

## 1.8 発展途上国における総合的な洪水リスクマネジメント方策の事例研究

### (Case study of Flood Risk Management)

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担当チーム：水災害研究グループ（防災）

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**Abstract:** The final aim of this research project is to develop a comprehensive flood risk management methodology for Bangladesh with the best-mix combination of existing mitigation methods. In this report we summarize various management practices in the country and outlined a new approach. We found out that the cyclone shelters are effective to save people if they evacuate to shelter; early warning system, awareness and disaster education play important role weather people evacuate during a disaster or not. Bio-shields help reduce the force and height of the storm surge during a cyclone. Keeping the benefits of these counter measures in mind we propose that the combination of existing embankment/polders with coastal forest as the best-mix to save both the life and property during devastating cyclone in Bangladesh and elsewhere.

**Keywords:** Flood risk, cyclone shelters, embankments, bio-shield, best-mix, new approach

#### 1. Introduction

Bangladesh is prone to water-related disaster because it lies in the sub-tropical zone with humid climatic condition, located at the delta of Ganges, Brahmaputra and Magna Rivers, which cause flooding during monsoon; has a long coast line that makes it prone to coastal floods, storm surge due to high tides and cyclones; and most of the land area (90%) is less than 10m from mean sea level (reference) rendering it vulnerable to flooding. The occurrence of the future natural water-related disasters cannot be prevented but the magnitude of the impact the disasters could be significantly reduced through structural and non-structural countermeasures. The combination of various methods of water-related disaster mitigation is thought to be critical and with optimal care we proposed the following method (Fig.1). From the available information of 1991, 2007 cyclones and other investigation we are optimistic to develop a proposal that will help reduce fatalities with the best mix of the existing measures which will be helpful in Bangladeshi contest or elsewhere with similar criteria.

#### 2. State of the problem

The results of the factor analysis of water-related disasters in Bangladesh conducted by ICHARM pointed out that both the structural and non-structural counter measures against storm surge

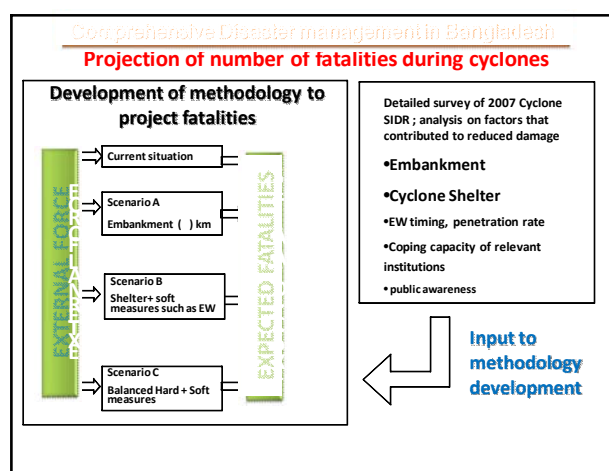


Fig. 1. The general concept of the development of a methodology to reduce cyclone fatalities in Bangladesh

have continuously produced good results in the reduction of the fatalities. However, there is a need to do more. The first important task is to think of

disaster prevention measures for the seasonal migrant workers in Bangladesh. The seasonal labor migration practice is prevalent in Bangladesh until today, these laborers are mostly landless, living out-doors and do not integrate to the community where they work because of their short residence in a particular place. An estimated 4 million people live in Very High Risk Area (VHRA); another 5 million people live in High Risk Area (HRA) of which up to 30% are seasonal migrant laborers and 70% of this population is landless (Fig.2) (WB). Therefore, identification of most vulnerable class of people is very critical to provide effective support at the time of calamity.

### 3. Existing mitigation methods and their expected function

Cyclone shelters, as reported, are said to be an effective counter measures against storm surge flooding during cyclone to save lives; but however, there are also some constrains; the shelters are expensive to construct and maintain, not meant to accommodate and protect livestock and cannot protect properties (Fig.3(b)). Besides, only the people who evacuate to a shelter will be saved; people often do not evacuate because they prefer to stay with their property since it is their only reason to live. Furthermore, some people do not evacuate just because they don't believe the cyclone warnings since they have encountered many false warnings in the past. It does not mean that cyclone shelter does not help, at present there are more than 3000 shelters but their capacity could only accommodate 50% of HRA population though their construction started way back in 1960s.

