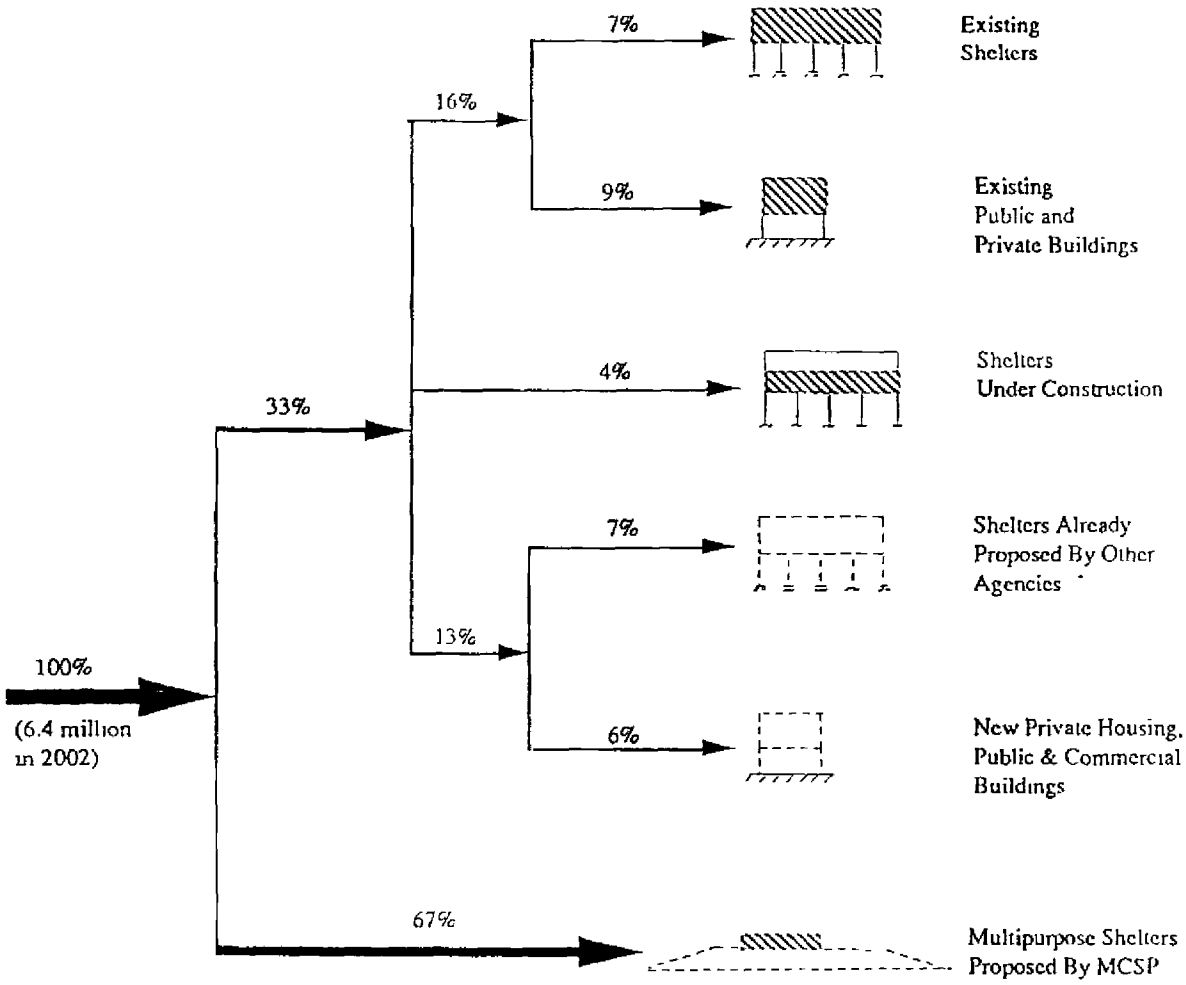

Fig. 7 *Distribution of probable movement of population of HRA to different types of shelter accommodation*

Development of Design of New Shelters

28. One of the objectives of this study is to prepare model plans and designs for multipurpose shelters, which would form the basis of cost estimates to be used in the economic analysis of the MCSP. With this end in view, several preliminary designs have been prepared.

The design criteria for the cyclone shelters have been made on the basis of the following considerations :

- Functional Considerations.
- Climatic Considerations.
- Layout and Spatial Considerations.
- Shape and Formal Considerations.
- Behavioural Considerations.
- Typological Considerations.

Two types of designs of school-cum-shelters have been prepared, viz. shelter-on- killa (Fig. 8) and free-standing shelter (Fig. 9). The preferred design solution is a shelter located on top of a killa. This would enable the people to move in along with their livestock, rather than leaving them unattended in a remote killa. This also appears to be the least cost solution. Three heights of killa, viz. 3m, 4.5m and 6m have been used depending on maximum surge height in the location. The land required for a typical killa (43 m x 43 m at top) including the borrow pit, varies from 0.84 ha (3.0m ht.) to 1.76 ha (6.0m ht.). The total land area required for the 2500 killas is 2867 ha (7084 acres), which is 0.35% of the High Risk Area.

