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Adaptation Strategies to Climate Change-Induced Flood and Erosion Hazards in Lagos Barrier Island, Nigeria

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Abstract- ***Climate change-induced flooding and coastal erosion present significant environmental challenges for the Lagos Barrier Islands, Nigeria, threatening livelihoods, infrastructure, and ecosystems. This study examines adaptation strategies adopted by households, communities, and relevant institutions to address these hazards. This study used a mixed-methods approach, combining household surveys, key informant interviews, and document review. The study collected data from households within a 1 km coastal buffer across the Apapa, Eti-Osa, Epe, and Ibeju-Lekki Local Government Areas (LGAs), and interviewed selected government agencies and community representatives. Quantitative data were zanalyzed using descriptive statistics, while qualitative responses were subjected to the Content Analysis Technique (CAT). The findings indicate that household adaptation to flooding is dominated by tree planting and building reinforcement, whereas sandbagging, drainage construction, and reliance on government or NGO assistance are the most common responses to coastal erosion. Awareness of hazard management plans remains relatively low among residents, and significant gaps exist between institutional claims and community experiences, indicating weak implementation and limited local engagement. The study recommends strengthening participatory planning and promoting hybrid adaptation approaches to enhance coastal resilience.***

Keywords: Adaptation Strategy, Barrier Island, Erosion, Flood

I. INTRODUCTION

Coastal Barrier Islands (BIs) worldwide are distinctive, highly dynamic landforms that support diverse resources and serve various purposes [1]. They are bordered by the Atlantic Ocean on one side and shallow lagoons on the other side, separating BIs from the mainland [1]. Barrier islands (BIs) are highly vulnerable to wind, waves, and tides because of their low-lying nature, and sea-level rise intensifies this vulnerability, causing erosion on more than 24 per cent of the world's sandy beaches at rates exceeding 0.5 m/yr [2]. In Africa, [3] note that these areas face various climate change-related hazards, including erosion, floods, heatwaves, droughts, storms, and sea-level rise. The significance lies in the resulting hazards, especially coastal flooding, which affects 61% of coastal areas [3].

Nigeria is no different, with sea-level rise and storm surges driving flooding and coastal erosion. These processes threaten human, animal, and plant life and generate substantial economic losses, mortality, and large-scale population displacement. Flooding, in particular, causes more national displacement than any other natural hazard, putting an estimated 20% of the population at risk [4,5]. The study by [6] regarded flooding as one of the world's most dangerous natural disasters, associated with devastating social, economic and environmental impacts. According to [7], high vulnerability to flooding is mainly found along streams, river channels, and water bodies. In Lagos, coastal erosion is particularly pronounced along the barrier systems, where persistent wave activity exerts continuous geomorphic pressure. According to [8], approximately 84% of the Lagos shoreline has been lost over the past five decades, with an average shoreline retreat rate of about 2.64 m per year. Some development and adaptation initiatives have reduced vulnerability across sectors and regions [9]; however, many developing nations, including Nigeria, remain highly vulnerable because of limited adaptation capacity.

A foundational global typology in the coastal adaptation literature classifies responses into protect,

accommodate, and retreat. Adaptation is an ongoing process that requires continuous risk assessment and monitoring rather than a single intervention [10]. Building on this typology, [11] distinguishes four governance archetypes for responding to sea-level rise by cross-cutting two paradigms: protecting against hazards versus adapting to them, with the degree of integration and stakeholder engagement required for implementation.

Barrier islands pose adaptation challenges distinct from mainland coasts owing to their narrow, low-lying, and morphologically mobile character. Using a morphological numerical model of a developed US barrier island under hurricane forcing, [12] found that beach nourishment confined to the active beach zone gives only marginal protection as sea levels rise, and that raising an existing dune or buried seawall reduces volumetric erosion but does not prevent bay-side (back-barrier) flooding under higher sea-level-rise scenarios. The authors propose a staged adaptation pathway keyed to the magnitude of sea-level rise rather than a single fixed design.

