JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

LOCAL GOVERNMENT ENGINEERING DEPARTMENT,
MINISTRY OF LOCAL GOVERNMENT, RURAL DEVELOPMENT
AND COOPERATIVES,
THE PEOPLE' S REPUBLIC OF BANGLADESH

# BASIC DESIGN STUDY REPORT
# ON
# THE PROJECT FOR THE CONSTRUCTION OF MULTIPURPOSE CYCLONE SHELTERS
# IN
# THE PEOPLE' S REPUBLIC OF BANGLADESH

APRIL, 1993

JAPAN ENGINEERING CONSULTANTS CO., LTD.

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## PREFACE

Upon receipt of a request from the People's Republic of Bangladesh (Bangladesh), the Government of Japan decided to conduct the Basic Design Study for the Project for the Construction of Multipurpose Cyclone Shelters in the People's Republic of Bangladesh (the Project) and commissioned the Japan International Cooperation Agency (JICA) to conduct the study.

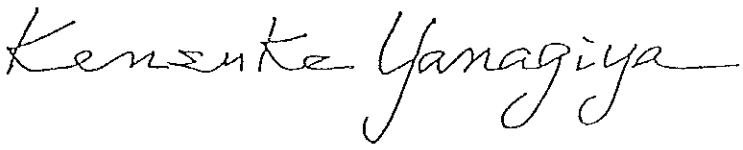
JICA dispatched the First Basic Design Study Team headed by Masashi Kono, Assistant Director of the Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs, and the Second Basic Design Study Team headed by Masayuki Watanabe, an international cooperation specialist of JICA, to Bangladesh for the periods between October 31st and December 9th, 1992 and between January 21st and February 19th, 1993 respectively to conduct field surveys.

The members of both Study Teams held discussions with officials of the Government of Bangladesh and conducted various surveys in the project area. On their return to Japan, the Study Team members conducted the relevant domestic work and surveys and a mission headed by Masayuki Watanabe was dispatched to Bangladesh for the period between April 3rd and April 12th, 1993 to explain the contents of the Draft Report. The Final Report has now been completed upon receipt of the approval of both the Government of Bangladesh and the Government of Japan.

It is sincerely hoped that this report will contribute to the promotion of the Project and also to the enhancement of the friendship between the 2 countries.

Finally, I would like to express my utmost gratitude to the people and organizations related to the Project for their kind cooperation and assistance.

April, 1993



Kensuke Yanagiya
President
Japan International Cooperation Agency

April 1993

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency

Letter of Transmittal

Dear Mr. Yanagiya,

We are pleased to submit to you the Basic Design Study report for the Multipurpose Cyclone Shelter construction Project in the People's Republic of Bangladesh. This report contains the basic design formulation for cyclone shelter construction in consideration to suggestions and added advice from the Government of Japan and your agency. Also included in this report are comments made by the Local Government Engineering Department, Ministry of Local Government, Rural Development and cooperatives, the Government of Bangladesh, which were made during technical discussions for the draft report which were held in Dhaka.

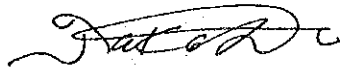
The aim of this study is to carry out the basic design, and to evaluated the appropriateness of Japanese grant aid for the construction of 10 cyclone shelters as means of disaster prevention and the preservation of human life in Bangladesh.

As you are aware the study team in October 31, 1992 began executing two phases for site surveys and explanation study for this project from which the draft final report was compiled and further revised to accomplish the aim of this study in the form of final report.

In view that cyclone shelters will be able to save human life during the occurrence of a cyclone an that these same shelters will be used as educational facilities during normal weather conditions the viability of the Project is deemed high and the implementation of this project through Japan's grant aid system is considered appropriate. We are therefore hopeful that thiis report will contribute to the promotion and initiation of this report.

We would like to take this opportunity to express our sincere gratitude to your agency, and to the Ministry of Foreign Affairs for your kind assistance. We also wish to express our deep gratitude to the Local Government Engineering Department and to other authorities concerned in the Government of Bangladesh for their closes cooperation and assistance extended in the Government of Bangladesh for their close cooperation and assistance extended to us during our investigations and study.

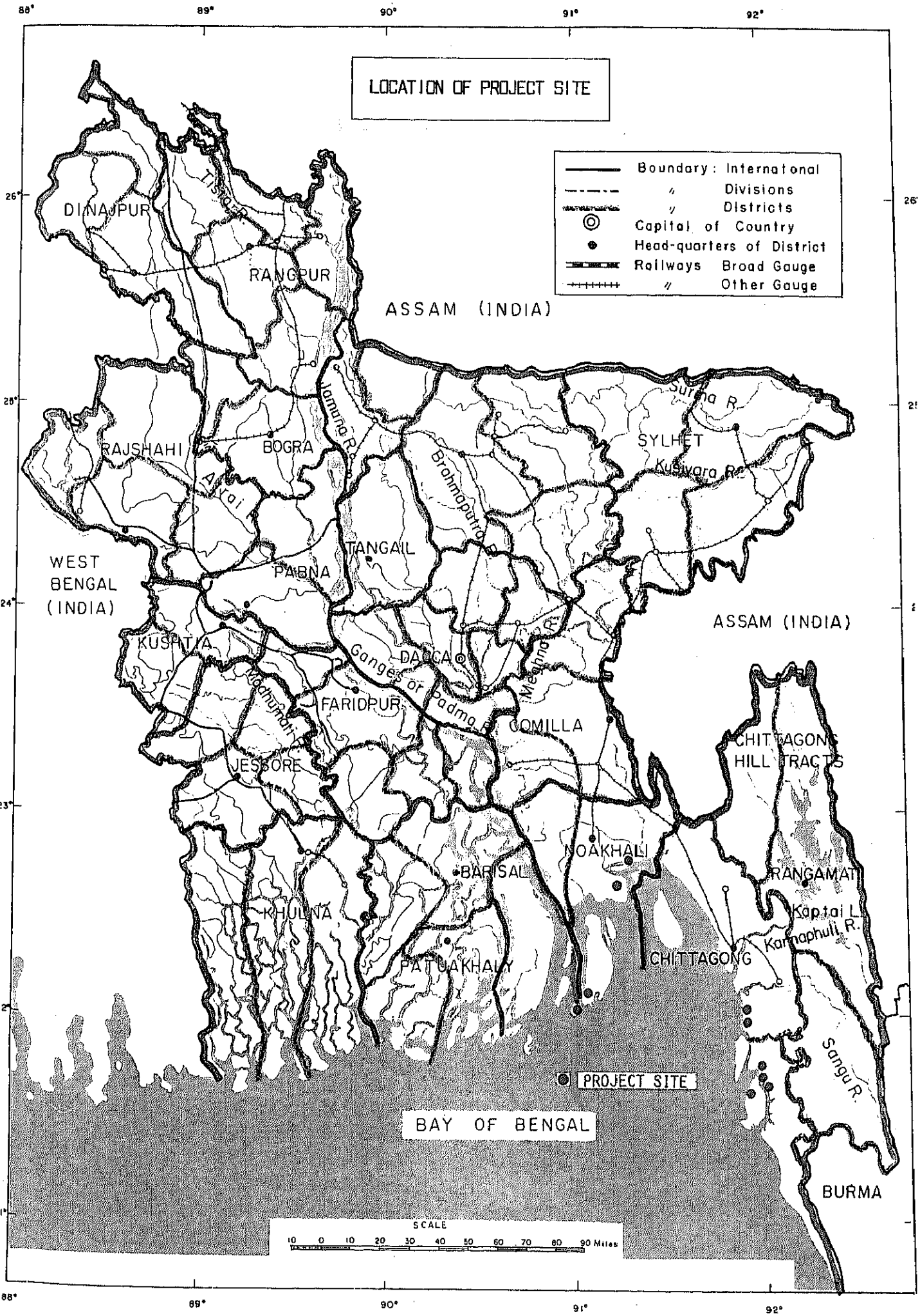
Very truly yours,



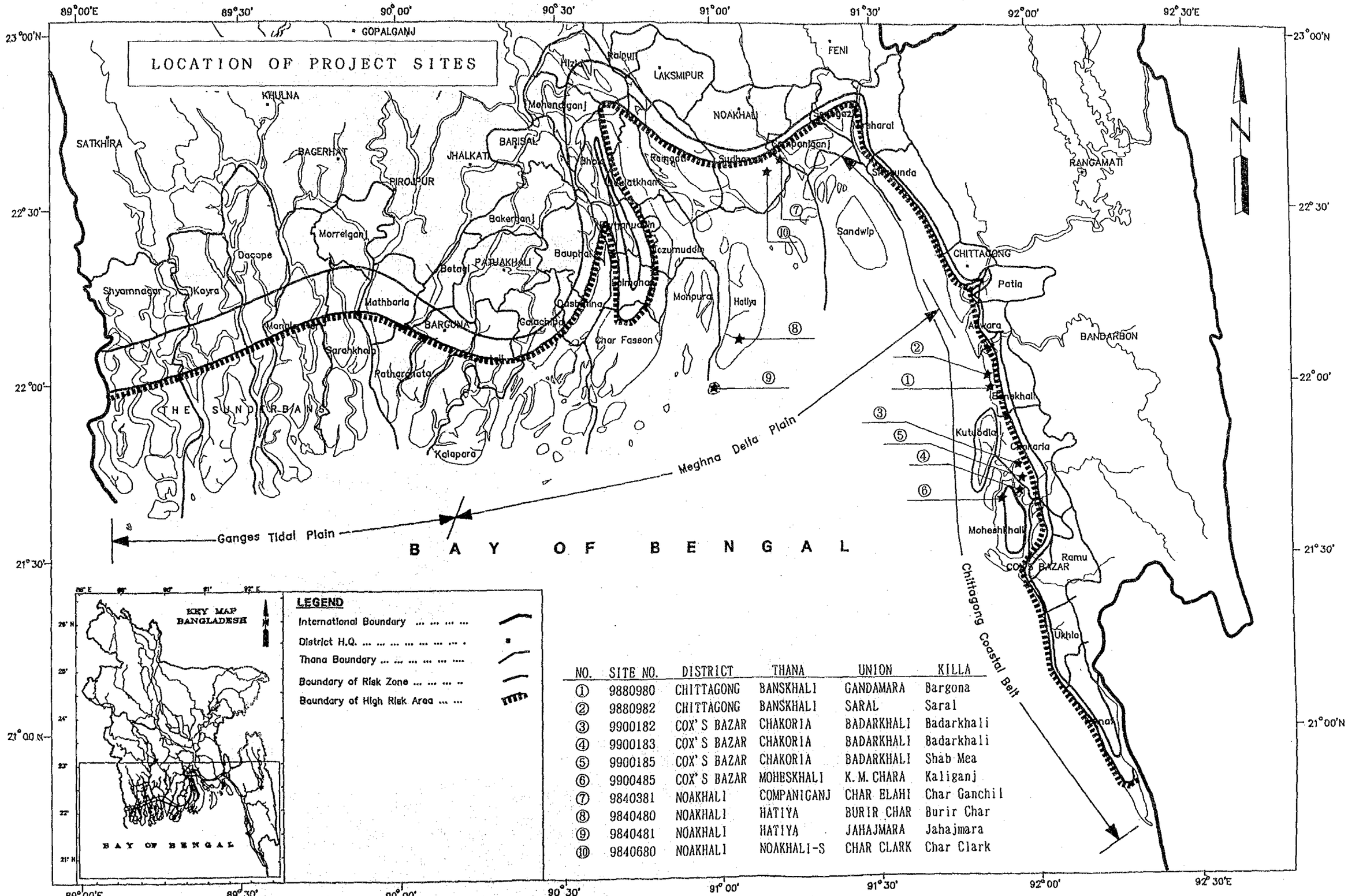
Hisashi Takada
Project Manager

Basic design study team on the project
for the Construction of Multipurpose
Cyclone Shelters

Japan Engineering Consultants Co., Ltd.