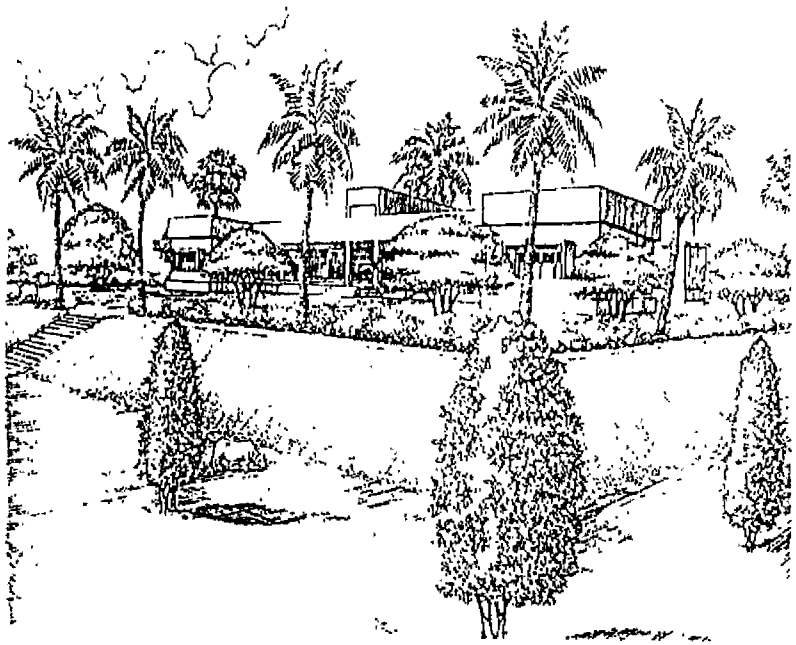

Fig. 8 (a) Perspective of Shelter on Killa

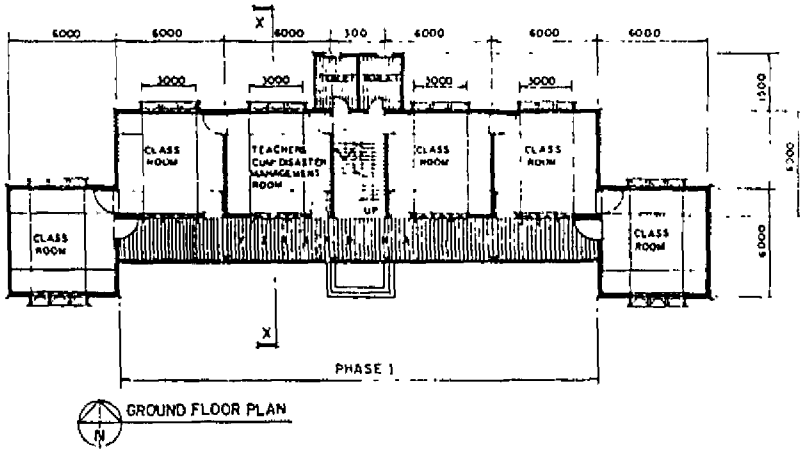

Fig. 8 (b) Plan of Shelter on Killa

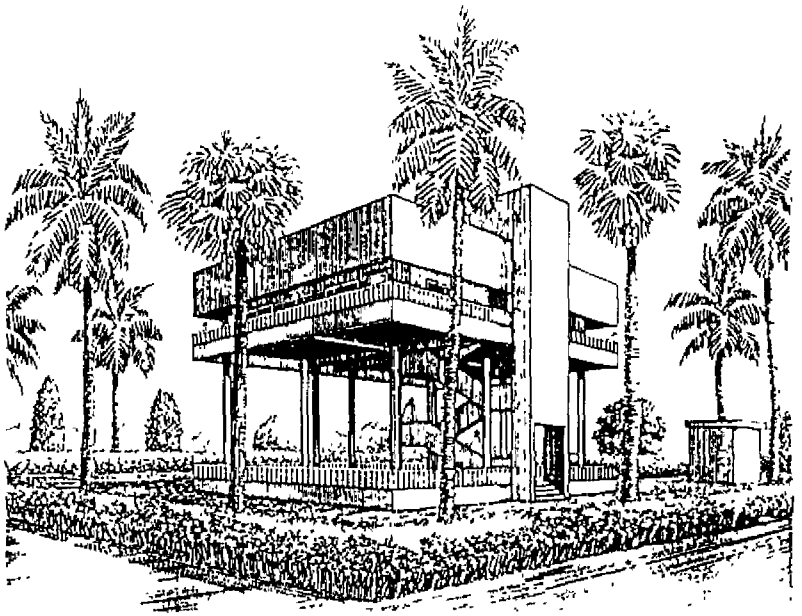

Fig. 9 (a) Perspective of Shelter on Stilts

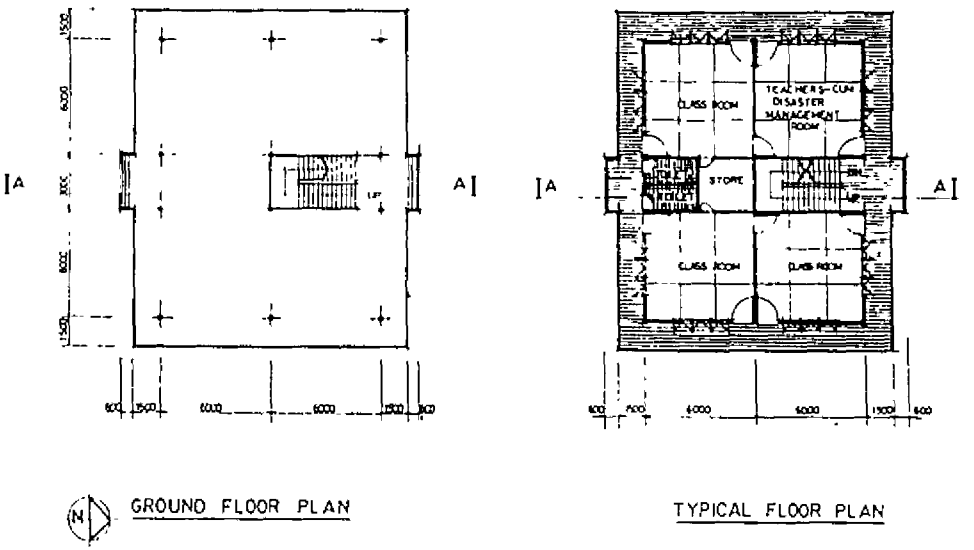

Fig. 9 (b) Plan of Shelter on Stilts

29. Architectural conceptual designs have been prepared for typical 250-student primary schools. In the first phase these schools, run on a double shift basis, would have 3 class rooms and a teachers room. These may later be extended to 5-class room schools. The class room dimensions formed the basic module. The module has been taken as 6m x 6m to accommodate 50 students in each class, which is close to the standard of 0.74 m^2 (8 sft.) per student currently being used by the Facilities Department. Similar student number and space requirements for classrooms have also been proposed by other agencies.

Based on analysis of shelter occupancy during previous cyclones, it has been assumed that, on the average, each person occupies 0.186 m^2 (2 sft.) of floor area; in case of other public/ private buildings the corresponding figure is 0.372 m^2 (4 sft). Adequate storage area has been provided in the verandah as well as inside the rooms.

