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# **Disaster risk reduction infrastructure requirements for South-Western Bangladesh: Perspectives of local communities**

Wedawatta Gayan, Kulatunga Udayangani, Amaratunga Dilanthi and Ahmed Parvez

## **Purpose (mandatory)**

Development of effective disaster risk reduction strategies for communities at risk of being affected by natural disasters is considered essential, especially in the wake of devastating disaster events reported worldwide. As part of a wider research study investigating community perspectives on existing and potential strategies for enhancing resilience to natural disasters, community perspectives on infrastructure and structural protection requirements were investigated.

## **Design (mandatory)**

Patuakhali region in south-western Bangladesh is a region significantly at risk of multiple natural hazards. In order to engage local communities and obtain their perspectives, focus group discussions were held with local community leaders and policy makers of at-risk communities in Patuakhali region, South-Western Bangladesh.

## **Findings (mandatory)**

Infrastructure and structural protection requirements highlighted included multi-purpose cyclone shelters, permanent embankments, and improved transport infrastructure. Much of the discussions of focus group interviews were focused on cyclone shelters and embankments, suggesting their critical importance in reducing disaster risk and also dependence of coastal communities on those two measures.

## **Originality (mandatory)**

The research design adopted sought to answer the research questions raised and also to inform local policy makers on community perspectives. Local policy makers involved in disaster risk reduction initiatives in the region were informed of community perspectives

and requirements, thus contributing to community engagement in implementing disaster risk reduction activities.

**Keywords: Community engagement, Cyclone, Disaster risk reduction, Flooding, Infrastructure**

Manuscript type: Research paper

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## 1. Introduction

Geographical location and land characteristics make Bangladesh one of the most hazard-prone countries in the world (World Bank, 2011), and hence the country is often considered to be one of the world's natural disaster hotspots. Whilst the country is exposed to a range of natural hazards, flooding and cyclones have posed the greatest risk when taken as a whole at country level (World Bank, 2011, MoFDM, 2010). Flooding affects Bangladesh almost every year (Gupta and Muralikrishna, 2010) and is the most recurring type of disaster affecting the country (World Bank, 2011). The total land area that floods is significant, ranging, on average, between 30% - 50% of the country (World Bank, 2011). These figures are not an over estimation because flood events in years 1987, 1988, and 1998, inundated over 60% of the country (IPCC, 2012). Risk of cyclones, accompanied by storm surges, is also significant. On average Bangladesh is affected by more than 16 major cyclones in a decade (Gupta and Muralikrishna, 2010).

Further, the risk of and vulnerability to such natural hazards is projected to further increase in the future, due to changing climatic conditions. The Bangladesh government has conceded that the country was the "most climate vulnerable country in the world" (MoFDM, 2010). The government further conceded that the impacts of climate change were already affecting natural hazards in the form of an increase in the number of intensified floods, cyclones and droughts as well as temperature extremes and erratic rainfall (MoFDM, 2010). Such claims are not without a scientific basis. For example, Dasgupta et al (2010) highlighted that changing climatic conditions are likely to intensify cyclone activity and storm surges in the region. Karim and Mimura (2008) found the area flooded, flooding depth and surge intrusion length to be substantially larger due to intensified surge conditions under climate projections in the future. Coastal communities are likely to be the hardest hit due to intensified cyclonic activities in the Bay of Bengal.

The current, significant risk of natural disasters coupled with the likelihood of increased intensity and frequency of such events in the future; under changing climatic conditions, points to the need for enhancing disaster preparedness of vulnerable communities within the country. As a country with a history of devastating natural disasters, many initiatives have been undertaken to limit the damage and adverse impacts of such events, and the

country's preparedness for such events has evolved and developed over the years. The government of Bangladesh acknowledges "the need for pre-disaster mitigation and preparedness of the people, as opposed to the earlier concepts of responding after a disaster has taken place, as a necessary as well as a cost-effective approach" (MoFDM, 2010). The world bank (2011) attributed the country's development of disaster preparedness to a gradual shift from a response-based approach to a strategy that incorporates preparedness and risk reduction. However, it also identified a number of key deficiencies and gaps in existing national and local disaster management policies, including an assessment of deficiencies in key risk mitigation infrastructure such as shelters and embankments (World Bank, 2011). As Bangladesh has traditionally relied on engineered physical strategies to protect against natural disasters (Bhatia et al., 2010), this element is considered significantly important given the extent of risk and vulnerability of communities; especially deprived coastal and riverside communities.