LOCATION OF PROJECT SITE
Boundary : International
Divisions
Districts
Capital of Country
Head-quarters of District
Railways Broad Gauge
Other Gauge
DINAJPUR
RANGPUR
ASSAM (INDIA)
RAJSHAHI
BOGRA
Jamuna R.
Brahmaputra R.
Surma R.
SYLHET
Kushiara R.
Atrai
TANGAIL
PABNA
WEST BENGAL (INDIA)
KUSHTIA
DACCA
Ganges or Padma R.
Meghna R.
Madhumati
FARIDPUR
COMILLA
ASSAM (INDIA)
CHITTAGONG HILL TRACTS
JESSORE
NOAKHALI
BARISAL
RANGAMATI
Kaptai L.
Karnaphuli R.
KHULNA
PATUAKHALY
CHITTAGONG
Sangu R.
PROJECT SITE
BAY OF BENGAL
BURMA
SCALE
10 0 10 20 30 40 50 60 70 80 90 Miles
88°
89°
90°
91°
92°
26°
25°
24°
23°
22°
21°

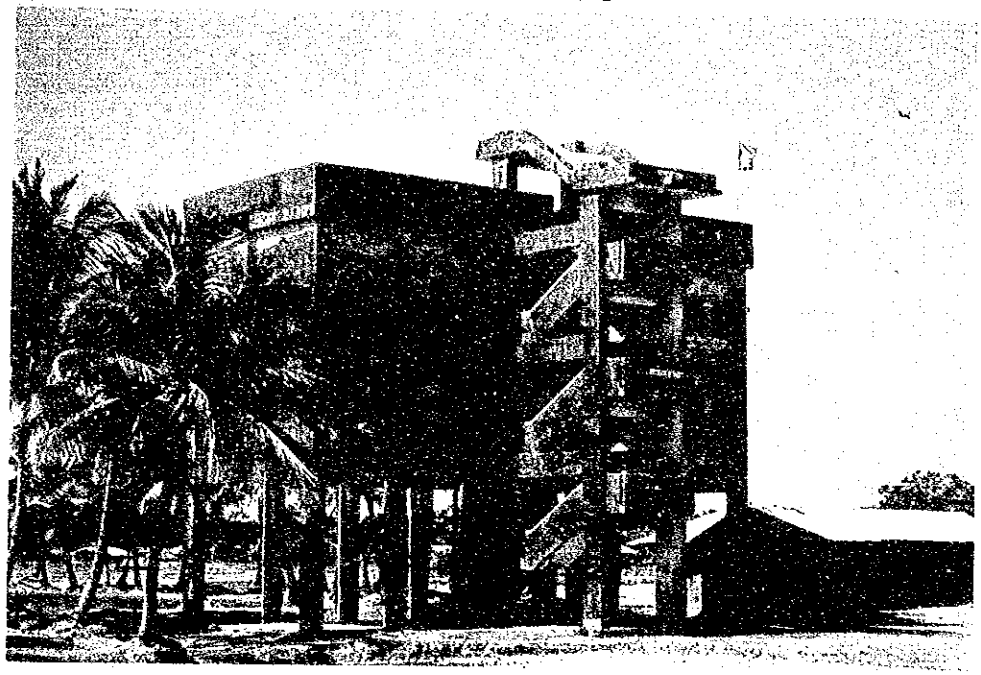
# LOCATION OF PROJECT SITES

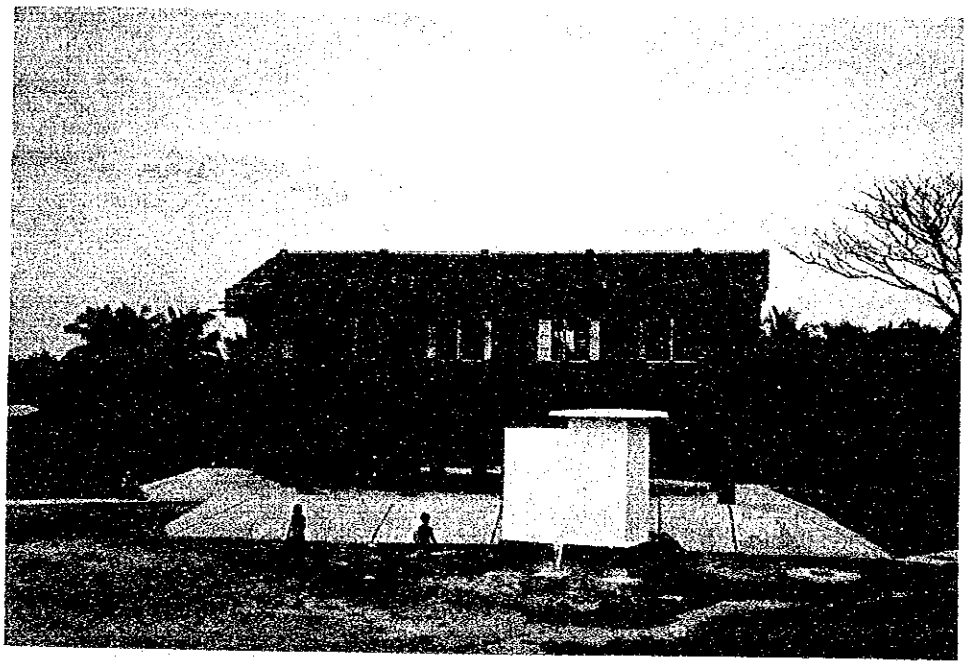



| NO. | SITE NO. | DISTRICT | THANA | UNION | KILLA |
|---|---|---|---|---|---|
| ① | 9880980 | CHITTAGONG | BANSKHALI | GANDAMARA | Bargona |
| ② | 9880982 | CHITTAGONG | BANSKHALI | SARAL | Saral |
| ③ | 9900182 | COX'S BAZAR | CHAKORIA | BADARKHALI | Badarkhali |
| ④ | 9900183 | COX'S BAZAR | CHAKORIA | BADARKHALI | Badarkhali |
| ⑤ | 9900185 | COX'S BAZAR | CHAKORIA | BADARKHALI | Shab Mea |
| ⑥ | 9900485 | COX'S BAZAR | MOHESKHALI | K.M. CHARA | Kaliganj |
| ⑦ | 9840381 | NOAKHALI | COMPANIGANJ | CHAR ELAHI | Char Ganchil |
| ⑧ | 9840480 | NOAKHALI | HATIYA | BURIR CHAR | Burir Char |
| ⑨ | 9840481 | NOAKHALI | HATIYA | JAHAJMARA | Jahajmara |
| ⑩ | 9840680 | NOAKHALI | NOAKHALI-S | CHAR CLARK | Char Clark |

[ SHELTERS IN THE PROJECT AREA ]

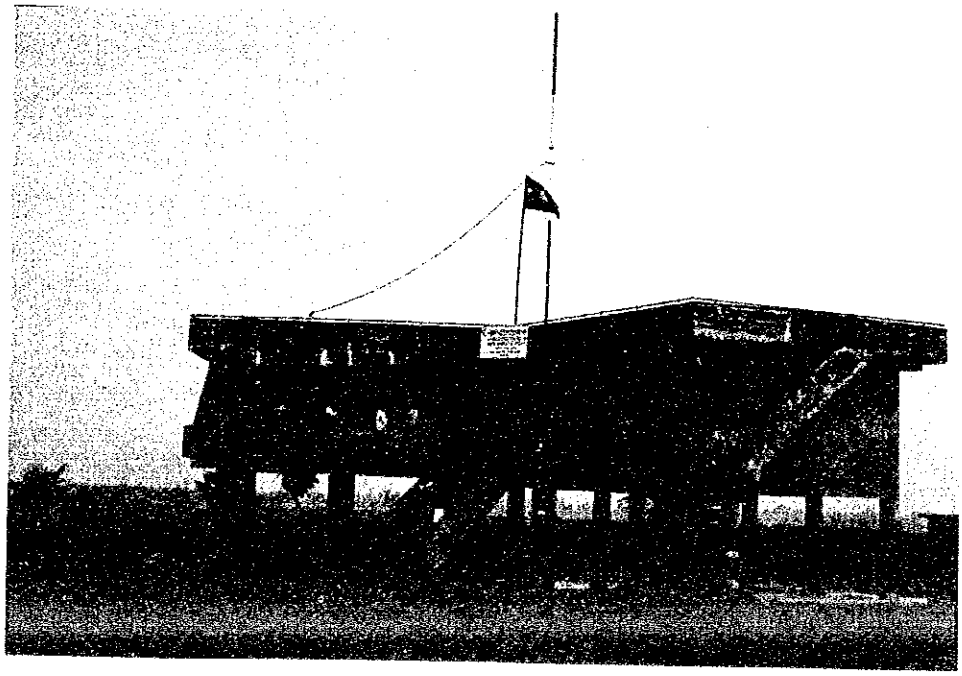
Shelter constructed by PWD





Shelter constructed by Caritas

Shelter constructed by BDRCS



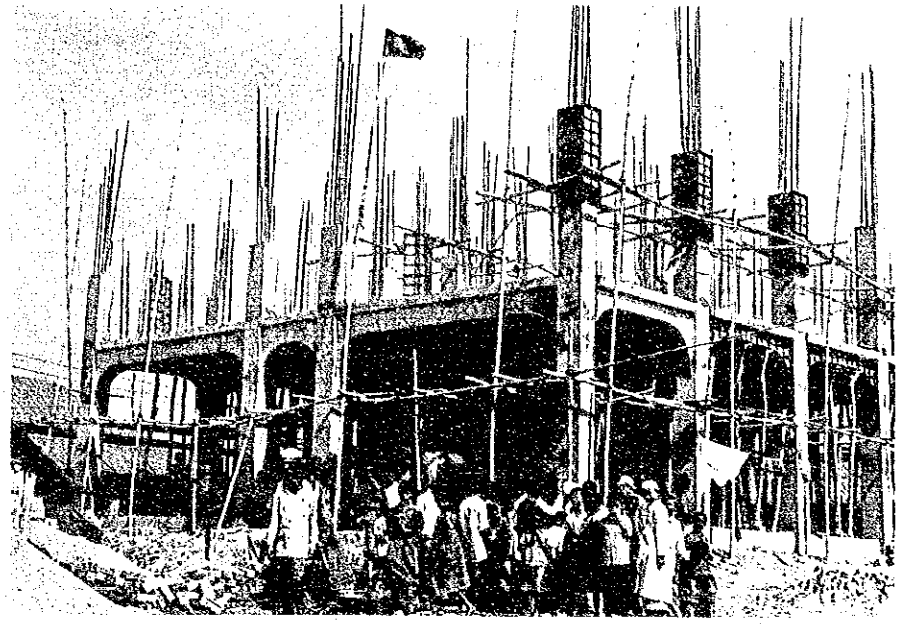
# [ CONDITIONS OF KILLAS IN THE PROJECT AREA ]

Killa at the Site-No.7
(nearly completed)

Killa at the Site-No.3
(banking is half done)

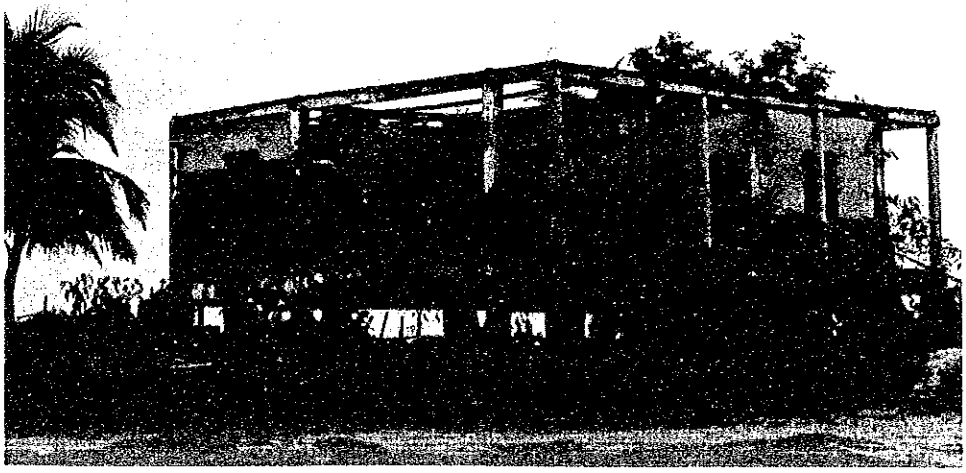
-ditto-
(banking condition)

Primary school cum cyclone shelter construction by FD



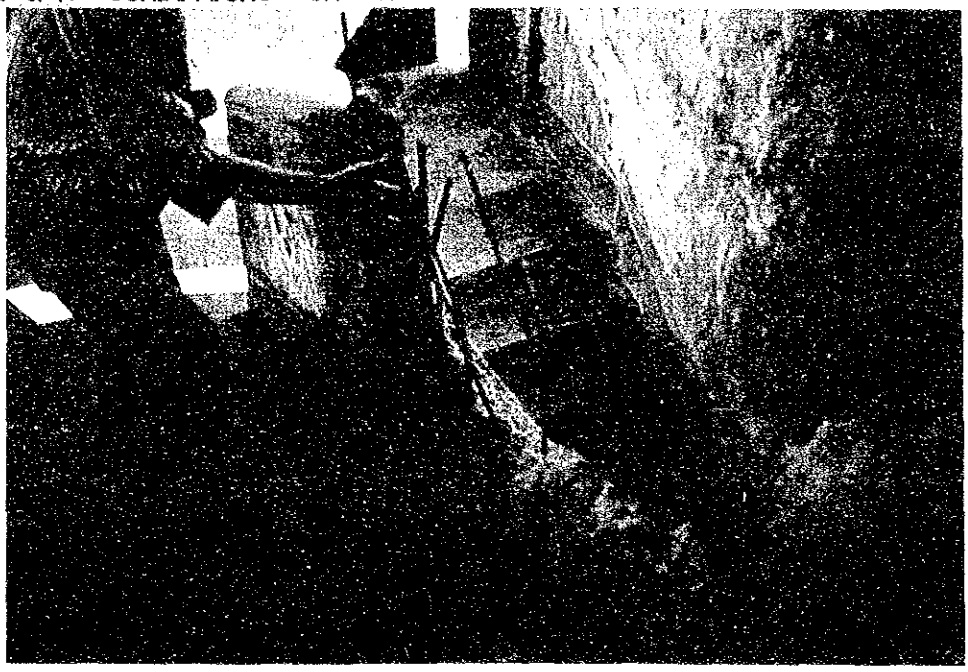
Community center using as primary school at present and to be used as cyclone shelter at cyclone time

