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**Institute of Water and Flood Management (IWFM),BUET**

**TERM PAPER ON ,  
FROM CRISIS TO RECOVERY: A  
STUDY OF EMBANKMENT BREACH  
MANAGEMENT IN POLDER 22.**

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# From Crisis to Recovery: A Study of Embankment Breach Management in Polder 22

**Abstract:** This study analyses the embankment breach closure procedure in Polder 22 Deluti Union, Paikgacha through the lens of community-based engineering. Embankments are essential for flood protection in Bangladesh. Nevertheless, their susceptibility to breaches presents significant challenges. This study investigates the causes of embankment breaches, the impacts on local communities and the methodologies employed for repair. The study highlights the effectiveness of community-driven initiatives in the maintenance and repair of embankments, providing insights into the ideal procedures for sustainable and resilient water management systems.

## 1. Introduction

### 1.1. Background on Embankments in Bangladesh

Bangladesh is a deltaic nation with a long coastline and an extensive river system. The country is quite susceptible to cyclones, tidal surges, and floods. Embankments or polders, have been constructed since the 1960s to protect agricultural lands and settlements from salt water intrusion and flooding[1]. Such structures are critical for ensuring food security and protecting livelihoods in coastal regions. However, maintaining these embankments has proven difficult due to funding constraints, inadequate engineering practices and governance issues.

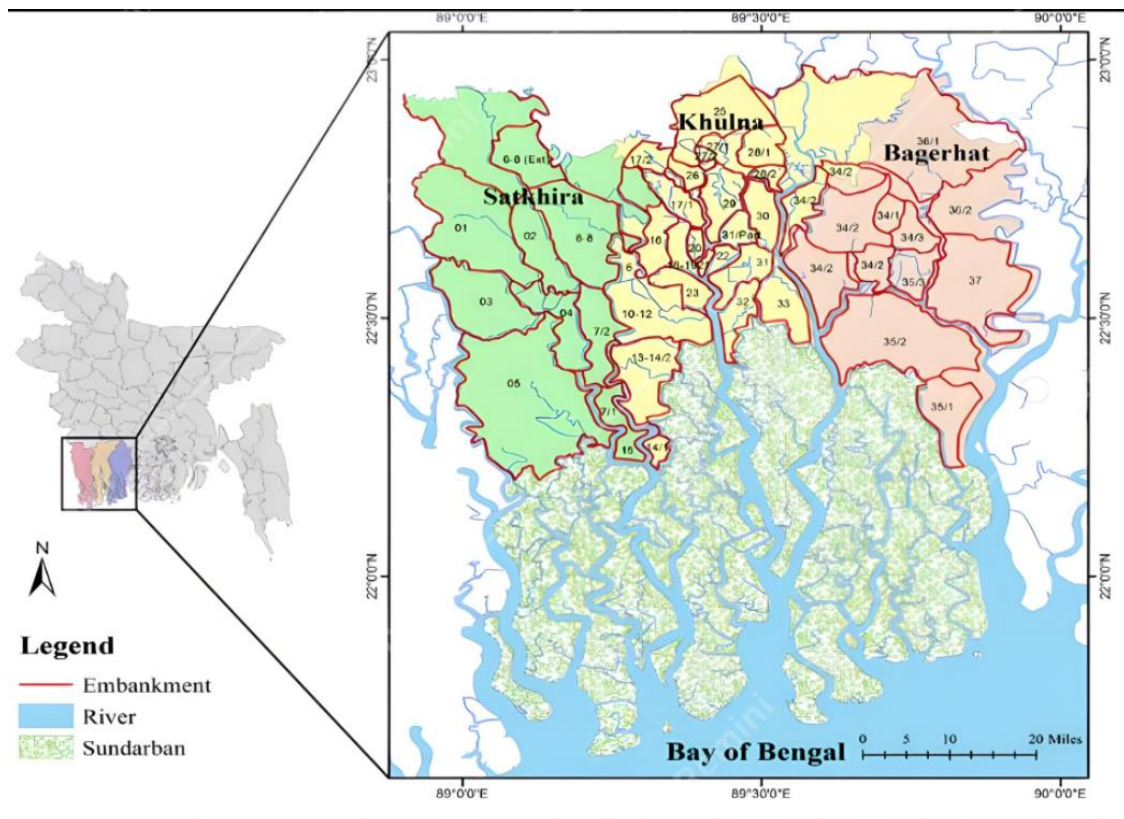


Figure 01: Coastal Polders of Southwest Regions[2]

## 1.2. Why Embankment Breaches occur

Embankment breaches in Bangladesh are caused from a combination of natural and human-induced factors. Cyclones and tidal surges commonly affect coastal districts such as Khulna, Satkhira with Cyclone Sidr in 2007 and Cyclone Aila in 2009 causing significant embankment failures. More recently, in May 2024 Cyclone Remal hit the region, destroying embankments in places like Paikgacha, causing widespread flooding and displacement [3].