The most directly relevant regional synthesis is [13], a peer-reviewed synthesis of coastal erosion and flooding management practices across West Africa from Mauritania to the Gulf of Guinea. The review documents that most adaptation measures to date have been implemented reactively and at the local scale, predominantly hard protection (groynes, seawalls, revetments) and finds that these structures frequently displace erosion to downdrift communities; the authors recommend regional, holistic coastal zoning and stronger observation networks as the primary route to more sustainable management. A study by [14] suggested an integration of blue growth, such as coastal zone management, marine spatial planning, coastal protected areas, coastal biodiversity, and blue justice discourse, into policy design, prioritizing sustainability.

For Nigeria specifically, [15] reviewed the degradation of Niger Delta mangroves, Africa's largest mangrove expanse, under oil-related and urban pressure. They proposed a conceptual restoration and co-management framework built around stakeholder engagement and the integration of indigenous ecological knowledge, noting that no standardised national framework for mangrove-based coastal adaptation yet exists. [16], observed a land loss of 15.1 sq. km to the Atlantic over the last 35 years in his study on shoreline, which could trigger an additional 1.26 sq. km by the year 2032. The study recommended adopting the shoreline management plan (SMP) for sustainable management. [17], describe a century-long history of hard engineering on the Lagos barrier coastline, beginning with the East and West Moles built at the Lagos harbour entrance (1908–1912), which disrupted longshore sediment transport and is credited with initiating chronic erosion at Bar Beach, Victoria Island. More recent interventions include the Eko Atlantic City seawall and land-reclamation project (from 2005) and state-led groynes construction announced in 2024 for erosion-affected communities in Ibeju-Lekki.

A study by [18] combined resident interviews (n = 14), a household survey (n = 300), and GIS-based land-use-change mapping (1990–2020) with sea-level-rise inundation scenarios (0.5–2.0 m) for a Lagos coastal informal settlement, concluding that effective adaptation will require restoring degraded natural ecosystems and integrating indigenous adaptation systems alongside formal planning. The study found that the Lagos Climate Adaptation and Resilience Plan (2024) has not yet substantively incorporated this knowledge.

Nature-based and hybrid measures, particularly mangrove restoration, are supported by strong global and Nigeria-specific modelling evidence [15,19] but lack a standardised implementation framework for Nigeria's barrier and lagoon coastline. Only very few of these accessible identified reviews evaluates how structural, nature-based, and community-led adaptation coexist and interact specifically within Lagos's barrier islands, a gap this study addresses.

II. METHODOLOGY

Study area

The study area is Lagos State in southwestern Nigeria. Lagos State has the smallest land mass (3,577 square kilometres) in Nigeria, with 20 local government areas, 20 inland waters, and over 20 million

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inhabitants [20]. The barrier lagoon divides the state into mainland and island areas, with water bodies covering about 22% of the state [21]. The Barrier Island Coast is the study area: a low-lying coastal region in Lagos State, bounded by the two major lagoons, the Lagos Lagoon and Lekki Lagoon, covering about 980 km². It is geographically located between latitude 6.4º North of the Equator and 6.6º North of the Equator and longitude 3.4º East of the Greenwich Meridian to 4.3º East of the Greenwich Meridian (Figure 1).

