BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

Course Title: Coastal Zone Management

Course Code: WFM 6305

Submitted To:

ANISUL HAQUE & MOHAMMAD ASAD HUSSAIN

Professor, IWFM, BUET

Submitted by:

Name	Roll
Fariha Aktar	**1024282201**
Most. Raisha Tasnim	**1024332507**
Afiya Kashem Ishra	**0424282143**
Salah Uddin Ahmed Dipu	**0424282214**
Muid. Mahmud Khan	**0424282133**

Date of Submission: September 23, 2025

Abstract

Bangladesh's coastal regions, especially Cox's Bazar, are highly vulnerable to climate change-induced hazards such as sea-level rise, salinity intrusion, shifting erosion-accretion patterns, and recurrent storm surges. These environmental challenges threaten the livelihoods, infrastructure, and natural resources of coastal communities. This study explores the vulnerability of Cox's Bazar Sadar Upazila to these climate impacts and proposes site-specific adaptation strategies to enhance resilience. The research utilizes remote sensing data and standardized indices like the Normalized Differential Salinity Index (NDSI) to assess salinity intrusion and erosion-accretion dynamics. The findings highlight the significant risks posed by sea-level rise and storm surges, particularly the impact of Cyclone Sidr in 2007. Adaptation measures such as ecosystem-based solutions, strengthening early warning systems, and diversifying livelihoods are recommended to mitigate the risks and enhance community resilience in the face of ongoing climate change.

2. Introduction

Bangladesh's coastal zone ranks among the world's most climate-vulnerable areas because of its low-lying terrain, dense population, and heavy reliance on natural resources(T. Islam et al. 2025). This zone faces multiple climate change-induced threats, such as sea level rise (SLR), salinity intrusion, shifting erosion–accretion patterns, and recurring storm surges(Rahman et al. 2024). These hazards endanger not only the natural environment but also undermine livelihoods, deplete resource sustainability, and weaken community resilience(Hassan et al. 2025).Coastal zones, defined as areas less than 10 meters above mean sea level, are ecologically rich, diverse, and highly productive, yet they remain extremely vulnerable to sea-level changes(IPCC 2022).During the 20th century, sea-level rise (SLR) was primarily driven by the mass loss of glaciers and ice caps hereafter collectively referred to as glaciers and by the thermal expansion of oceans(Durand et al. 2022).In recent decades, the combined effects of sea level rise and stronger cyclones have accelerated displacement, land degradation, and food insecurity in coastal regions(Cheng et al. 2016). In Bangladesh, salinity-affected land covered 83.3 million hectares in 1973, increased to 102 million hectares by 2000,and further expanded to 105.6 million hectares by 2009(Ashrafuzzaman, Artemi, et al. 2022).Salinity intrusion has lowered agricultural yields, deteriorated freshwater resources, and disrupted ecosystem services(Shammi et al. 2019). Storm surges caused by hurricanes and tropical cyclones (TCs) rank among the deadliest natural hazards worldwide, claiming over half a million lives in the last six decades(Rezaie, Ferreira, and Rahman 2019).The Bangladesh Meteorological Department reports that from January 1974 to May 2018, 269 depressions and storms were recorded. These events have led to considerable economic losses and loss of life. Nevertheless, the extent of the damage cannot be attributed to the storms alone, as Bangladesh's coastal morphology and geological conditions also significantly influence the impact(Al Mohit et al. 2018). Similarly, erosion and accretion processes have altered coastlines, threatened settlements and weakened infrastructure(M. T. Islam et al. 2024).For coastal communities to thrive, adaptation measures must be both practical and tailored to local conditions. Effective strategies should leverage existing resources while creating sustainable pathways to strengthen livelihoods(Hossain et al. 2021).For instance, diversifying agriculture and aquaculture systems can mitigate risks and stabilize incomes. Equally critical are infrastructural and institutional interventions, including building embankments, enforcing zoning regulations, and enhancing disaster preparedness(Chowdhury et al. 2025).Resource management policies should strike a balance between economic growth and ecological preservation amid climate uncertainties. Additionally, adopting gender-responsive, community-led approaches is crucial to promote inclusivity and ensure fair, effective adaptation(Shammi et al. 2019).This paper develops site-specific adaptation strategies for a vulnerable coastal area of Bangladesh, addressing the complex links between climate hazards, resources, and livelihoods. It aims to identify practical solutions that reduce vulnerabilities, enhance opportunities, and strengthen community resilience in the face of climate change.