Severe monsoon rainfall and continuous river erosion weaken these protective structures, making them more vulnerable to breach. Human activities also contribute significantly to embankment deterioration. Unplanned settlements destabilize these crucial flood barriers. Furthermore, a lack of regular maintenance due to a limited budget and weak administration exacerbates the situation while mismanagement and inefficient coordination among government agencies. Combined these features make embankments highly vulnerable, posing a constant threat to coastal communities and livelihoods.



Figure 02 : Breached Embankment during Tidal Surge

## 1.3 Overview of Polder 22, Deluti Union, Paikgacha

Polder 22 situated in Deluti Union of Paikgacha Upazila under Khulna District, is one of the nine polders established to protect agricultural land and settlements from tidal surges and saline intrusion. Covering an area of 1,630 hectares, it plays a vital role in sustaining the livelihoods of local communities primarily engaged in agriculture and fisheries. With over 2,132 households, the region faces challenges due to frequent cyclones, tidal surges, and embankment breaches causing frequent flooding, loss of crops, and displacement. The embankment of Polder 22 stretches 20 km and serves as a crucial protective barrier. However, poor maintenance, river erosion, and storm surges have caused multiple breaches over the years, which is affecting food security and water availability [4].

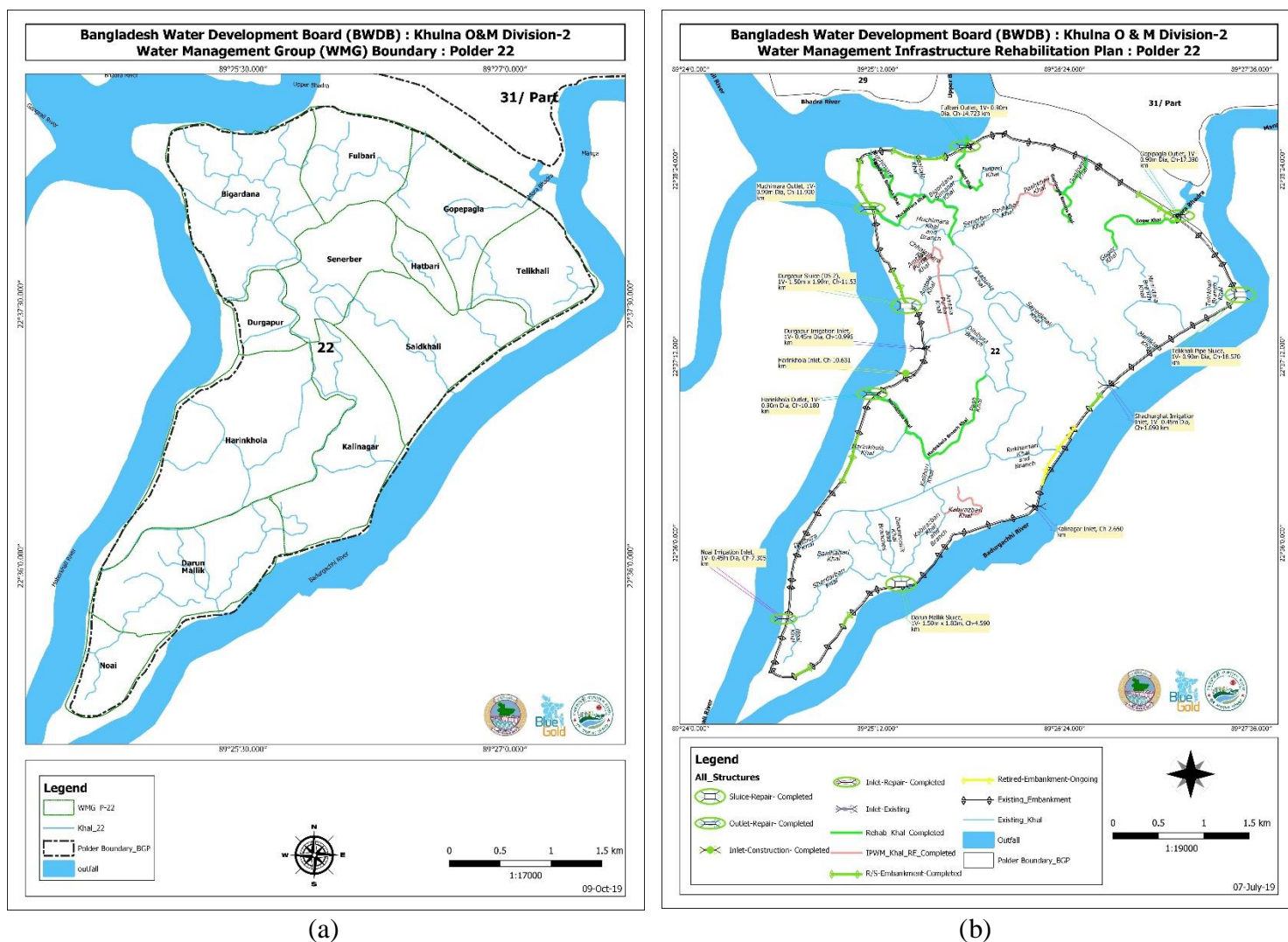


Figure 03 : Map of Polder 22 (a) Water Management Group Boundary;(b) Water Management Infrastructure Rehabilitation Plan [5]

### Geographical and Climate Feature of Polder 22 :

Polder 22 is situated in the Deluti Union, approximately 12 km from the Paikgacha Upazila. The region experiences a humid climate during the summer months and a pleasant climate in winter. The annual average temperature is 26.3°C with monthly temperatures ranging from 12.4°C in January to 34.3°C in May. The area receives an annual average rainfall of 1,809.4 mm with approximately 87% of the rainfall occurring between May and October, making the region highly dependent on seasonal rains for agriculture and water resources.