Access stairs leading to roofs have been provided. Along the entire length of the parapet a canopy has been extended upto 1m within the roof for people to take refuge inside the alcove spaces. In determining shelter capacity, it has been assumed that some people will take shelter on the roof; an area of 0.74 m^2 (8 sft.) per person has been assumed.

There are provisions for vertical extension also, so that other public/community facilities (e g. Post Office, T&T office) may be accommodated.

30. The structural design criteria for the cyclone shelters to be constructed under the Multipurpose Cyclone Shelter Programme have been developed. These criteria should be followed in all future shelters irrespective of design.

The shelters proposed to be constructed on killas have reinforced concrete beam and floor system on brick masonry walls. To minimise the effects of differential settlements, reinforced concrete strip foundation below the walls have been considered. This type of foundation will also allow uniform settlement of the structure, if there is any, due to the settlement of the soil over which the killas will be constructed. In addition to such reinforced concrete foundation, the structural design has been made considering reinforced concrete columns at each corner of the rooms of the proposed buildings. These columns with the minimum reinforcements as per codes of practice have been considered as an integral part of the masonry wall. At the roof level these columns will be connected by beams in both the directions forming the frames with infill masonry walls.

Water Supply and Sanitation Facilities

31. In the design of a water supply system for new shelters, hydrogeological conditions, water quality constraints, source problem intensities, present water consumption patterns and alternative water supply options in the coastal areas have been given due consideration In most areas where deep and shallow tubewells are successful due to availability of low-saline water bearing aquifers, the water supply for shelters will be developed through installation of manually operated deep and shallow tubewells with a supplementary rainwater cistern system. In few shelter locations, community type Iron Removal Plants (IRP) attached to tubewells will be required to reduce iron content of ground water to acceptable level. In the ground level a small sump is made near the tubewell with a manually operated pump to raise water occasionally to roof level water tank-cum-rainwater reservoir. In areas where ground water of salinity lower than the acceptable level is not available, Slow Sand Filter (SSF) units will be installed to treat available low-saline surface water to produce water of acceptable quality for water supply in cyclone shelters. In the supplementary rainwater system, the rainwater from the roof will be used for flushing toilets. The rainwater from the roof of the stair will be collected in water tank-cum-rainwater reservoir for drinking purpose.

Shelters on killas are designed with two attached toilets intended for exclusive use in cyclone time. Rain water from the roof will be collected in water tanks placed on the lower roofs of toilets and the excess water will be used to clean the toilet in a continuous flow. Tubewell water stored in a separate tank shall be used for drinking purpose during and after the cyclone period.

Design of New Killas

32. In order to protect the livestock from storm surge, killas or earthen mounds, with the top level raised above maximum probable surge height, appear to be the least cost solution. From planning

point of view, an integrated solution with a shelter on top of a killa appears to be the best solution The area required for sheltering the cattle and goat/sheep in the catchment area of a shelter has been calculated. The areas required for an average ovine and bovine have been assumed to be 1.2 and 0.4 sq.m. respectively. For almost all the Unions, the net area available on top of a standard killa (1200 sq.m) is adequate to meet the needs of livestock shelter. In some Unions, it may be necessary to have a larger killa, but the total number of such cases would be very small. In some newly accreted land, where there is an influx of transient agricultural labour during harvesting season, a small number of killas may have to be built to protect human lives. The dimensions of all types of killas proposed together with dimensions of borrow pits are shown in Table 13.

Table 13 Killas and Borrow Pit Dimensions

(All dimensions in metres)

Killa Type	Height	Dimensions of Killas (Square in Plan)		Dimensions of Borrow pit (Square in Plan)		Land required in hectares
		Top	Bottom (*)	Top	Bottom(*)	
K-1 (Shelter on top)	3.0	43	55	59	49	0 84
K-2 (Shelter on top)	4.5	43	61	75	65	1.22
**K-3 (Shelter on top)	6.0	43	71	93	83	1.76
K-4	3.0	38	50	54	44	0.71
K-5	4.5	38	56	69	59	1.05
**K-6	6.0	38	66	87	77	1.56

* *Side slope = 1:2 , depth of borrow pit = 2 5 m*

** *Killas with 6m height will have a berm of 2m all around at mid level.*

33. Considerable advantage in terms of cost and function can be achieved if cyclone shelters are built on properly compacted killas. In addition well-compacted killa would provide a stiff layer on otherwise soft soil and add to the stability and provide uniformity in settlement of the constructed structure.

Cost Estimates for Shelters

34. Detailed estimates have been made of the costs of typical shelter on killa and shelter on stilts. Designs have been prepared for there heights of stilts and three values of soil bearing capacity (viz. 37, 49 and 74 kPa). The cost per sq. metre varies from Tk. 8,829 to Tk. 9,943 of SOK and Tk. 11,719 to Tk. 13,959 for shelter on stilts. In determining project cost estimates it has been assumed, based on field survey, that 60% of the shelters may be built on killas and 40% of the shelters on stilts (with a killa built separately). The cost of a killa varies from Tk. 0.51 to 1.11 million including land cost (Table 19).

Table 14 Cost Estimates for Proposed Shelter on Killa

Shelter Type	Bearing capacity of soil assumed, kPa (psf)	Civil Engineering cost in Taka	Water Supply & Sanitation cost in Taka	Total cost in Taka	Cost/m^2 (Cost/ft^2) in Taka
A1	37 (750)	2,340,000	275,000	2,615,000	9,943 (924)
A2	49 (1000)	2,180,000	275,000	2,455,000	9,335 (868)
A3	74 (1500)	2,047,000	275,000	2,322,000	8,829 (821)