In this context, this paper seeks to discuss exploratory research undertaken to investigate local community perceptions and requirements for Disaster Risk Reduction (DRR) infrastructure, especially addressing the key risks of cyclone and storm surges and flooding. A bottom-up approach was undertaken where the community was actively engaged in identifying existing risk reduction infrastructure, their deficiencies, and community requirements.

## **2. Disaster risk reduction infrastructure**

McEntire et al (2011) discussed four schools of thought with regard to reducing vulnerability; physical science, engineering, structural, and organisational. It was noted that successful disaster management systems will incorporate the strengths of each of these approaches to form a comprehensive system (McEntire et al., 2011). The engineering school recognises the key role that infrastructure plays in reducing vulnerability to disasters (McEntire et al., 2011), and promotes DRR by building adequate structures and infrastructure. Further, investing in and maintaining critical infrastructure that reduces risk, adjusts to cope with changing climatic conditions and is considered as an essential in making a city / community resilient to natural disasters (UNISDR, 2010).

As identified by Bhatia et al (2010), activities in Bangladesh often concentrate on engineered physical systems such as dykes and emergency shelters. Such infrastructure is essential in the case of Bangladesh, given the nature and extent of risk posed by natural disasters; especially cyclones, storm surges and flooding, as well as the inability of poor communities to implement protection measures of their own. Previous research has noted that many people in Bangladesh are left unable to adequately protect their property and livelihoods from floods and cyclone surges due to factors such as shortage of resources and pressure of immediate needs (Thompson and Tod, 1998, Concern Universal Bangladesh, 2010). For example, a study by Concern Universal Bangladesh (2010) found that although the most vulnerable households were aware of the measures that should be taken to reduce the risks to their households, they were unable to implement those measures due to lack of resources. Further, Paul and Routray (2010) emphasised the ineffectiveness of individual, often indigenous, coping strategies beyond a critical threshold, requiring people to seek the safety of places like cyclone shelters when the flood level increases.

These issues require special attention should be placed on providing protection to such communities via essential infrastructure in order to safeguard the lives and livelihoods of poorer communities. Whilst recognising the need for a comprehensive disaster management strategy, the Government of Bangladesh (MoEF, 2009) recognises infrastructure as one of the key areas that it seeks to build on; “Infrastructure to ensure that existing assets (e.g., coastal and river embankments) are well maintained and fit-for-purpose and that urgently needed infrastructure (e.g. cyclone shelters and urban drainage) is put in place to deal with the likely impacts of climate change”. Repairing and rehabilitation of existing infrastructure (e.g. coastal embankments, river embankments, drainage systems), procuring urgently needed new infrastructure (e.g. cyclone and flood shelters, coastal and river embankments), and undertaking strategic planning for future infrastructure needs are key aspects endorsed therein.

### **3. Community engagement in developing Disaster risk reduction infrastructure**

A key reason leading to ineffective local structural projects is identified as the fact that such initiatives are undertaken on the basis of technical information alone, rather than based on

both technical information and local knowledge (IPCC, 2012), thus highlighting the importance of taking local knowledge into account. The Hyogo Framework for Action 2005-2015 also identified the need for empowering both communities and local authorities to manage and reduce disaster risk (UNISDR, 2005). As noted by Allen (2006), knowledge and capacities of local people and local resources are considered valuable in policy making aimed at disaster preparedness and climate adaptation. Furthermore, local governments are expected to play a central role in implementing DRR activities within their region. Engaging local communities with such activities and linking their concerns with government priorities is a key role expected to be played by the local authorities (UNISDR, 2010). In the case of Bangladesh, the government's National Plan for Disaster Management (MoFDM, 2010) endorses community involvement via strategies such as community based risk assessment and preparedness planning. However, the development culture of the country often follows a top down approach; making development activities service oriented rather than being people oriented (Morshed and Huda, 2002). As noted in previous research, this approach has largely been unsuccessful in addressing the needs of vulnerable communities in Bangladesh (Haque and Uddin, 2013).