### Resources and Community Infrastructure :

Polder 22 spans 1,630 hectares with 1,417 hectares of cultivable land but salinity intrusion from February to May threatens both agriculture and drinking water availability. To cope with these, some villagers buy drinking water from nearby areas at 30 taka for 25-30 liters. Water resource management is facilitated by 1 Water Management Association (WMA) and 12 Water Management Groups (WMGs) which oversee embankment maintenance and water distribution. 86.1% of households rely on tube wells while 12% use pond water for drinking. Sanitation remains a challenge with only 30.5% of households having sanitary toilets while 36.2% use



non-sanitary facilities. The polder has 28 km of roads including 18 km of earthen roads, 7 km of brick roads and 3 km of pucca roads, with a road density of 0.0105 km per hectare. That reflects the limited infrastructure development.

## General Information of Polder 22

Category	Details
Location	Deluti Union ,Paikgacha Upazilla Khulna
Population	8,444 people
Total Area	1,630 hectares
Embankment Length	20 km
Number of Households	2,132 households
Net Cultivable Area	1,417 hectares
Main livelihood	Agriculture, Fisheries
Annual Rainfall	1809.4 mm
Temperature Range	12.4 °C (Jan)-34.3 °C (May)
Drinking Water Sources	Rainwater, Tubewells, Pondwater
Common Crops	T. Aman, Sesame, mung bean

## Key Challenges Faced By Polder 22:

- **Embankment Breaches:** High tidal pressure and erosion weaken the embankment structure, leading to repeated breaches.
- **Salinity Intrusion:** Affects both drinking water and soil quality, reducing agricultural productivity.
- **Flooding and Waterlogging:** Due to poor drainage and siltation in nearby canals.
- **Limited Market Access:** Road connectivity issues hinder economic growth and trade opportunities.
- **Lack of Sustainable Maintenance:** Insufficient funding and coordination for embankment repairs.

## 2. Major Problem Statement: Polder Embankment Breach

### 2.1 Description

The embankment breach in Polder 22 has been a reoccurring event with the most recent incident taking place during Cyclone Remal in May 2024 and August 2024 Flood. The cyclone brought severe winds and large tidal waves which overwhelmed the already vulnerable embankments. The breach resulted in extensive flooding which caused widespread damage to homes, farmlands and local infrastructure. Flooding not only destroyed crops but also caused saltwater intrusion which is affecting soil quality and severely reducing agricultural productivity. This breach impacted the livelihoods of nearly 2,000 households resulting in food insecurity and financial losses.