Table 15 Cost Estimates for Proposed Shelter on Stilts

Shelter Type	Stilt height m	Bearing capacity of soil assumed kPa (psf)	Civil Engineering cost in Taka	Water Supply & Sanitation cost in Taka	Total cost in Taka	Cost/ m^2 (Cost/ft^2) in Taka
D11	3.5	37 (750)	3,140,000	300,000	3,440,000	12,741 (1,184)
D21	5.25	37 (750)	3,232,000	300,000	3,532,000	13,081 (1,216)
D31	7.0	37 (750)	3,469,000	300,000	3,769,000	13,959 (1,297)
D12	3.5	49 (1000)	2,951,000	300,000	3,251,000	12,041 (1,119)
D22	5.25	49 (1000)	3,078,000	300,000	3,378,000	12,511 (1,163)
D32	7.0	49 (1000)	3,342,000	300,000	3,642,000	13,489 (1,254)
D13	3.5	74 (1500)	2,864,000	300,000	3,164,000	11,719 (1,089)
D23	5.25	74 (1500)	2,964,000	300,000	3,264,000	12,089 (1,124)
D33	7.0	74 (1500)	3,229,000	300,000	3,529,000	13,070 (1,215)

Communications

35. The overall communication network in the study area, mostly served by road and water transport, is relatively less developed compared to the rest of the country. The problems have been reviewed and improvements in road network and construction of jetties have been suggested. The criterion adopted after consultation with local people is that the approach road should be of such standard as to allow at least 3-wheeled Rickshaw Vans to ply over it. On the basis of field survey, it has been estimated that an average of 80m of new road would be necessary for each shelter.

    On the basis of review of reports of earlier studies, examination of communication linkages in the study area, discussion with concerned people and information obtained through field surveys conducted for this study, a total of 1459 km of roads required in the RZ have been identified.

36. Most of the coastal islands (except Maheshkhali) do not have any acceptable form of port facilities such as jetties. The movement of passengers and freight between islands and from island to mainland are constrained for want of such facilities. It is proposed that jetties be constructed on the islands of Sandwip, Hatiya, Kutubdia and Bhola. A supplementary jetty may be constructed on the mainland at Kumira. A minor jetty was also proposed for the island of Manpura in Bhola district. Location, type, estimated length and brief comments on respective jetties are given in Table 16.

37. During the past cyclones, helicopters have been used extensively in post-disaster relief works. By FY 1990-91, construction of 190 helipads were completed and 96 others in various stages of construction in the whole of Bangladesh. Among the completed helipads only 8 are in the study area. It is also reported that the construction of one helipad each at Lalmohan (Bhola district), Hizla and Mehendiganj (Barisal district) is nearly complete. In addition two airports in Chittagong and Cox's Bazar can also be used by the helicopters.

Table 16 Proposed New Jetties

Location	Priority Rating	Suggested Type of Jetty	Estimated Length x Width (m x m)	Brief Comments
Sandwip west	1	R.C. Deck on Perm. Supports	150 x 4	Provides link with Chittagong and Dhaka route. Can service main town of Sandwip. Present access to island at this point is very difficult
Sandwip east	2	R.C. Deck on Perm. Supports	350 x 4	Provides link with mainland and is shortest route. Most convenient. East side of Sandwip is less affected by erosion
Kumira	2	R.C. Deck on Perm. Supports	300 x 4	
Hatiya	3	R.C. Deck on Perm. Supports	200 x 4	Little access to any major city/town. Need to connect with Dhaka-Chittagong route. Improves communications.
Kutubdia	4	R.C. Deck on Perm. Supports	150 x 4	Provides link with Chittagong and Cox's Bazar Route. Economic need.
Daulat-khan	5	R.C. Deck on Perm. Supports	300 x 4	At Daulatkhan, very busy area, large number of fishing boats and ships anchor here. Exchange point for ships, pilot and captain.
Manpura	6	Wooden	100 x 4	Smaller of the islands. Within large fishing are. Need to attract commerce.

Source : SMEC, 1991

Plantation

38. On the basis of review of coastal afforestation programmes, the Consultants have recommended planting of various types of trees along coastal embankments, around homesteads and cyclone shelters and killas (Table 17 and Figs. 10 to 11). These would not only help in reducing the fury of cyclones and storm surge, but also lead to overall improvement in the environment. The Cyclone Shelter Master Plan (CSMP), being primarily concerned with shelters and killas, includes only the part of tree planting around shelters and killas. Coconut and Jhau *(Casuarina equisetifoila)* could be planted in large scale around shelter; shrubs (e.g. Dhol Kalmi, Sada Akanda, Keya and Hoglapata) and trees (e.g. Babla, Shonboloi, Akashmoni, Ipil-Ipil and Coconut) would be planted around the edges of killas.

Lighting

39. The stationary lighting needs for shelters as well as mobile lighting needs for movement and rescue operation have been investigated. While the present practice of use of dry cell battery-operated torch lights by CPP volunteers may continue for meeting the needs during movement to shelters, different solutions, e.g. solar photo-voltaic (PV) system and kerosene generator, may be adopted depending on the normal time use of the shelter facilities at night . An approximate indication of cost is also included. A solar PV system may be used for shelters which have normal time use at night (e.g. as community centres, adult literacy centres). The estimated cost for provision of lighting in all the shelters is Tk. 273 million; this has been included in the project cost estimate.

Table 17 Choice of Species

Coastal Accretions

Keora *(Sonneratia apetala)*
Baen *(Avicennia officinalis)*
Gewa *(Excoecaria agallocha)*
Kankra *(Bruguiera gymnorrhiza)*
Goran *(Ceriops decandra)*
Golpata *(Nypa fruticans)* (on river and stream banks where sweet water flows)

Sandy Beach

Jhau *(Casuarina equistifolia)*
Coconut *(Cocos nucifera)*

Coastal Embankment

Shrubs
Dhol Kalmi *(Ipomoea fistulosa)*
Shada Akanda *(Calotopis procera)*
Keya *(Pandanus odoratissimus)*
Hoglapata *(Typha angustata)*

Trees
Babla *(Acacia nilotica)*
Akasmoni *(Acacia auriculiformis)*
Jhau *(Casuarina equisetifolia)*
Shon bolai *(Thespesia populnea)*
Ipil-ipil *(Leucaena leucocephala)* (Not in acid soil)
Khaiya Babla *(Pithocellobium dulce)* (Not in acid soil)
Sisoo *(Dalbergia sisoo)* (For non-saline and neutral to alkaline soil only)
Sonalu *(Cassia fistula)*
Date palm *(Phoenix sylvestris)*
Coconut *(Cocos nucifera)* (where protection is assured)