3 Methodology

3.1 Study area

The study area, Cox's Bazar, is shown in Figure 1. This region, located on the southeastern coast of Bangladesh, is highly vulnerable to coastal hazards such as storm surges and cyclones.

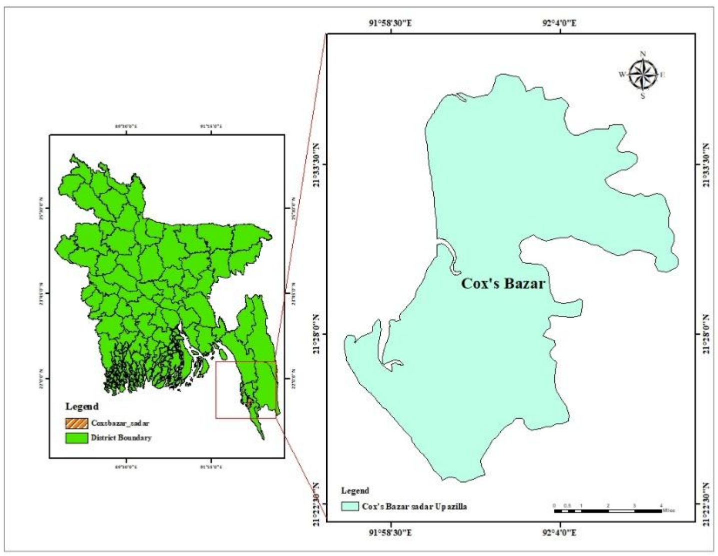

Figure 1. Study area map

3.2 Normalized differential salinity index (NDSI)

The NDSI is calculated using the formula 1.

$$\mathrm{NDSI}=\frac{\mathrm{R}-\mathrm{NIR}}{\mathrm{R}+\mathrm{NIR}}\text{………………………………….. (1)}$$

Where, R is the reflectance in the red band and NIR is the reflectance in the near-infrared band (Moreira, Teixeira, and Galvão 2015).

4. RESULTS AND DISCUSSION

4.1 Sea level rise

Figures 2(a) and 2(b) illustrate the projected impact of sea-level rise (SLR) on Cox's Bazar Sadar Upazila for the years 2050 and 2100, respectively. These maps, created using Google Earth Engine, simulate inundation scenarios based on projected SLR data. The study, (Ashrafuzzaman, Santos, et al. 2022) indicates that from 1993 to 2011, the SLR at the Cox's Bazar station was 14.5 mm/year. Based on this trend, the SLR is projected to reach 435.7 mm by 2050 and surpass 1162 mm by 2100. Figure 2(a) shows the inundation scenario for 2050, highlighting areas such as Bharuakhali and Pokhkhali unions, which are expected to be submerged due to rising sea levels. Figure 2(b) presents the scenario for 2100, revealing a more extensive flooding area, with the Bharuakhali, Pokhkhali, and Patail Machuakhali unions experiencing significant impacts.