### 2.2 Vulnerabilities of Polder 22

**Weak Embankment Structures:** The embankments in Polder 22 are prone to erosion since they were built using earthen materials and insufficient reinforcement. Over the time, the embankments have weakened, making them vulnerable to breaches during high tides and cyclones. The absence of consistent maintenance simply made things worse and left the

embankments prone to collapse. The recent breach during Cyclone Remal demonstrated the vulnerability of these structures as the embankments failed to resist the force of the tidal surges.

High Exposure to tidal surges: Polder 22's proximity to the Bay of Bengal makes it vulnerable to tidal surges and storm impacts. Cyclone Remal is a recent example of how these natural forces can cause significant damage. Climate change has exacerbated the situation by raising sea levels and increasing the frequency of cyclones.

Limited funding and poor coordination between government agencies have hindered proactive maintenance and rehabilitation efforts leading to delayed responses to embankment breaches and inadequate long-term planning. The absence of a structured governance framework for embankment management has left communities vulnerable and often forcing them to rely on temporary fixes that fail to address the scale of the problem. Without sustained investment and coordinated action, these challenges continue to threaten the stability of embankments and the livelihoods of those who depend on them.

### **2.3 Community Perspective on Breach**

The embankment breach during Cyclone Remal and August 2024 flood devastated the local communities. Residents suffered immediate losses including displacement, food insecurity and loss of income. Many families had to evacuate their homes as a result of flooding while others struggled to recover from crop and livelihood losses. The community has expressed frustration and outrage toward the Bangladesh Water Development Board (BWDB) for the lack of maintenance of the embankments and the use of substandard materials during previous recovery efforts.



(a)



(b)



(C)

Figure 04 : Embankment Breaching at Polder 22

#### **2.4 Stakeholder Conflicts and Delays in Embankment Repairs:**

Conflicts regarding the repairs of the embankment in Polder 22, Deluti Union, Paikgacha, have emerged between public officials and local residents, resulting in delays in repair efforts and exacerbating the damage inflicted by Cyclone Remal. According to BWDB sources, cracks initially appeared along a 10-meter section of the embankment, prompting immediate repair efforts by local residents and BWDB contractors. However, conflicts escalated when a heated argument between contractors and followers of the Deluti Union Parishad chairman led to a work stoppage, further delaying critical repairs. This incident highlighted the lack of coordination and miscommunication among stakeholders, underscoring the urgent need for structured collaboration and clear policies to ensure timely and effective embankment repairs. Proactive communication and stakeholder coordination are crucial to preventing such disputes in the future. Clearly defining the roles and responsibilities of public representatives,

contractors, and local communities can help streamline repair efforts and protect vulnerable coastal populations from future embankment failures[6].

### **3.Methodology**

**3.1 Observation and Analysis:** To assess the extent of the embankment breach,community response, and BWDB's repair interventions,media footage and documentaries, particularly from **The Business Standard** were analyzed. These visual documentation offered immediate insights into the extent of the damage, the emergency measures taken by residents and the effectiveness of repair techniques.

**3.2 Expert Consultation with BWDB Engineers:** Discussions with BWDB engineers were conducted to obtain technical insights into embankment repair strategies.Engineers provided a comprehensive explanation of the Ring Dike Technique which was employed as a temporary measure to stabilize the breach.The discussion also highlighted on structural challenges including the use of substandard materials, adverse weather conditions and logistical restraints in executing the repair work.Additionally,long-term embankment strengthening strategies and lessons learned from previous breaches were discussed to evaluate the sustainability of current flood protection measures.

**3.3 Document Review and Analysis:**A review of government reports, research papers documents provided context on Polder 22's embankment history and socio-economic conditions. Media reports and newspaper articles were analyzed to gauge public perception and response.

**3.4 Technical Assesment of Repair techniques:**The repair process integrated traditional knowledge and indigenous practices, such as the use of bamboo and sandbags, which have been used by the local community for generations to protect against flooding. These practices were combined with modern engineering techniques to create a hybrid approach that leveraged the strengths of both methods.