Engaging local communities in DRR is important as local communities often possess valuable knowledge and are able to provide useful insights on initiatives for their locality. A report by the Concern Universal Bangladesh (2010) discussed various structural and non-structural indigenous mitigation measures, focused at both community and individual-property levels, used by the local residents (in project areas of Mirzaganj – Patuakhali district and Pathargata – Barguna district) to reduce their vulnerability to the negative impacts of cyclones and tidal surges. The wealth of indigenous knowledge available in the area, among the local residents, was highlighted in the study by Concern Universal Bangladesh therein and the need for building capacity and providing information and support for local residents to replicate their indigenous good practices was emphasized (Concern Universal Bangladesh, 2010). The findings reported therein affirm that local residents possess invaluable knowledge about community level structural DRR strategies. Further, Alam and Collins (2010), following their study related to the vulnerability of coastal communities in Bangladesh to cyclones and storm surges, concluded that much local knowledge and capacity exists in local communities that can be incorporated in disaster prevention and

response strategies. It was noted that the cyclone response experiences of local communities could be more central to cyclone disaster preparedness activities in Bangladesh (Alam and Collins, 2010). Therefore, it is important that their knowledge, understanding and viewpoints are captured in developing infrastructure and structural protection measures in the area, in order to make sure that such measures are delivered to, and embraced by, local residents effectively.

## **4. Research Method**

### **4.1. Research questions**

Addressing the requirement of developing DRR strategies in consultation with local communities and local governments, the research sought to investigate local community and local policy maker perspectives of DRR and to integrate the perspectives of the two groups. A bottom-up approach was adopted in conducting the research. Firstly, local community perspectives were investigated by conducting focus group interviews and secondly local policy maker perspectives were investigated. The findings from the first phase, community perspectives, were also fed to the policy makers for their feedback in the second phase. This paper seeks to present the findings from the focus group interviews with local community and policy makers, addressing the research questions of; perceptions of existing DRR initiatives in place; what are the deficiencies of existing initiatives; how can they be improved; and what new initiatives are required, focusing on infrastructure /structural risk reduction measures.

### **4.2. Study area**

Patuakhali is a South-Western region in Bangladesh, facing the Bay of Bengal and consisting of a number of rivers connected to the Indian Ocean. The constituent districts of Patuakhali region, for this study, are considered to be Patuakhali and Borguna. The area is highly vulnerable to a range of natural disasters; most importantly cyclones and storm surges, flooding, and also river erosion. The study area was one of the hardest hit by the 2007 super cyclone Sidr (MoFDM, 2010, Government of Bangladesh, 2008). Furthermore, one of the study areas (Mirzaganj) investigated by Concern Universal Bangladesh mentioned above is within the region, which concluded that the local residents were capable of offering invaluable knowledge about structural risk reduction measures. The area was selected for



the study due to its significant vulnerability to the two most devastating disasters affecting Bangladesh; that of cyclones and flooding, previous experience of such events, and the ability of local communities to provide useful insights into structural risk reduction measures.

### **4.3. Data collection and analysis**

A qualitative approach was taken in conducting the research. It was thought that adopting a qualitative approach would benefit answering the research questions raised and as claimed by Alam and Collins (2010) qualitative approaches are useful for investigating peoples' responses to and the impact of disasters. Focus group interviews were conducted with local community leaders and policy makers, in order to gain answers to the research questions raised. The focus group method is a form of group interview where several participants are questioned about a tightly defined topic (Bryman, 2008). The emphasis of focus group discussions is on the joint construction of meaning, derived from the interaction within the group (Bryman, 2008). According to Morgan (1996), a focus group interview should possess the components of; a research method devoted to data collection, locate the interaction in a group discussion as the data source, and the researcher's active role in creating the discussion is acknowledged. Focus group interviewing was selected for the purpose of this research as it provided the opportunity to identify the collective viewpoints of the community leaders involved. Furthermore, it was thought that this method would eliminate cultural barriers such as interviewing women on an individual basis (Kulatunga, 2010) and would foster participation. Accordingly, whilst difficulties were experienced in conducting individual interviews with women at an earlier stage of the research, this obstacle was eliminated by conducting focus group interviews. It was noted that women were proactively involved in focus group discussions, possibly due to being among a group well known to them. This could also be due to women involved in focus groups being used to playing a leading role in local disaster response, as opposed to ordinary residents. The research approach adopted lead to improved participation by women and therefore the perceptions of women were captured within the study. This aspect was considered important, as women are traditionally underrepresented within the cultural context of Bangladesh.

