Coastal City Adaptation in Caribbean Small Island Developing States: The Case of Greater Bridgetown, Barbados

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Keywords	Low-lying coastal cities; coastal adaptation; SIDS cities
City Population (Metropolitan)	110,000
City Area (Metropolitan)	50 km^2
City GDP (per capita)	14,350 USD
Climate Zone	Aw(tropical savanna/dry winter)
ARC3.3 Linkage	Equity, Development, and Informality Element

Introduction. Climate change is impacting populations, ecosystems, and economies all over the globe and this calls for adaptation and mitigation responses that are complementary and effective. Small island developing states (SIDS) face an existential threat should global warming rise above 1.5°C. SIDS will be significantly impacted by climate change, causing the loss of lives and livelihoods, decreased food and water security, loss of infrastructure and settlements, degradation of human health and well-being and loss of cultural resources and heritage. Some Caribbean cities face unprecedented challenges especially as they battle with the impacts of sea level rise on their low-elevation coastal cities. SIDS present the most urgent need for investment in capacity building and adaptation strategies, but face barriers and constraints that hinder the implementation of adaptation responses (Mycoo et al., 2022). Barriers and constraints arise from governance arrangements, lack of financial resources and human resource capacity. Additionally, institutional and legal systems are often inadequately prepared for managing adaptation strategies such as large-scale settlement relocation and other planned and/or autonomous responses to climate risks.

The case study of Bridgetown, Barbados provides a useful insight into the impacts of climate change on cities in small islands, barriers to adaptation such as the current governance structure and system, and the integral role technical and community actors and other enabling factors play in finding pathways to sustainable and climate resilient development and climate justice.

History and Overview. Caribbean coastal cities are among the most vulnerable and exposed to climate-related slow onset events such as sea level rise (SLR), as well as rapid onset extreme events including tropical cyclones, storm surges and flooding. Greater Bridgetown, which comprises Barbados' capital city and its urban corridor, is highly exposed to climate-related events as reflected in spatial and temporal changes associated with the global community's inability to adhere to the Paris Agreement to limit temperature below 2°C above pre-industrial temperatures.

Context and Drivers. Barbados' population and capital investments are spatially concentrated in the low elevation coastal zone (LECZ) which is impacted by flooding. Population health and safety, freshwater security (Cashman et al., 2010), buildings and infrastructure are vulnerable to annual flood events. Figure 1 shows Bridgetown's main coastal assets in relation to a 1 in 100-year flood hazard. Figure 2 shows Holetown and Trent in the LECZ and 25-year flood events and impacts based on various climate change scenarios.

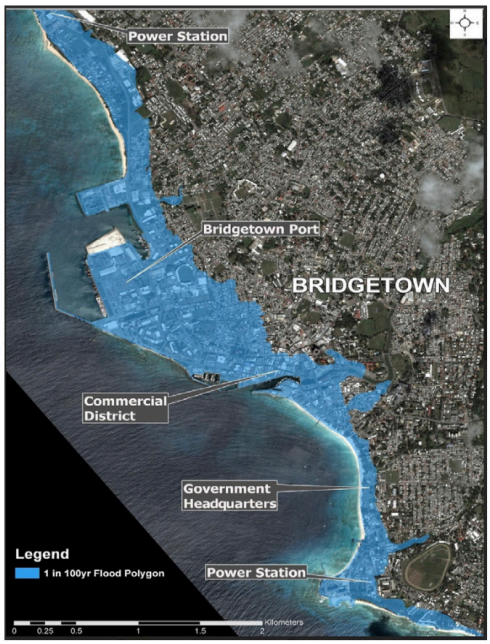

Figure 1: *Flood hazard map of Bridgetown showing key coastal assets*

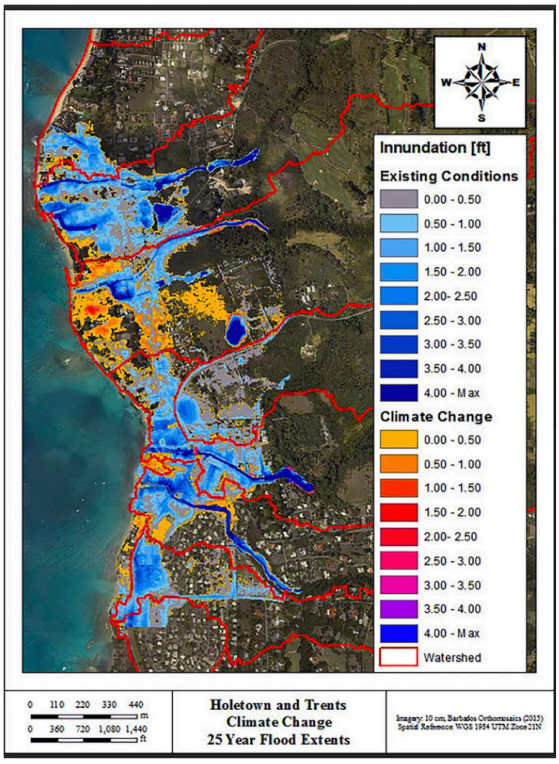

Figure 2: *Low Elevation Coastal Zone and Flooding in Holetown and Trents based on Climate Change Scenarios*

Analysis, Evaluation and Implementation. Formal governance: national-level institutions, policies and plans to reduce coastal hazard risk in Greater Bridgetown. Barbados' Physical Development Plans (PDPs) of 2017 articulate risk-informed land use planning measures to minimize climate change impacts on Greater Bridgetown. These are ecosystem-based adaptation responses, which include greening urban areas through the adoption of tree preservation and replacement plans for all development in the Integrated Coastal Zone Management areas; and increasing forest and ground cover through the policies of the Natural Heritage System to improve infiltration, enhance rainfall retention in watersheds and reduce surface water run-off. These responses seek to integrate adaptation and mitigation responses to climate-related hazards.