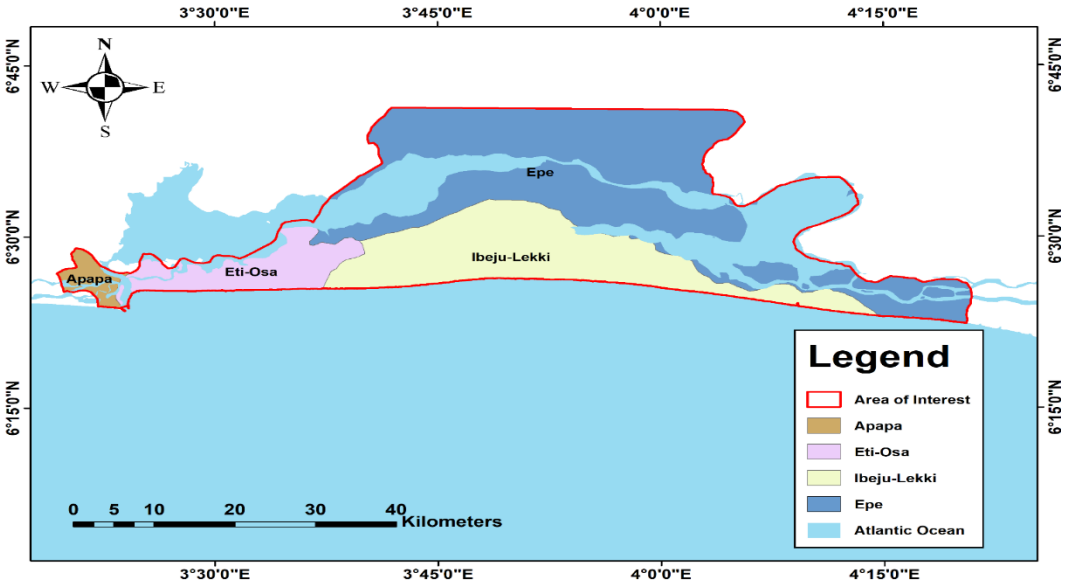

Figure 1: Lagos map showing the study area
Source: Digitized by the author, 2026

Database description

This study employed a mixed-methods survey design, incorporating both qualitative and quantitative data collection and analysis. The study used structured questionnaire to obtain information on strategies residents have been using to adapt to flood and erosion hazards. Government Oragnisations in charge of the coast, and Local Community Association were interview on their impact in reducing climate hazards in the barrier island. Secondary data such as; journal articles, literature review, and textbooks were also used. The study administered questions on mitigation and adaptation measures to household heads using systematic random sampling. The data collected were subjected to descriptive statistical analyses. Qualitative data consisted of open-ended information gathered through interviews with agencies in public and private establishments. The data were transcribed and organised into thematic categories for further analysis using Content Analysis Techniques (CAT).

Household units in four (4) LGAs were digitised to determine the sample base, including Apapa (20,975), Epe (4,515), Eti-Osa (40,638), and Ibeju-Lekki (30,580) housing units. Government agencies and community development associations (CDAs) also constituted part of the research population. Buildings within a 1km buffer of water bodies formed the sampling frame for this study. This distance aligns with the policy-oriented definition of coast by [22]. Consequently, the sampling frame consisted of 9,794 housing units. A pilot survey identified twelve (12) organisations for interview. Following [23], which stated that larger populations permit smaller sampling ratios for good results, 4% of the total sampling frame were selected, and copies of the administered questionnaire were prepared.

Based on pragmatic criteria, the study selected only four (4) organisations for interviews to identify relevant adaptation measures in the study area. They include: Lagos State Ministry of Environment and Water Resources (LSMEWR, state policy/planning level), the National Emergency Management Agency (NEMA, federal level), the Lagos State Emergency

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Management Agency (LASEMA, state emergency-response level), and the Lagoon Community Development Association (LCDA, community level). The results obtained were analysed using the Content Analysis Technique (CAT)

III. RESULT AND DISCUSSION OF FINDINGS

The study incorporated residents' responses from barrier islands and applied qualitative content analysis, combining the directed (deductive-dominant) approach of [24] with the systematic coding procedure of [25] and drawing on the category-development logic of [26].

Household heads' responses (Quantitative)

Flooding Adaptation Measures

The results indicate that planting trees and grasses around buildings is the most common adaptation measure (80.8%), followed by reinforcing buildings (69.1%), which suggests a preference for self-implemented actions without external support. Capital-intensive drainage infrastructure remains limited, as reflected in the low uptake of drainage construction (28.8%). The near-total absence of the use of local floating materials (0.6%) contrasts with the Makoko waterfront settlement in Lagos, where floating and stilt-based structures are established adaptation responses to chronic flooding [27], indicating that such techniques are not part of local building practice in the study area.

Table 1: Flooding Adaptation Measures

Adaptive Measure	Yes (%)	No (%)	Not Sure
Planting of trees/grasses around buildings	80.8	16.4	2.8
Reinforcement of buildings	69.1	29.5	1.4
Self-education at regular interval	50.2	46.8	2.9
Rain harvesting	28.8	69.0	2.2
Construction of more stable drainage	44.3	53.3	2.3
Temporary relocation	22.2	73.8	4.0
Use of local floating materials	0.6	99.4	—

Adaptive Measure Strategies to Coastal Erosion

Sandbagging (85.0%) remains the most widely adopted adaptive strategy, followed by drainage construction (71.0%) and seeking relief materials from governments and NGOs (66.8%). Relocation (45.1%) was moderately adopted, notably higher than the temporary relocation rate recorded for flooding, suggesting that erosion is perceived as a more permanent, irreversible threat, pushing some households toward more drastic responses. The higher relocation rate for erosion than for flooding implies that erosion-affected households may require distinct, longer-term land-use and resettlement planning support, rather than the same short-term, coping-focused interventions typically used in flood response.