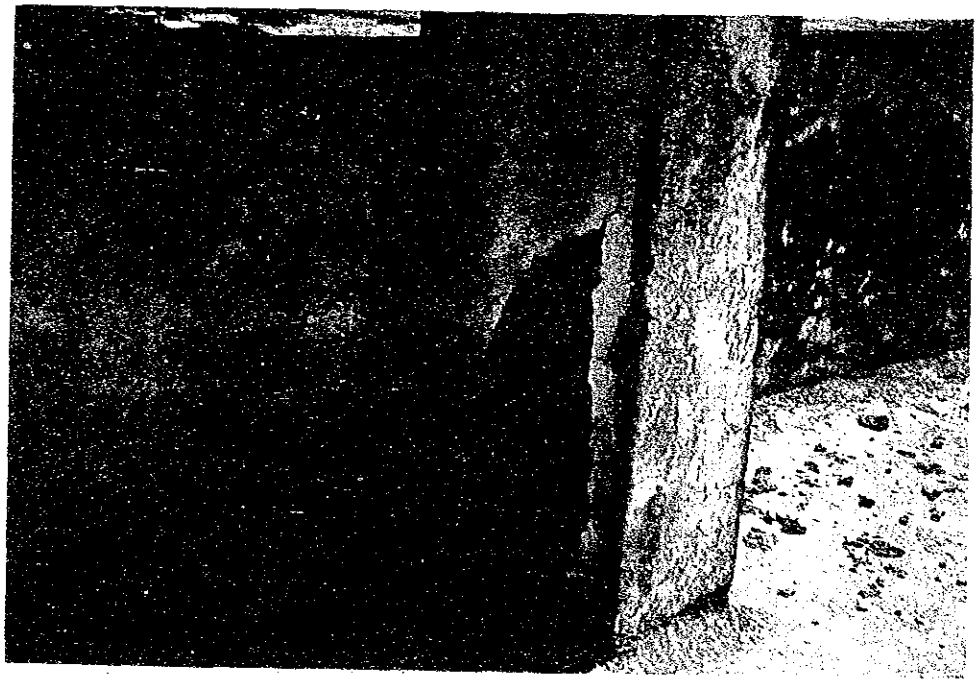
Former clinic having elevated floor in Nijhumdwip Island



[ O & M CONDITIONS ON THE EXISTING SHELTERS ]

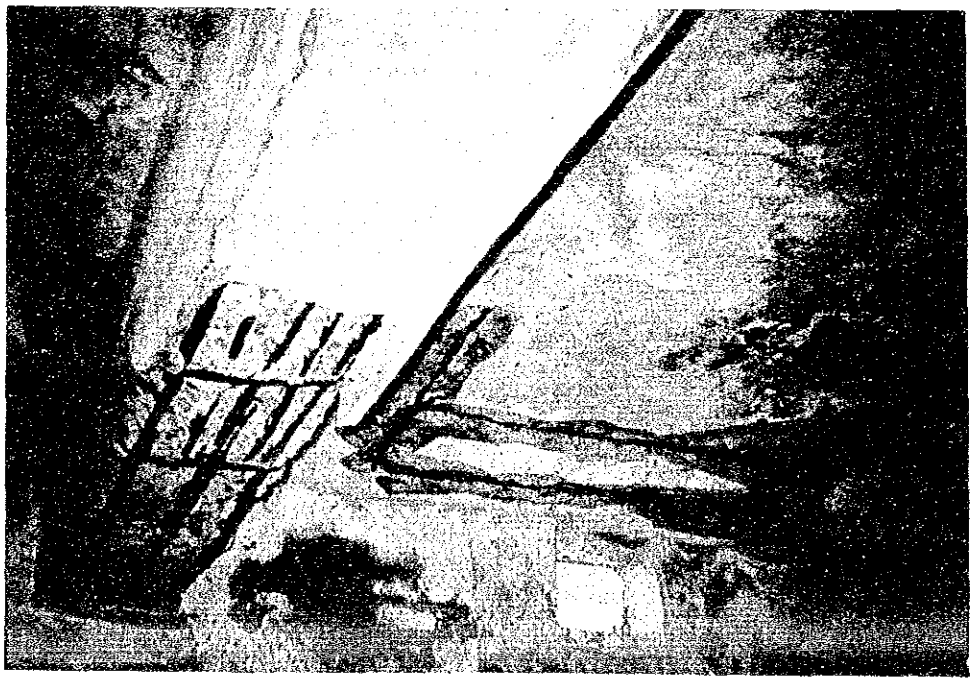
Maintenance of the PWD's shelter previously mentioned





-ditto-

Maintenance of the community center previously mentioned (condition of ceiling)

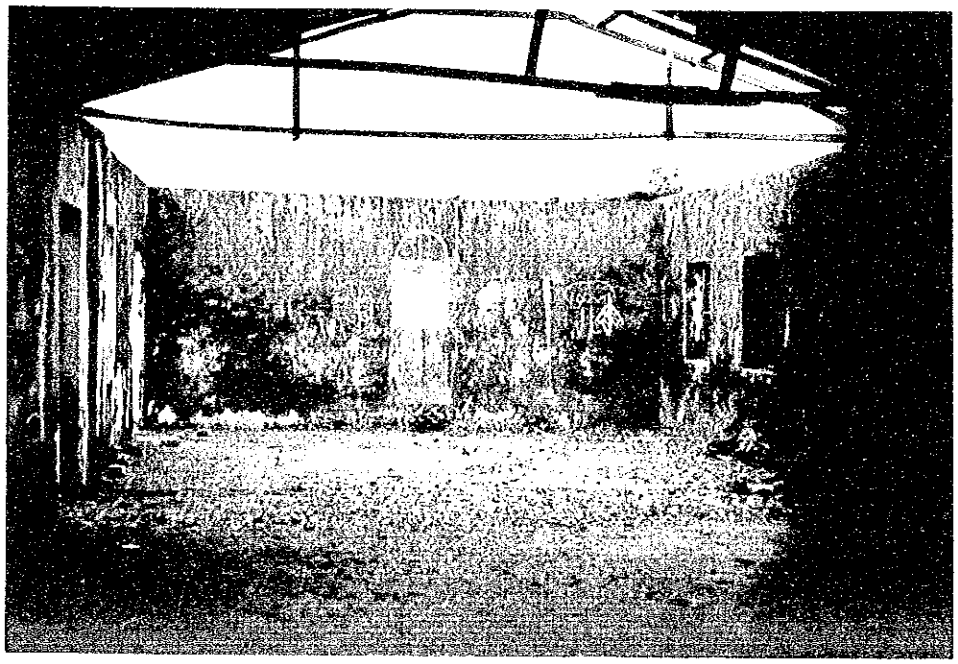


[ EDUCATIONAL FACILITIES IN THE PROJECT AREA ]

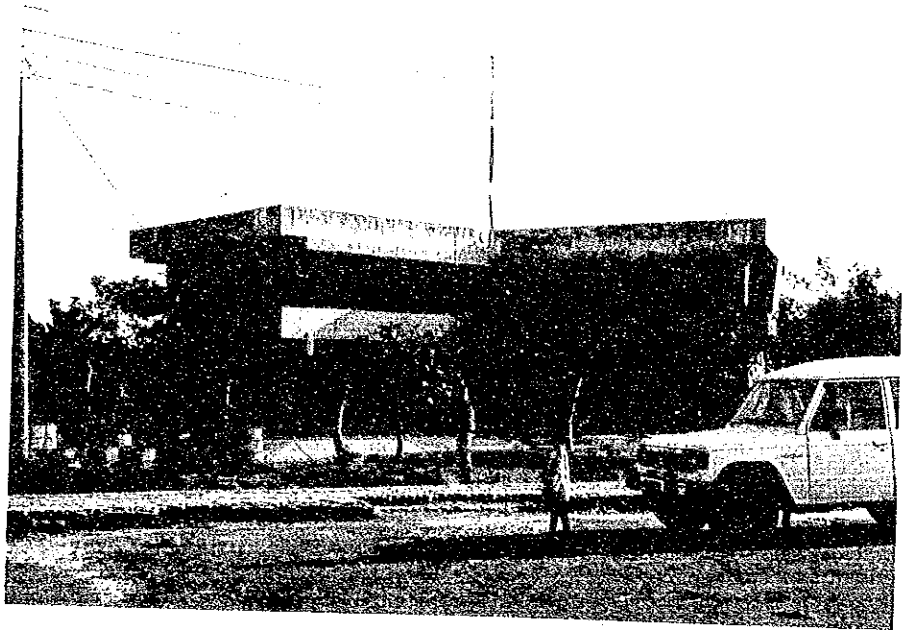
Class-room at the PWD's shelter previously mentioned

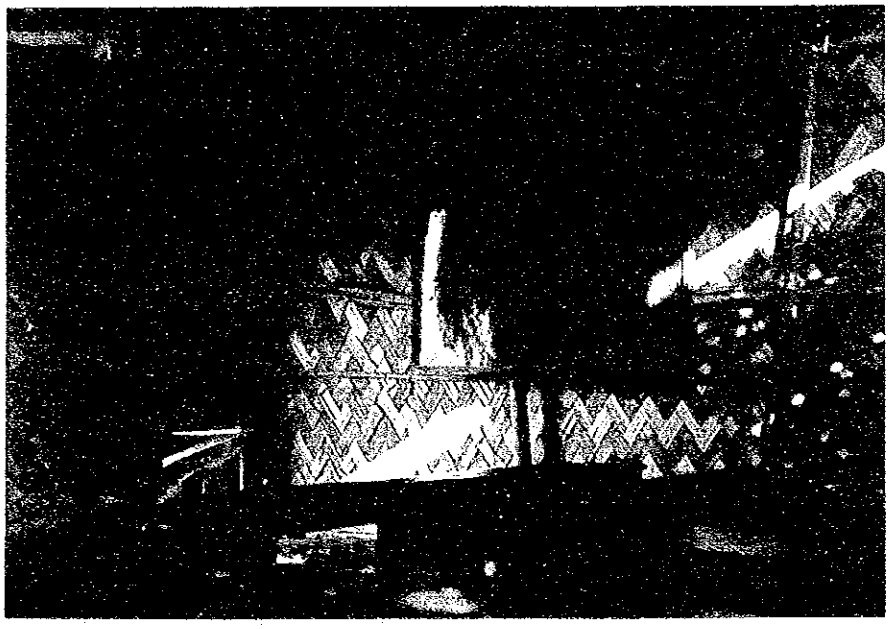

Primary school ajacent to the Site- No.8 in Hatiya Island

-ditto-



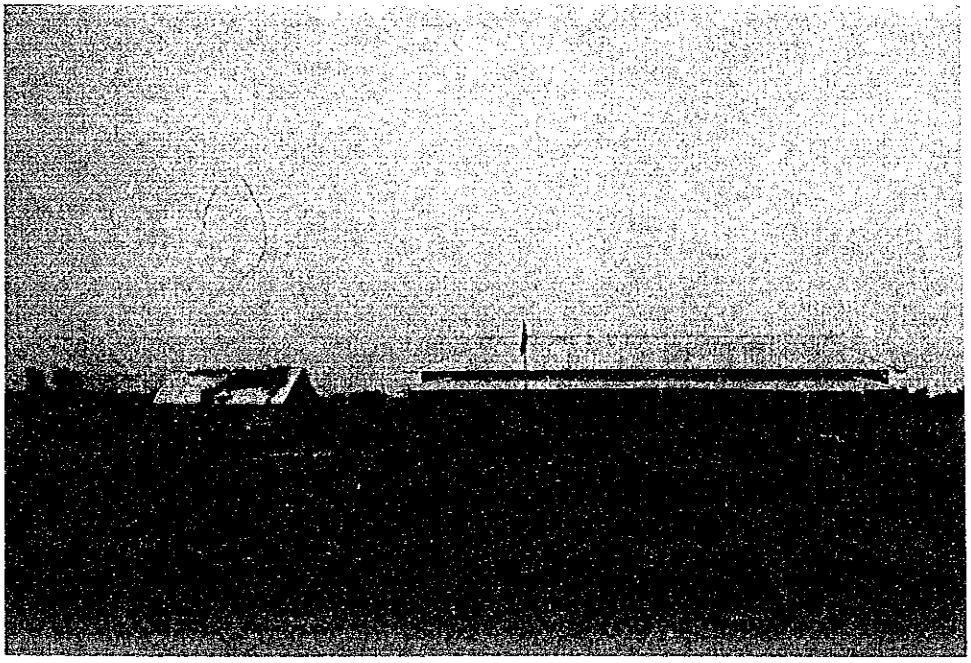
Primary education at the BDRCS's shelter in Hatiya Island





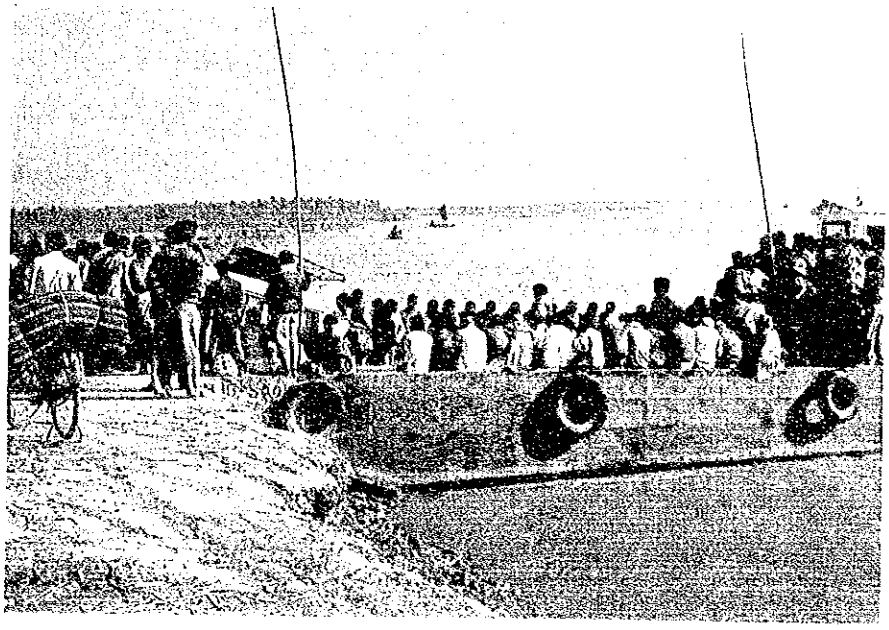
-ditto-
condition of class-room on the ground floor
first floor is used as community center