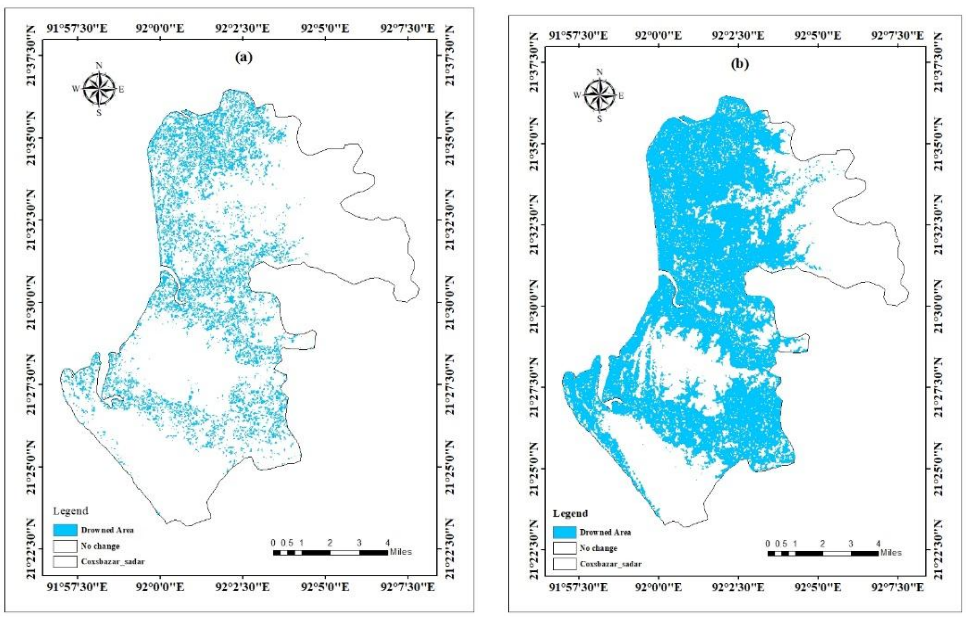

Fig. 2. Inundation due to sea level rise in Cox's Bazar Sadar Upazila for the years: (a) 2050 and (b) 2100

4.2 Salinity intrusion and erosion accretion

Figure 3 shows the salinity intrusion maps for the years (a) 1994, (b) 2004, (c) 2014, and (d) 2024. The maps were generated using the normalised differential salinity index (NDSI) derived from remote sensing data. The salinity levels are categorized into non-saline (green), low saline (yellow), and moderate saline (red) areas. The maps highlight the salinity intrusion zones in Bharuakhali, Pokhkhali, and Jhilwanja union, illustrating the progression of salinity intrusion over time. The spatiotemporal dynamics of erosion and accretion from 1994 to 2024, assessed using remote sensing techniques (Figures a–d) also shown in figure 3. The erosion, accretion, and change in km² from 1994 to 2024 are shown in Table 2. These values were initially generated using remote sensing data and then analyzed and processed using ArcGIS. This approach provided a detailed analysis of the spatiotemporal dynamics of coastal changes in Cox’s Bazar Sadar Upazila, highlighting fluctuations in land loss due to erosion and land gain from accretion over the 30-year period.

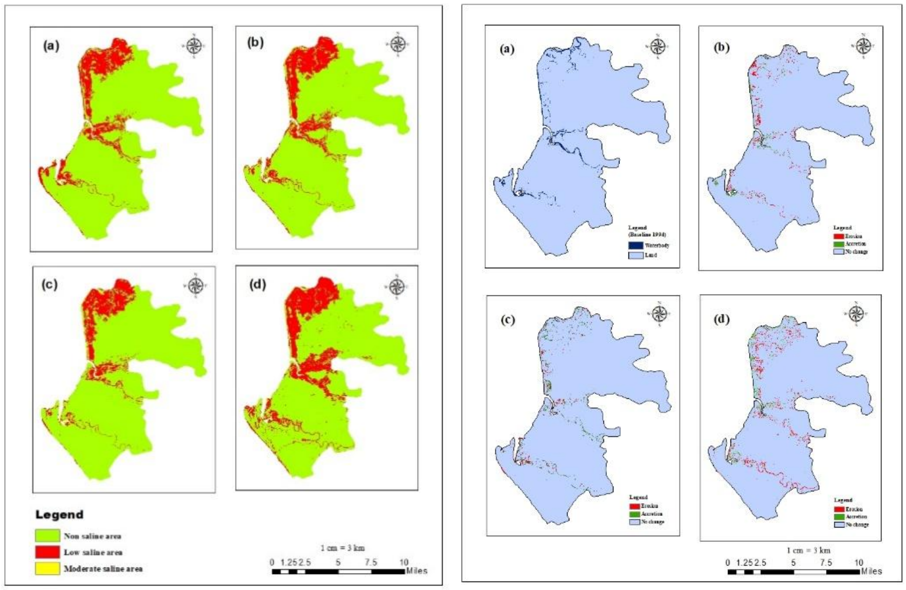

Figure 3. Salinity intrusion and erosion accretion map for the year (a) 1994 (b) 2004 (c) 2014 (d) 2024

According to Table 1, during the period from 1994 to 2004, the area experienced a loss of 3.14 km² due to erosion and a gain of 1.80 km² from accretion, resulting in a net land loss of 1.34 km². In contrast, from 2004 to 2014, erosion decreased to 1.58 km², while accretion increased to 2.67 km², leading to a net positive change of +1.09 km². The most significant changes occurred between 2014 and 2024, when erosion expanded to 5.29 km², while accretion decreased to 1.67 km², resulting in a substantial net positive change of +3.62 km². Overall, the results highlight an area where erosion and accretion alternated over the decades, with the period from 2014 to 2024 showing a notably higher rate of geomorphic change compared to earlier decades.