The community leaders involved in focus group discussions included village headmen, residents appointed to the village disaster management committee, local religious leaders,

heads of schools, and senior residents. Vulnerable groups such as elderly and women were represented in each of the focus groups. Active representation of women and elderly ensured that their views and requirements are captured in the research. Three such discussions were conducted in communities that are highly vulnerable and recently affected by natural disasters. Localities where focus group discussions were held within the Patuakhali region are given in Table 1. All the localities were highly vulnerable to cyclones and flooding and have been frequently affected by both types of events previously, including the Sidr cyclone in 2007. The number of focus groups was decided to capture the perceptions of local communities adequately to answer the research questions, covering different risk profiles and community demographics. The second phase of the research included a focus group discussion with local policy makers from the Patuakhali region who are involved in implementing DRR activities within the region. Participants included local council members, government officials and non-governmental organisations actively involved in DRR initiatives. Focus group interviews were transcribed, and were then coded and analysed via content analysis technique. Conceptual content analysis, where the text is scrutinised to check the existence of a concept, considering terms related to the concept both implicitly and explicitly was adopted therein.

Table 1 – Details of focus group interviews

Focus group	Participants	Locality	Number of participants
FC1	Local community leaders	Taltuli	8
FC2	Local community leaders	Amtali	7
FC3	Local community leaders	Galachipa	9
FPM1	Local policy makers	Patuakhali region	7

## 5. Findings and Discussion

The following sections discuss the findings from the focus group interviews, primarily addressing participant views on existing DRR infrastructure, their deficiencies and community requirements.

### 5.1. Existing risk reduction infrastructure

The primary risk reduction infrastructure mentioned in the focus group interviews were cyclone shelters and coastal / river embankments. This was common across all the focus groups, including that with the local policy makers. This is in line with the fact that Bangladesh relies heavily on cyclone shelters and embankments for protection against

cyclones and flooding (Karim and Mimura, 2008, Bhatia et al., 2010), although the country has managed to reduce the devastating impacts of cyclones by implementing early warning systems, developing evacuation plans, maintaining coastal forest cover and raising community awareness in addition to developing cyclone shelters and constructing embankments (Haque et al., 2012). Community leaders interviewed were aware of existing cyclone shelters and embankments in their respective areas. Although the discussions with the policy makers revealed various other structural measures that are in place; such as sluice gates, dykes etc, awareness of such initiatives by local communities was often limited to cyclone shelters and embankments (in terms of infrastructure measures at the community level). Communities felt insecure when these schemes were not in place and when there were substantial deficiencies in existing stocks of shelters and coastal / river embankments. Community concerns were not without a reason as they are frequently affected by cyclones and flooding, thus requiring them to seek protection inside cyclone shelters.

Whilst the need for addressing disaster risk through various other means; e.g. early warning systems, enhancing community awareness, emergency preparedness, landscaping measures such as tree planting etc. were also identified, local community leaders and policy makers stressed the need for cyclone shelters and embankments to provide protection for communities. Focus group discussions confirmed the dependence by poor communities on community level infrastructure for protection against disasters, and their inability to implement measures on their own, primarily due to financial constraints. It has to be noted that the local community leaders interviewed were from river bank / coastal communities, where the residents mainly relied on farming or fishing and were financially constrained. These findings are consistent with previous studies. Mutton and Haque (2004) recognised that in Bangladesh poorer residents live closer to the river making them more vulnerable and resulting in substantial flood damage. Interviews with community leaders revealed that people are willing to make their homes structurally stronger and implement property-level protection measures such as raising floor levels or relocating to higher ground where the risk of cyclone surges and flooding is lesser. Financial constraints were cited as the main factor that prevented them implementing such measures. For instance, FC1 is a relocated community that lives outside the existing earthen embankment on a river bank. As a result

flooding was mentioned as a frequent threat especially during monsoon periods. Financial constraints were cited as the reason that prevents them relocating to land inside the embankment or raising the floor levels in houses and cattle farms.