Homesteads

Timber trees
Raintree *(Samanea saman)*
Koroi *(Albizzia spp.)*
Mahogony *(Swietenia spp.)* (In mainland of Patuakhali, Bhola and Noakhali)
Sisoo *(Dalbergia sisoo)* (In mainland of Patuakhali, Bhola and Noakhali)
Shon boloi *(Thespesia populnea)*
Shimul *(Bombax ceiba)*

Fuelwood and Fodder
Akasmoni *(Acacia auriculiformis)*
Babla *(Acacia nilotica)*
Jhau *(Casuarina equisetifolia)*
Ipil-ipil *(Leucaena leucocephala)* (Not in acid soil)
Khaiya babla *(Pithocellobium dulce)*

Horticultural Species
Coconut *(Cocos nucifera)*
Date palm *(Phoenix sylvestris)*
Palmyra palm *(Borassus flabellifer)*
Jam *(Syzygium cumini)*
Tetul *(Tamarindus indica)*
Am *(Mangifera indica)*
Payara *(Psidium guajava)*
Chalta *(Dillenia indica)*
Bel *(Aegle marmelos)*
Amra *(Spondius pinnata)*
Lebu *(Citrus spp.)*
Bamboo *(Bambusa spp.)* (Baijja bansh)

Cyclone Shelters

Coconut *(Cocos nucifera)*
Jhau *(Casuarina equistifolia)*

Killas

Shrubs (For the edge of the killa)
Dhol Kalmi *(Ipomoea fistulosa)* (on extreme sites)
Keya *(Pandanus odoratissimus)*
Hoglapata *(Typha angustata)*

Trees
Khaiya babla *(Pithocellobium dulce)*
Shon bolai *(Thespesia populnea)*
Akashmoni *(Acacia auriculiformis)*
Sisoo *(Dalbergia sisoo)* (For non saline, and neutral to alkaline soils)
Ipil-ipil *(Leucaena leucocephala)* (Not in acid soil)
Coconut *(Cocos nucifera)*

Educational and Religious Institutions

Coconut *(Cocos nucifera)*
Jhau *(Casuarina equisetifolia)*
Mahogony *(Swietenia spp.)* (In mainland of Patuakhali, Bhola and Noakhali)
Koroi *(Albizzia spp.)*

Road and Canals

Mahogony *(Swieteria spp.)*
Sisoo *(Dalbergia sisoo)*
Koroi *(Albizzia spp.)*
Raintree *(Samanea saman)*
Coconut *(Cocos nucifera)*
Date palm *(Phoenix sylvestris)*
Golpata *(Nypa fruticans)* (where sweet water flows)