Table 1. Erosion-Accretion area (km^2)

Time	Total Area (km^2)	Erosion (km^2)	Accretion (km^2)	Change (km^2)
1994-2004		3.14	1.80	-1.34
2004-2014	228.23	1.58	2.67	+1.09
2014-2024		5.29	1.67	+3.62

4.3 Storm Surges

The possibility of vulnerability and taking protective measures always depends on the background history of that particular location. Based on previous history, the threshold of adversity can be predicted, and necessary measures can be taken accordingly. Therefore, checking the history is essential. As storm surges are a primary concern for coastal hazards, the previous record of storm surge heights and their effects on Cox's Bazar Sadar Upazila have been analyzed and presented in Table 2. The highest damage was caused by Cyclone Sidr in November 2007, with a storm surge height of 8.0 meters. It resulted in approximately 10,000 deaths and widespread devastation across the region. The cyclone caused massive destruction of homes, infrastructure, and crops, making it one of the deadliest cyclones in the history of Bangladesh.

Table 2. Major Cyclones Impacting Cox's Bazar and Their Damages

Year	Location	Storm surge height (m)	Damages	References
15 Dec 1965	Cox's Bazar	6.1	873 death and 40 000 salt beds in Cox's Bazar were inundated. 35 636 houses were destroyed	(Alam & Dominey-Howes, 2014)
7 Mar 1970	Cox's Bazar	4.88	No data available	Alam & Dominey-Howes, 2014)
24–28 Nov 1974	Cox's Bazar to Chittagong coast	3.1	20 people were died	(Akter & Dayem, 2021)
16–20 May 1998	Cox's Bazar	2.44	No data available	(Akter & Dayem, 2021)
16 Nov 2007	Cox's Bazar	8.0	Cyclone Sidr, 10,000 death	(Rezaie & Haque, 2022)
2009	Cox's Bazar	4.5 - 6	Cyclone Aila, 339 death case	(Rezaie & Haque, 2022)
29–31 May 2017	Cox's Baza	2.03	20,000 houses damaged in refugee camps	(Akter & Dayem, 2021)
May 2021	Cox's Baza	1.52	Cyclone Yaas, several villages flooded	BIWTA

4.4 Existing local resource

Table 3. Demographic Statistics of Cox's Bazar

Demographic Information	
Area (Sq.km)	228.23
Population (Urban)	357357
Population (Rural)	434901
Population (Slum)	10355
Population (Floating People)	131
Employed Population	128434
Ethnic Population	4048 (Highest in Cox’s Bazar District)
Households	90680
Growth Rate	-0.85%
Sex Ratio	108.48
Literacy Rate	76.71
Internet User	19.37% (Lowest in Cox’s Bazar District)
Dependency Ratio	55.77 (Lowest in Cox’s Bazar District)

Source: Bangladesh Bureau of Statistics, 2022 (Cox’s Bazar District Report)

Local resource base of Cox’s Bazar Sadar Upazila includes fertile lowlands, hills, mangroves, suitable lands for vegetables and fruits, timber works, beach-dune materials as well as coastal marine sources alongside the Bakhkhali river and a Fish Landing center called BFDC. This institution handles the artisanal marine catches and it is recently being updated with the support of JICA to reduce the post-harvest losses (Asiatic Society of Bangladesh, 2023; Dhaka Tribune, 2024; The Business Standard, 2025). The river’s water quality met the basic standards from the water quality monitoring which supports landing and processing functions (Hasan et al., 2020). There is a huge species variety recorded in this upazila near the river mostly around 50+ species across seasons which underlines both economic value and conservation needs. To the north-west and south salt cultivation areas remain a positive flagship indicating a productivity upgrading opportunity with governance improvements and integration with local processing (ILO, 2024). Most of the areas of this upazila covered with hills and tilas and these areas contains valuable trees like Shal, Mehagoni, Garjan, Rubber and rare Orchid. Due to tourist spots numerous hotels and other important structures are also situated in this upazila. Overall these assets agriculture and horticulture, mineral sands, salt production, forest ecosystem and integrated with small and medium sized enterprises are essential exiting local resources (Asiatic Society of Bangladesh, 2023).

