Revised Draft

BANGLADESH FLOOD ACTION PLAN

ISSUES REPORT

FAP - 23 FLOOD PROOFING STUDY

Prepared for :

The Flood Plan Coordination Organization (FPCO)

Ministry of Irrigation, Water Development and Flood Control

December 1992

ISPAN
IRRIGATION SUPPORT PROJECT FOR ASIA AND THE NEAR EAST
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FOREWORD

Following suggestions made during the FAP 14/23 Workshop held on 9-10 November 1992, the draft FAP 23 Issues Report (dated August 1992) has been revised to include case studies of flood proofing requirements in three specific areas. The field work for the case studies was undertaken in November 1992. In addition, the sections in the draft report on economics and institutional aspects of flood proofing have been revised and expanded.

FAP 23 Issues Report

Executive Summary

1. The overall objective of the Flood Proofing Study (FAP 23) is to identify and implement effective flood proofing measures that form an effective program for economic development and improving social welfare in a flood prone environment. Such a program would avoid or reduce the adverse effects of flooding on the social and economic activities of communities, and on infrastructure, particularly in those areas which are not protected by more comprehensive flood protection measures.

2. The Flood Proofing Study is being carried out in two phases. During Phase I, people and institutions in small urban areas were surveyed to determine their responses to floods. The findings of the survey were combined with the findings of the FAP 14 Study of the flood response in rural areas to identify flood proofing measures being taken in Bangladesh. During Phase II, comprehensive flood proofing measures will be planned and implemented in a number of pilot areas. This Issues Report relates Phase I of the Flood Proofing Study.

3. Flood proofing is the provision of long-term, non-structural or minor structural measures to mitigate the effects of floods. The objectives of flood proofing are to avoid the loss of human life, reduce the disruption to normal activities during and after a flood and provide people with the security and motivation necessary to make and sustain improvements in their economic and social welfare and achieve prosperity in an environment that frequently floods.

4. Flood proofing is complementary to flood protection and flood preparedness which are the other flood mitigation measures being planned and implemented under the Flood Action Plan. An important difference between flood proofing and flood protection is the area over which the respective measures have an impact; flood proofing is focused on local measures that affect one or several households, a village, small urban areas or specific infrastructure facilities while flood protection provides protection for all social and economic activities and infrastructure within larger areas ranging from a number of villages to parts or complete unions, upazilas or even districts. Successful flood proofing requires public participation and low to medium capital inputs from either the public or private sector. Flood protection also requires public participation but tends to require high capital investment from the public sector.

5. Individuals, communities and institutions in Bangladesh experience frequent flooding and already use their personal resources to implement many flood proofing measures but a shortage of resources or information about the changing characteristics of floods has resulted in many communities and institutions being unable to provide effective flood proofing. The purpose of a flood proofing program would be to combine the information, resources and technology available to individuals, communities, and government and non-government agencies to make individual or community actions more effective.

6. The inadequacies of present flood mitigation measures (including flood proofing) were demonstrated in 1988 flood when 45 million people were affected by the flood. 7.2 million houses were damaged during the flood, along with 45 hospitals, 1400 health centers, 19,000 schools, 10,000 km of highways, 144,000 km of rural roads and 1,300 km of railway embankment. The estimated total cost of the damage was Tk 45,600 million ($US 1,200 million) of which damage to housing accounted for 66 percent and damage to infrastructure 29 percent.

7. Families have traditionally flood proofed their houses by constructing them on the highest ground available. If this high ground is still liable to flood, plinth or floor levels are raised above ground level, sometimes by as much as 3 or 4 meters depending on local conditions, but often their efforts are inadequate especially for the more severe floods of 1987 and 1988 and the cyclone of 1991. In addition to damage from inundation, flood damage to houses tends to be so widespread because of the poor standards of construction of many houses. There are several programs aimed at improving the standard of rural houses, but the housing sector will still be vulnerable to significant damage by floods for many years.

8. Where resources have not been available to flood proof individual houses, the government along with several non-government organizations have constructed community flood shelters as refuges for those whose own houses are vulnerable during floods. Flood shelters have been constructed in active floodplain areas adjacent to the main rivers and cyclone shelters have been constructed in coastal areas, although the coverage of shelters in either location is far from complete. In the April 1991, many people found safe refuge in the available cyclone shelters during the storm surge and many lives were saved in the communities that were fortunate enough to have access to one. Many donors are contributing to the construction of additional cyclone shelters and a comprehensive study of the requirement and design of cyclone shelters is presently under way. Inland flood shelters are not receiving the same attention at present, partly because the loss of life during river floods is much less, although the total suffering of the population may not be so.