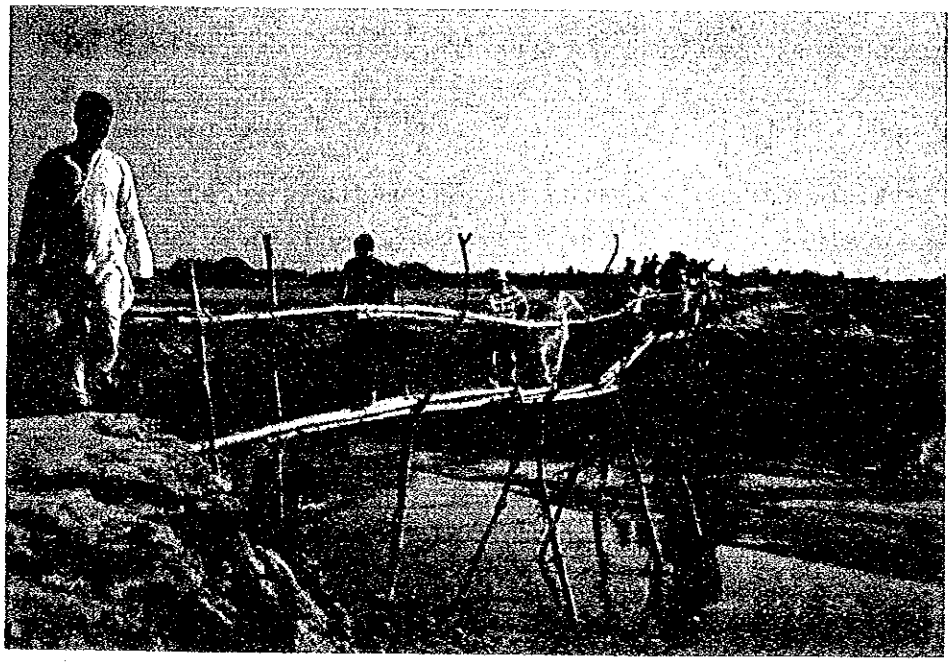
Primary school operated by NGO in Nijhumdwip Island (ajacent to the Site-No.9)



# [ INFRASTRUCTURES IN THE PROJECT AREA ]

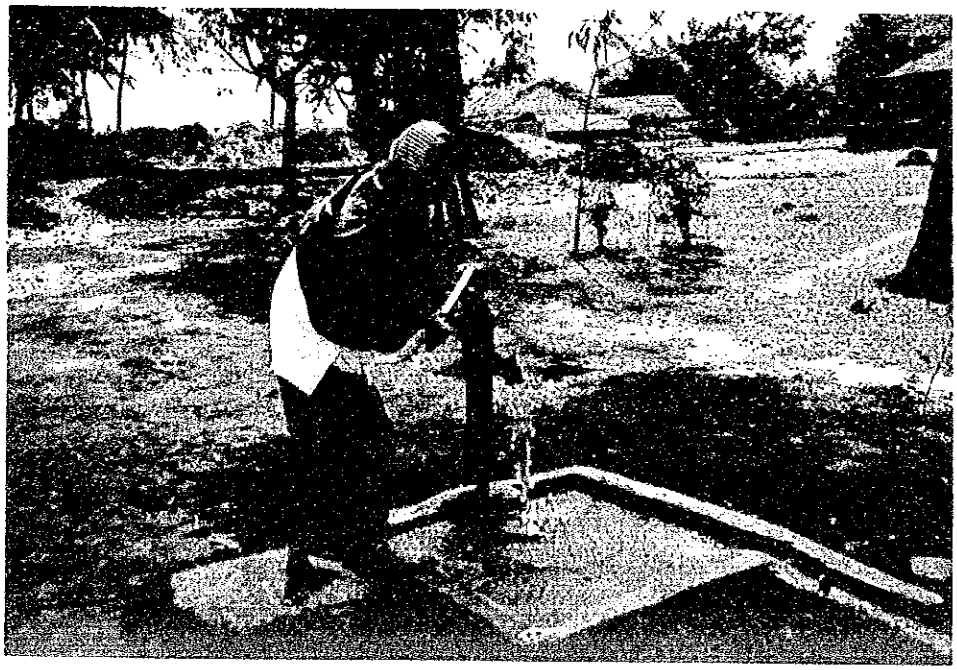
Sea truck (Noakhali ~Hatiya) and natural wharf





Condition of temporar access to Site-No.7

Common water supply facility in the Project area



## SUMMARY

The People's Republic of Bangladesh (Bangladesh) has the world's largest delta formed by the Ganges, Brahmaputra, and Meghna rivers which covers as much as 90% of the total national land area. Because of the delta's topographical conditions, and an elevation of less than 10m above sea level, many natural disasters, particularly flooding and cyclones, have a devastating effect on land areas.

While the primary characteristic of cyclones which hit Bangladesh are steady winds often exceeding 60m/sec, storms frequently surge causing in fact stronger and much more dangerous wind patterns. Water levels along the sea coast often raise as much as 1m or more above normal levels, due to winds from the Bay of Bengal. Together with a high tides between 3 - 5m above the normal tide level, storm surges along the coastal area can be as high as 5 - 9m, inundating land areas up to 5 - 8km inland and causing many casualties, both human and livestock.

Some 5.2 million people currently live in Bangladesh's High Risk Area (HRA), two-thirds of whom are without proper emergency shelter. There have been many cyclone disasters in recent years and maximum wind velocities appear to be getting stronger. Recent death tolls include 300,000 people in 1970, 11,000 in 1985, 2,000 in 1988 and 140,000 in 1991.

With the intent of protecting human life, livestock and property, some 400 cyclone shelters have been constructed by various aid organizations since the 1960's. Despite the need to construct many more shelters, the speed in which actual construction has taken place has been particularly slow. Following the great disaster in 1991, the Government of Bangladesh made an urgent request to donor countries for assistance in the construction of additional cyclone shelters. Assisted by strong concerns as expressed by the international community, for the speed of future shelters, the speed in which international aid has been made available has accelerated the start of some 200 cyclone shelters which are currently under construction and a pledge to build an additional 340 cyclone shelters (sites already confirmed) by various aid organizations. Nevertheless, the number of completed cyclone shelters, those under construction and those pledged to be built are still far below the original target of 2,500 suggested by the Multipurpose Cyclone Shelter Programme (Master Plan) prepared by the Government of Bangladesh with the assistance of the World Bank and UNDP.

As part of this Master Plan, the Government of Bangladesh made a request to the Government of Japan for the provision of grant aid for the Project to Construct Cyclone Shelters, the

contents of which consist of the construction of cyclone shelters on top of 40 killas presently under construction, with support assistance from the World Food Program (WFP).

In response to this request, the Government of Japan commissioned the Japan International Cooperation Agency (JICA) which dispatched a Preliminary Study Team and an Additional Study Team consisting mainly of former Japan Overseas Cooperation Volunteers (JOCV) members to Bangladesh in March, 1992. The Study Teams subsequently judged that 18 sites of the requested 40 for suitability for the construction of cyclone shelters.

Based on the teams findings it was decided to conduct a Basic Design Study for the Cyclone Shelter Project and as such JICA dispatched the Basic Design Study Team to Bangladesh between October 31st and December 9th, 1992 and again between January 21st and February 19th, 1993. The Basic Design Study Team conducted field surveys, collected relevant data and information, and discussed the possible contents of the Project with the Government of Bangladesh. Upon the Study Team's return to Japan, further analysis of the collected data and information was conducted, (contents of which were compiled in this report) upon which an explanation of the draft contents of the report were given to the Bangladesh counterparts between April 3rd and April 12th, 1993.

A Basic Design Study was conducted for 10 sites selected from the previously identified 18 most suitable sites for high priority cyclone shelter construction. The 10 most suitable sites are listed below all of which are located in 6 Thanas in 3 Districts.

| Site No. | District | Thana | Union | Killa |
|---|---|---|---|---|
| 1. 9880980 | Chittagong | Banskhali | Gandamara | Barghona |
| 2. 9880982 | Chittagong | Banskhali | Saral | Saral |
| 3. 9900182 | Cox's Bazar | Chakoria | Badarkhali | Badarkhali near Samsul House |
| 4. 9900183 | Cox's Bazar | Chakoria | Badarkhali | Badarkhali near Abdul Ahmed House |
| 5. 9900185 | Cox's Bazar | Chakoria | Badarkhali | Shab Mea |
| 6. 9900485 | Cox's Bazar | Moheskhali | K.M.Chara | Kaliganj |
| 7. 9840381 | Noakhali | Companiganj | Char-Elahi | Char Ganchil |
| 8. 9840480 | Noakhali | Hatiya | Burir Char | Burir Char |
| 9. 9840481 | Noakhali | Hatiya | Jahajmara | Jahajmara |
| 10. 9840680 | Noakhali | Noakhali-Sadar | Char Clark | Char Clark |

Twenty two sites of the originally requested 40 sites were rejected as cyclone shelter sites by the Preliminary Study Team based on the following criterium.

1. Total absence of inhabited houses in the vicinity.
2. Long distance (more than 2km) from the nearest inhabited houses.
3. Position on a dry riverbed (unprotected by embankments).
4. Existence of a hill or cyclone shelter for evacuation in the vicinity.

While the original request anticipated the construction of cyclone shelters on top of killas, this was judged inappropriate by the Preliminary Study Team because of the poor soil texture, absence of rolling compaction to support a heavy structure. The construction of free-standing shelters on stilts near or in the vicinity of neighboring killa sites was instead proposed.

The Basic Design Study Team examined the suitability of the Project, taking into consideration the findings of the Preliminary Study Team, and thus has prepared a construction plan based on its own judgment; that the construction of the 10 proposed cyclone shelters are essential for the protection of local lives due to their location within the HRA.

In view of the fact that the construction of 498 new cyclone shelters located in 6 Thanas of the Project have been found necessary by the Master Plan, the present Project which anticipates the construction of 10 cyclone shelters is by no means excessive. It is also proposed that these cyclone shelters will be used as educational facilities during times other than crises in order to maintain them, through continued and efficient use.

As the Basic Design Study Team concluded, the implementation of the Project is both appropriate and necessary as a disaster prevention measure and as a community facility having the following components for each of the sites as planned.

(1) Cyclone Shelter

- Facilities to be Provided at Each Site

| | | |
|---|---|---|
| Classrooms | x | 3 (50 pupils/classroom) |
| Staffroom | x | 1 (for 4 teachers) |
| Storage | x | 1 (for emergency supplies) |
| Toilets | x | 2 (male and female) |
| Verandah | x | 1 |

- Structural Components

| | | |
|---|---|---|
| Main Structure (pillars, beams and floors) | : | reinforced concrete |
| Walls | : | brick masonry |
| Number of Storys | : | 2 |

- Area (measured between pillar centers)

| | | |
|---|---|---|
| Ground Floor (piling section) | : | $262m^2$ |
| First Floor | : | $262m^2$ |
| Total | : | $524m^2$ |

- Floor Height

  First Floor : GL +5.0m (1 site), or +6.0m (6 sites), or +7.0m (3 sites)

  Roof Floor : 4.0m above first floor height

- Fixtures

  "Long" Desks and Chairs (for 3 pupils) : 51 units

  Desks and Chairs (for teachers) : 7 units

  Blackboards : 4

(2) Auxiliary Facilities

- Hand Pump
- Borehole for deep set tube well (GL -300 to -400m)
- Septic Tank

(3) Lighting

A solar system with battery for lighting of night school will be provided at Site-No.3 as a test case.

The estimated project cost to be borne by the Government of Bangladesh is expected to provide 3,604,000 TK (approximately 11.6 million yen). The project implementation period is scheduled for 12 months, i.e., 4 months for the detailed design work (including the tender procedure) and 8 months for the actual construction work.

The project implementaing agency is the Local Government Engineering Department (LGED) of the Ministry of Local Government, Rural Development and Cooperatives (MLGRD&C). The LGED is responsible for all public civil engineering works and similar building construction works in local areas, including the construction and repair of government schools, government offices and housing for civil servants. The LGED has also been managing 10 cyclone shelters on Kutubdia Island in recent years with the financial assistance from the International Fund for Agricultural Development (IFAD). The LGED is, therefore, believed to be sufficiently competent to act as the implementing agency for the Project in view of its excellent manpower and experience. The maintenance of the completed facilities will, in principle, be the responsibility of the LGED while their management responsibility will preferably be transferred to the Primary and Mass Education Division (PMED) through mutual consultation. The annual maintenance cost of the 10 cyclone shelters is estimated to be 48,000TK (approximately 150,000 yen), a relatively small percentage which will be appropriated from annual LGED budget. (Fiscal 1992/93 LGED budget 4,398,200,000TK).

The implementation of the Project will protect the lives of some 170,000 people living in the HRA. The cyclone shelters will also serve as school buildings during normal weather conditions for as many as some 3,000 pupils, greatly assisting the consolidation of education in Bangladesh. Moreover, the implementation of the Project will encourage the settlement of inhabitants in the HRA due to the additional safety provided by the cyclone shelters, thus stimulating the development of agriculture, fisheries and stock raising. The consolidation of access roads, the availability of a water supply and the planting of trees will all contribute to improving the social infrastructure for the further economic development and improvement of the living standard of local communities. The implementation of the Project with the help of grant aid from the Government of Japan is, therefore, deemed highly appropriate.

The Project envisages the construction of a cyclone shelter at 10 different sites which was reduced from one cyclone shelter at 40 sites as originally requested by the Government of Bangladesh. Because of the suitability and necessity of these cyclone shelters as verified by this report, the approval and implementation of a basic design study on the remaining 30 sites is highly recommended as soon as appropriate sites have been selected by the Government of Bangladesh.

The Project is in line with the objectives of the International Decade for Natural Disaster Reduction (IDNDR) and is appropriate vis-a-vis Japan's policy to promote international aid for the prevention of natural disasters world-wide, particularly in developing countries.