4.5 Livelihoods

70% of Cox's Bazar Sadar Upazila's economy is driven by service and trade-based activities including hospitality, fisheries related labour and trading, SMEs (Small and Medium Size Enterprises), manufacturing and constructions (ACAPS, 2020). Most of the works are informal and require moderate to low skilled and petty trade for low wages (WFP, 2020). The total monthly income of a daily-wage labour is higher than the monthly wage-based workers. However, as daily wage labour has no predefined works, they are more vulnerable to external risks such as disasters, strikes and conflicts. Recently, COVID-19 has affected hugely. Tourism related day labour in this upazila is both prominent and seasonal.

Female households are less educated with a low average of attainment in primary schools (ACAPS, 2020). Their primary source of income is unskilled day labour which is susceptible to income shocks. Usually, men have more employment opportunities than women due to conservative nature of this upazila's society. Vulnerable households struggle financially and adopt consumption based coping mechanisms such as cheaper foods and reducing their daily meals. Thus, the overall health condition of Cox's Bazar Sadar is vulnerable and severely stunted.

Cox's Bazar Sadar supports marine and coastal aquaculture, including boat crews, fish processing, and salt cultivation, as two waterbodies from the Bakhkhali River flow into the upazila. Department of Forest yearbooks suggested fisheries and aquaculture experienced production growth of 4.9 MT in 2022-23 representing a strong market pull for coastal labour which also faces safety issues (DoF, 2024). Due to geographical location and entry of sea water in this area, salt cultivation is dominant practice. This area also holds hundreds of slat pans. It creates seasonal wage opportunities, harvesting and trading. A recent study emphasized the intrusion of microplastics in salt cultivation requires quality control also (Rakib et al., 2021).

4.6 Regulations

Fisheries & marine use

- Marine Fisheries Act, 2020 — Governs sea fishing, licensing, gear, offences; supersedes the 1983 ordinance. Critical for BFDC Fishery Ghat operations and near-shore artisanal fleets.
- Protection and Conservation of Fish Act, 1950 (+ amendments & rules) — Foundational inland/coastal conservation powers (mesh, gears, closed seasons), used for hilsa sanctuaries and jatka bans that affect Sadar fishers and traders.
- Hilsa Fishery Management Action Plan (HFMAP) — Government action plan establishing sanctuaries, seasonal bans, compensation—drives seasonal supply and market flows in Cox's Bazar.
- Territorial Waters & Maritime Zones (Amendment) Act, 2021 — Updates the 1974 law to UNCLOS standards; frames Bangladesh's EEZ rights over marine resources that land through Cox's Bazar.

Salt economy & food safety

- Iodized Salt Act, 2021 (re-enacts/updates the 1989 IDD Act) — Makes iodization mandatory for edible salt; relevant to Cox's Bazar salt production/processing and market enforcement.
- Food Safety Act, 2013 — Creates BFSA and hygiene/inspection powers across processing, storage, and sale (fish landing center icing/handling, markets).

Environment, EIA & biodiversity

- Bangladesh Environment Conservation Act, 1995 + Environment Conservation Rules, 2023 — EIA/clearance regime and Red/Orange project categorization for facilities like ice plants, cold storage, fish processing, and salt refining.
- Wildlife (Conservation & Security) Act, 2012 — Habitat/species protection (incl. marine megafauna caught as bycatch); enables sanctuaries and penalties.
- Coastal Zone Policy, 2005 (ICZMP) — Cross-agency policy for sustainable coastal development, risk reduction, and resource stewardship guiding projects in the Cox's Bazar coast.

Water & land/urban regulation

- Bangladesh Water Act, 2013 — Integrated water resources management, abstraction & pollution control (Bakkhali River use, landing-center water quality).