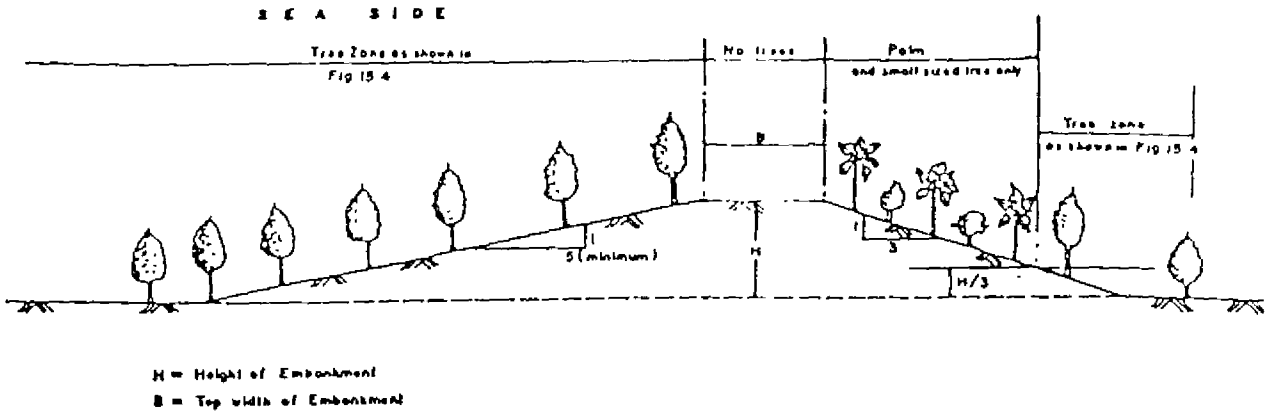

Fig 10 Schematic Diagram of Afforestation on Seafacing Coastal Embankments

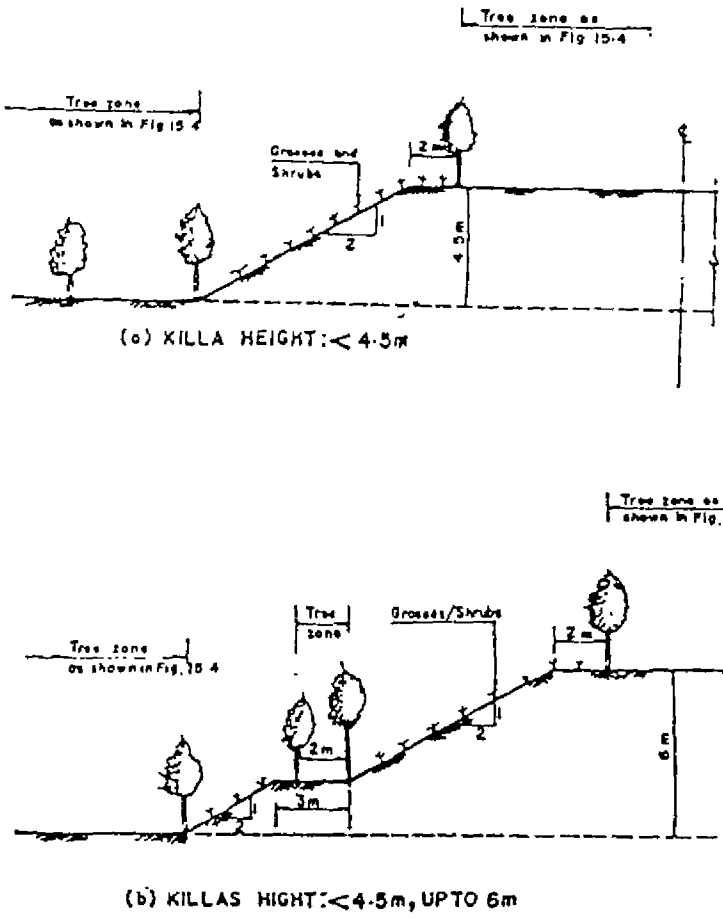

Fig 11 Schematic Diagram for Afforestation in Killas

Telecommunication

40. The existing telecommunication network of BTTB, implemented under a sub-project of the IDA-financed Coastal Area Rehabilitation and Cyclone Protection Project during 1972-79, is primarily based on VHF/UHF network of 12 UHF 24-channel system, 16 VHF base stations, 67 fixed VHF PCOs and 40 maritime mobile PCOs. Apart from these, 5 more VHF bases with 30 more PCOs have been added to this network in recent years. Cox's Bazar-Chittagong and Barisal-Khulna microwave links connected with Dhaka, serve as the back bone of the existing telecommunication facilities in the coastal region of Bangladesh. A preliminary review of the various available wireless technologies e.g. Satellite Technology (with VSAT), VHF/UHF communication and HF communication has been carried out to recommend a suitable telecommunication network for the coastal region. The network should be capable of providing normal telecommunication service to the area as well handling disaster-time emergencies. The preliminary studies show that the most likely network for this coastal area would be a VHF/UHF fixed cellular type of network. A cell around a Thana area having a Thana Base Station (TBS) will consist of about 100 or so terminals designated as PCOs/subscribers situated at the cyclone shelters. These terminals would be connected by VHF with the TBS while the TBS would be connected by UHF link with a Zonal Station situated on the mainland connected with the national microwave link. The network would thus represent itself as a double star network. By increasing the cell radius the number of cells could be reduced

The approximate cost of a cell with 100 cell terminals, a TBS and a UHF link with the zonal station is about US $ 7,83,000. The total cost for the whole system in the region would depend on the number of cells and terminals. The Consultants recommend that a VHF/UHF fixed-cellular type communication network, with around 50 cells may be adopted in the Study Area. The cost of telecommunication has not been included in the Project cost estimates.

Community Development

41. In order to make the use of cyclone shelters (CS) more effective during normal time, so as to ensure better maintenance and greater emergency time use, community development activities, including involvement of women, have been proposed. The activities proposed for a shelter include identification of Catchment Area (CA), formation of a Community Development Committee (CDC), preparation of a Community Emergency Plan, awareness creation and education, training of volunteers and an annual drill. The CA concept is central to the planning and execution of the Community Development Programme. The definition of a CA will have 3 steps :

a) Enumeration
b) Delineation
c) Designation

In the Enumeration step the list of Primary or Secondary school students will be used to locate and enumerate their family members and dependents.

The next step will be to delineate the boundary of the CA through a simple sketch map. The map will show the location of the school, the roads and paths giving access to it and the approximate location of the houses of the families of the students. The third step will be to designate the persons within a specific CA. This list may include not only family members of the schools students but also families without any school-going children and merchants, officials and resident workers who may be living without family members in hats and bazars within the CA.

A source of complication present is the presence of large number of migrant labourers during the first cyclone season (April-June). Over time this influx may be reduced due to population growth in the HRA itself, but over the next decade their numbers may be substantial. A cost effective solution may be to designate certain killas for their refuge during cyclones.

A number of shelter-based community development activities have been identified, with particular emphasis on participation of women. Non-formal education and other training programmes may be run by NGOs using the shelter facilities. There is also the scope to introduce many different types of income generating activities centred in and around the CS. This will perforce have to be a gradual development and has to be led by BRDB and NGOs (e.g. Grameen Bank, BRAC or other local NGOs). The borrow-pits adjacent to killas can be used for organized pisciculture and the income generated may contribute towards maintenance of the shelter facility. The formation of a

Community Development Committee (CDC) in each CA will be the first step towards building a sense of community between the families in the area.

The CDC will consist of three Sub-committees as follows :

1) Shelter Management
2) Community Development
3) Post Cyclone Relief and Rehabilitation

It is proposed that Sub-committee (1) be headed by the Head of the Institution which is the main user of the building (e.g. the head teacher of the primary school if the cyclone shelter is a primary school) The Secretary of this Sub-committee will be chosen by the committee.

Sub-committee (2) may be headed by a local elite who is also in the CDC as representative of the guardians. The CPP volunteer in the CDC will act as the secretary of this Sub-committee.

Sub-committee (3) may be headed by the Ward Member of the Union Parishad, with the CPP volunteer or one of the school teachers as the Secretary.

Shelter Management

42. The responsibility of Shelter Management may be entrusted with Community Development Committee, who will also co-ordinate the plans for evacuation along with CPP volunteers. The Headmasters of the educational institutions, who are responsible for operation of the facilities during normal time, would also be designated as Shelter Managers. This would be included in their charter of duties. Additional remuneration may be provided to them for this additional responsibility. Where Primary School or Madrasas are designated as CS, the CDC will consist of the School/Madrasa Management Committee and four other members. If the CS is in a college or Government Institution other than a Primary or Secondary School the CDC will consist of seven members. In both cases there will be representative of CPP and BRDB. Management Committees should include local NGOs and at least two members of their CDC should be women. As for CS managed by NGOs, it is recommended that their CDCs include representative of CPP and the Union Parishad.

Warning System

43. The Consultants have reviewed the present cyclone warning system Responses received during field survey indicate that local people have difficulties in interpreting the present signals. The systems used in other countries have been reviewed and suggestions for improvement have been made. The officials and volunteers of Cyclone Preparedness Programme (CPP) rendered valuable service in dissemination of warning and assisting people to move to safer places during 1991 cyclone. The expansion of the CPP activities to all the areas under HRA and strengthening of their facilities have been recommended.

Implementation of Multipurpose Cyclone Shelter Programme

44. Detailed engineering specifications for construction of new shelters have been prepared. A combination of Lump Sum and 'measure and value' contracts has been recommended. Based on detailed assessment of capability of local contractors, the consultants have concluded that the construction of the shelters and killas may be undertaken by the local contractors. LCB (Local Competitive Bidding) procedure, after proper pre-qualification of contractors, is recommended However, in order to attract the more competent larger contractors, the bid-packages should be based on a cluster of shelters.

