead to substantial flooding. The city has implemented a comprehensive Green Infrastructure and Flood Resilience Project aimed at addressing these challenges through sustainable urban development and resilience strategies (Reynoso Vanderhorst et al., 2024). Strategies Used: Urban Green Spaces: Development of parks and green areas that serve as natural water retention sites during heavy rains, helping to mitigate the impact of floods. Permeable Pavements: Implementation of permeable paving materials in urban areas to enhance groundwater recharge and reduce surface runoff, which is a common cause of urban flooding. Rain Gardens and Bioswales: Construction of rain gardens and bios wales along streets and in public spaces to capture and filter storm water, reducing the load on traditional drainage systems and improving water quality. Effectiveness and Impact: The green infrastructure initiatives have managed storm water, reducing instances of flash flooding that previously led to economic losses and displacement of communities. These measures have also contributed to improving urban air quality and reducing the urban heat island effect, enhancing overall urban livability and biodiversity. Community involvement in the maintenance and monitoring of green spaces has fostered a strong sense of community ownership and environmental stewardship. Challenges Overcome: Urban planning constraints due to existing infrastructure made the integration of green solutions challenging, requiring innovative design and strategic placement of green infrastructure elements. Securing sustained funding for the maintenance of green infrastructure was initially a challenge, necessitating the development of partnerships with private sectors and non-governmental organizations to support long-term sustainability.

Each of these case studies demonstrates how diverse and context-specific adaptation strategies, when effectively implemented, can significantly enhance the resilience of coastal cities in the Global South. These projects combine technical, ecological, and social interventions, illustrating the importance of integrated approaches to climate change adaptation.

## Method

This study used a qualitative research approach to examine climate adaptation strategies in coastal cities of the Global South. The research methodology follows a structured process comprising five key stages: literature review, case study selection, policy analysis, data interpretation, and policy recommendations.

The research begins with a systematic literature review, which examines climate adaptation policies, governance structures, and resilience frameworks applicable to coastal cities. Peer-reviewed journal articles, policy reports, and climate adaptation documents were systematically sourced from Google Scholar, Scopus, and Web of Science. The selection criteria focused on studies published in the past decade, ensuring relevance to contemporary climate adaptation discourse. The literature review provided for us the foundation for understanding existing climate adaptation measures, governance challenges, and financial mechanisms supporting urban resilience.

Following the literature review, a comparative case study approach was applied to analyze climate risks and adaptation strategies in three coastal cities: Alexandria (Egypt), Cape Town (South Africa), and Dakar (Senegal). These cities were selected based on their high vulnerability to sea-level rise, coastal erosion, and flooding, as well as their regional significance in urban resilience planning. Data for the case study analysis were gathered from official government reports, climate adaptation plans, and urban development strategies.

The next stage involved a qualitative policy analysis, which assessed governance structures, funding mechanisms, and adaptation policies relevant to coastal resilience. Key climate policy frameworks, including the Paris Agreement, Nationally Determined Contributions (NDCs), and regional adaptation initiatives, were examined. The objective of this policy analysis was to evaluate the effectiveness of adaptation policies, identify governance gaps, and highlight financial constraints that hinder implementation efforts in these cities.

After that we proceeded to data interpretation through a comparative thematic analysis. The adaptation efforts in Alexandria, Cape Town, and Dakar were assessed against the best global practices and international climate adaptation frameworks to identify strengths and weaknesses in their approaches. This comparative evaluation facilitated an understanding of how different governance models and adaptation strategies influence urban resilience outcomes.