Levees/embankments and polders are thought to be one of the best ways to protect people from storm surge and flooding in Bangladesh or elsewhere but it is very expensive and time consuming to construct (Fig.3(a)). In Bangladesh, embankment is constructed with a maximum crest height of 5.2m from the sea level which will not barricade a wave that is greater than 5.2m. But the devastating 1971, 1991 and 2007 cyclones generated much greater waves (cyclone Sidr

more than 6m) than the maximum height of the crest of the embankment. It is also reported that Cyclone SIDR, 2007, destroyed or badly damaged 740 Km of embankment.

Bio-shields are getting more attention in recent years because they are environmental friendly, comparatively low cost and capable to reduce the energy and height of storm surge (Fig.3(c)). Though coastal forest may require long tracks of land and time for the forest to grow to the effective age they could be used as environmental buffers, grazing area for cattle and also for tourism and the forest could be managed and used by communities.

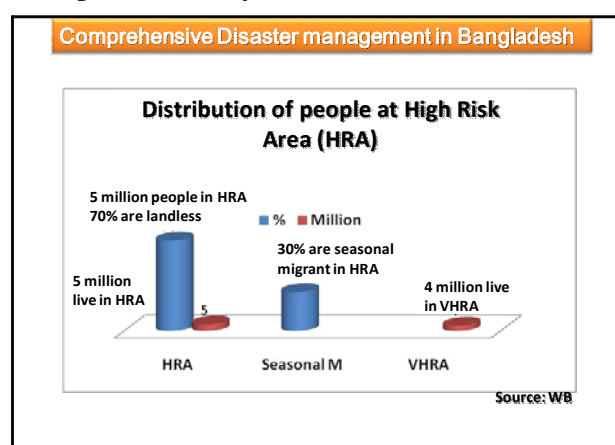


Fig. 2. Distribution of people in high risk area (HRA) in Bangladesh

As mentioned earlier, the early warning system, raising awareness among local residents, training are very important and part and parcel of the mitigation process. In Bangladesh or elsewhere, the best way to protect people is to evacuate to a safe place and evacuation to a cyclone shelter is one of such methods. If there is safe location where people could start new life with better livelihood then the best way is to relocate people to that place (Fig. 3(d)). But this might be a difficult process. The first thing is the availability of such a place that can accommodate the people, second, weather the people are willing to move, third, are the basic infrastructures in place or not, and fourth, are there enough jobs or livelihood for the people to stick to that place. If these criteria are not fulfilled the relocated people might return back to the same place where they used to be and all the effort