45. The implementation of the Master Plan may commence in FY 1994-95 and it should be possible to complete the construction of all the shelters and killas by the year 2000. Based on a prioritisation exercise, it has been proposed that 1250 shelters would be in Priority 1 (i.e. *most severy affected areas*) and 1250 shelters would be in Priority 2 (i.e. *severely affected areas*).

46. The organizational structure and capabilities of the three major agencies of the Government currently involved in building construction (viz. PWD, Facilities Department and LGED) have been analyzed. To undertake implementation of the proposed programme, setting up of a separate organisation, namely "Cyclone Shelter Construction Organisation" (CSCO) is suggested. Since implementation of the programme requires coordination among a number of agencies, CSCO may be placed under the Prime Minister's office or at a central location. An alternative may be having a

lean CSCO responsible for co-ordination and monitoring, with PWD, LGED and Facilities Department acting as the executing agencies. The repair and rehabilitation of existing shelters and killas may be undertaken immediately and the Consultants recommend that LGED (which has engineers already posted at Thana level) should be entrusted with this responsibility.

Environmental Studies

47. The coastal environment of Bangladesh is very sensitive to human intervention. The ecological, physico-chemical and human interest components of the environment and the likely impacts of MCSP on them have been evaluated through extensive environmental reconnaissance and summarized in Table 18. The Initial Environmental Examination shows no major negative impact and in general most of the impacts are positive in nature. Mitigation measures have been identified for incorporation in planning, design and implementation phases of the programme to eliminate, reduce and offset the negative impacts of MCSP.

Table 18 Environmental Impact of Multipurpose Cyclone Shelter Programme

Sl. No.	Environmental Parameters	Degree of Impact	
		Positive	Negative
	ECOLOGICAL		
1	Forest/Plantation	Low	Low
2	Fish Culture	Moderate	
3	Livestock	High	
	PHYSICO-CHEMICAL		
4	Environmental Pollution	Moderate	Low
5	Drainage Congestion		Low
6	Storm Surge Reduction	Moderate	
7	Construction Hazards		Low
8	Erosion and Accretion		Low
	HUMAN INTEREST		
9	Employment	Moderate	
10	Agricultural Land Loss		Moderate
11	Community /Social Benefits	High	
12	Settlement on Newly Accreted Lands		Moderate
13	Water Supply and Sanitation	Moderate	
14	Coastal Fishing	Low	
15	Landscape		Low

Economic Study

48. For economic analysis the MCSP is divided into two components, viz., cyclone shelters and killas Since the benefits and costs of killas, which aim at saving livestock during storm surges, can be valued in terms of money, the technique of benefit-cost analysis can be followed to evaluate that component of the project. In case of cyclone shelters, the principal aim is to save life which cannot be assigned any monetary value. The present consensus among the economists is that estimating the value of life by either productivity or insured sum is misleading. In such a situation, the technique of cost-effectiveness (C/E) is the appropriate technique The C/E ratio used in this study is (present valued) cost per life year gained adjusted by the quality of life.

49. Since major storm surges occur very infrequently, the cyclone shelters are planned to be used as primary schools. health care centres etc. during non-cyclone period. As a result benefits from constructing, repairing and rehabilitating shelters will flow from two sources : (i) use during storm surges—the benefit includes lives saved; and (ii) use during non-cyclone period—the benefits include primary education, health care services, community development activities etc.

50. A technique which may be called "residual cost-effectiveness approach" has been followed. In this approach, the principal goal of the programme is identified as adding quality adjusted present valued life years. To deal with the other benefits from the project, say primary education, the cost to construct a primary school building is calculated. Assuming that primary education is economically viable, this cost is then subtracted from the total project cost. This residual divided by the quality adjusted present valued life years prolonged is the residual C/E ratio.

51. In conformity with the current practice, all benefits and costs are valued at border prices for economic analysis. The conversion factors used in this report have been worked out by the Planning Commission and are used in the GOB approved projects. The rate of discount used in economic analysis is 12 per cent.

52. On the basis of a set of realistic assumptions, three scenarios . high, medium and low estimate of loss of lives and livestock have been constructed. These numbers have been used in the sensitivity analysis to estimate the cost per life year prolonged and IRR.

53. The costs of the project have been divided into four broad groups . (i) Construction of new shelters; (ii) Construction of new killas; (iii) Repair and rehabilitation (R & R) of existing shelters; and (iv) Repair and rehabilitation (R & R) of existing killas. The economic cost of these categories has been estimated separately. The unit financial and economic costs of killas and shelters are shown in Table 19. In estimating the economic cost of Shelter on Killa (SOK) type shelter, a portion of the cost of killa on which the shelters will be constructed has been included in the cost of SOKs. This adjustment reduces the cost of sheltering livestock and increases the cost of sheltering population.

Table 19 Unit Financial & Economic Cost of Killas and Shelters

(Thousand Taka) --

Type of killas and shelters	Number of units	Unit financial cost	Unit economic cost
K1: 3.0 m ht, 43x43 m on top	590	506.539	311.080
K2: 4.5 m ht, 43x43 m on top	518	825.878	512.260
K3: 6.0 m ht, 43x43 m on top	392	1,273.939	831.870
K4: 3.0 m ht, 38x38 m on top	394	413.258	311.080
K5: 4.5 m ht, 38x38 m on top	345	682.678	512.260
K6: 6.0 m ht, 38x38 m on top	261	1,111.287	831.870
S O K: Shelter on top of Killa	1500	3,288.000	2,535.000
D12: Shelter on 3.5 m stilt	394	4,266.000	3,094.000
D22: Shelter on 5.25 m stilt	345	4,427.000	3,208.000
D32: Shelter on 7.0 m stilt	261	4,748.000	3,436.000
Existing killa	146	59.521	43.431
Existing shelter	226	671.495	505.853

Note. The financial cost includes the cost of materials and labour, water supply, sanitation, lighting, transportation, supervision and access road. Unit economic cost has been derived from financial cost using conversion factors estimated by the Planning Commission. The basic cost of construction of shelters includes cost of water supply and sanitation and lighting. This has been enhanced by 10% to cover cost of transportation to the project sites.; 12.5% of the total cost upto this stage has been added as cost of supervision. Finally, cost of access road at the rate of Tk. 0.12 million per shelter has been added.