A national statute pre-dating climate change discussions establishes a minimum building setback for all new buildings along sandy coasts of 30 meters from the mean high-water mark and 10 meters along cliffs using the under portion of the cliff. The objective is to ensure that built development is located away from zones of risk where SLR, storm surges, coastal flooding and erosion occur (Mycoo, 2006). Applications for major developments or land use change within 30 meters of the coast are subjected to an environmental and social impact assessment and other technical studies (Town and Country Development Planning Office (TCDPO), 2017a). Coastal setbacks pose conflicts with investors who argue they lose valuable coastal land, and that insurance will pay for loss and damage suffered.

New urban development plans provide detailed guidelines for individuals, communities, and investors to safeguard their assets from coastal hazard impacts. Developers operating within Flood Susceptible Areas must prepare to the Drainage Ministry's satisfaction, a hydrologic design study to assess the suitability of the development project to withstand projected on-site flooding events, and propose flood-proofing measures (TCDPO, 2017b). They also may be required to prepare and submit vulnerability assessments that explicitly identify the potential risks and mitigation measures acceptable to the Chief Town Planner. The environmental and social impact assessment process will take into consideration impacts of climate change and climate variability on the proposed development, and the development's influence on ecosystem processes and provisioning services (TCDPO, 2017a). Costs incurred in conducting these studies by technical-scientific experts are borne by private investors and not taxpayers to ensure environmental justice.

Formal Governance: Programmes and projects to reduce coastal hazards in Greater Bridgetown. Flooding has deleterious impacts on residential, commercial and tourism assets. Estimated damages are approximately US$1.5 billion for the 100-year condition (Coastal Zone Management Unit, 2020). Due to losses, programmes and projects aimed at reducing coastal hazards and providing support for human adaptation in Greater Bridgetown are ongoing (Medina et al., 2019). In 2015, US$7 million was borrowed to implement flood mitigation engineering works in Bridgetown (Caribbean Development Bank, 2015). Although several PDPs seek to reduce climate vulnerability in Bridgetown, few plans have been implemented. For instance, Barbados participates in the Inter-American Development Bank's Emerging and Sustainable Cities Programme, which supports Caribbean cities in developing specific action plans to increase resilience. It has not, however, developed a Sustainable City Plan, and barriers to implementing action plans are unclear, likely limiting the number and effectiveness of Bridgetown-specific climate adaptation initiatives. Additionally, only half the initiatives address flooding or coastal inundation, which are the largest threats to key coastal assets and human safety (Mycoo et al., 2021). Such gaps suggest that vulnerability reduction efforts in Bridgetown are disconnected from the city's major climate risks.

Integrating Expert and Local Knowledge: Transcending the central government and its technocrats. As Barbados' government is highly centralized, emphasis has been placed on top-down city planning, but this undermines the capacity for organized responses that are catalytic in transforming city adaptation to climate change. Recent efforts to resolve tensions arising from centralized planning focus on integrating local community knowledge into city adaptation. During the drafting of the 2019 Planning and Development Act, the Government placed emphasis on public participation and hosted a stakeholder discussion for professionals involved in the planning process (Joy, 2018). Despite its efforts at increasing public participation, the absence of prominent city-level institutions could be hampering greater adaptation action (Robinson, 2020), as local institutions can be better informed by the public, and therefore minimize the risk of misaligned policy. Greater

Bridgetown's capacity for coastal/urban resilience cannot be maximized without institutional prioritization of vulnerability, increased stakeholder engagement, input, and support, along with significant investment in adaptation and protection of valuable coastal infrastructure (Mycoo et al., 2021).

Future Implementation and Conclusion. A robust urban governance framework, which guides urban planning and environmental management, is fundamental to informing decision-making of national-level institutions, relevant government and other stakeholder initiatives in reducing vulnerability to coastal hazards. Improved knowledge of the nexus between adaptation and mitigation will help urban planners in SIDS better prepare urban settlements to cope with future climate change challenges. Currently, there is a research gap in determining the feasibility of urban adaptation and mitigation measures in SIDS. In this regard, ongoing monitoring and evaluation of projects are key to assessing the feasibility of solutions and should form a critical component of research. Such feasibility studies are likely to have applicability to not only SIDS, but other regions where insufficient time has elapsed to draw lessons from which adaptation and mitigation measures work best, and in what context. Continued capacity building, through curriculum development in climate change adaptation and mitigation, urban planning and environmental management in a SIDS context is fundamental. Such capacity-building initiatives will enhance policymaking and implementation of adaptation and mitigation responses to coastal hazards occurring in cities. Ultimately, enhanced capacity and a reformed urban governance framework in SIDS are key components to foster sustainable climate resilient development and climate justice and sustainable development.

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Additional Data

- **Gross National Income (GNI):** 21,280 USD (High Income)
- **Population Density:** 7,300 people/km^2
- **Gini Coefficient:** 47
- **Human Development Index (HDI):** 0.809 (Very High)
- **Type of Climate Intervention:** Adaptation