Finally, based on the findings, we have developed actionable recommendations to address the specific vulnerabilities of coastal cities in the Global South. A flowchart of the steps, designed by the authors, is provided below:

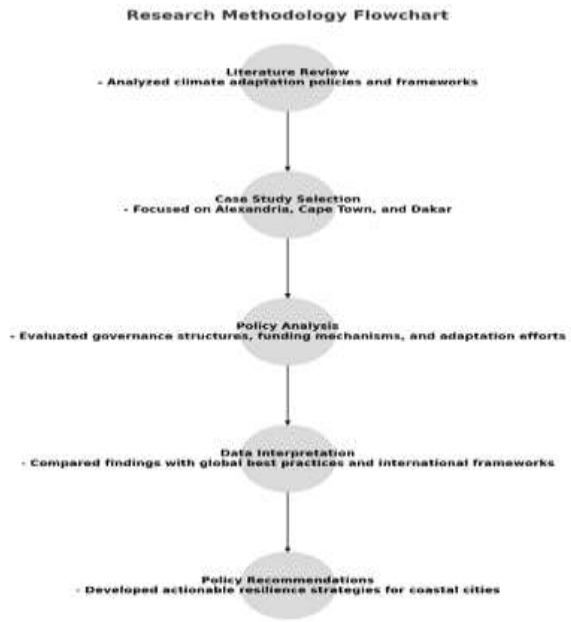


Figure 1. Research Flow Diagram
Source: *Designed by Authors*

## Results and Discussion

Cities, including Coastal Cities, are at the forefront of the climate crisis. Climate risks are escalating, and climate hazards are becoming more frequent and costly. Cities account for more than 80% of the global GDP and more than half of the world's population (World Bank Group, 2023). The impacts of climate change are often felt disproportionally in urban communities due to high population density, a concentration of key infrastructure in cities, and their role as economic hubs among other factors. Yet, investment in urban resilience is far from what is needed. To address these challenges, there are several policy recommendations that can be implemented:

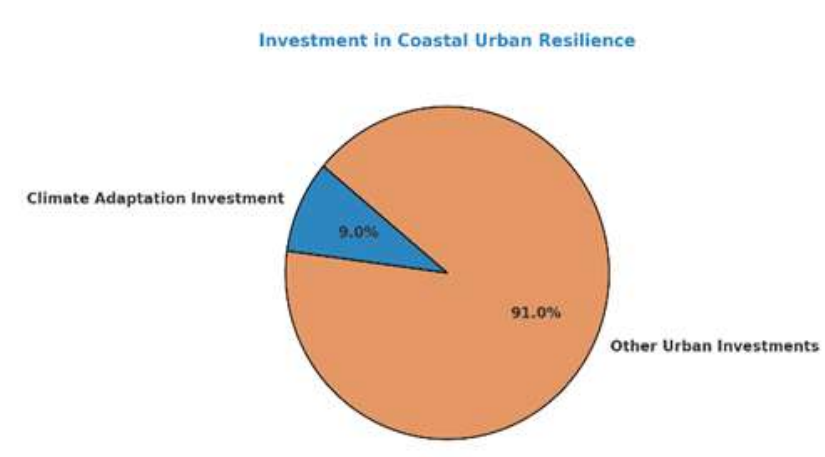


Figure 2. Improve the Investment in Coastal Urban Resilience
Source: *Compiled by Authors*

According to the Cities Climate Finance Leadership Alliance's 2021 State of Cities Climate Finance (SCCF) report 16, only 9% of global urban climate investments flow to climate change adaptation projects. Rapidly scaling urban climate adaptation financing is urgently needed (Negreiros et al., 2021). The global need for urban infrastructure investment amounts to USD 4.5 - 5.4 trillion per year, of which an estimated premium of 9–27 percent is required to make this infrastructure low-emissions and climate resilient (CCFLA 2015). A significant proportion of this demand is from cities in the Global South. For example, in sub-Saharan Africa, infrastructure spending needs (including capital and operations and maintenance) range from a high of 37 percent of GDP in fragile low-income countries to 10 percent in middle-income countries (World Bank, 2010).

