

# OPTIONS FOR CYCLONE PROTECTION : BANGLADESH CONTEXT

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## Abstract

Bangladesh is one of the most natural disaster prone countries, over the last 30 years and specially after 1991 cyclone, the methodology has developed considerable experiences and expertise in managing a wide range of disaster relief operations primarily concerned with cyclones and other natural disasters. The unprecedented floods of 1987, 1988 and 1998, the 'super' cyclone of 1991 and also 1996; all these events had stimulated fresh management measures to reduce vulnerability of natural disaster. In this regard the main theme of this paper is to review the options on structural and non-structural measures for reduction of vulnerability.

*Cyclone; Great danger; High Risk Areas; Killas; Refuge*

## INTRODUCTION

Bangladesh is one of the least developing and most disaster prone country in the world. Over last 30 years (Table 1) different scales of cyclones have been affecting the country with loss of valuable lives and property. It was estimated in 1996 that about five million people currently live in 'High Risk Areas' (HRAs) along the western, central and south-eastern coasts of Bangladesh. Of these, 4 million live in 'Very High Risk Areas'. However, only 10 % of the actual population in the HRAs could be accommodated in existing safe havens (excluding Sub-district headquarters buildings and cyclone shelters built outside these HRAs). Approximately 9 million more shelter places were needed in the three cyclone-prone zones by the year 2001 and 12.5 million by 2021 as a result (EU: 1998). The attached figure shows the areas affected by the 1970, 1985 and 1990 cyclones plus the designated High Risk Areas.

## Socio-Economic Status of Population at Risk

Field surveys indicate that the majority of the population living in the HRAs are low-income agricultural workers of whom 70% are 'landless' and relatively asset-poor, deriving their livelihood from fishing (as owners/operators) sharecropping or day labor (in crop agriculture) or as workers in shrimp or salt farms. The main economic

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assets at risk from cyclone are household possessions and large numbers of livestock and as a result, residents place a high priority on sequestering their cattle, goats and poultry on *killas* (raised platforms) before taking refuge in cyclone shelters.

**Table 1**

**Cyclones affecting Bangladesh since 1960**

<b>Date</b>	<b>Year</b>	<b>Max. wind speed in Kms/hr</b>	<b>Storms surge ht. (in ft)</b>	<b>Deaths</b>
09 Oct.	1960	162	10	3,000
30 Oct.	1960	210	15-20	5,149
09 May	1961	146	8-10	11,466
30 May	1961	146	20-29	-
28 May	1963	203	14-17	11,520
11 April	1964	-	-	196
11 May	1965	162	12	19,279
31 May	1965	-	20-25	-
14 Dec.	1965	210	15-20	873
01 Oct.	1966	146	15-30	850
11 Oct.	1967	-	6-28	-
24 Oct.	1967	-	5-25	-
10 May	1968	-	9-15	-
17 April	1969	-	-	75
10 Oct.	1969	-	8-24	-
07 May	1970	-	10-16	-

23 Oct.	1970	-	-	300
12 Nov.	1970	223	20-30	5,00,000
08 May	1971	-	8-14	-
30 Sep.	1971	-	8-14	-
06 Nov.	1971	-	8-18	-
18 Nov.	1973	-	8-13	-
9 Dec.	1973	122	5-15	183
15 Aug.	1974	97	5-22	-
28 Nov.	1974	162	7-16	a few
21 Oct.	1976	105	8-16	-
13 May	1977	122	-	-
10 Dec.	1981	97	6	02
15 Oct.	1983	97	-	-
09 Nov.	1983	122	-	-
03 June	1984	89	-	-
25 May	1985	154	10-15	11,069
29 Nov.	1988	162	5-10	2,000
29 April	1991	225	20-25	1,38,000
02 June	1991	100	6	-
02 May	1994	200	-	170
25 Nov.	1995	100	-	6
19 May	1997	225	15	126
26 May	1997	150	10	70

Source: Cyclone Shelter Preparatory Study (CSPS) 1996

Seasonal migrants from minority religious and ethnic groups also move into these HRAs at times of harvest and fish-processing, swelling the total resident population by 30%. These people live in temporary makeshift dwellings often outside embankments, and are at extreme risk from cyclone surge. As outsiders they feel themselves to be unwelcome in cyclone shelters and are often without refuge.