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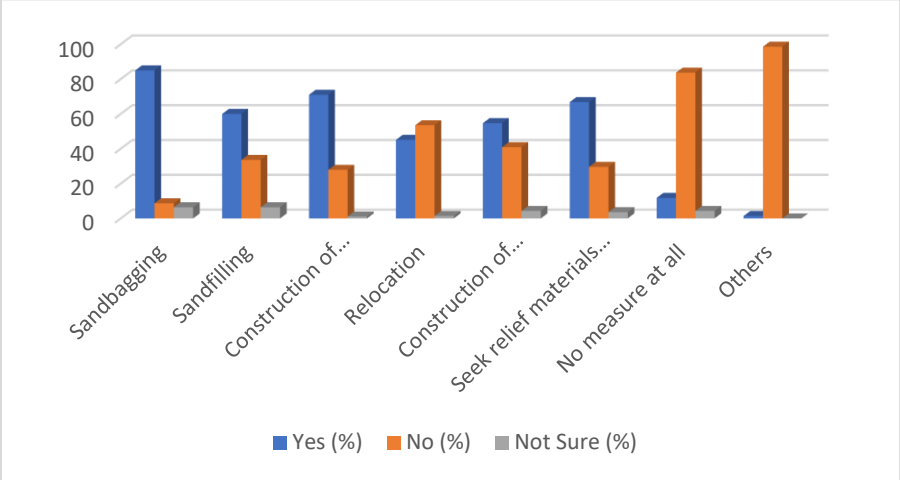

Figure 2: Adaptive Measure Strategies to Coastal Erosion

Awareness of Hazard/Disaster Management Plan

Analysis of Figure 3 indicates that a plurality of households (42.6%) are unaware of any hazard or disaster management plan in their area, while only 34.0% report that such a plan exists. The high proportion of households unaware of disaster management plans suggests that, even where institutional frameworks exist, poor communication and limited grassroots engagement undermine their effectiveness in practice.

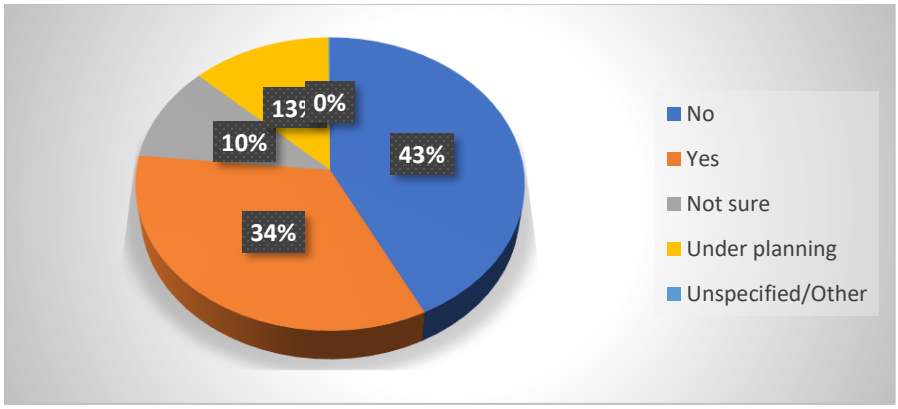

Figure 3: Awareness of Hazard/Disaster Management Plan

Rating of Bodies in Hazard/Disaster Management

Analysis of Table 2 shows that Community Development Associations (84.2% Poor), Private Institutions (82.0% Poor), and NEMA (76.1% Poor) are the most negatively rated bodies, while LASEMA received a comparatively better rating (31.5% Poor). relatively better rating compared to NEMA suggests that decentralized, state-level disaster management structures may be more responsive and trusted at the community level than centralised national agencies. This supports a policy argument for strengthening disaster management capacity at the state and local government levels. This finding aligns with [28]'s appraisal of NEMA, which identified poor logistics, weak inter-agency coordination, and the near-absence of functional emergency structures at the local government level as core institutional weaknesses, reflecting a disconnect between national mandate and community-level trust mirrored in these data.