9. There is an increasing need for land use controls because peoples' activities are encroaching on more vulnerable areas and interfering with natural floodways. Land use controls can be used to regulate settlement or land use in flood-prone areas in order to reduce the vulnerability of people, crops or property to flood damage. There are some legal provisions for land use planning and controls but they have been rarely used because of difficulties with their enforcement and the lack of political will. Flood insurance could be another measure for promoting flood proofing of buildings, but this option would be suitable for only more affluent people.

10. Domestic water supplies are often disrupted during floods and when combined with deterioration of the quality of available water due to inadequate sanitation facilities, the result is outbreaks of disease and other health problems. Rural water supplies can be flood-proofed at little cost and more widespread application of flood proofing measures is required.

11. Local economies are disrupted during floods and the resulting shortage or absence of employment is a major problem for the rural and urban poor

who have few resources to survive without regular wage income. Lack of income is often the main concern of poor people during floods.

12. Agriculture dominates the rural economy and, although farmers have adapted their farming systems to accommodate seasonal flooding, there is scope to make agricultural practices more resilient to flooding. The recent rapid expansion of small scale irrigation during the dry season is in part a response to the 1987 and 1988 floods when farmers suffered serious crop losses. Farmers have switched production from the flood-prone monsoon season to the dry season when irrigation is required. Some of the flood proofing measures being promoted include additional new high yielding rice varieties and small-scale flood control and drainage schemes.

13. The pace of industrialization has been slow during the past decade and ways will have to be found to increase industrial activity. Flood proofing can be applied to reduce the risk of flooding of industrial premises and the supporting infrastructure, and thereby create an environment that is safer for industrial investment. Flood proofing measures for industry include flood proofing of utilities, markets and transportation systems, and raising ground levels at industrial premises.

14. Livestock and fisheries are important sources of cash income and provide essential components to local diets. Both livestock and fisheries are vulnerable to severe damages during floods and possible flood proofing measures include provision of safe refuges for livestock and their feed, development of more flood resistant feed sources, raising of embankments around ponds to prevent entry of floodwater.

15. Roads are the key component in the government's transport policy but during the floods of 1987 and 1988 many roads were unusable which disrupted local economies and prevented the free movement of goods. Roads fail during floods because local hydrological conditions are not fully understood or accounted for during their design. In addition, *ad hoc* development of rural roads by numerous local, non-government, and national organizations has, in may areas, completely changed the local hydrology of the flood plains thus making irrelevant design data based on historic records. Flood proofing measures for roads include the provision of adequate structures to allow the passage of floodwater, planting of vegetation on side slopes to protect embankments from erosion, provision of sections in embankments with lower elevations to ensure overtopping takes place at designated locations. Railways have similar flood proofing requirements as roads.

16. Boats are an important part of rural transport systems, especially during the monsoon season when large areas of the floodplains are covered with water and the option of land travel is not available. The recent proliferation of road embankments has disrupted boats transport in many areas and too few provisions are made for boat passages across embankments. There is also a shortage of boats in many areas causing disruption to government and other services. Non-government organizations have credit programs for the purchase of boats.

17. Public buildings often are damaged during floods and building designs need to be improved to take account off local flood conditions. There needs

to be more coordination between those agencies with information on flood levels and those agencies designing buildings.

18. Government services and public utilities are also disrupted by floods and few if any have flood proofed their activities. The flood proofing measures required will depend on the particular services being offered but many would benefit from flood-proofed offices.

19. There is a definite requirement for more systematic application of flood proofing principles and a flood proofing program could have a wide social and economic impact. Flood proofing measures could be designed to directly improve the conditions of urban and rural poor who are disproportionately more vulnerable to floods. Women could also be principal beneficiaries of flood proofing by implementing measures that meet their specific needs during floods, for example measures related to flood proofing housing, water supplies and income.

20. Flood proofing measures need to be planned and designed on the basis of local needs and local resources, and implementation of a flood proofing program would require active participation from local communities.

21. A comprehensive flood proofing program would require coordination and cooperation between many government, non-government and private people and institutions. The institutional arrangements for implementing the Flood Action Plan would require a national level coordination committee. The lead ministry for implementing minor structural flood proofing measures should be the Ministry of Local Government Rural Development and Cooperatives. Union parishads, assisted by central government agencies and non-government organizations would promote, plan and implement flood proofing measures for local communities.

22. On the basis of the findings of the FAP 14 and FAP 23 surveys, a flood proofing program, based on comprehensive application of flood proofing principles, would yield substantial benefits in terms of saving human life, reducing suffering and make local and national economies more resilient to flooding. Investment in flood proofing would allow development of the country to proceed smoothly without catastrophic interruptions from floods.