Disputes over newly accreted land mar social relations in the HRAs. Every year, there is conflict between powerful landlords striving to claim possession of new land and other attempting to establish settlements. This creates tensions between insiders and outsiders as well as between government agencies and local residents. Land ownership is often not formally established and peoples fear seizure of their lands if forcibly evacuated. Despite the immense obstacles to long-term prosperity in these HRAs, people remain, still striving to establish assets and survive over the long-term.

### 1991 Cyclone: Lessons Learnt

In the 1991 'super cyclone' (which was a storm of exceptional intensity with wind velocities up to 225 km/hr) a large number of deaths occurred mainly in three coastal districts in the Eastern Zone: Chitagong (79,697 dead and 2600 injured) Cox's Bazar (51,147 dead and 133,000 injured) and Noakhali (8,878 dead and 995 injured) see Table-2 for rest other districts. Half a million cases of diarrhoeal (MoHFW: 1992) disease were also reported from the affected areas. In sum, the cyclone wreaked enormous social and economic havoc on these exceptionally vulnerable communities from which they have not yet recovered. The economic losses alone from the cyclone are estimated at US\$ 2.4 billion. The loss of life was, however, substantially less than the 1.2 million people killed by the 1970 cyclone.

Table-2  
District Wise Breakdown of Deaths and Injured.

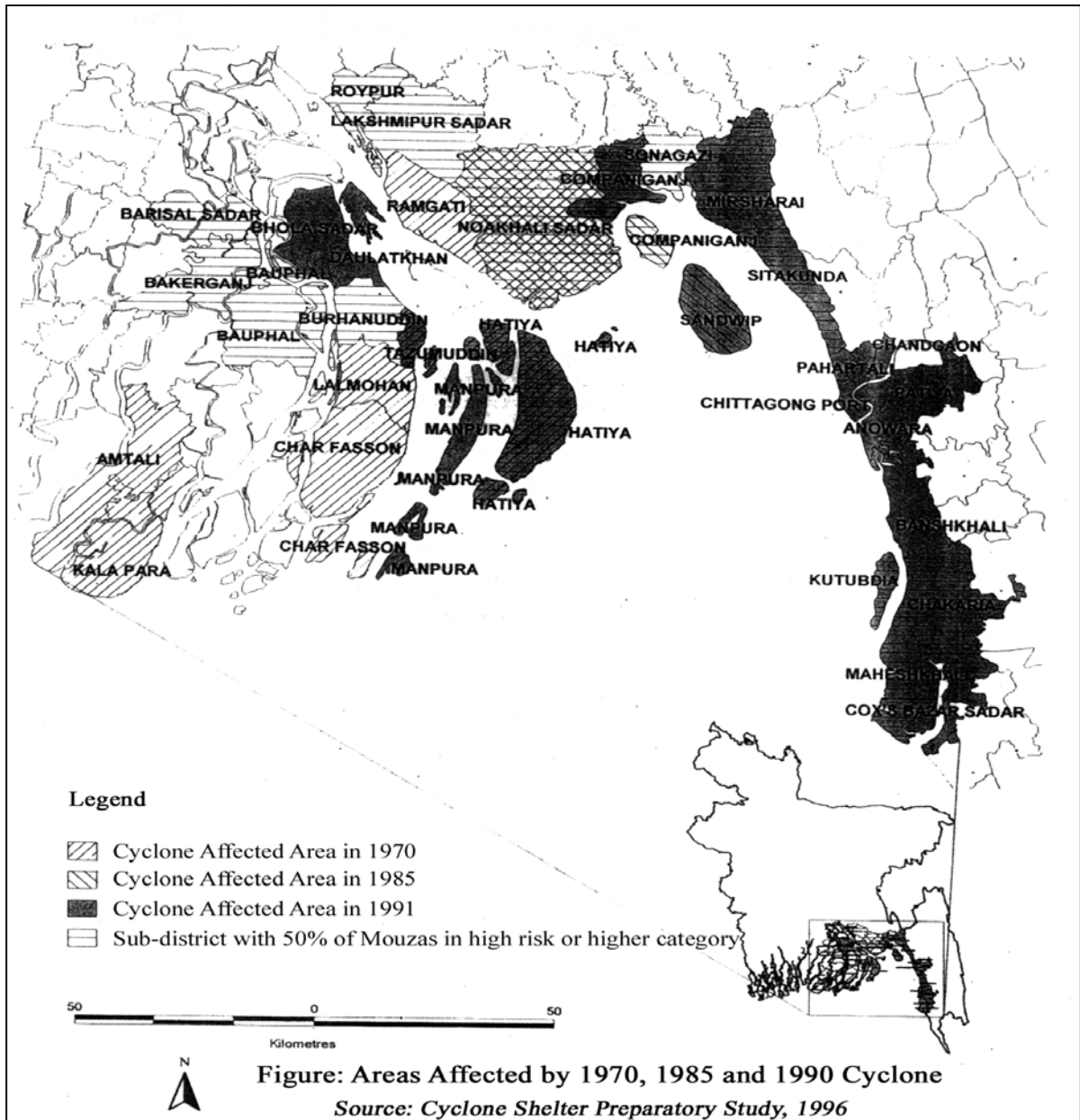
District	No. of Deaths	No. of Injured
Chittagong	79,697	2,600
Cox's Bazar	51,147	133,500
Noakhali	8,878	995
Bhola	221	771
Patuakhali	20	105