### **4.Breach Closing Proccedure at Polder 22**

Embankment breaches represent a serious threat to coastal communities, requiring immediate action to prevent further damage and long-term resilience planning to assure flood protection. The Polder 22 breach was resolved using a combination of community-driven emergency responses, government-led technical initiatives and temporary reinforcement measures.This section gives an in-depth analysis of the restoration process including community involvement, the role of the Bangladesh Water Development Board (BWDB) and ideas for adopting nature-based solutions into future embankment management.

#### **4.1 Overview of the Breach Closing Process**

##### **Community's Immediate Response**

When the embankment breach happened,the local community acted quickly to limit the damage.Residents used available materials such as sandbags, bamboo and wooden planks to create temporary barriers attempting to slow down water intrusion. Despite limited resources, community actions were crucial in stopping the breach from worsening before external assistance arrived.Traditional flood management skills passed down through generations proved valuable, as locals strengthened embankments using natural resources such as mud and



bamboo. However, due to the size of the break and the constant water pressure these efforts were just temporary solutions that needed government assistance. During this period, individuals expressed their disappointments regarding the lack of assistance from the Bangladesh Water Development Board (BWDB) from the very beginning. Although the government agency assigned an excavator to address the situation, it was unable to access the breach area and thus proved to be ineffective.



(a) Community efforts to immediate response in Breach Closing



(b) Community Participation in Breach Embankment closing



(c)Participation of Women in Embankment repair work

Figure 05: Community's immediate response including women's participation

### **BWDB's Response:**

The Bangladesh Water Development Board (BWDB) attempted to address the breach in Polder 22 using the Ring Dike Technique. This method is a well-known engineering approach used in emergency situations to stabilize embankments and prevent further erosion during breaches. The technique involves constructing a circular embankment (ring dike) around the breached area to isolate it from direct tidal forces allowing for reinforcement work to be carried out in a controlled environment.



Figure 06: Construction of Ringdike to protect the Embankment

## Ring Dike Construction Technique:

STEP	DESCRIPTION
01	Identify the Breach: The first step involves identifying the exact location and extent of the breach. Engineers mark the affected area to determine the size of the ring dike required.
02	Construct the Ring Dike: A temporary embankment (ring dike) is constructed around the breach using materials such as sandbags, clay, and geotextiles. The ring dike acts as a barrier, isolating the breached area from the surrounding water.
03	Pump Out Excess Water: Once the ring dike is in place, excess water trapped inside the enclosed area is pumped out.
04	Reinforce the Embankment: After the area is stabilized, the breached embankment is reinforced using additional sandbags and vegetation-based techniques to prevent future erosion.

Although the Ring Dike Technique provided a temporary buffer, it was not a long-term solution. Persistent tidal pressure and limited resources slowed down the full closure process.

## 5.Challenges due to embankment breaching

### 5.1 Technical Challenges:

**Adverse Weather Conditions:**Heavy rains, tidal surges, and strong currents washed away temporary reinforcements such as sandbags and bamboo constructions. Continuous rain weakened the embankment soil, delaying repair work and making it harder to build a solid foundation.

**Limited Resources and Funding Constraints:** Budget constraints limited the use of high-quality materials such as geotextiles, making the embankment vulnerable. Initial emergency repairs were carried out by the community using sandbags and bamboo, but long-term strengthening was delayed due to a lack of financing.

### 5.2 Social and Institutional Challenges:

**Coordination Issues Among Stakeholders:**Poor communication between BWDB, local authorities and communities led to inefficiencies.Delays in resource mobilization, unclear responsibilities, and lack of a centralized monitoring system slowed down the repair process, reducing the effectiveness of the response.

**Lack of responsibilities:** The Bangladesh Water Development Board (BWDB), which is in responsibility for embankment management,delayed its response, forcing the community to use sandbags and bamboo for temporary repairs.By the time help arrived, the harm had been done. The lack of clear policies on community involvement meant their efforts remained unrecognized and unsupported. Without proper guidance and resources,locals struggled to implement effective solutions.This underscores the need for defined policies outlining roles, responsibilities, and resource allocation to ensure a faster, more coordinated response in future breaches.

### **5.3 Environmental Concern:**

Climate change and rising sea levels: Polder 22, like many other coastal areas in Bangladesh, is under increasing threat from climate change and rising sea levels. Cyclones have become more frequent and intense in recent years, subjecting embankments to higher tidal forces. Furthermore, salinity intrusion from rising sea levels reduces soil quality as well as water quality making it more difficult to survive here. If no adaptive measures are implemented, future breaches may become more frequent and severe.