Bangladesh Laws

- Local Government (Municipalities) Act, 2009 — Municipal powers over markets (hat-bazar), sanitation, drainage, slaughtering, and local permits affecting SMEs and street vendors in Cox's Bazar municipality.
- Cox's Bazar Development Authority Act, 2016 — Establishes CoxDA to prepare and enforce master planning and controlled development in the district's urban/coastal corridor.

Disaster risk & coastal shocks

- Disaster Management Act, 2012 — National framework for disaster risk reduction and response; crucial for seasonal cyclone/storm-surge preparedness across fishery, salt, and tourism livelihoods.

4.7 Adaptation measures

Cox's Bazar Sadar faces rising sea levels, shoreline change, salinity intrusion, and repeated cyclone-driven storm surges that threaten people, assets and livelihoods (Shamsuzzoha and Ahamed 2023). Adaptation must therefore be multi-layered, site-specific, and combine engineered, ecosystem-based, and socio-institutional actions (Gijón Mancheño et al. 2025; M. F. Islam et al. 2020).

1. Adaptations for Sea-Level Rise: Introducing a coastal setback policy that incorporates local sea-level projections and beach morphology can reduce the exposure of infrastructure and settlements (Ali, Amin, and Hasan 2025; Saddam et al. 2025). Upgrading embankments and seawalls with conservative design standards that consider future run-up heights and overtopping is also crucial to maintaining their protective capacity (Ali, Amin, and Hasan 2025; Bernard et al. 2022). Where hard structures are applied, integrating them with vegetated buffers such as mangrove plantations and dune reinforcement offers hybrid protection and ecological co-benefits (Gijón Mancheño et al. 2025; Sunkur et al. 2023).

2. Erosion–Accretion Management: A high-resolution shoreline monitoring system, using both satellite and ground-based surveys, is necessary to identify and respond to erosion or accretion hotspots (Shamsuzzoha and Ahamed 2023). Soft measures such as beach nourishment and dune stabilization should be prioritized as well to maintain coastal morphology and tourism-based services (Gijón Mancheño et al. 2025; M. F. Islam et al. 2020). Besides these, low-crested offshore breakwaters can be applied to promote sediment deposition in critical erosion zones. Although careful monitoring is required to avoid adverse downdrift effects (Bernard et al. 2022).

3. Responses to Salinity Intrusion: Freshwater availability can be enhanced through managed aquifer recharge systems, controlled abstraction, and the construction of protective recharge ponds (Haq et al. 2024; Seddique et al. 2019). Agricultural adaptation should include the use of salt-tolerant crop varieties, adjusted cropping calendars, raised-bed cultivation, and small-scale rainwater harvesting techniques (Khanom 2016). Ecosystem-based interventions such as mangrove regeneration and estuarine habitat restoration can act as natural barriers. It will reduce saline intrusion inland (Gijón Mancheño et al. 2025; Lovelock, Barbier, and Duarte 2022).

4. Storm Surge and Cyclone Risk Reduction: Strengthening community-based early warning systems that link forecasts with local evacuation plans can significantly improve response efficiency (Sarkar, Rudra, and Santo 2024). Cyclone shelters and critical facilities need structural reinforcement to withstand projected surge heights (Bernard et al. 2022). Further, they should be strategically located to serve the most at-risk populations. Ecosystem buffers, particularly mangroves and tidal wetlands, provide natural surge attenuation and reduce wave energy before reaching built areas. Therefore, they should be expanded (Gijón Mancheño et al. 2025; Sunkur et al. 2023).

5. Safeguarding Local Resource Bases: Rehabilitation of coral and oyster reefs will offer dual benefits of stabilizing sediments and enhancing coastal fisheries resources (Gijón Mancheño et al. 2025; Sunkur et al. 2023). Additionally, unregulated dredging and land reclamation activities should be restricted, as they disrupt sediment supply and accelerate erosion in downstream areas (Ali, Amin, and Hasan 2025; Shamsuzzoha and Ahamed 2023).

6. Livelihood Adaptation: Diversification of income sources, such as eco-tourism, sustainable aquaculture, mangrove-based enterprises, and coastal services etc., can reduce dependence on climate-sensitive sectors (Gijón Mancheño et al. 2025). Livelihood resilience can also be supported through microfinance, insurance schemes, and cash-for-work initiatives linked to ecological restoration projects (Lovelock, Barbier, and Duarte 2022). Furthermore, skill development and seasonal migration programs provide supplementary income opportunities. As a result, vulnerability during agricultural or fisheries downturns will be reduced.