By 2030, without significant investment into making cities more resilient, natural disasters may cost cities worldwide $314 billion each year, up from around $250 billion today, and climate change may push up to 77 million more urban residents into poverty, according to a new report by the World Bank and the Global Facility for Disaster Reduction and Recovery (GFDRR). The World Bank / GFDRR report cautions that failing to invest in making cities more resilient to natural disasters, shocks, and stresses will result in significant human and economic damages – with the urban poor bearing the brunt of losses. If high climate impact coincides with inequitable access to basic infrastructure and services, natural disasters will force tens of millions of urban dwellers into extreme poverty and may cost cities worldwide $314 billion each year by 2030, up from around $250 billion today (World Bank, 2016).

Increased investment in urban resilience for coastal cities in the Global South is important to mitigate the escalating risks posed by climate change and safeguard the well-being of millions of residents. With over 90% of urban growth projected to occur in Asia and Africa by 2050, coastal cities in these regions face mounting challenges from sea-level rise, storm surges, and flooding. According to the World Bank, the population of low-elevation coastal zones in developing countries is expected to increase from 171 million in 2010 to 420 million by 2060, exacerbating the vulnerability of urban coastal communities to climate-related hazards (Report, 2024).

Furthermore, investing in urban resilience can yield substantial economic returns and long-term cost savings for coastal cities in the Global South. The Global Commission on Adaptation estimates that every dollar invested in climate adaptation measures can generate up to four dollars in benefits, including avoided damages, increased productivity, and reduced recovery costs. For example, a study by the Asian Development Bank found that investing $1.2 billion in flood management infrastructure in Kolkata could yield net benefits of $8.1 billion over 50 years, highlighting the potential economic value of resilience investments. Additionally, resilient infrastructure and urban planning can attract private investment, spur economic growth, and enhance the overall competitiveness of coastal cities (Asian Development Bank, 2023).

By prioritizing investments in climate-resilient infrastructure, green spaces, and disaster risk reduction measures, coastal cities in the Global South can build a more sustainable and prosperous future for their residents while mitigating the impacts of climate change. In achieving this goal, all parties must collaborate more actively. International and regional Climate Fund initiatives need to be directed more towards coastal city resilience programs. National and local governments need to carry out evaluation and restructuring of budgets and planning for climate adaptation. Development partners, Donors, NGOs, including private

sector can provide more support and funding in projects related to the resilience of urban coastal areas.


Figure 3. Improve the cities governance and promote integration of climate adaptation into broader urban planning and development strategies

Source: *Compiled by Authors*

Local and regional governments are facing extreme challenges regarding their ability to plan for sustainable urban development (Polk, 2011). Climate adaptation and cities resilience stands or falls with the ability of administrations to take appropriate adaptation measures in time. Governments must invest in training and capacity building initiatives because they require highly qualified employees (Douglas et al., 2008). The high expenses and lack of an immediate, noticeable impact are two main barriers to risk reduction strategies, including human resources capacity building. However, support for these initiatives usually doesn't become widespread until after the disaster occurs. In areas with high levels of social inequality, anticipatory policies that call for shared responsibilities are unlikely to gain widespread acceptance. On the other hand, climate adaptation can be included in policies that directly benefit society, such spending on health and education, building decent, affordable housing, and enhancing the water and sanitary infrastructure (Janani Vivekananda & Neil Bhatiya, 2017). Measures can be designed such that they contribute to reduce the potential impact of climate change, by increasing the resilience of citizens, by providing faster and better emergency aid, by building flood-proof homes, by securing critical infrastructure and by preventing the dispersal of hazardous substances (das Neves et al., 2023).

Beside the need for human resources capacity building, integrating climate adaptation into broader urban planning and development strategies is also essential for coastal cities in the Global South to build resilience and mitigate the impacts of climate change. As these cities continue to experience compounding challenges such as rapid population growth, urbanization, and economic development, they face increasing exposure to climate-related hazards such as sea-level rise, storms, and flooding.

Integrating climate adaptation into urban planning can generate multiple co-benefits including improved public health, enhanced ecosystem services, and increased social equity. For instance, green spaces and urban forests designed to mitigate heat stress and reduce flood risk can also provide recreational opportunities, enhance biodiversity, and improve air quality. Similarly, investments in climate-resilient infrastructure such as water management systems and transportation networks can create jobs opportunity, stimulate economic growth, and enhance social cohesion. Moreover, coastal cities can reduce their vulnerability and enhance

adaptive capacity by incorporating climate-resilient design principles, such as green infrastructure, and zoning regulations into urban development plans.