CONTENTS

APPENDICES

Appendix 1



Appendix 2



Appendix 3

## LIST OF TABLES

## LIST OF FIGURES

## ABBREVIATIONS

| | |
|---|---|
| ADP | : Annual Development Programme |
| BDRCS | : Bangladesh Red Crescent Society |
| BRAC | : Bangladesh Rural Advancement Committee |
| BTTB | : Bangladesh Telephone & Telegraph Board |
| BWDB | : Bangladesh Water Development Board |
| CCC | : Coastal Community Center |
| CCDB | : Christian Commission for Development in Bangladesh |
| CDC | : Community Development Committee |
| CEC | : Commission of European Communities |
| CPP | : Cyclone Protection Project |
| CSCO | : Cyclone Shelter Construction Organization |
| DANIDA | : Danish International Development Agency |
| E/N | : Exchange of Notes |
| ERD | : Economic Relation Division |
| FAD | : Flood Action Plan |
| FD | : Facilities Department |
| HRA | : High Risk Area |
| IDA | : International Development Agency |
| IDNDR | : International Decade for Natural Disaster Reduction |
| IFAD | : International Fund for Agricultural Development |
| IGA | : Income Generating Activity |
| JICA | : Japan International Cooperation Agency |
| JOCV | : Japan Overseas Cooperation Volunteers |
| LGED | : Local Government Engineering Department |
| MCSP | : Multipurpose Cyclone Shelter Program |
| MLGRD&C | : Ministry of Local Government, Rural Development & Cooperatives |
| NFP | : National Flood Programme |
| NGO | : Non-Government Organization |
| O&M | : Operation and Maintenance |
| PMED | : Primary and Mass Education Division |
| PWD | : Public Works Department |
| RZ | : Risk Zone |
| SPD | : Society for Peace and Development |
| VSAT | : Very Small Aperture Terminal |
| WFP | : World Food Program |
| WVB | : World Vision of Bangladesh |

# CHAPTER 1

# INTRODUCTION

# CHAPTER 1 INTRODUCTION

Approximately 90% of the land area of the People's Republic of Bangladesh (Bangladesh) consists of the world's largest delta formed by the Ganges, Brahmaputra, and Meghna rivers with most of the delta land of less than 10 meters in elevation. The country is subject to 2 types of serious natural disasters, the first of flooding which is caused by the low elevation of the land and a very large water catchment area of 1.73 million $km^2$ (12 times larger than the national land area), located above the three great rivers, extending to India, Nepal, Bhutan, and China. The second natural disaster is storm surges in coastal areas due to the simultaneous occurrence of high tides and cyclones which tend to hit Bangladesh during two different seasons, i.e., April - June and September - November. The damage caused by cyclones is particularly devastating in terms of loss of human lives and livestock.

Recent cyclone disasters include one in 1970 (death toll of 300,000 people) and another in 1985 (death toll of 10,000). The cyclone which hit Bangladesh on the 29th and 30th of April, 1991 also took the lives of some 140,000 people in addition to incalculable damage to buildings and other structures, which are mainly located in and around Chittagong.

In view of potential future disasters, the Government of Bangladesh has requested international aid organizations, the governments of industrialized countries, NGOs, etc., to assist with the construction of badly needed cyclone shelters. Because of the urgency for the need for cyclone shelters, several donor countries have assisted in providing these shelters. The Government of Japan has received a request for the construction of cyclone shelters on top of 40 killas being constructed by the LGED with the assistance of the WFP.

In response to this request, JICA sent a Preliminary Study Team (4 members, including Hidefumi Ohi, the team leader) to Bangladesh for the period between March 28th and April 24th, 1992 to investigate the appropriateness and suitability of the inclined conditions of banks in addition to conditions of Killa neighboring areas. JICA also sent a separate study team (team leader: Takeo Oshima) consisting of 22 former JOCV members to Bangladesh between March 4th and April 22nd, 1992 to conduct basic surveys on project sites and their surrounding areas.

Based on preliminary findings of the above 2 Study Teams, it was decided that a Basic Design Study should be carried out at 8 designated project sites. Following this decision, JICA sent the Basic Design Study Team headed by Masashi Kono, Assistant Director of the Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs, to Bangladesh from October 31st to December 9th 1992. The purpose of the team was to assess the suitability of

the Project as a grant aid project of the Government of Japan and to develop a basic design to confirm the necessity and optimal scope of cooperation.

The members of the Basic Design Study Team discussed the contents of the request with officials of the Government of Bangladesh, conducted field surveys on the 8 different project sites, which included a survey of natural conditions at 4 sites and collecting relevant information and data. Issues noted for 2 different sites were compiled in the Minutes of Discussions (M/D) which were officially signed and exchanged by representatives of both sides on November 24th, 1992 at the Economic Relations Division (ERD) of the Ministry of Finance.

The M/D included a discussion of an additional 2 sites, increasing the total number of prospective project sites to 10. As per agreement a survey of the natural site conditions would be conducted at all 10 sites instead of the original planned 4 sites. A Supplementary Study Team was sent to Bangladesh between January 21st and February 19th, 1993 for the purpose of conducting additional surveys.

Upon their return to Japan, the members of both the Basic Design Study Team and Supplementary Study Team examined the findings from the field surveys and then began preparations for the project plan; basic design of the facilities, estimation of project costs, preparation of the maintenance plan and assessment of the Project. The results from this analysis were then compiled in the Draft Report.

Upon completion of the Draft Report JICA sent a team headed by Masayuki Watanabe, international cooperation specialist, to Bangladesh between April 3rd and April 12th, 1993 to explain the contents of the Report to the Bangladesh side. The Report has now been finalized with the approval of the Government of Bangladesh.

The list of the study team members, survey schedule, list of interviewees (interviewed officials of the Government of Bangladesh) and the M/D, etc., are included in the appendices of this report.

# CHAPTER 2

# BACKGROUND OF THE PROJECT

# CHAPTER 2 BACKGROUND OF THE PROJECT

## 2.1 General Review of Cyclones

### 2.1.1 Current State of Cyclones

The most devastating natural disasters in Bangladesh are floods and cyclones. Cyclones mainly hit the Bay of Bengal during 2 seasons, i.e. (i) from April to June and (ii) from September to November. A cyclone is a strong tropical depression which often form in the eastern portion of the South China Sea, then developing along its path into the Bay of Bengal. The predominant characteristic of cyclones which hit Bangladesh is a strong wind (velocity over 60 m/sec). However, these storms often surge which cause even higher velocity winds which are in fact more dangerous.

Coastal sea levels can be raised as much as 0.6 - 1.0m due to southwesterly winds. Together with a high tide of 3 - 5m above the normal tide level, storm surges along the coastal area can be as high as 5 - 9m, resulting in many casualties. The following list details cyclones in the Bay of Bengal area with a high death toll.

Table 2-1-1 Death Toll by Severe Cyclones in the Bay of Bengal

| Year | Location | Deaths |
|---|---|---|
| 1970 | Bangladesh | 300,000 |
| 1737 | India | 300,000 |
| 1897 | Bangladesh | 175,000 |
| 1991 | Bangladesh | 138,868 |
| 1876 | Bangladesh | 100,000 |
| 1882 | India | 100,000 |
| 1864 | India | 50,000 |
| 1833 | India | 50,000 |
| 1822 | Bangladesh | 40,000 |
| 1839 | India | 20,000 |
| 1789 | India | 20,000 |
| 1965 | Bangladesh | 19,270 |
| 1963 | Bangladesh | 11,520 |
| 1961 | Bangladesh | 11,468 |
| 1985 | Bangladesh | 11,069 |
| 1977 | India | 10,000 |

As shown in Fig. 2-1-1, while serious cyclone damage in Bangladesh used to occur every 2 years prior to 1960, it has become almost an annual event since 1969, most often in May, June and October. Figure 2-1-2 shows the path of severe cyclones indicating that no coastal area along the Bay of Bengal is spared from cyclone damage. The following table shows prominent storm surges recorded since 1960.

Table 2-1-2 Prominent Storm Surges Since 1960

| Date | Max. Wind Velocity (km/hr) | Storm Surge Height (m) | Date | Max. Wind Velocity (km/hr) | StormSurge Height (m) |
|---|---|---|---|---|---|
| 9-10-1960 | 162 | - | 3-5-1971 | - | 2.5-4.0 |
| 30-10-1960 | 210 | 4.5-6.0 | 30-9-1971 | - | 2.5-4.0 |
| 9-5-1961 | 146 | 2.5-3.0 | 6-11-1971 | - | 2.5-5.5 |
| 30-5-1961 | 146 | 6.0-9.0 | 18-111973 | - | 2.5-4.0 |
| 28-5-1963 | 203 | 4.0-5.0 | 9-12-1973 | 122 | 1.5-7.5 |
| 11-4-1964 | - | - | 15-8-1974 | 97 | 1.5-6.5 |
| 11-5-1965 | 162 | 3.5 | 28-11-1974 | 162 | 2.0-5.0 |
| 31-5-1965 | - | 6.0-7.5 | 21-10-1976 | 105 | 2.0-5.0 |
| 14-121965 | 210 | 4.5-6.0 | 13-5-1977 | 122 | - |
| 1-10-1966 | 146 | 4.5-9.0 | 10-12-1981 | 97 | 2.0 |
| 11-10-1967 | - | 2.0-8.5 | 15-10-1983 | 97 | - |
| 24-10-1967 | - | 1.5-7.5 | 9-11-1983 | 122 | - |
| 10-5-1968 | - | 2.5-4.5 | 3-6-1984 | 89 | - |
| 17-4-1969 | - | - | 25-5-1985 | 154 | 3.0-4.5 |
| 10-10-1969 | - | 2.5-7.0 | 29-11-1988 | 162 | 1.5-3.0 |
| 7-5-1970 | - | 3.0-5.0 | 29-4-1991 | 225 | 6.0-7.5 |
| 23-10-1970 | - | - | 2-6-1991 | 100 | 2.0 |
| 12-11-1970 | 223 | 6.0-9.0 | | | |

Source: Haider et al., 1991)

The cyclone causing the most damage in recent years was in November, 1970 having a maximum wind velocity of 61.9 m/sec, causing a storm surge of 6.0 - 9.0m in height and claiming between an estimated 300,000 - 500,000 lives. Human loses of an estimated 11,000 and 2, 000 lives due to cyclones were also recorded in 1985 and 1988 respectively. The cyclone which hit Bangladesh on the night of April 29th, 1991 and the morning of the following day recorded a maximum wind velocity of 62.5 m/sec with a storm surge of 6.0 - 7.5m. The Chittagong Region was the worst hit in terms of casualties and property damage and the estimated death toll was approximately 140,000 people.

One of the reasons why cyclones hitting Bangladesh cause so much devastation, particularly in terms of human lives, is that geographically the trumpet shape of the Bay of Bengal creates a high storm surge which in turn tends to claim excessive casualties in the densely populated, flat delta area.

### 2.1.2 Current Conditions of Cyclone Shelters

(1) Existing Shelters

Due to the almost incessant cyclone damage in the 1960's, a total of 132 cyclone shelters were constructed to serve as Union Offices (Coastal Community Centers). Of these, 118 were located in the High Risk Area (HRA), 9 in the Risk Zone (RZ) and the remaining 5 in other areas. In the 1970's, cyclone shelters were constructed at 238

sites by the Public Works Department (PWD) using funds provided by the International Development Association (IDA) in order to increase the coastal resistance to cyclone damage. Of these, 11 shelters were washed away in subsequent years. Of the surviving 227 shelter sites, 196 are located in the HRA, 19 in the RZ and 13 in other areas. Following the severe cyclone in 1985, the Bangladesh Red Crescent Society (BDRCS) constructed additional cyclone shelters at 62 sites. The Facilities Department (FD) of the Ministry of Education has also constructed 24 cyclone shelters, which also act as primary schools, as part of the initial phase of the general primary education improvement program.

In addition, 12 cyclone shelters using the same design adopted by the BDRCS have been constructed by NGOs and Caritas. Other existing shelters include those constructed by the Danish International Development Agency (DANIDA), 6 constructed with assistance provided by New Zealand, one constructed with Indian assistance and 4 with Swiss assistance. Bangladesh currently has a total of some 400 cyclone shelters.

(2) Cyclone Shelters Under Construction

The BDRCS has started a program to construct cyclone shelters at 40 sites while Caritas planned the completion of 23 shelters by the end of 1992. The Bangladesh Rural Advancement Committee (BRAC) has selected 16 sites and shelter construction is in progress at 9 sites. The Christian Commission for Development in Bangladesh (CCDB) has also selected 15 sites and has commenced construction work at 5 with work on the remaining 10 sites scheduled to start soon. The Sampreeti (SPD) also planned the completion of shelter construction at 4 sites by the end of fiscal 1992, while the Church of Bangladesh has so far constructed shelters at 5 sites in addition to 2 sites where primary schools have been converted for dual use as a cyclone shelter and school.

### 2.1.3 Cyclone Shelter Construction Plans

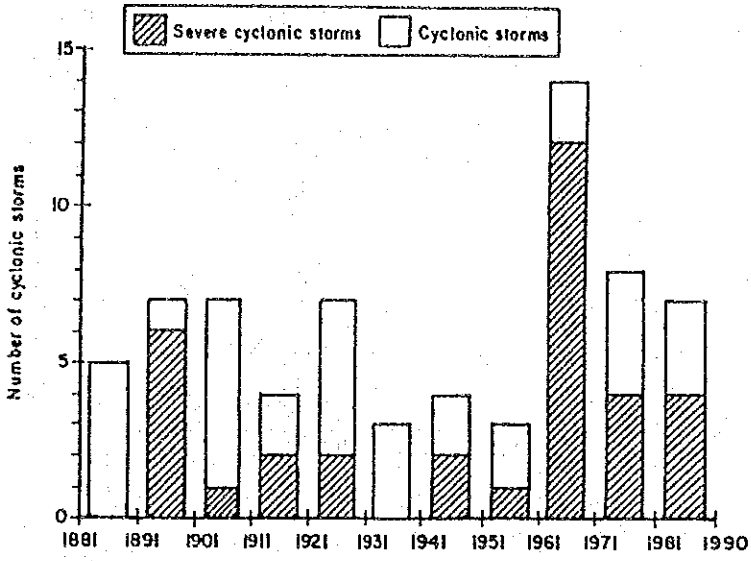
Bangladesh suffers from chronic damage in terms of loss of human life and that of livestock by the regularity of cyclones which hit the country. Having experienced serious cyclone damage throughout the 1960's, the Government of Bangladesh authorized a plan to construct cyclone shelters at 2,000 sites which would serve as Union Offices (Community Centers) in normal weather conditions. This plan was, however, abandoned after completing only 132 sites due to financial problems. Cyclone shelters (cum-school buildings) have since been constructed at some 300 sites with the assistance of such NGOs as the IDA and BDRCS.