Rangamati	12	381
Laxmipur	9	287
Barguna	7	112
Feni	5	-
Jhalakathi	1	12
Pirojpur	1	-
Chandpur	1	-
Bandarban	1	86
<b>Total</b>	<b>140,000</b>	<b>138,849</b>

Source: Workshops Proceedings on Lessons Learnt During Cyclone-April 1991

Deaths occurred in different areas according to varied circumstances. In Banshkhali district, a surge up the channels caused flooding in inland areas, taking residents by surprise. On Hatiya in the Meghna estuary, 80% of the 8000-10,000 people who died drowned because they took refuge on the embankment or were inside when it was overtopped. The other 20% were outside the embankments or at sea, fishing (Haider et al., 1991). In all of the affected areas, there were insufficient numbers of cyclone shelters to accommodate all people. According to an 'environmental and perceptual study' of the impacts, most people died "because they did not believe the warnings" (Haider et al., 1991).

Under the Cyclone Preparedness Programme (CPP) set up by the Red charged to spread the message through the community via hand-held microphones. In 1991, though there was ample warning that a cyclone might strike, few people were convinced of the imminent danger until they saw the embankment overtopped or the wave advancing. Analysts of the '91 cyclone event concluded that the warning system in place was not really designed to convey information to local people. The use of numbers for cyclone warning was only ever intended for port authorities as it contained "technical information" only. Further investigations showed that many people did not believe the warning in 1991 because the number 10 warning (which means "Great Danger") had been issued on several occasions prior to this event, with no cyclone occurring. In 1991, the "Great Danger" warning was broadcast well in advance of the cyclone but when it increased in intensity and a new, more urgent warning needed to be broadcast, the imminent arrival of the storm could not be communicated to the public (EU: 1998).



## Needs Assessment

The survey revealed that, Lakshmipur, Barguna, Patuakhali and Cox's Bazar all these districts are High Risk Areas, cited cyclone and tidal bore as major problems.

### ***Cyclone Shelter Preparatory Study: Participatory Rural Appraisal (PRA)***

A critical needs' assessment using Participatory Rural Appraisal was conducted with target communities by the Cyclone Shelter Preparatory Study (CSPS) in 1996 which concluded:

- ◆ There is little understanding or awareness of the role of CPP volunteers in the Western (Sundarbans) HRA and no knowledge of the role of Disaster Management Committees in the central and eastern HRAs.
- ◆ There is a need to simplify the number-based warning system and link it to traditional warning systems for greater credibility.
- ◆ Warnings should be made more often especially if a storm increases in intensity and techniques of dissemination improve.
- ◆ Access by the community to existing shelters *pucca* public buildings and private houses is difficult.
- ◆ Fishermen and migrant boat populations, though most at peril, have limited access to warning systems.