7. Regulatory and Governance Measures: Land-use regulations and building codes must be revised to incorporate risk zones identified for sea-level rise, erosion, and conservation (Ali, Amin, and Hasan 2025). Participatory governance models, involving local communities, fishers, women's groups, NGOs, and government agencies, are also vital for inclusive decision-making in resource management. Along with these, clear frameworks for compensation and resettlement are required to ensure continuity of livelihoods, social equity, and access to essential services in cases of relocation (M. F. Islam et al. 2020; Lovelock, Barbier, and Duarte 2022).

8. Implementation and Policy Relevance: Pilot initiatives, such as mangrove greenbelts, TRM projects, and upgraded shelters, should be accompanied by rigorous social and environmental monitoring to guide scaling-up. Scenario-based planning, using multiple projections of sea-level rise and cyclone intensification, can test the robustness of adaptation investments and reduce long-term uncertainty (Al Mohit et al. 2024).

Overall, a balanced integration of structural defenses, ecosystem restoration, livelihood diversification, and institutional reforms offers the strongest pathway to sustain Cox's Bazar Sadar as a safe and productive coastal region under climate change.

5. CONCLUSION

Sea-level rise and cyclone intensity have heightened the risks, resulting in widespread damage and displacement. However, the study highlights practical adaptation measures based on various parameters that can help build resilience. These include the integration of ecosystem-based solutions such as mangrove restoration, alongside infrastructure improvements and community-based early warning systems. The study emphasizes the importance of incorporating local knowledge and governance models to ensure the sustainability of these adaptation efforts. Furthermore, effective resource management, livelihood diversification, and robust regulatory frameworks are vital for safeguarding the region against future climate risks.

References

ACAPS. (2020, September). Cox's Bazar: Upazila profiles. ACAPS Analysis Hub. https://www.acaps.org/

Akter, A., & Dayem, A. (2021b). Tropical cyclone risk mapping for a coastal city using geospatial techniques. Journal of Coastal Conservation, 25(1), 1–14. https://doi.org/10.1007/s11852-020-00788-y

Alam, E., & Dominey-Howes, D. (2014). A new catalogue of tropical cyclones of the northern Bay of Bengal and the distribution and effects of selected landfalling events in Bangladesh. International Journal of Climatology, 35(6), 801–835. https://doi.org/10.1002/joc.4035

Al Mohit, Md Abdul et al. (2018). Impact assessment of a major river basin in Bangladesh on storm surge simulation. Journal of Marine Science and Engineering, 6(3).

Al Mohit, Md Abdul, Masaru Yamashiro, Md Towhiduzzaman, and Atish Kumar Joardar. (2024). A study on the future cyclone characteristics and its associated storm surge along the Bangladesh coast. Quaternary Science Advances, 13(July 2022): 100157.

Ali, Maliha, Md. Khairul Amin, and G. M. Jahid Hasan. (2025). Assessing the correlation between sea level rise, temperature, and erosion-accretion along the coastline of Bangladesh. Discover Geoscience, 3(1).

Ashrafuzzaman, Md, Artemi Cerdà, Filipe Duarte Santos, and Luísa Schmidt. (2022). Current and future salinity intrusion in the south-western coastal region of Bangladesh. Spanish Journal of Soil Science, 12(March): 1–20.

Ashrafuzzaman, Md, Filipe Duarte Santos, João Miguel Dias, and Artemi Cerdà. (2022). Dynamics and causes of sea level rise in the coastal region of southwest Bangladesh at global, regional, and local levels. Journal of Marine Science and Engineering, 10(6): 1–30.

Bernard, Aurélia et al. (2022). Bangladesh's vulnerability to cyclonic coastal flooding. Natural Hazards and Earth System Sciences, 22(3): 729–751.

Cheng, Y.-L. et al. (2016). We Are IntechOpen, the World's Leading Publisher of Open Access Books Built by Scientists, for Scientists. Intech 11(tourism): 13.

Chowdhury, Kishwar Jahan, Md Rahmat Ali, Md Arif Chowdhury, and Syed Labib Ul Islam. (2025). Climate change-induced risks assessment of a coastal area: A 'socioeconomic and livelihood vulnerability index' based study in coastal Bangladesh. Natural Hazards Research, 5(1): 75–87.