While the construction of cyclone shelters was delayed, Bangladesh was severely damaged by heavy flooding in 1987 and also by flooding and cyclonic storm surges in 1988. The government urgently prepared the National Flood Programme (NFP) which consequently stimulated international aid activities. With coordination by the World Bank, the Flood Action Plan (FAP) has been prepared and 16 donor countries, including Japan, are currently working to implement the Plan from 1995. The construction of cyclone shelters is included in the Plan under the Cyclone Protection Project (CPP) which is a component of the FAP. One of the largest cyclones ever recorded, which hit Bangladesh in April, 1991 causing a death toll of some 140,000 people further illustrates the urgent need for cyclone shelters and many international aid organizations, donor countries and NGOs have started individual projects to construct these necessary shelters.

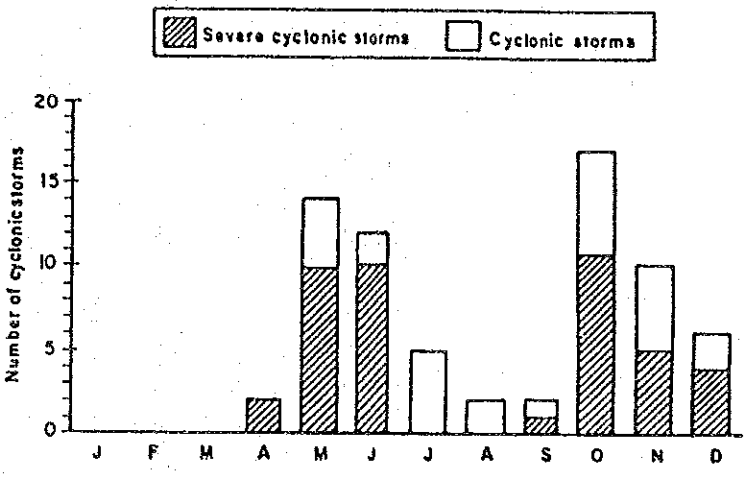
Meanwhile, the Government of Bangladesh believes it is necessary to coordinate all cyclone shelter construction plans, implemented by public and private concerns and international aid organizations, and has started to prepare a Master Plan for the construction of multi-purpose cyclone shelters with the assistance of the World Bank and UNDP.

The draft final report for the Master Plan has been completed, according to which the estimated population of the HRA in the year 2002 is 6.35 million people. As existing shelters can only accommodate one-third of this estimated population, the construction of new shelters at 2,500 sites (based on 1,750 people/site) is necessary.

The Government of Bangladesh intends to construct cyclone shelters in accordance with the Master Plan and hopes that donor countries and international aid organizations will follow suit.




*Number of Cyclonic Storms Landed on Bangladesh Coast in Different Decades (after Matsuda, 1991)*




*Monthly distribution of cyclonic storms landed on Bangladesh coast between 1877 and 1990 (after Matsuda, 1991)*

Fig. 2-1-1 Cyclonic Storms

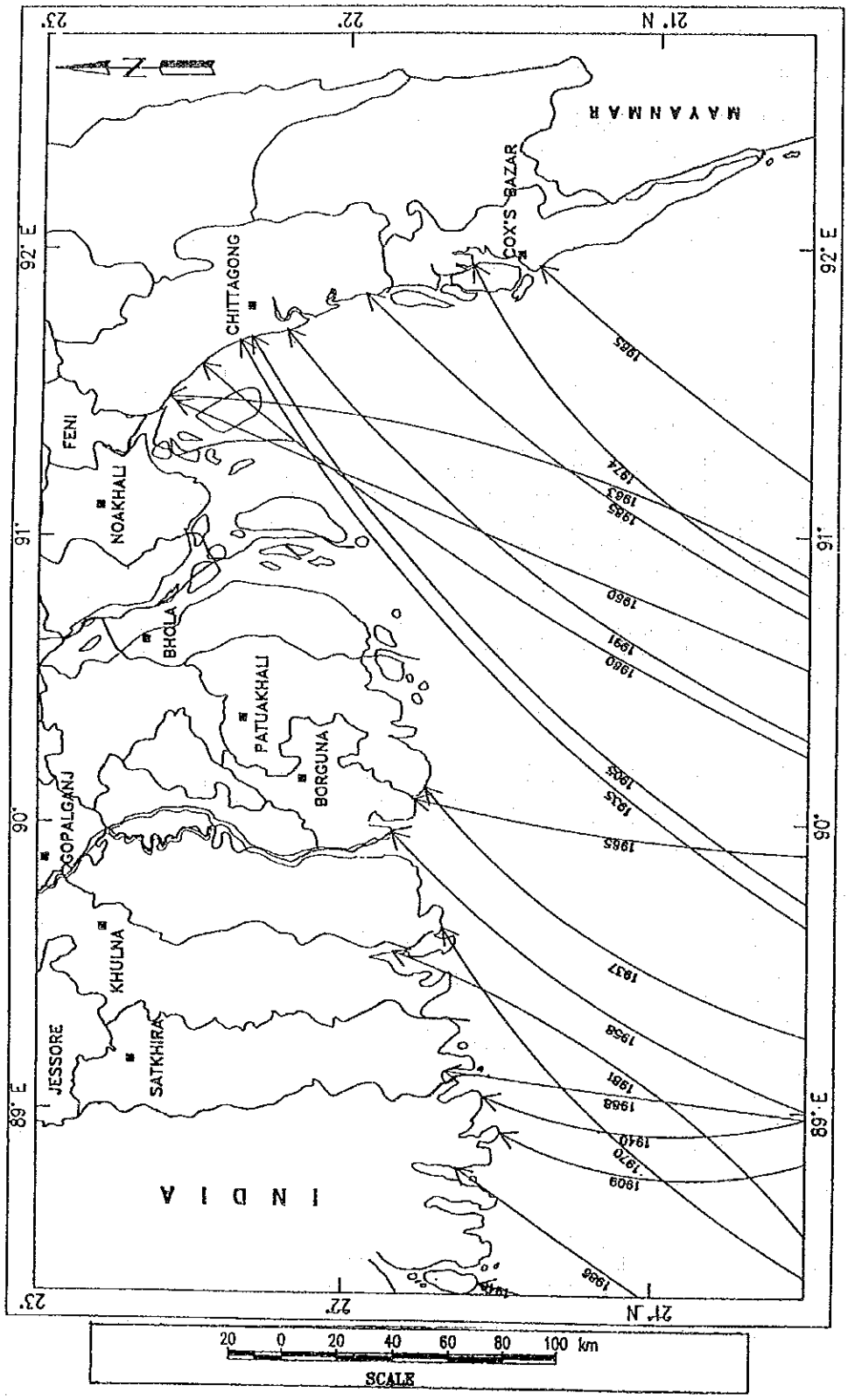



Fig. 2-1-2 Paths of Severe Cyclones

Table 2-1-3 Inventory of Shelters

HIGH RISK AREA (HRA)

| Sl. No. | Thana | Existing Cyclone Shelters | | | | | | Cyclone Shelters Under Construction | | | | | Cyclone shelters Proposed by Various Agencies | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PWD/ IDA | BDRCS | CARITAS | CCC | Others | Total | BDRCS | CARITAS | Facilities | Others (d) | Total | BDRCS (a) | CARITAS | Facilities (b) | Others (c) | Total |
| 1. | Shyamnagar | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| 2. | Dacope | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 3. | Koyra | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 4. | Serankhola | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 |
| 5. | Mongleport | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 2 |
| 6. | Patharghata | 1 | 1 | 0 | 7 | 0 | 9 | 2 | 0 | 0 | 1 | 3 | 3 | 0 | 0 | 0 | 3 |
| 7. | Barguna | 1 | 1 | 0 | 3 | 0 | 5 | 1 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 2 |
| 8. | Amtali | 1 | 2 | 0 | 3 | 0 | 6 | 1 | 0 | 0 | 0 | 1 | 3 | 4 | 0 | 0 | 7 |
| 9. | Betagi | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10. | Bauphal | 3 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11. | Galachipa | 24 | 4 | 0 | 8 | 0 | 36 | 3 | 0 | 0 | 0 | 3 | 7 | 0 | 0 | 0 | 7 |
| 12. | Dashmina | 6 | 1 | 0 | 1 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 |
| 13. | Kalapara | 21 | 1 | 2 | 6 | 0 | 30 | 1 | 2 | 0 | 0 | 3 | 4 | 11 | 0 | 0 | 15 |
| 14. | Mathbaria | 1 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15. | Bhola Sadar | 5 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16. | Burhanuddin | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17. | Lalmohan | 13 | 0 | 0 | 1 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 12 | 0 | 13 |
| 18. | Char Fasson | 24 | 3 | 0 | 6 | 0 | 33 | 5 | 0 | 0 | 1 | 6 | 2 | 0 | 12 | 0 | 14 |
| 19. | Manpura | 6 | 0 | 4 | 1 | 0 | 11 | 7 | 6 | 0 | 0 | 13 | 1 | 0 | 3 | 0 | 4 |
| 20. | Tazumuddin | 9 | 3 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 11 | 0 | 12 |
| 21. | Daulatkhan | 8 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 11 | 0 | 12 |
| 22. | Bakerganj | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23. | Barisal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24. | Ramgati | 8 | 0 | 0 | 4 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 |
| 25. | Raipur | 1 | 0 | 0 | 2 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26. | Lakshmipur Sadar | 1 | 0 | 0 | 2 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27. | Haliya | 13 | 16 | 0 | 7 | 0 | 36 | 6 | 0 | 12 | 0 | 18 | 0 | 3 | 13 | 0 | 16 |
| 28. | Noakhali Sadar | 10 | 6 | 0 | 3 | 0 | 19 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 8 |
| 29. | Companiganj | 3 | 6 | 0 | 2 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 6 |
| 30. | Sonagazi | 3 | 0 | 0 | 5 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 |
| 31. | Sandwip | 7 | 6 | 6 | 9 | 1 | 29 | 0 | 0 | 0 | 0 | 0 | 6 | 6 | 34 | 0 | 46 |
| 32. | Mirsarai | 3 | 0 | 0 | 3 | 0 | 6 | 0 | 0 | 7 | 0 | 7 | 0 | 0 | 2 | 0 | 2 |
| 33. | Sitakunda | 1 | 0 | 0 | 7 | 0 | 8 | 0 | 0 | 13 | 0 | 13 | 0 | 0 | 0 | 0 | 0 |
| 34. | Patiya | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35. | Anwara | 2 | 0 | 0 | 5 | 0 | 7 | 0 | 1 | 13 | 0 | 14 | 10 | 0 | 5 | 0 | 15 |
| 36. | Banshkhali | 4 | 0 | 0 | 8 | 0 | 12 | 9 | 0 | 12 | 4 | 25 | 9 | 0 | 13 | 0 | 22 |
| 37. | Kutubdia | 3 | 4 | 0 | 3 | 0 | 10 | 0 | 0 | 0 | 9 | 9 | 10 | 0 | 24 | 17 | 51 |
| 38. | Chakaria | 3 | 2 | 0 | 8 | 0 | 13 | 0 | 8 | 18 | 0 | 26 | 13 | 0 | 17 | 0 | 30 |
| 39. | Maheshkhali | 3 | 3 | 0 | 5 | 0 | 11 | 2 | 0 | 0 | 20 | 22 | 3 | 0 | 6 | 0 | 9 |
| 40. | Cox's Bazar Sadar | 1 | 0 | 0 | 4 | 0 | 5 | 1 | 1 | 15 | 0 | 17 | 4 | 0 | 3 | 0 | 7 |
| 41. | Ramu | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 4 | 0 | 0 | 3 | 0 | 3 |
| 42. | Ukhia | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 5 | 0 | 5 |
| 43. | Teknaf | 1 | 3 | 0 | 4 | 0 | 8 | 2 | 0 | 5 | 0 | 7 | 2 | 0 | 4 | 0 | 6 |
| 44. | Bandar | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| 45. | Chandanaish | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 |
| TOTAL : | | 196 | 62 | 12 | 118 | 1 | 389 | 40 | 23 | 101 | 35 | 199 | 109 | 30 | 183 | 17 | 339 |

WITHIN RISK ZONE (BUT OUTSIDE HRA)

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL : | 18 | 0 | 0 | 9 | 0 | 27 | 0 | 0 | 1 | 0 | 1 | 1 | 2 | 13 | 0 | 16 |

OUTSIDE RISK ZONE

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL : | 13 | 0 | 0 | 5 | 0 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 107 | 0 | 112 |

(a) Location of 5 Nos. are unknown

(b) Location of 19 Nos. are unknown and not included; 64 Nos. of CEC financed primary schools are included

(c) Includes LGEB (10 nos.), BRAC (7 nos.)

(d) Includes Grameen Bank (1 no.), Church of Bangladesh (5 nos.), BRAC (9 nos.), CCDB (15 nos.), SAMPREETI (4 nos.), DRF (1 no.)