According to the PRA findings, both women and men are sceptical of the validity and meaning of the cyclone warnings. Where signs of an impending cyclone coincide with CPP warnings, it appears that people have been more convinced that a cyclone will take place and react accordingly.

#### ***Women's Needs and Constraints***

Though comprising 50% of the resident population, women in most cases, do not feel willing or able to take refuge in cyclone shelters (EU: 1998). This reticence relates as much to women's perceptions of social appropriateness, mobility and domestic responsibility as to the design and location of current cyclone shelters.

As managers of the household, women recognise that they are responsible for its assets in the absence of the male head of household. However, they may not leave the *bari* (Homestead) in many cases, without his permission. In a cyclone emergency, women are placed in an invidious position. Before going to the refuge or depositing their cattle on the *killa*, women know that they must prepare fodder and water for their livestock as well as for their families. These tasks often delay their departure. In the 1991 cyclone and the Orissa cyclones in August and October 1999 tidal surges persisted for several days after the cyclone had past. People know that if they have to take refuge, they will need to provide their own food and water especially if a safe and reliable water supply is not assured. In the future, more

attention will need to be given to emergency food and water depots, if communities are to survive the extended flooding wreaked by super cyclones.

In extreme emergencies, some women have gone to cyclone shelters but once in the shelter, women find that no separate facilities are provided for their needs. In the past, some women have been rejected by their husbands if *pardah* is seen to be compromised by going to an unlit and crowded cyclone shelter. When cyclone shelters are used for exclusively male activities (mosques or madrasahs in particular) women do not believe themselves to have sanctioned access and will not enter. This suggests that future cyclone shelters should be designated as gender-neutral places for multi-purpose, community use.

There are several options and scenarios which might improve these problems of access and exclusivity of 'safe havens' and address the community's reluctance to take refuge in shelters. Women fear for their safety en route to the shelters. In this regards, a community-based system can be developed which ensures safety of women both en route to and in the shelter. Up to now, few mosques, madrasha, cyclone shelters and only 5% of the EC-funded 'cyclone cum primary schools' built since 1991 have managed to attract women inside since those have been used for male literacy classes. The problem of access for women remains unresolved.

## **Infrastructure Constraints**

### ***Cost of Shelters***

Estimates of the safe haven capacity in 1996 indicated a shortfall of more than 2 million places in the Western Zone, 4.8 million in the Central and 2.2 million in the Eastern where the 1991 cyclone took its mammoth toll (EU: 1996). The cost *per capita* of building cyclone shelters then was estimated at \$150/space for large capacity (1000 person) GoB structures and \$187/50/space for 500 capacity NGO building (cf 1996 prices: \$1=41). This does not include the cost of constructing *killa* refuges for livestock estimated to be Tk. 1,000,000 per *killa* with a total estimated cost of \$26.87 m. for a required 872 extra *killas* (as per consultants' estimates, EU: 1996). In addition, some NGO-funded shelters built to date may not be high enough to withstand up to 6 metres high surge as occurred in the 1991 cyclone.

Obtaining funds to provide sufficient shelters in the future may be a forlorn hope. It may be necessary to consider alternative para-based solutions in the intermediate term. Access to shelters is dominated by the elites and inactive shelter management committees. Minority groups and others may not be granted entry and at the same time, religious centres of minority groups are often not open to outsiders. Unless these issues can be addressed in a community-managed plan, it may be futile to construction further refuges.



Local people need more knowledge of where and when to take refuge. Embankments often give a false sense of security to some people who wrongly imagine they can take refuge on them. Although embankments are now built 7 metres in height and the Coastal Embankment Project has been rebuilding and erecting embankments to protect communities who were previously exposed, the problem of inland flooding remains an ever-present danger, however, for people living in low-lying coastal regions. Residents in those areas (e.g. Banskhali and Chokoria) will have no recourse but to take-refuge in cyclone shelters in the future.