## **5.2. Deficiencies in existing measures: Community and Policy-maker perspectives**

As the communities interviewed have been affected by cyclones and flooding previously, they were able to provide a detailed account of the virtues and shortcomings of existing measures as well as community requirements. Local community leaders identified a number of issues with regard to cyclone shelters. One of the main concerns regarding cyclone shelters is their inadequacy during a disaster. Lack of cyclone shelters has also been identified in previous studies (Karim and Mimura, 2008). The government estimated that about 2000 new shelters need to be constructed in coastal areas, in addition to nearly 3000 that are already available (MoFDM, 2010).

The location of shelters and transport infrastructure to and from the shelters also warrants attention. The community leader interviews revealed that poor road networks leading to shelters to be a major factor that hinders speedy access in an emergency situation. Alam and Collins (2010) singled out lack of a proper transport infrastructure as an important factor that makes coastal communities in Bangladesh vulnerable to cyclone disasters. Transport infrastructure being in a poor state and lack of cyclone shelters results in people having to travel to distant and difficult to reach shelters, making them vulnerable in cyclone situations (Alam and Collins, 2010). Moreover, poor road network was quoted as a reason for remote communities not receiving disaster warnings in time. For example, in FC3 it was mentioned that they only receive early warnings at the last minute when the level of warning is very high. It was mentioned that timely warnings are not received; especially lower level warnings, due to the difficulty for local authorities to access their village. According to community leaders, belated warnings give them very little time to take appropriate action. Lack of transport infrastructure then adds to their difficulties, making it difficult for them to move quickly to a nearby cyclone shelter. It was noted in the policy maker focus group that little attention is paid to access routes to shelters and thus the increased vulnerability of local communities. For instance, the main road connecting the shelter and a village might get flooded before the village, thus making it riskier for people to access the shelter. Therefore, the need for conducting a proper risk assessment of the

locality; location of the cyclone shelter and the road network connecting communities to the shelter, can be identified as a key finding emerging from the study.

Community leaders were particularly concerned about the maintenance of cyclone shelters. It was pointed out that due to lack of maintenance, in some instances, the shelters were not in a fit state to be occupied by the evacuated residents. The government proposed facilitating the maintenance of shelters by appointing a cyclone center management committee for each shelter, comprising a member of the local disaster management committee, locally elected representative, head master of local primary school, Imam of local mosque (leader of the local mosque), Non-Governmental Organisations (NGOs) and women representatives (MoFDM, 2010). The focus group discussion with policy makers revealed that in some instances such committees are successfully maintaining local cyclone shelters. Therefore, it seems that issues surrounding lack of maintenance can be reduced to a minimum by implementing the government proposal of devolving the responsibility of maintenance to a local committee.

The need for assessing future scenarios, under changing climatic conditions, was highlighted in discussions with policy makers. As cyclone shelters are permanent structures built to last many years into the future, it is important that future conditions are also considered in their design and location. For example, Karim and Mimura (2008) highlighted the need for considering future flood depths when estimating appropriate cyclone shelter height. It was estimated that surge flood depths may increase significantly due to climate change, especially in coastal areas, leaving the first floor of many existing cyclone shelters inundated and making the first floor unusable in the event of a cyclone (Karim and Mimura, 2008). The policy maker interview did not reveal occasions where future scenarios have been considered in designing and building cyclone shelters.

These facts suggest the need for comprehensive guidelines at a national level including the location, design and construction and maintenance of cyclone shelters. Whilst guidelines already exist for these in Bangladesh, for e.g. Guidelines for Construction, Management & Maintenance of Cyclone Shelters (MoFDM, 2009), and elsewhere, for e.g. in India (Arya and Agarwal, 2006), it has to be seen whether these guidelines are comprehensive and whether they are properly adhered to. Especially, practical issues pertaining to cyclone shelters seem

to be often overlooked. For example, whilst the guidelines often identify the extent of toilet facilities required, location of them within the shelter seems to be overlooked. The policy maker interviews cited cyclone shelters where toilets have been constructed on the ground floor level making them unusable during a cyclone or flood situation.