Table 2-1-4 Inventory of Shelter Construction Plans

(Multipurpose Cyclone Shelter Programme)

| Organizations | Nos | Table 2-1-3 | | | | Remarks |
|---|---|---|---|---|---|---|
| | | HRA | R Z | Outside R Z | total | |
| 1. Existing Cyclone Shelter | | | | | | |
| Coastal Community Center | 132 | 118 | 9 | 5 | 132 | |
| PWD/IDA | 227 | 196 | 18 | 13 | 227 | |
| BDRCS (Red Crescent Society) | 62 | 62 | — | — | 62 | |
| Facilities Department | 24 | — | — | — | — | |
| NGO' S | | | | | | |
| Caritas | 12 | 12 | — | — | 12 | |
| DANIDA | 1 | 1 | — | — | 1 | |
| Netherlands | 6 | — | — | — | — | |
| India | 1 | — | — | — | — | |
| Swiss Disaster Relief (SDR) | 4 | — | — | — | — | |
| Total | 469 | 389 | 27 | 18 | 434 | |
| 2. Cyclone Shelters under Construction | | | | | | |
| BDRCS | 40 | 40 | — | — | 40 | |
| NGOS (Caritas | 48 | 23 | — | — | 23 | Other 25 Nos? |
| BRAC (Bangladesh Rural Advencement Committee) | 16 | 9 | — | — | 9 | Other 7 Nos? |
| CCDB (Christian Commission for Development in Bangladesh) | 15 | 15 | — | — | 15 | |
| SPD (Society for Peace & Development) | 4 | 4 | — | — | 4 | |
| Chruch of Bangladesh | 7 | 5 | — | — | 5 | |
| Grameen Bank | — | 1 | — | — | 1 | |
| DRF | — | 1 | — | — | 1 | |
| Facilities Department | — | 101 | 1 | — | 102 | |
| Total | 130 | 199 | 1 | — | 200 | |
| 3. Cyclone Shelters Proposed by Various Agencies | | | | | | |
| Red Cross Societies /FD | 115 | 109 | 1 | — | 110 | 5 Nos unknown |
| Saudi Government/FD | 311 | } 119 (171) | 13(14) | 107(107) | } 239 (292) | 19 Nos unknown |
| Islamic Development Bank/FD | 49 | (49) | — | — | (49) | |
| Commission of the European Communities | 200 | 64 | — | — | 64 | 136 Nos unknown |
| IFAD/LGED | 10 | 10 | — | — | 10 | |
| Japanese government /LGED | 40 | — | — | — | — | |
| NGOS | | | | | | |
| Caritas | 37 | 30 | 2 | 5 | 37 | 23 Nos started |
| Grameen Bank | 20 | — | — | — | — | |
| ※ 8 NGO | 36 | — | — | — | — | |
| WVB & CCDB | 50 | — | — | — | — | |
| Gonoshathya Kendra | 30 | — | — | — | — | |
| Prism-Bangladesh | 10 | — | — | — | — | |
| Swedish Free Mission | 2 | — | — | — | — | |
| Children International Bangladesh | 1 | — | — | — | — | |
| -S. O. S (USA) | | | | | | |
| Unnyan Shahajogi Team | 2 | — | — | — | — | |
| BRAC | — | 7 | — | — | 7 | |
| Total | 913 | 339 | 16 | 112 | 467 | |

### 2.1.4 Project Implementation System

Most of the existing cyclone shelters dating from the 1960's and 1970's were constructed by the PWD using IDA funding. Since 1985, the BDRCS has been the main organization for the construction of cyclone shelters however small number of shelters have also been constructed by Caritas, (both BDRCS and Caritas use their own funds).

The Union Offices in the 1960's were managed as coastal community centers. Due to poor maintenance, however, these shelters have deteriorated to the extent that the use of some is now considered dangerous. The PWD-type cyclone shelters constructed in the 1970's have been transferred to provincial government and the Ministry of Education responsibility and are mainly used as primary schools. Many of these shelters have also deteriorated due to the shortage of maintenance funds. The cyclone shelters constructed by the BDRCS were principally used as community centers but have been used as school buildings in recent years. A high level of maintenance is conducted by the BDRCS with those shelters used as schools being maintained by the teachers. The cyclone shelters constructed by Caritas adopted the same design as those constructed by the BDRCS and are used for multiple purposes, including schools, health centers, training centers and conference centers, etc.

As described so far, the existing cyclone shelters have been constructed and managed by many different organizations, serving many purposes in normal weather conditions, but primarily as schools. The poor management of the old PWD-type shelters, however, now necessitates the urgent repair of these shelters, without which many of the shelters will become unusable.

## 2.2 Outline of Related Plan

### 2.2.1 Multipurpose Cyclone Shelter Programme

The Inter-Ministerial Task Force of the Government of Bangladesh is currently preparing the Master Plan for the Multipurpose Cyclone Shelter Programme with the assistance of the World Bank and UNDP. This Master Plan is outlined as follows:

(1) Subject Area

The initial survey for the Master Plan was conducted in 2 identified areas, i.e. (i) the RZ with the risk of being hit by storm surges and (ii) the HRA with a high risk of loss

of human life due to large-scale flooding via a storm surge height of up to 1m. The latter (HRA) is the subject area for the construction of cyclone shelters under the Master Plan. The HRA consists of 44 Thanas (235 Unions) and covers an area of 8,093km$^2$ accounting for 5.6% of the total land area of Bangladesh (Fig. 2-2-1).

(2) Population

Based on population census data for 1991, the estimated population of the HRA in 1992 is 5.2 million (approximately 4.5% of the total population of Bangladesh). The population of the HRA in the year 2002 is estimated to be approximately 6.35 million based on an assumed average annual population increase of 2.12% between 1992 and 2002.

(3) Livestock

It is estimated that some 1.26 million head of cattle and 0.85 million sheep (including goats) are raised in the HRA and these figures are expected to increase to 1.41 million and 1.13 million respectively in the year 2002.

(4) Existing Cyclone Shelters

Refer to 2.1.2-(1) for the state of existing cyclone shelters.

(5) Existing Killas

While the BDRCS has constructed 180 killas for use as animal shelters, 24 of these have so far been washed away and only 146 killas were identified by the survey team. The remaining 10 could not be found and therefore could not be identified.

(6) Secure Public and Private Buildings

There are a total of 626 government or community buildings in the HRA which are capable of providing shelter for a total of 511,485 people. In addition, 235 private buildings can also shelter 93,572 people. One disadvantage of these structures is that almost all these are concentrated in an area in which the main Thana municipal office is located.

(7) Cyclone Shelter Construction Plan

New cyclone shelters are planned for only the HRA. As the total capacity of all cyclone shelters (existing shelters, those under construction, and those which have had concrete construction plans already been prepared), and secure public and private buildings (existing buildings and planned buildings) is 2.16 million, serving

approximately one-third of the total population of the HRA in 2002, new shelters are required to meet the needs of the remaining 4.19 million. A construction plan for some 2,500 new cyclone shelters has been prepared (Table 2-2-2), assuming an accommodation capacity of 1,750 people/shelter. These shelters are designed to be used as school buildings during normal times while the longest distance to a nearby shelter from any point in the HRA is set at 1.5km, or the longest distance one would need to travel to find shelter to avoid cyclone. In addition the construction of killas above the high tide level is also proposed to protect livestock.

The proposed use of the cyclone shelters as mainly primary school buildings during normal weather conditions is linked to a new law which aims at achieving compulsory primary education by the year 2000, which is a main pillar of the educational policy of the Government of Bangladesh. It is estimated that the construction of more than 3,000 primary schools is necessary to achieve this target.

A standard primary school consists of 3 classrooms and 1 staff room for the teaching of 250 pupils in 2 shifts. The proposed designs for these cyclone shelter-cum-school buildings are (1) on top of killas, (2) on stilts on top of killas and (3) on stilts next to a killa. The first alternative is said to be preferred from both the technical and financial point of view.

(8) Operation and Maintenance of Cyclone Shelters

Each cyclone shelter requires a management committee for their long term operation and maintenance. The BDRCS can be relied on for this task because of its expertise in managing such shelters.

The smooth operation and maintenance of a cyclone shelter requires an organization to be responsible for such work, as manpower appropriations and proper funding. As the existing shelter management committees lack both sufficient manpower and funds, their management activities fall short of what is required. The restructuring of government organizations in order to make sufficient operations and maintenance funds available is necessary. The main government organizations associated with the operation and maintenance of cyclone shelters are those involved in education and road construction, and the Bangladesh Water Development Board; (BWDB is responsible for flood control, irrigation and drainage). In principle, cyclone shelter operation and maintenance costs should be borne by government ministries and development boards. It is feasible to entrust the operation and management of cyclone shelters to community development committees, provided that the operation

and maintenance costs are small. However, alternatives could be generated through Income Generating Activity (IGA), local donations and/or a charge for shelter use. An additional fund raising method may be through the conversion of former killa excavation sites to fish culture ponds.

(9) Related Projects

- Transport

Access to cyclone shelters in the HRA is mainly provided by roads and water channels. In view of the relatively poor transport network compared to other areas, improvement of the road network in the HRA has been recommended. The design adopted for approach roads envisages a three meter road width capable of accommodating 3-wheeled rickshaw vans in two directions.

- Planting of Trees

The planting of coconut, Jhau and other trees around shelters and killas is proposed to reduce the damage force of cyclones and storm surges and to improve the general environment.

- Lighting

The current lighting system using dry cell-operated torch lights satisfies the lighting requirements for evacuation to cyclone shelters. Depending on the use of the shelters during normal times, the use of a solar PV system and/or kerosene generators is feasible.

- Telecommunications

The existing BTTB telecommunications network is inadequate. The Master Plan recommends the introduction of a VHF/UHF fixed cellular-type network based on the examination results on various available technologies, including VSAT, HF and VHF/UHF, etc.

(10) Implementation Plan

- Implementation Schedule

Implementation of the Master Plan for the Multipurpose Cyclone Shelter Programme is planned to commence in fiscal 1994/95 and the construction of all cyclone shelters and killas will be completed by the year 2000.

- Implementation Body

The establishment of the Cyclone Shelter Construction Organization (CSCO) responsible for the implementation of the Master Plan has been proposed. As the assistance of all government departments and agencies is required for the smooth completion of the Master Plan, the CSCO may be placed under the jurisdiction of the Prime Minister's Office.