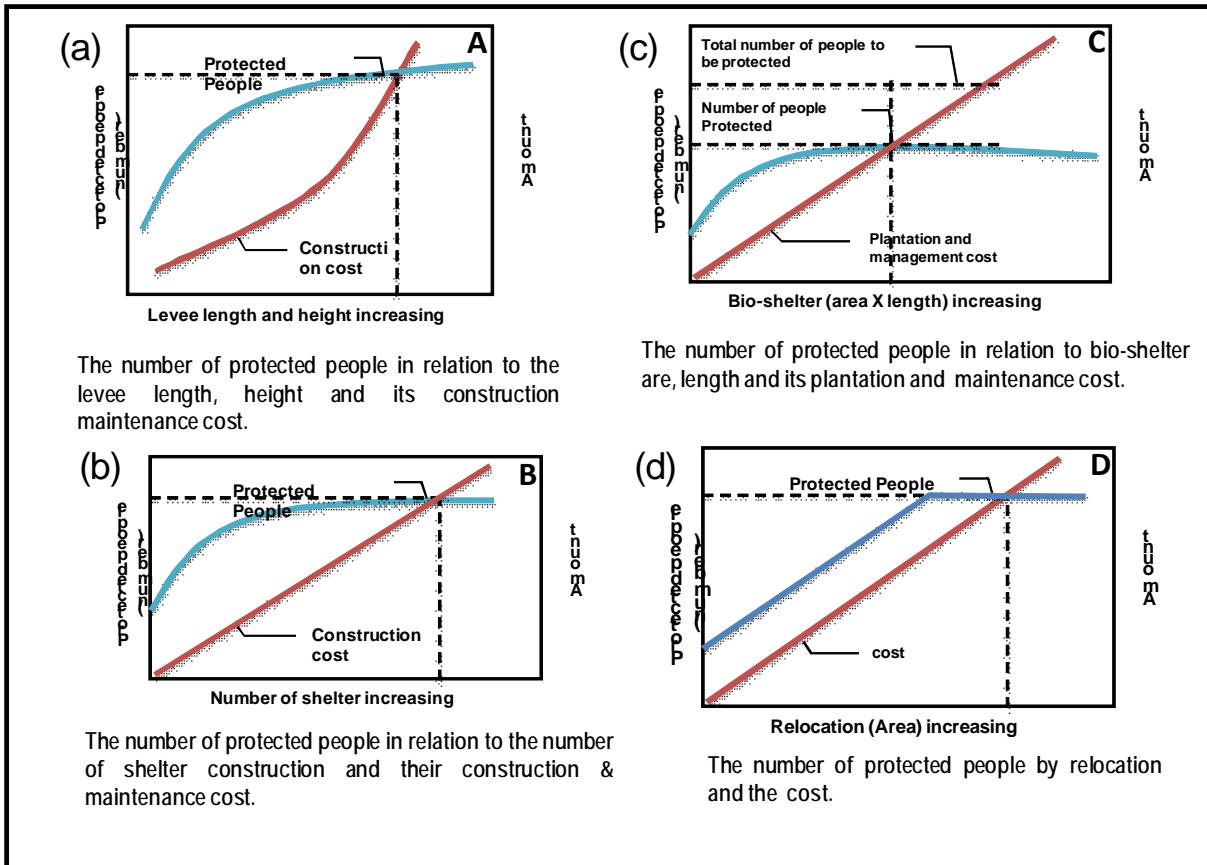


Fig. 3. How and to what extent cyclonic disasters could be reduced (experienced guess)