### ***Livestock Refuges***

Under various cyclone shelter projects funded by GoB and NGOs, earthen platforms called *killas* (30x43 m square) often physically linked to shelters, have been constructed to safeguard livestock. Where the land for the *killas* is donated, issues of access and ownership of *killas* arise which limit their effectiveness. *Killas* are seldom maintained by the communities and as the access roads are not embanked, they can be easily submerged, rendering the refuges inaccessible. Social conflicts also may erupt when people have to cross-land owned by people inadequately compensated when the land was acquired. In future, suitable land should probably be acquired in the safest sites possible rather than in remote and relatively inaccessible locations.

NGO's have endeavoured to create income generating programmes by renting space and setting service charges on revolving loans, shops and donations to help maintain *killas* and shelters under their auspices. In the eastern I-IRA, people offered during the PRA consultations to pay subscriptions to maintain facilities. In most HRAs, however, O&M programmes designed to maintain cyclone shelters are not successful in eliciting local contributions. Without full community support and O&M systems in place, *Killas* will only provide short-term benefits.

The effectiveness of welfare systems in future to provide food grain storage, potable water and shelter in the event of cyclone is also in question. At the moment, there is inadequate management of disaster relief. From lessons learnt in the colossal 1991 cyclone, in the eastern zone (and possibly the recent Orissa cyclone), it appears there is need for better provision of emergency supplies (namely, storage of food, reliable water supply basic first aid, medical supplies, ORS packages, blankets etc.) to be housed in flood-proofed structures locally as well as flood-proofed pre-determined access routes to applicated area.

### **Options for Cyclone Protection**

#### ***Multi-purposes***

Much of the past investment has been in shelters which, while multi-purpose, have had male-dominated uses. Any future investment in shelters needs to take full

account of the specific needs of women discussed in the previous sections. Shelters should provide facilities for both sexes. Studies have shown that unless a cyclone shelter is within 1.5 km of a house, it may be too distant, a reflection of the fact that local people postpone their withdrawal to the shelter to the eleventh hour. One possible solution would be to establish a consensus at community level and agree that all *pucca* public and private building above one storey could act as 'safe havens' accessible to all. This might require some resiting of important community infrastructure in more valuable coastal areas but could be planned with local people to determine the optimum placement of these refuges.

There are clear advantages in having smaller shelters which are nearer to the communities: Less time is required to reach the shelters and people will remain much closer to their homes. All shelters should have an adjacent *killa* for livestock.

Access routes from the communities to shelters should be metalled and those roads or tracks to be reinforced should be identified at the community level.

### ***Cyclone-proofing of Communities***

Measures can be taken at community level to improve their safety during cyclone conditions. These measures include building earth platforms to raise up the houses, planting more trees, which will both break the tidal surge and provided sources of refuge. Consideration should be given to providing climbing nets which can be suspended from either trees or concrete pylons in event of cyclones and can be used by women and children to get above flood level.

The quantities of earthmoving involved to raise homestead sites are substantially lower than the embankments required to protect whole areas. Borrow pits could be come rainwater storage ponds or fishponds, both of which provide their own benefits although subject to loss during inundation caused by cyclones.

Families living in HRAs could be urged to keep even greater stores of goods in the *bari* (Homestead) for exceptional emergency events than they do at present. Where *killas* are attached to cyclone shelters, dry fodder supplies could also be stored as a community stock for emergency use only. These arrangements are only feasible where communities can work together and trust each other with valuable resources. A new comprehensive disaster management project with the Disaster Management Bureau will begin in 1999 will examine all aspects of cyclone and flood preparedness. In the meantime, the international community and NGOs have endeavoured to set out a formula for establishing the minimum standard of resources needed in the event of a disaster called SPHERE (SPHERE: 1999).

## ***Coastal Forestry Planning***

The Meghna Estuary Study (BWDB: 1988), concluded that it is highly desirable to plant newly accreted land in coastal areas with appropriate mangrove species for cyclone protection to assist in land stabilisation and dissipation of wave energy, at the same time making productive use of the land. such a policy would need to be managed in a sustainable way with thinning and cutting the mangroves at suitable times and also carried out with the full participation of local people. Appropriate vegetation on the embankment itself, but care is needed to select species that will not damage it. (bananas are particularly problematic) and ideally use those with a splayed root system which assist in stabilising the earthworks. the selection of species has been investigated by FAP 12/13 (MIWDFC: 1992) and followed up by the coastal afforestation projects (FRRL: 1993). Disputes arise over rights to previously accreted as well as new land, however, which makes the execution of this afforestation policy extremely difficult.