In achieving this goal, all parties must collaborate more actively. Strong commitment is needed from all international, regional, national and local actors. More capacity strengthening programs, training and technical assistants need to be implemented. Development partners, donors, NGOs and the private sector can help and encourage accelerated capacity building for city personnel. Civil society also has an important role in overseeing and ensuring that climate change resilience and adaptation agendas are integrated into city development planning.


Figure 4. Strengthening South-South Cooperation and platforms for coastal cities in the global south:
Source: *Compiled by Authors*

Strengthening South-South Cooperation and platforms for coastal cities in the Global South is important for enhancing their adaptation strategies to climate change. South-South cooperation is a modality of cooperation in which Southern countries establish horizontal partnerships for the sharing of knowledge, training, technology, and expertise, in order to facilitate development. Through knowledge-sharing and peer learning, South-South cooperation facilitates the identification of common development problems and the proposal of solutions that are responsive to the specific context and needs of Southern countries, resulting in a more significant development impact (Patrícia Nogueira Rinaldi, 2023).

According to the United Nations, over 90% of the world's urban population growth is expected to occur in Asia and Africa by 2050, with many of these cities located in low-lying coastal areas vulnerable to sea-level rise and extreme weather events (World Bank Group, 2023). By connecting city officials, practitioners, researchers, and policymakers through networks and platforms, coastal cities can share experiences, best practices, and lessons learned, enabling them to develop context-specific adaptation solutions tailored to their unique socio-economic and environmental contexts.

For example, initiatives like the Asian Cities Climate Change Resilience Network (ACCCRN) and the African Union's Programme on Climate Change (AU-PACC) bring together cities across regions to share knowledge and experiences on climate adaptation (Dulal, 2019). These networks facilitate peer learning, technical assistance, and collaborative projects that help cities identify effective adaptation measures and build resilience to climate change impacts. Coastal cities in the Global South can develop innovative solutions and scale up successful adaptation initiatives to address their common challenges.

Through south-south cooperation and coastal cities platform, coastal cities can strengthen their collective advocacy efforts, influence decision-making processes, and access funding and technical support for adaptation projects. In achieving this goal, all parties must collaborate more actively. Strong commitment is needed from all international, regional, national and local actors. More communication, coordination, and cooperation agreement need to be implemented. Also, development partners, donors, NGOs and the private sector can help and encourage accelerated these initiatives.

## Conclusion

This research highlights that coastal cities in the Global South face increasing vulnerability due to climate change impacts, including sea-level rise, flooding, and coastal erosion. The findings demonstrate that strengthening urban resilience through increased investment, governance reforms, and south-south cooperation is essential for sustainable adaptation. The case studies of Alexandria, Cape Town, Dakar, and other cities illustrate how climate-induced risks intersect with socio-economic challenges, necessitating integrated policy responses. Effective adaptation requires financial commitments, decentralized governance, and inclusive planning that involve both public and private stakeholders. Furthermore, international climate agreements and regional adaptation initiatives can play a crucial role in fostering cross-border collaboration and knowledge-sharing among coastal cities.

Despite these insights, the study has certain limitations. The research primarily relies on case studies and policy analysis, which may not fully capture localized adaptation dynamics in all coastal cities. Additionally, data constraints and variations in climate vulnerability assessments across different regions pose challenges to comparative analysis. Future studies should consider empirical assessments, quantitative modelling of adaptation scenarios, and long-term monitoring of policy implementations to provide more robust evaluations of climate resilience strategies.

Further research could also explore the role of indigenous and community-led adaptation approaches, the impact of private sector engagement in urban resilience, and the long-term economic implications of climate adaptation investments in coastal cities. Addressing these gaps will enhance the understanding of sustainable resilience planning for coastal urban environments in the Global South.

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