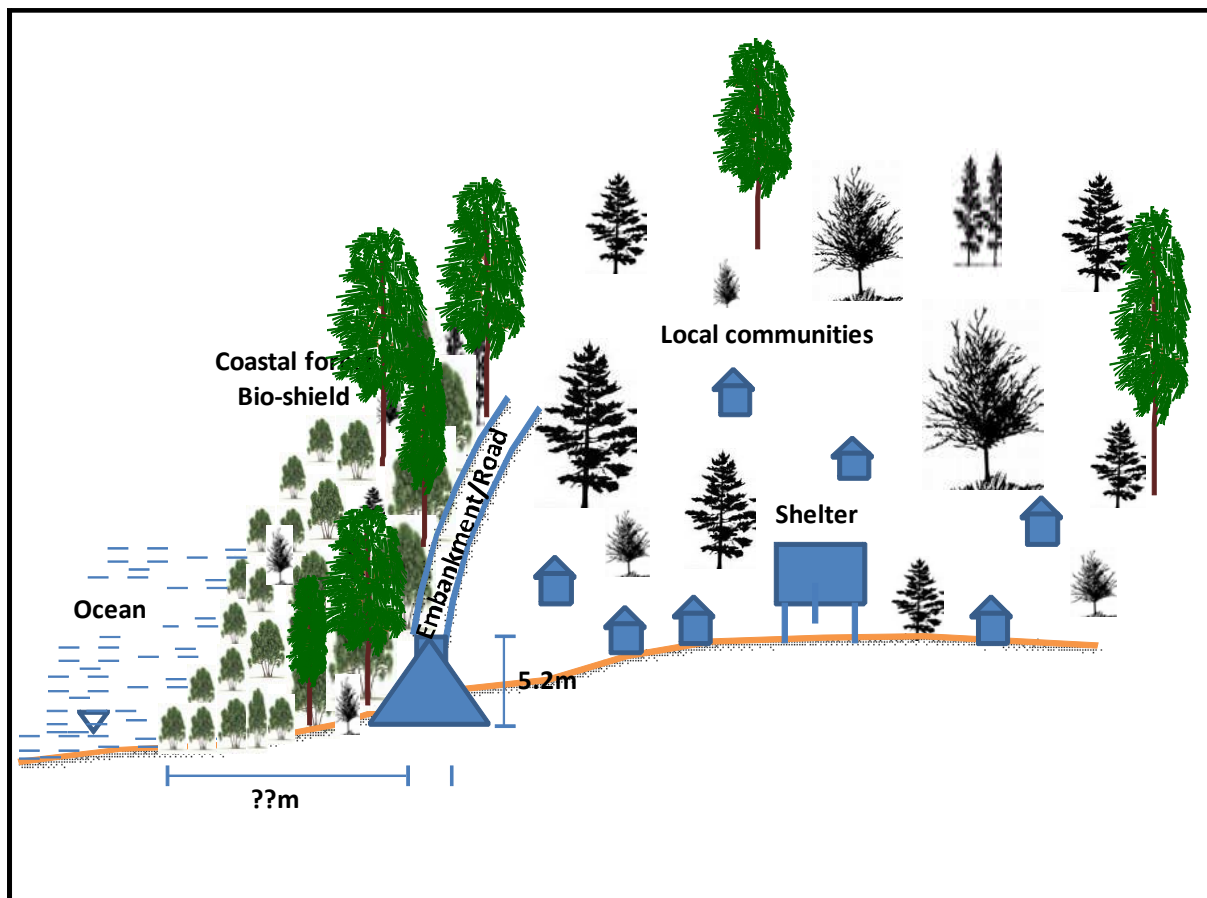


Fig. 4. Illustration of a sound combination of cyclone mitigation measures

would be in vain. The governance might play an important role here for administering and funding the whole process.

#### 4. Conclusions

Therefore, considering the economic and environmental benefit a combination of coastal forest (bio-shield) at the seafont and an embankment at the back might be the best combination to protect people in Bangladesh because there is already the 5.2m high existing embankment. The coastal forest should be designed in such a way that it will reduce and keep the highest waves to at most 5.2m when they reach embankment so that the combination would be effective. Furthermore, the structure, height, type of vegetation and the forest width plays an important role in reducing the wave height therefore a best combination should be investigated. Similarly, the embankment construction design, construction materials are important as well and should be dealt carefully at the planning stage.

The difficulty to combine embankment and bio-shield in Bangladeshi coast is availability or acquisition of land for bio-shield with optimum width along the coast and the maintenance of both embankment and coastal bio-shield. The most advantageous part of this is that the embankment could be used as a road which will be direct benefit to the local people and a separate road construction budget could be used to maintain the embankment cum road (Fig. 4).

As we understand that the cyclone shelters are effective if people evacuate to shelter; early warning system, awareness and disaster education play an important role weather people evacuate during a disaster. On the other hand, further investigation will be conducted to understand the characteristic of the bio-shields and their combination with the existing embankment to find the best mix which will be helpful for the Bangladeshi situation and elsewhere with similar conditions.

## 1.8 CACE STUDY OF FLOOD RISK MANAGEMENT

**Abstract:** The final aim of this research project is to develop a comprehensive flood risk management methodology for Bangladesh with the best-mix combination of existing mitigation methods. In this report we summarize various management practices in the country and outlined a new approach. We found out that the cyclone shelters are effective to save people if they evacuate to shelter; early warning system, awareness and disaster education play important role weather people evacuate during a disaster or not. Bio-shields help reduce the force and height of the storm surge during a cyclone. Keeping the benefits of these counter measures in mind we propose that the combination of existing embankment/polders with coastal forest as the best-mix to save both the life and property during devastating cyclone in Bangladesh and elsewhere.

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## 1.8 発展途上国における総合的な洪水リスクマネジメント方策の事例研究

### 【要旨】

本研究プロジェクトは、バングラデシュの包括的な洪水リスク管理手法として既存の洪水低減法の最適な組み合わせを検討する手法を開発することを目的とする。本報告書では、バングラデシュにおける様々な洪水管理技術をレビューするとともに、新たなアプローチについて報告する。住民らがサイクロンシェルターに避難さえすれば、人命救済に有効であることがわかった。それには、警戒避難体制の整備に加え、防災教育を行うことで災害時であるか通常時であるかに関わらずシェルターを利用する習慣づけをする必要がある。防潮林は暴風により発生する高潮時に流体力と波の高さを軽減する効果がある。しかしながら、沿岸林だけではなく堤防や遊水池を組み合わせることにより、バングラデシュあるいはその周辺国において、人命と財産を守る経済的で効果的な洪水（高潮）対策として期待できることがわかった。

キーワード： 洪水リスク、サイクロンシェルター、堤防、植生帯、防潮林、最適配分、新たなアプローチ