Pertaining to embankments, the concerns highlighted included lack of coverage by embankments, embankments being earthen rather than permanent, maintenance issues, inadequate height of existing embankments, and in some instances, communities living outside the existing embankments. Although the at-risk communities called for more embankments constructing embankments has also been found to have negative consequences. For example, Choudhury et al (2004) found that the severity of flash flooding in their study area in Coastal Bangladesh has intensified, both in terms of depth and duration of flood water, since 1991 following the reconstruction of most embankments. Therefore, it recommended addressing the risk via other non-structural means such as flood forecasting and early warning systems as well as structural measures such as proper maintenance of existing embankments, additional sluice gates, dredging channels and reducing deforestation (Choudhury et al., 2004). These concerns were also echoed in the focus group discussion with the policy makers. Conversely, embankments are attributed with increased protection against cyclones and flooding; for instance the case of Sidr cyclone in 2007 can be cited (Government of Bangladesh, 2008).

In all the community leader focus groups the issue of embankment maintenance was raised, and was confirmed by the policy maker's focus group. Community concern was that the embankments are not properly maintained and as most embankments are earthen they get washed away creating gaps in the structure. It was mentioned that flood waters often escape through the gaps, and creates water logging as flood water cannot flow back through the embankment. Furthermore, some instances were mentioned where surges have overtopped existing embankments due to inadequate height, thus creating localised flooding and water logging. These were cited as reasons for the water salinity in coastal areas affecting portable water supplies and reducing crops production. Moreover, the government loss assessment following the Sidr cyclone found that the impact of the storm surge was severest on those nearest and behind the embankments that had not been properly maintained or had been eroded (Government of Bangladesh, 2008). Proper

maintenance of existing embankments can thus be identified as critical in protecting coastal and river bank communities.

In general, policy makers were largely in agreement with the concerns of local community leaders with regard to cyclone shelters and embankments. On one hand, this confirms the findings from the community leader interviews and the research. On the other hand, it highlights the drawbacks of existing measures, and more importantly, how they can be improved. It also has to be noted that many initiatives, including structural measures as well as other measures, were found to be in place to reduce disaster vulnerability in the region. Initiatives where community concerns are addressed or are planned to be address were mentioned in discussions with the local policy makers. Where new initiatives are required these were acknowledged by the local policy makers. As an example of the former, the issue of multi-purpose cyclone shelters can be cited. It was mentioned that cyclone shelters nowadays are made as multipurpose shelters that can be used for community, educational or economic purposes during non-disaster periods. The government also recognises the need for building multi-purpose cyclone shelters and converting existing shelters (MoFDM, 2010). In this regard, the Government’s Disaster Management Bureau (DMB) has proposed promotion of multi-purpose use of shelters by allowing local NGOs, civil society groups and community access to the shelters for public functions like marriage ceremonies, meetings, training sessions and other social functions under the supervision of local shelter management committee (MoFDM, 2010). Yet, the fact that local community leaders specifically mentioning the need for multi-purpose shelters suggests that these proposals are yet to be fully realised and in some instances local residents are yet to visibly benefit from shelters in day-to-day life. Table 2 summarises the deficiencies identified by local community leaders, their requirements and policy maker suggestions to improve existing DRR infrastructure.