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Table 2: Rating of Bodies in Hazard/Disaster Management

Body	Excellent (%)	Good (%)	Fair (%)	Poor (%)
NEMA	7.9	2.3	13.3	76.1
LASEMA	20.2	23.4	25.0	31.5
Lagos State Ministry of Environment & Water Resources	6.0	7.0	38.0	49.0
Community Development Association	8.5	0.2	7.1	84.2

Key Informant Interview (KII) (Qualitative)

Frequency Distribution of Adaptation Strategy Categories

Seventy-one substantive statements were coded across the four respondents; contextual, non-strategy items (e.g., single-word responses on economic dependence) were excluded from the category count. Structural/Hard Engineering, Community-led/Institutional, and Policy/Governance are tied as the most frequently coded categories (21.1% each), with Nature-based/Soft Engineering notably lower at 15.5%. Four statements were coded with absent status, reporting that a strategy does not exist at the respondent's level, and all four come from the community-level respondent.

Table 3: Frequency distribution of adaptation strategy categories by respondent

Category	LSM-EWR	NEMA	LAS-EMA	LCDA	%
Structural/Hard Engineering	6	3	3	3	21.1
Nature-based/Soft Engineering	4	2	3	2	15.5
Community-led/Institutional	4	5	5	1	21.1
Policy/Governance	6	3	4	2	21.1
Cross-cutting: Funding	2	3	2	0	9.9
Cross-cutting: Monitoring & Evaluation	1	3	2	2	11.3
Total	23	19	19	10	100

Category Descriptions with Illustrative Data

Hard Engineering

Existing groynes and dunes were the most widely confirmed measure, mentioned by all four respondents (LSMEWR, NEMA, LASEMA, LCDA). LSMEWR gave the most detail overall, describing the sea walls known as the 'Great Wall of Lagos' (mentioned twice) and geosynthetic membranes used to stop sand loss underground, along with community-level measures like retreat and sandbag use. LASEMA was the only respondent to mention state-led dam and drainage construction. In contrast, both NEMA and LCDA raised drainage clearing at the practice level, suggesting this is one of the few activities happening at both the institutional and community level. LSMEWR, NEMA, and LASEMA confirmed plans to expand hard infrastructure. Still, LCDA was the only respondent to say no such expansion plan exists locally, again highlighting the gap between state-level planning and local awareness.

Nature-Based Solutions

LSMEWR was the only respondent to mention dune vegetation management as a soft-engineering introduction. Both LSMEWR and LASEMA confirmed state-organised tree-planting, while LCDA reported a separate, household-level version in which residents planted trees on their own initiative rather

than through any state programme. Green infrastructure and mangrove conservation were the two most consistently mentioned nature-based measures, each confirmed independently by LSMEWR, NEMA, and LASEMA. However, LCDA was again the outlier, reporting no awareness of any green infrastructure reaching the community, reinforcing the pattern that soft-engineering measures may be discussed and coordinated at state level without becoming visible where residents live.

Community Involvement

Three engagement mechanisms were confirmed to be identical across LSMEWR, NEMA, and LASEMA: CDA partnerships and town-hall engagement; community workshops and school outreach; and meetings with community heads. The single largest code in this entire category, however, was emergency response personnel and equipment, mentioned five times in total once by LSMEWR and twice each by NEMA and LASEMA suggesting this is where state agencies feel most confident describing tangible community-facing capacity. Despite this range of reported engagement, no such engagement has reached the community, directly contradicting the volume and consistency described by the three state agencies.

Policy & Governance

Zoning, setback, and building regulations were the most frequently cited codes in this table, mentioned five times, mostly by LSMEWR (three mentions) with additional confirmation from NEMA. LSMEWR, NEMA, and LASEMA confirmed emergency coordination structures identically. LSMEWR and LASEMA both described a resource allocation approach, while LSMEWR alone raised early warning and response planning. LASEMA was the only respondent to describe proactive “build back better” planning, mentioning it twice. Set against all of this institutional detail, LCDA’s two contributions were split: one stating that no local emergency plan exists, and the other describing the community’s practice of relying on the state emergency body when disaster strikes, meaning LCDA’s account is less about formal governance and more about how residents cope in its absence.