Durand, Gaël et al. (2022). Sea-level rise: From global perspectives to local services. Frontiers in Marine Science, 8(January).

Gijón Mancheño, Alejandra et al. (2025). Nature meets infrastructure: The role of mangroves in strengthening Bangladesh's coastal flood defenses. Sustainability (Switzerland), 17(4): 1–14.

Haq, Md Izazul et al. (2024). What drives changes in surface water salinity in coastal Bangladesh? Frontiers in Water, 6(April).

Hassan, Sakib Al et al. (2025). Correction to: Livelihood vulnerability and public health outcomes in south-west coastal regions in Bangladesh. Sustainable Earth Reviews, 8(1): 1–15.

Hossain, M N et al. (2021). Livelihood vulnerability and adaptation strategies of coastal areas in the face of climate change in Bangladesh: A literature review. J. Mater. Environ. Sci, 2021(12): 1601–1613.

IPCC. (2022). The Ocean and Cryosphere in a Changing Climate Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities.

Islam, Md Feroz et al. (2020). Enhancing effectiveness of tidal river management in southwest Bangladesh polders by improving sedimentation and shortening inundation time. Journal of Hydrology, 590(April).

Islam, Md Tariqul et al. (2024). Climate change impacts on shoreline migration and community livelihood resilience: Evidence from coastal Bangladesh. Frontiers in Sustainability, 5(January): 1–13.

Islam, Thuhidul et al. (2025). Perceptions of local communities on climate change and associated impact on livelihood capital in the coastal area of southeastern Bangladesh. Discover Environment, 3(1).

Khanom, Tanzinia. (2016). Effect of salinity on food security in the context of interior coast of Bangladesh. Ocean and Coastal Management, 130: 205–212.

Lovelock, Catherine E., Edward Barbier, and Carlos M. Duarte. (2022). Tackling the mangrove restoration challenge. PLoS Biology, 20(10): 1–15.

M. S. I. Hasan, M. S. Islam, M. H. Kabir, J. Hasan, & M. E. Hoq. (2020). Water quality of Bakkhali River as major water source of Fish Landing Center, Cox's Bazar. Bangladesh Journal of Fisheries, 31(2), 325–333.

Moreira, Luis Clenio Jario, Adunias Dos Santos Teixeira, and Lênio Soares Galvão. (2015). Potential of multispectral and hyperspectral data to detect saline-exposed soils in Brazil. GIScience and Remote Sensing, 52(4): 416–436.

Rahman, Md Mizanur et al. (2024). Assessing the climate-induced livelihood vulnerability of coastal people using sustainable livelihood framework: A study in south-central Bangladesh. Social Sciences, 13(12).

Rezaie, Ali Mohammad, Celso Moller Ferreira, and Mohammad Rezaur Rahman. (2019). Extreme hydroclimatic events and multivariate hazards in a changing environment: A remote sensing approach storm surge and sea level rise: Threat to the coastal areas of Bangladesh. Elsevier Inc.

Sarkar, Showmitra Kumar, Rhyme Rubayet Rudra, and Md Mehedi Hasan Santo. (2024). Cyclone vulnerability assessment in the coastal districts of Bangladesh. Heliyon, 10(1): e23555.

Seddique, Aahraf Ali et al. (2019). Hydrogeochemical and isotopic signatures for the identification of seawater intrusion in the paleobeach aquifer of Cox's Bazar city and its surrounding area, south-east Bangladesh. Groundwater for Sustainable Development, 9(April): 100215.

Shamsuzzoha, Md, and Tofael Ahamed. (2023). Shoreline change assessment in the coastal region of Bangladesh delta using tasseled cap transformation from satellite remote sensing dataset. Remote Sensing, 15(2).

Sunkur, Reshma, Komali Kantamaneni, Chandradeo Bokhoree, and Shirish Ravan. (2023). Mangroves' role in supporting ecosystem-based techniques to reduce disaster risk and adapt to climate change: A review. Journal of Sea Research, 196(September): 102449.

WFP. (2020, July). Cox's Bazar Urban Vulnerability Assessment. World Food Programme. https://www.wfp.org/