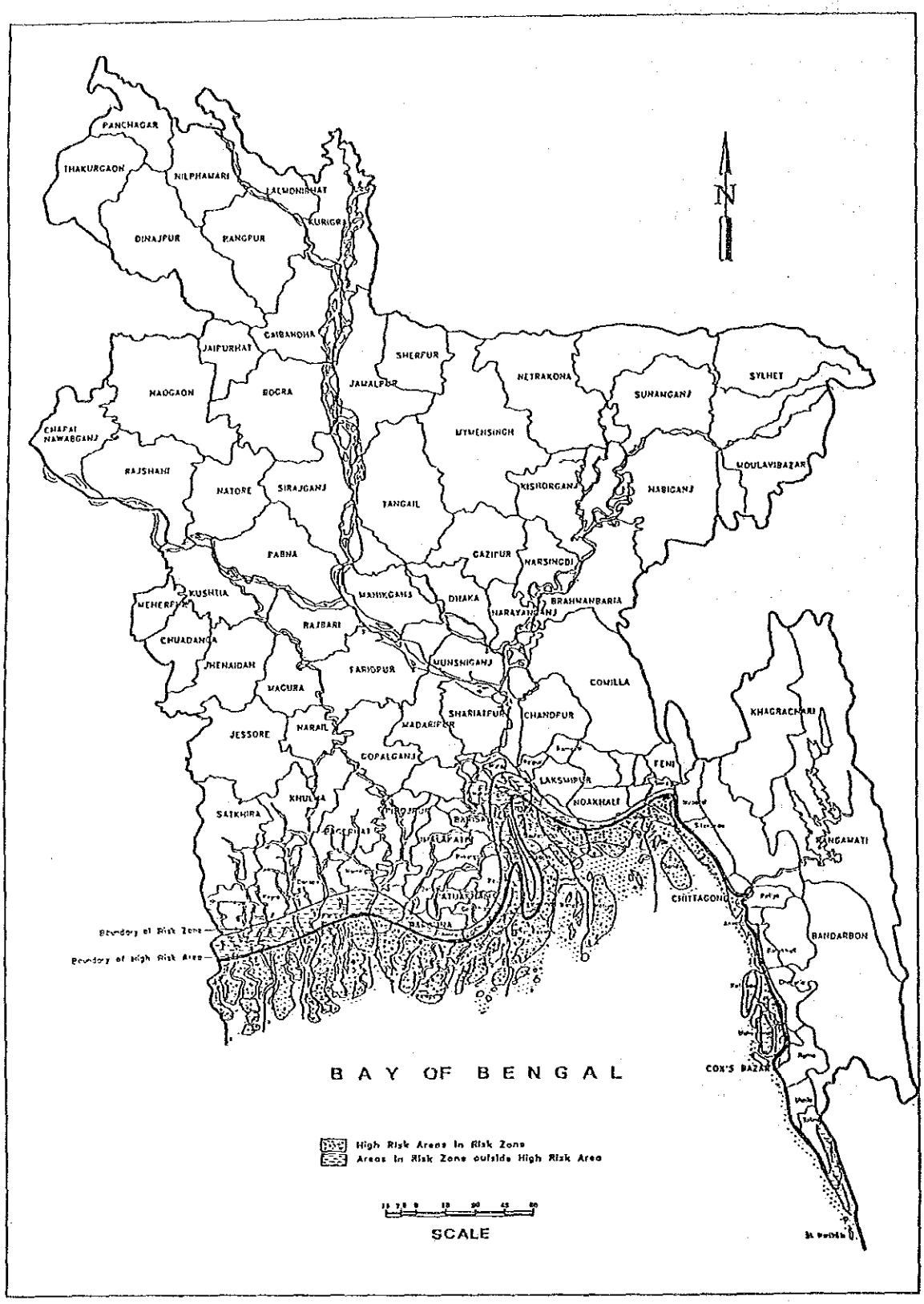



Fig. 2-2-1 Risk Zone and High Risk Area

Table 2-2-1 Probable Distribution of Population in Various Types of Shelters

| Sl. No. | Name of Thana | Total Population (July 1, 2002) | Probable Distribution of Population in Various Types of Shelters | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Existing Cyclone Shelter | Existing Public & Private Buildings | Shelters Under-Construc-tion | New Public, Private and Commercial Buildings | Shelters Proposed by Other Agencies | Shelters Proposed by MCSP |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | TOTAL (*) | 6,353,760 | 425,430 | 601,765 | 265,980 | 415,537 | 452,820 | 4,253,301 |
| 1. | Dacope | 48,514 | 0 | 430 | 1,000 | 3,026 | 0 | 44,058 |
| 2. | Koyra | 37,497 | 0 | 5,050 | 1,000 | 2,875 | 0 | 28,572 |
| 3. | Sarankhola | 41,323 | 0 | 9,500 | 0 | 2,366 | 2,000 | 27,457 |
| 4. | Monglaport | 26,943 | 0 | 3,150 | 1,000 | 1,647 | 3,000 | 18,146 |
| 5. | Shyamnagar | 52,549 | 0 | 600 | 1,000 | 3,428 | 1,000 | 46,521 |
| 6. | Mathbaria | 87,195 | 2,010 | 1,950 | 0 | 5,660 | 0 | 77,575 |
| 7. | Amtali | 98,993 | 5,010 | 3,097 | 1,000 | 6,749 | 7,000 | 76,137 |
| 8. | Barguna | 162,688 | 4,010 | 1,575 | 1,000 | 10,535 | 2,000 | 143,568 |
| 9. | Patharghata | 164,933 | 6,010 | 14,625 | 2,000 | 10,646 | 3,000 | 128,652 |
| 10. | Betagi | 46,657 | 1,510 | 900 | 0 | 3,333 | 0 | 40,914 |
| 11. | Kalapara | 224,539 | 37,710 | 8,992 | 3,000 | 14,228 | 14,000 | 146,609 |
| 12. | Bauphal | 133,212 | 4,530 | 9,175 | 0 | 8,661 | 0 | 110,846 |
| 13. | Galachipa | 260,225 | 44,240 | 26,725 | 3,000 | 15,511 | 7,000 | 163,749 |
| 14. | Dashmina | 100,024 | 10,560 | 17,937 | 0 | 6,402 | 3,000 | 62,125 |
| 15. | Barisal Sadar | 15,072 | 0 | 800 | 0 | 1,254 | 0 | 13,018 |
| 16. | Bakerganj | 17,303 | 1,510 | 0 | 0 | 865 | 0 | 14,928 |
| 17. | Char Fasson | 397,694 | 42,240 | 20,775 | 6,000 | 26,035 | 21,680 | 280,964 |
| 18. | Bhola Sadar | 225,268 | 7,550 | 4,062 | 0 | 15,663 | 0 | 197,993 |
| 19. | Burhanuddin | 131,283 | 1,510 | 4,300 | 0 | 9,563 | 0 | 115,910 |
| 20. | Lalmohan | 224,881 | 20,130 | 2,360 | 0 | 14,744 | 20,680 | 166,967 |
| 21. | Manpura | 65,477 | 13,560 | 9,975 | 13,000 | 4,273 | 5,920 | 18,749 |
| 22. | Daulatkhan | 169,084 | 12,080 | 19,500 | 0 | 12,253 | 17,400 | 107,851 |
| 23. | Tazumuddin | 138,799 | 16,590 | 10,855 | 0 | 8,540 | 19,040 | 83,774 |
| 24. | Sonagazi | 140,416 | 8,030 | 10,812 | 0 | 8,521 | 5,000 | 108,053 |
| 25. | Ramgati | 399,504 | 14,080 | 15,787 | 0 | 23,974 | 5,000 | 340,663 |
| 26. | Raipur | 92,505 | 2,510 | 2,750 | 0 | 5,625 | 0 | 81,620 |
| 27. | Lakshmipur Sadar | 93,572 | 3,510 | 1,350 | 0 | 5,678 | 0 | 83,034 |
| 28. | Haliya | 371,464 | 39,130 | 19,165 | 25,680 | 22,573 | 24,320 | 240,596 |
| 29. | Noakhali Sadar (Sudharam) | 167,496 | 20,600 | 300 | 0 | 11,374 | 8,000 | 127,222 |
| 30. | Companiganj | 56,193 | 11,530 | 8,300 | 0 | 4,309 | 6,000 | 28,886 |
| 31. | Sandwip | 332,847 | 28,070 | 41,075 | 0 | 23,240 | 67,760 | 172,702 |
| 32. | Banshkhali | 292,826 | 10,040 | 25,250 | 32,680 | 20,142 | 30,320 | 174,394 |
| 33. | Mirsarai | 78,321 | 6,030 | 3,220 | 11,480 | 5,717 | 2,000 | 49,874 |
| 34. | Sitakunda | 194,422 | 5,010 | 26,649 | 21,320 | 13,522 | 0 | 127,921 |
| 35. | Anwara | 141,248 | 5,520 | 18,283 | 22,320 | 9,164 | 16,560 | 69,401 |
| 36. | Patiya | 162,833 | 0 | 70,210 | 0 | 11,942 | 0 | 84,345 |
| 37. | Cox's Bazar Sadar | 140,837 | 3,510 | 52,237 | 28,240 | 8,841 | 8,920 | 65,616 |
| 38. | Kutubdia | 126,902 | 8,520 | 41,448 | 11,700 | 8,645 | 78,460 | 6,176 |
| 39. | Maheshkhali | 165,329 | 10,030 | 18,941 | 22,000 | 10,767 | 12,840 | 90,751 |
| 40. | Chakaria | 353,645 | 10,530 | 32,450 | 37,520 | 22,283 | 40,880 | 209,982 |
| 41. | Ramu | 27,250 | 0 | 1,600 | 6,560 | 2,363 | 4,920 | 11,810 |
| 43. | Ukhia | 34,292 | 1,510 | 1,200 | 3,280 | 2,215 | 6,560 | 19,527 |

(*) Since the capacity of various types of shelters other than those proposed by MCSP is higher than the population in some Unions (viz. Char Fakira, Char Patharghata, Sikalbaha, Jhilawnja, all unions of Kutubdia Thana other than Ali Akbar Deil and Khuniapalong), the total of Cols. 4 to 9 is slightly larger than Col. 3.

Table 2-2-2 Shelter and Killa Construction Priorities

| Sl No. | District | Thana | Priority | | Total |
|---|---|---|---|---|---|
| | | | 1 | 2 | |
| 1. | Cox's Bazar | Cox's Bazar | 35 | 3 | 38 |
| 2. | " | Kutubdia | 4 | 0 | 4 |
| 3. | " | Moheshkhali | 25 | 26 | 51 |
| 4. | " | Chakaria | 67 | 54 | 121 |
| 5. | " | Ramu | 0 | 7 | 7 |
| 6. | " | Teknaf | 13 | 13 | 26 |
| 7. | " | Ukhia | 0 | 11 | 11 |
| 8. | Chittagang | Banshkhali | 54 | 45 | 99 |
| 9. | " | Mirsarai | 25 | 4 | 29 |
| 10. | " | Sitakunda | 39 | 33 | 72 |
| 11. | " | Anwara | 15 | 25 | 40 |
| 12. | " | Patiya | 14 | 34 | 48 |
| 13. | " | Sandwip | 99 | 0 | 99 |
| 14. | " | Chandanaish | - | 13 | 13 |
| 15. | Lakshmipur | Ramgati | 75 | 120 | 195 |
| 16. | " | Raipur | 0 | 47 | 47 |
| 17. | " | Lakshmipur | 0 | 47 | 47 |
| 18. | Feni | Sonagazi | 30 | 32 | 62 |
| 19. | Noakhali | Noakhali Sadar | 64 | 8 | 72 |
| 20. | " | Hatiya | 131 | 8 | 139 |
| 21. | " | Companigonj | 16 | 0 | 16 |
| 22. | Bhola | Bhola Sadar | 31 | 81 | 112 |
| 23. | " | Char Fasson | 104 | 56 | 160 |
| 24. | " | Daulatkhan | 25 | 36 | 61 |
| 25. | " | Lalmohan | 34 | 61 | 95 |
| 26. | " | Manpura | 11 | 0 | 11 |
| 27. | " | Tazumuddin | 32 | 16 | 48 |
| 28. | " | Burhanuddin | 25 | 42 | 67 |
| 29. | Barisal | Bakerganj | - | 9 | 9 |
| 30. | " | Barisal Sadar | - | 7 | 7 |
| 31. | Patuakhali | Bauphal | - | 64 | 64 |
| 32. | " | Dashmina | 24 | 12 | 36 |
| 33. | " | Galachipa | 50 | 42 | 92 |
| 34. | " | Kalapara | 35 | 50 | 85 |
| 35. | Barguna | Barguna | 39 | 43 | 82 |
| 36. | " | Amtali | 25 | 18 | 43 |
| 37. | " | Patharghata | 59 | 15 | 74 |
| 38. | " | Betagi | 0 | 23 | 23 |
| 39. | Perojpur | Mathbaria | 19 | 25 | 44 |
| 40. | Khulna | Dacope | 0 | 25 | 25 |
| 41. | " | Koyra | 0 | 16 | 16 |
| 42. | " | Monglaport | 0 | 11 | 11 |
| 43. | " | Sarankhola | 0 | 16 | 16 |
| | " | Dublar Char | 5 | - | 5 |
| 44. | Sathkhira | Shymnagar | 0 | 27 | 27 |
| Other Locations | | | 26 | 25 | 51 |
| Total : | | | 1250 | 1250 | 2500 |

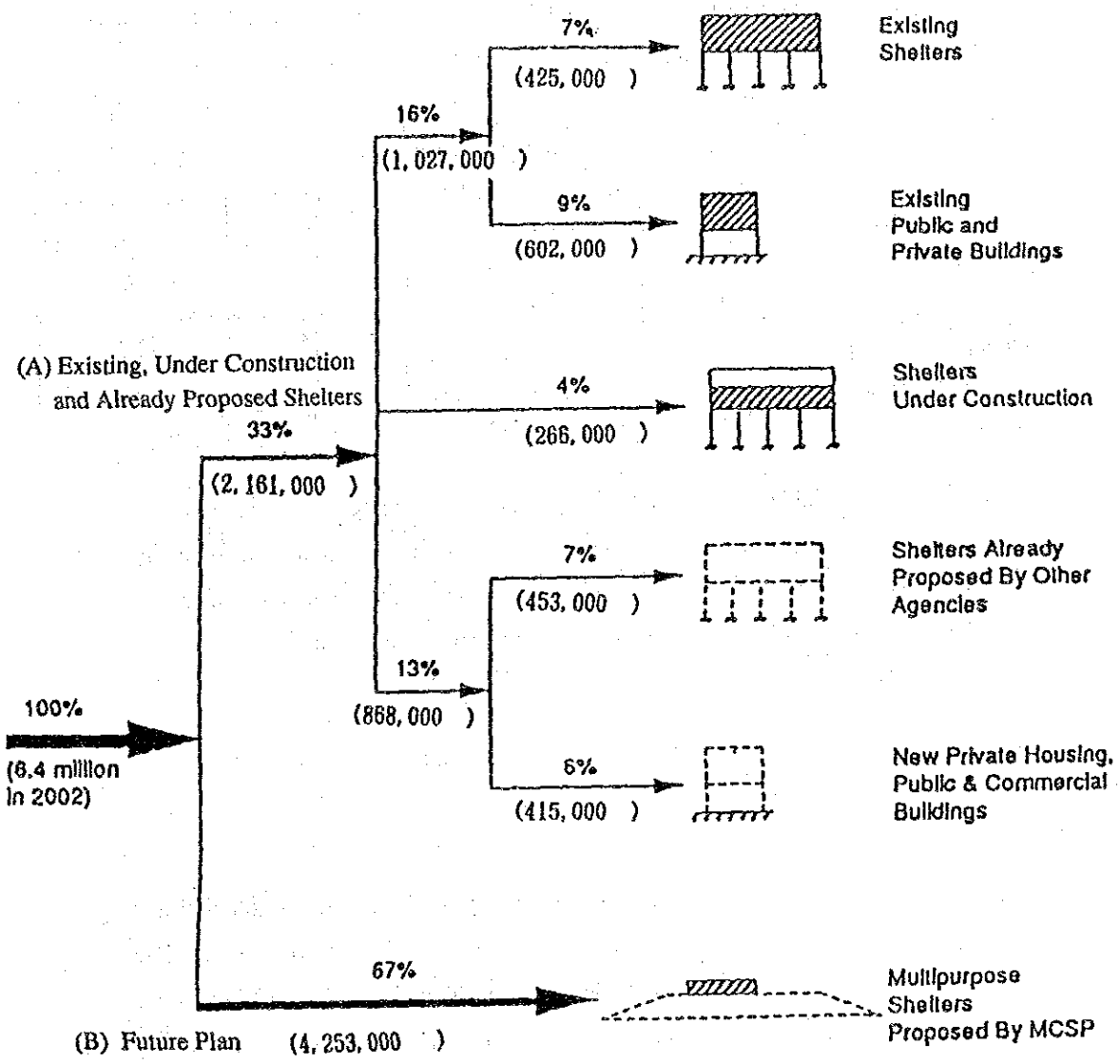



Fig. 2-2-2 Probable Movement of Population in HRA to Different Types of Shelter Accommodation