Table 2 – Summary of key deficiencies, community requirements and policy maker requirements of DRR infrastructure

Existing DRR infrastructure	Deficiencies	Community requirements	Policy maker suggestions
Cyclone shelters	<ul style="list-style-type: none"> <li>Lack of adequate number of cyclone shelters</li> </ul>	<ul style="list-style-type: none"> <li>More multi-purpose cyclone shelters closer to community</li> <li>Better access roads to</li> </ul>	<ul style="list-style-type: none"> <li>Increased number of multi-purpose cyclone shelters</li> <li>Risk assessment to</li> </ul>

	<ul style="list-style-type: none"> <li>• Inappropriate location of shelters</li> <li>• Damaged road network accessing cyclone shelters</li> <li>• Lack of maintenance</li> </ul>	<ul style="list-style-type: none"> <li>• shelters</li> <li>• Timely warnings</li> <li>• Better maintenance of existing shelters</li> <li>• Ability to use cyclone shelters in day-to-day life for alternative purposes</li> </ul>	<ul style="list-style-type: none"> <li>• determine suitable locations for cyclone shelters and access routes</li> <li>• Assessment of future scenarios under changing climatic conditions in building shelters</li> </ul>
Coastal / river embankments	<ul style="list-style-type: none"> <li>• Lack of coverage</li> <li>• Inadequate height of embankments</li> <li>• Lack of maintenance</li> <li>• Communities living outside existing embankments</li> <li>• lower structural stability of earthen embankments</li> </ul>	<ul style="list-style-type: none"> <li>• Better maintenance of existing embankments</li> <li>• Increasing the height of existing embankments</li> <li>• Provide embankments where there is no protection</li> </ul>	<ul style="list-style-type: none"> <li>• Proper maintenance of existing embankments</li> <li>• Addressing the risk via alternative strategies such as reducing deforestation, early warning.</li> </ul>

## 6. Conclusions

Bangladesh is a country at risk of a range of natural hazards. Following devastating impacts of such disaster events, DRR initiatives in the country have evolved and developed over the years. This paper specifically looked at DRR infrastructure in Patuakhali, Bangladesh. Although comprehensive DRR initiatives should not be limited to infrastructure alone but should encompass a broad range of measures as appropriate; representing physical science, engineering, structural, and organisational schools of thinking, infrastructure facilities play a significant role in reducing the vulnerability of at-risk communities. This is especially critical in a developing country like Bangladesh where the ability of communities to implement measures of their own is limited.

Whilst the risk reduction strategies in Bangladesh have improved over the years gaps seem to still exist in providing DRR infrastructure to local communities. It is key that community concerns are addressed and necessary technology is embraced in doing so. For instance, a key recommendation to emerge from the study is to develop and undertake adequate risk assessment process when deciding shelter locations, layout and access routes; involving mapping exercises integrating future projections under changing climatic conditions.

Findings from the focus group discussions revealed the critical importance of and heavy reliance on cyclone shelters and embankments. Much of the discussions in focus group interviews centred around these two measures, suggesting the reliance of vulnerable



communities on these two measures and the significance attached to these by the communities. Significant reliance of communities on community-level structural protection measures is linked to the financial status of the residents, these mostly being financially deprived communities. Lack of financial resources has significantly hindered their ability to better prepare; for e.g. by moving out of highly vulnerable areas and making their homes safe, despite their willingness to do so. The communities recognised the need for improving their financial status, if they are to better prepare. Financial incentives can therefore be identified as an effective measure that will enable preparedness. At a more fundamental level, this highlights the importance of empowering vulnerable communities financially by means such as vocational training, self-employment and micro business opportunities etc.

Focus group discussions with local community leaders revealed a number of shortcomings in relation to those two measures and community requirements; mainly addressing the shortcomings, were identified. Generally, concerns raised by local community leaders were acknowledged by local policy makers. Therefore, validity of the concerns raised and the importance of addressing those concerns is evident. Importantly, it shows that local policy makers were considerate of local community concerns. However, it has to be seen as to what extent such concerns are taken into account when DRR infrastructures are commissioned and maintained. In this regard, it is essential that national policy ensure local community views are taken into account in implementing regional risk reduction infrastructure.

The research design adopted in this study served two purposes; to answer the research questions raised and also to bridge the gap between local communities and local policy makers. The study sought to promote the agenda of local community engagement in DRR activities by actively linking community perspectives with that of local policy makers. Although the study was focused on Patuakhali region, the issues identified and the lessons learned inform policy making on structural risk reduction measures concerning wider coastal and river bank communities in Bangladesh; especially where the risk of cyclones and flooding is high and where cyclone shelters and embankments play a significant role in protecting at-risk communities.

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