Long-Term Sustainability of Embankment Repairs: Even after reconstruction, the long-term sustainability of the embankment is uncertain due to environmental challenges. Soil erosion, sedimentation and tidal changes constantly damage embankment constructions which requires constant reinforcement and maintenance. Without adaptive strategies such as nature-based solutions (e.g., mangrove plantations to buffer against tidal forces), the reconstructed embankment may be prone to further breaches.

## **6. Recommendations and Conclusion:**

### **6.1 Recommendations:**

The Polder 22 embankment breach emphasizes how urgently proactive embankment management and disaster preparedness are needed in coastal Bangladesh. Delayed action and poor coordination among stakeholders exacerbated the damage, leaving the community to rely on temporary, unsustainable repair methods. Proactive maintenance which includes early warning systems, frequent inspections and timely reinforcements can significantly reduce the risk of embankment failures, preventing higher costs, greater damage and increased displacement of communities.

To improve resilience, an integrated approach that combines engineering solutions with nature-based strategies should be prioritized. Mangrove plantations and vegetative buffers can enhance embankment stability by reducing erosion and mitigating tidal impacts. Additionally, sustainable and cost-effective reinforcement techniques, such as bamboo barriers and jute geotextiles should be promoted as alternatives to traditional repair methods. The government should also encourage the adoption of Tidal River Management (TRM) in selected areas to prevent prolonged waterlogging and improve sediment deposition.

Effective embankment management also depends on improved stakeholder cooperation. Strengthening coordination between BWDB, local government, NGOs and community groups will ensure a faster and more effective breach response. Establishing Community-Based Embankment Committees (CBECs) can involve local residents in monitoring, reporting vulnerabilities and conducting small-scale repairs while clear government policies defining stakeholder roles can prevent miscommunication and inefficiencies.

These strategies will help to avoid or control future embankment breaches therefore guaranteeing more effective flood protection and improved disaster resilience for Bangladesh's most vulnerable coastal areas.



## 6.2 Conclusion:

The embankment breach in Polder 22 highlights the urgent need for a proactive and coordinated approach to embankment management. The delayed response from the Bangladesh Water Development Board (BWDB) and poor stakeholder coordination significantly worsened the impact on local communities. Community-led initiatives were crucial in the immediate response but their efforts were largely unsupported due to the absence of structured policies. This paper highlights the importance of integrating community engagement, government intervention and sustainable engineering solutions to quick recovery of a breached embankment.

A multi-stakeholder approach, involving government agencies, local communities and environmental experts is essential for long-term embankment sustainability. By investing in early warning systems, structured maintenance policies and nature-based solutions, future embankment breaches can be effectively managed or prevented. Implementing these recommendations will not only protect livelihoods and infrastructure but also contribute to a more resilient and adaptive coastal management system in Bangladesh.

## References:

- [1] "Bangladesh polders under threat - Bangladesh | ReliefWeb." Accessed: Feb. 02, 2025. [Online]. Available: <https://reliefweb.int/report/bangladesh/bangladesh-polders-under-threat>
- [2] M. Nahid, M. Hasan, A. Sarkar, and W. Islam, *A REMOTE SENSING AND GIS APPROACH FOR MONITORING LIVELIHOOD ADAPTATION WITH CHANGE OF SOIL SALINITY IN POLDER 21 AND 22 OF SOUTHWEST BANGLADESH*. 2024.
- [3] "Breached embankments inundate Khulna villages," Dhaka Tribune. Accessed: Feb. 02, 2025. [Online]. Available: <https://www.dhakatribune.com/bangladesh/nation/355790/breached-embankments-inundate-khulna-villages>
- [4] "Blue Gold Program - Blue Gold Program." Accessed: Feb. 05, 2025. [Online]. Available: <http://www.bluegolddb.org/>
- [5] "Maps," Blue Gold Program. Accessed: Feb. 02, 2025. [Online]. Available: <http://www.bluegolddb.org/downloads/maps/>
- [6] I. Mahmud, "Embankment damage on the rise amid local disputes," Prothomalo. Accessed: Feb. 06, 2025. [Online]. Available: <https://en.prothomalo.com/bangladesh/7ws5mh1kf4>