Funding

Both LSMEWR and LASEMA described funding sufficiency as uncertain or qualified, while NEMA was the only respondent to state outright that funding is explicitly insufficient. LSMEWR and LASEMA also raised resource and capacity constraints, echoing the funding uncertainty. NEMA additionally raised two funding-related concerns not mentioned by the others: reactive, ad hoc resource allocation, and long-term sustainability concerns about whether current funding levels can be maintained. LCDA did not contribute to this table, which may be meaningful, as funding discussions appear confined entirely to state-level agencies, with no visibility or input from the local government tier closest to residents.

Monitoring & Evaluation

Technology-enabled monitoring using satellites and drones was confirmed identically by all three state agencies, LSMEWR, NEMA, and LASEMA. NEMA additionally described two monitoring practices not mentioned elsewhere: formal site visitation and hazard mapping. LASEMA was the only respondent to mention physical auditing and digital tracking. In contrast, ’LCDA’s monitoring account was entirely different: informal community visitation, mentioned twice, with no reference to any of the technological tools described by the state agencies, reinforcing the disconnect between high-tech, state-level monitoring and the informal, ad hoc methods used at the community level.

Institutional–Community Divergence

A key pattern emerges when categories are compared across the governance-scale gradient rather than examined individually. All three government-level respondents described structured community engagement, and each independently described some form of emergency-response capacity reaching the community: LSMEWR, an early warning system and pre-positioned supplies; NEMA, an evacuation camp and medical response units; LASEMA, a firefighting fleet and mobile medical services. LCDA, the respondent positioned to receive these mechanisms, reported the opposite on each corresponding item

Table 4: Institutional claims versus community-reported experience

Claimed by state/federal respondents	” ’LCDA’s corresponding account
CDA partnerships, public town halls, coastal community forums	No organisation had engaged community leaders during the respondent’s tenure
Early warning systems and pre-positioned supplies (LSMEWR); comparable emergency-response capacity: evacuation camps, fire and medical fleets described independently by NEMA and LASEMA	No emergency plan exists; residents rely on informal appeals for help when flooding occurs.
Green infrastructure is present, though described by LASEMA as insufficient.	No awareness of any such infrastructure

Implications of the Findings

The KII findings carry four categorical implications that follow directly from the coded evidence, not interpretation alone. First, the adaptation strategy in the Lagos barrier islands is real but incomplete: it is robust in institutional design and discourse, yet fails to translate reliably into experience at the point of hazard exposure. This is not a matter of degree or rank, but a result of four of LCDA’s ten coded responses reporting the flat absence of provision that LSMEWR, NEMA, and LASEMA each independently described as present.

Second, the imbalance across categories is not incidental but structurally reinforced: hard engineering is fundable, visible, and politically demonstrable, while nature-based and community-facing measures require sustained, less visible investment and are the categories in which respondents were least confident funding is sufficient.

Third, informal community self-help drainage clearing and household-level tree-planting undertaken without state involvement is not a supplementary detail but a substantive finding: it indicates that adaptive activity is occurring at the barrier islands regardless of, rather than because of, institutional provision.

Fourth, the near-identical wording used by NEMA and LASEMA on several items, treated conservatively in this study as a single corroborating source, itself signals a governance pattern worth naming: institutional accounts of community engagement and emergency response converge with each other but not with the community’s own account, which is the more consequential form of agreement or disagreement for assessing real-world sufficiency.

IV. CONCLUSION

The effectiveness of adaptation strategies in the barrier islands remains constrained by limited resources, weak coordination, and inadequate community integration. Households rely mainly on accessible, low-cost measures such as tree and grass planting, sandbagging, drainage construction, and, increasingly, relocation from erosion-prone areas. Institutional responses include groynes, seawalls, mangrove conservation, early-warning systems, and hazard monitoring. However, substantial gaps persist between reported institutional provisions and community experiences. Limited awareness of disaster-management plans and poor ratings of several responsible institutions further underscore weaknesses in communication, funding, and local implementation. Sustainable adaptation therefore requires integrating community knowledge and existing coping practices with nature-based and appropriate structural measures, while strengthening local governance, public awareness, monitoring, funding, and coordinated long-term coastal planning.

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