The impacts of forestry planting in the coastal areas are nearly all positives, the one major exception is the increased risk of malaria that forest habitats create by providing a suitable breeding ground for mosquitoes. The planting of forestry may also be in competition for use of land as grazing, (although with careful and sensitive management both can co-exist to

## ***Coastal Embankment Construction***

The Meghna Estuary Study also concluding that once natural accretion of land in the coastal areas has reached an equilibrium dictated by tidal and sedimentation transport conditions, than consideration can be given to the construction of coastal embankments with appropriate heights and slopes, based upon predicated water level conditions. The advantage of such an intervention are the reduction in saline flooding from high lunar tides and storm surges. However there will still be a need for cyclone shelters to provide protection from the high winds and rain. The costs of such embankments are high as the crest levels are greater and the seaward slopes are much shallower than for inland riverside embankments. The costs per unit area embanked and beneficiary household area also highly variable and related to the slope of the accreted land to be embanked. In addition great care needs to be taken to ensure that adequate drainage for rainfall runoff is provided and that the embankment location takes into consideration the location of saline water shrimp activities. Such embankments need to be designed, construction and managed in a multi-purpose way to maximize their benefits as places of residence, economic production from forestry and also roads. A major negative impact is the effect on the movement of migratory fish species and significant conflicts arise in cases where settled land has to be acquired for construction purposes. Disruption to navigation can also be an issue but with careful planning this can normally be mitigated.

## ***Cyclone Forecasting and Warning System***

The existing forecasting system which uses satellite imagery to monitor the formation of cyclone storms is excellent and its capabilities are constantly being upgraded. However, because of the nature of such storms, forecasters are not able to predict the future intensity, speed and direction of such storms. Tropical cyclones frequently change course and or intensity. For public confidence-building in the warning system in future, it will be important to distinguish between the possibility of a cyclone striking Bangladesh and the probability (beyond a reasonable doubt) of land fall, plus its likely target and timing.

As one option, the warning system could be refined to indicate first of all, whether a storm is possible or probable and if probable, when evacuation should begin. In both cases, preliminary preparation could be made and relief supplies collected at the cyclone shelter. Because insecurity of tenure creates tensions, as forecasts become increasingly accurate, only in the most life-threatening (i.e. when residents risk loss of all fixed assets either through theft or cyclonic winds) would full-scale evacuation be required.

Ten cyclone warnings were issued between 1991-1995 of which two were Severe Cyclonic Storm (Hurricane) strength. Though they were all broadcast as "Great Danger" events, in actuality, they developed into events of a very different magnitude. In November 1998 when a cyclone was predicted to hit the central region, widespread TV warnings were issued and CPP volunteers took the step of compelling people to take shelter. This resulted in the forced evacuation of one million people. In the long run, however, coercion of people is not answer. The cyclone did not strike with full force. Some fishermen's lives were lost and crops damaged. In the future, however, if a cyclone advances in that region, will local people respond by going to cyclone shelters? The task will be to improve public access to information about cyclones in the vicinity, the intensity of the storm and likelihood of its landfall. this should bolster public confidence in cyclone warnings with the end result that more lives can be saved.

There are several compelling reasons why people do not go to cyclone shelters. The majority inhabitants in the HRAs are poor and few assets. Unless they are convinced that their lives are in immediate danger and the risk of death to be grater than the risk that their property will be stolen in their absences, they will not leave their houses. According to recent reports, when local people are convinced, (often at too late a stage) that they should evacuate, they will only do so if there is time to put their livestock in a safe place and then reach a known refuge.

## ***Communication***

Accurate forecasting is of no benefit unless the information can be conveyed to the people at risk in a timely manner. The ability of cyclones to quickly change direction

and or intensity makes it particularly important to disseminate update forecasts very quickly.