Considering the time required for pre-construction activities, the construction of new shelters and killas and R & R of existing shelters and killas have been phased and the financial and the economic cost of construction as well as R & R of killas and shelters have been worked out.

The total financial cost of construction and R & R of the project has been estimated at Tk. 11,454 million at 1992-93 prices (or US dollar 286 million). This includes Tk. 9,379 million for new shelters , Tk. 152 million for existing shelters, Tk. 1,914 million for new killas and Tk. 9 million for existing killas. (The costs of new roads, jetties and telecommunication have not been included).

54. The average annual financial cost of maintenance of shelters and killas comes to approximately Tk. 24,840 and Tk. 9,050 respectively. Funding for maintenance of cyclone shelters may originate from three sources: (i) grant from the central government; (ii) contribution of local government (Union Parishad); and (iii) earning from shelter-based income generating activities. It appears that the major share of the cost of maintenance of shelters will have to be borne by the central government.

55. The valuation of bovine and ovine animals saved can be made in two ways : direct and indirect. The direct method is to value the bovine and ovine animals saved with world (international) import prices of live bovine and ovine animals. The indirect method is to value the components of loss by

world import / export prices. These components are : i) meat, ii) hides and skin, iii) milk, iv) loss of agricultural output.

Table 22 presents the economic IRR and NPV of the new and existing killas. Benefit-1 and Benefit-2 represent direct and indirect method of valuation respectively.

Table 20 IRR and NPV of Existing and New Killas

(NPVs in million taka)

	Benefit - 1			Benefit - 2		
	Low	Medium	High	Low	Medium	High
New - IRR	33 76	38.99	45.73	22.30	24.48	27.20
NPV	1714.645	2048.117	2447.815	891.243	1059 885	1262.030
Existing-IRR	-	-	-	164.45	238.31	414.33
NPV	180.583	205.345	235.042	119.408	131.917	146.921

It can be seen from Table 20 that the killa component of the project is economically viable. While the "cut-off" discount rate is 12 per cent the lowest IRR comes to 22 3 per cent.

56. Cost-effectiveness (C/E) ratios of various life saving programmes have been estimated on the basis of government expenditure. Life saving programmes studied include health care (preventive and curative), provision of safe drinking water, improved sanitation and road transport safety. The C/E ratios of various life saving programmes at economic cost are shown in Table 21.

Table 21 Cost-Effectiveness Ratios of Various Life Saving Programmes

(taka)

Programme	C/E ratio at economic cost	Programme	C/E ratio at economic cost	
			Scenario-1	Scenario-2
I. Expanded Programme on Immunization (EPI)	36.82	V. Disease-specific treatment		
		1. Tuberculosis	1228.41	1474.09
		2. Cancer	9397.18	11276.62
		3. Bronchitis	273.35	328.01
II. Safe drinking water		4. Diarrhoeal diseases	31.22	37.44
1. Shallow tube-well	49.75	5. Bone-fracture	163.33	195 98
2. Tara tube-well	104.53	6. Eye disease	295.90	355.07
3. Deep tube-well	221.99	7. Hypertension	1292.16	1550.60
		8. Jaundice	409.39	491.27
III. Improved sanitation		9. Ulcer in abdomen	1058.60	1270.31
1. 1 slab & 1 ring latrine	38.22	10. Gallbladder stone	157.97	189.58
2. 1 slab & 5 ring latrine	92.79	11. Kidney disease	12042.00	14450.40
		12 Leprosy	1246.60	1495.92
		13. Gynae disease	244.97	293.96
		14. Asthma	1558.69	1870.42
IV. Road transport safety	370.36	15. Cardio-vascular disease	359.43	431.32
		16 Schizophrenia	849.12	1018.94
		17. Diabetes	807.08	968.49

Note : Scenario-1 : Considering fixed cost as 25% of operating cost
Scenario-2 : Considering fixed cost as 50% of operating cost

C/E ratios of new and existing shelters have been estimated separately. In estimating the residual C/E ratio, only the cost of construction of a primary school has been subtracted from the weighted average cost of a new shelter although the shelter is likely to be used for other purposes as well during normal time. The residual C/E ratio thus over estimates the cost of saving lives.

The cost-effectiveness ratio for the cyclone shelters is sensitive to the cost of construction of primary schools in the coastal areas. The Facilities Department of the Ministry of Education follows a number of designs for the construction of new primary schools in the rural areas throughout the whole country. These schools are not designed to withstand cyclones and surges. The Consultants

have developed a design for primary school which is suitable for the High Risk Areas. The financial cost of constructing these type of schools is estimated at Tk. 1 84 million. The adjusted C/E ratios, based on consultants design, are presented in Table 22. The C/E ratios show that if the adjusted C/E ratios for the new cyclone shelters are lower than or close to that of a number of life saving programmes the government.

Table 22 Adjusted C/E Ratios for New Shelters

	Estimate -1				Estimate - 2			
	Medium*		High*		Medium*		High*	
	90%	100%	90%	100%	90%	100%	90%	100%
Without adjustment	7,082	6,374	3,219	2,897	5,089	4,580	2,171	1,954
With adjustment **	3,187	2,868	1,449	1,304	2,290	2,061	977	879

* *90% and 100% indicate the probability of survival of those persons who are likely die without cyclone shelter.*

** *Net cost-effectiveness ratio for saving life, i.e., (total cost - cost of school) ÷ PV of life years prolonged.*

In addition to providing shelter, loss of life (and property) can be reduced to a considerable extent by constructing coastal embankment and afforestation and by enhancing amount of investment in transportation facilities including roads, culverts, bridges, which would facilitate movement of people during storm surges and thus reduce the extent of loss of life. Among the policy of direct interventions, the government may consider a programme of subsidizing construction of shelter quality private housing. The government may decentralize location of government buildings as well as redesign and reinforce the existing public/community buildings located in the HRA. In the short run, however, construction of new shelters and killas may be the only option available to the government for providing shelter to human beings and livestock during storm surges. It would be risky to keep the coastal population exposed to surge hazard while pursuing the other alternatives.