Short wave radios appear to be the best medium for communicating warning of impending cyclones at local level though reports indicate that the CPP infrastructure is old in some areas, the stations are too far apart for the message to be effectively relayed quickly. It may be advisable to feed information in vulnerable fishing areas especially. In that way, people even in the most remote areas may be made aware of an impending storm. Mosque megaphones can be used to broadcast frequent warnings. Grameen village phone networks do not currently operate in the HRAs so isolated residents will be dependent on community warnings prompted by wireless and mass media broadcasts. Special warning lights for fishermen at sea or flashing beacons on cyclone shelters have been suggested by communities as innovations.

TV and radio broadcasts are effective tools for communication to people in rural centres (markets and shops) though in emergencies, radio transmission may not be relied upon to inform communities. In the 1991 cyclone, the Dhaka radio station ceased broadcasting at midnight just before the cyclone struck. On being hit by the cyclonic force, the Chittagong station (which was expected to stay on air) also ceased to function. Those in the direct path of the storm who would normally listen to radio beamed from Dhaka were not warned about the dear and present danger. Had residents heeded the prior warnings about the storm (which had been tracked for several days in the Bay of Bengal) or been told of the actual impending size and force of the 'super cyclone' on the radio, more people might have been persuaded to take refuge and the death toll reduced.

While not all households have radios, television and public broadcasting channels to disseminate regular updates on cyclones have been used as recently as October 1999 to disseminate the latest forecasts to a large number of people, who can then spread information by word of mouth. Care will be needed to phrase the forecasts in a language and a way which will be understood by the people at risk. It will also be necessary to arrange for stations to stay "on-air" all night during emergency situations.

## **Review of Options**

The following structural and non-structural options are proposed in parallel:

### ***Structural Options***

- (a) Construction of flood-proofed access routes to cyclone shelters (and where necessary, *killas*) from each *para* local area through community contribution and government-NGO subsidy.

- (b) Construction of multi-purpose, multi-storey concrete structures as secular community-owned buildings, e.g. primary school-health centres etc. to act as cyclone shelters rather than be specifically for cyclone refuge.
- (c) The safety and adequacy of existing cyclone shelters be evaluated and possible O&M measures reviewed.
- (d) Local people be encouraged to build community *killas* for livestock refuge, perhaps through the offer of small subsidies where community contribution is pledged.
- (e) Mangrove planting be taken up as a community-managed activity for the purposes of ensuring consensus on land use.
- (f) The efficacy of coastal embankments to prevent tidal surge be reviewed and rehabilitated if found to be advantageous.

### ***Non-structural Options***

- (a) Improve local communities' knowledge of how cyclones strike by teaching the history of cyclones in Bangladesh, when and where they strike and how people can protect themselves, where refuges are and the likely seasons of risk in primary and secondary schools in High Risk Areas, in particular.
- (b) Through the existing network of local volunteers and Disaster Management Committees, initiate discussions about the community-based precautions which should be taken to protect livestock, assets and houses at *para* level, so that even in remote areas, preventive actions can be taken.
- (c) Communities are encouraged to undertake a practice exercise to test the capacity of existing cyclone shelters to accommodate all residents.
- (d) Improve the accuracy and timing of cyclone warnings by adopting a system of sequenced warnings: first, that a cyclone may strike, secondly, that a change to the warning has occurred as more information about the cyclone is gathered and thirdly, emergency actions to take if the cyclone is near to the area and may strike soon.
- (e) Boost confidence of local men and women in the warning system by arranging briefings of each group, in separate meetings, of these changes.
- (f) If necessary in local circumstances, designate certain cyclone centres as women's refuges and appoint volunteer women co-ordinators to link up in an informal women's network, *para* to *para*, and be responsible for alerting women locally.

## CONCLUSION

However, the long-term objective is the construction of sufficient and easily accessible multipurpose cyclone shelters. Other measures to enhance survivability at the community level will need to be developed and should be adapted to local understandings, so the people at risk will be able to better comprehend what is happening and take action accordingly.

While the cyclone forecasting system is well developed, the nature of the warnings issued and the methods of dissemination will need to be adapted to local understandings, and improved, so that the people at risk will be able to better comprehend what is happening and take action accordingly.

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