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ACRONYMS & ABBREVIATION

ADB	Asian Development Bank
BARC	Bangladesh Agriculture Research Council
BBS	Bangladesh Bureau of Statistics
BIDS	Bangladesh Institute of Development Studies
BIWTA	Bangladesh Inland Water Transport Authority
BRAC	Bangladesh Rural Advancement Committee
BSCIC	Bangladesh Small & Cottage Industries Corporation
BUET	Bangladesh University of Engineering and technology
BWDB	Bangladesh Water Development Board
CARE	Cooperative for American Relief Everywhere
CIDA	Canadian International Development Agency
DANIDA	Danish International Development Agency
DPHE	Department of Public Health Engineering
EEC	European Economic Community
FAP	Flood Action Plan
FFW	Food for Works
FPCO	Flood Plan Coordination Office
FIC	Flood Information Centre
GDP	Gross Domestic Product
GIS	Geographic Information Systems
HBFC	House Building Finance Corporation
HBRI	House and Building Research Institute
ISPAN	Irrigation Support Project for Asia and the Near East
JICA	Japan International Cooperation Agency
LGEB	Local Government Engineering Bureau
MCC	Mennonite Central Committee
MIDAS	Micro Industries Development Assistance Society
MOI	Ministry of Information
MPO	Master Plan Organization
NORAD	Norwegian Agency for International Development
ODA	Overseas Development Administration (United Kingdom)
PDB	Power Development Board
PWD	Public Works Department
SCI	Service Civil International
REB	Rural Electrification Board
RESP	Rural Employment Sector Programme
SIDA	Swedish International Development Authority
SPARRSO	Space Research and Remote Sensing Organization
TTB	Telephone and Telegraph Board
UNCHS	United Nation Centre For Human Settlements.
UNDP	United Nations Development Programme
UNICEF	United Nations Children Emergency Fund
USAID	United States Agency for International Development

Chapter 1

INTRODUCTION

1.1 Scope

The overall objective of the Flood Proofing Study (FAP 23) is to identify and implement effective flood proofing measures that form an effective program for economic development and improve social welfare in a flood-prone environment. Such a program would avoid or reduce the adverse effects of flooding on the social and economic activities of communities, and on infrastructure, particularly in those areas which are not protected by more comprehensive flood protection measures.

This Issues Report covers Phase I of the Flood Proofing Study.

1.2 Background

1.2.1 Floods in Bangladesh

Floods are part of the natural environment of Bangladesh and the success of local people in adapting their life styles to accommodate seasonal floods has resulted in high population densities throughout most parts of the country. However, in recent years the characteristics of floods have changed for a number of reasons including changes in land use, changes in the settlement pattern, and man-made alterations to natural drainage channels and rivers. A further factor influencing the severity of recent floods has been the unusual combination of contributing events such as flood peaks in major river systems occurring at the same time. The net result is that many people have been less able to continue their normal lives during floods and have suffered increased losses to their property and disruption to their livelihoods. More comprehensive flood damage mitigation measures are required to reduce the disruption caused by floods.

The inadequacies of present flood damage mitigation measures were highlighted in 1987 and 1988 when the magnitude and extent of the monsoon floods had disastrous consequences over large areas of the country and caused widespread disruption of normal social and economic activities. Floods in 1987 inundated about 40 percent of the land area (57,000 km^2), affected about 30 million people, and caused about 1800 deaths. In 1988, the floods inundated about 60 percent of the land area.(82,000 km^2), affected 45 million people, and caused about 2330 deaths. Damages from the 1987 and 1988 floods have been estimated to be about $ US 500 million and $ US 1200 million respectively (World Bank 1989). In the 1988 flood, about 7.2 million houses were totally or partially damaged, accounting for 66 percent of total damages, while infrastructure accounted for 29 percent, agriculture 2 percent, industries 2 percent and health and sanitation facilities 1 percent of damages. Thus, the main facilities damaged by the flood were housing and infrastructure. However, these statistics do not reflect the human misery and adverse impact on earning capacity of most of the individuals, families and communities affected by floods.

In 1991, the inadequacies of flood mitigation measures in coastal areas was apparent when the coastal areas were hit by one of the most severe cyclones this century. Winds gusting up to 225 km/hour, torrential rains and a tidal storm

surge, up to 7 m deep in places, lashed a 150 km stretch of coast. Rising water submerged densely populated offshore islands and an estimated 140,000 people died, mainly by drowning. The cyclone affected a population of over 12 million people and damaged or destroyed more than 1.75 million houses, 6700 schools, and coastal embankments, roads, ports and other infrastructure The estimated cost of damages was $ US 260 million.

1.2.2 The Flood Action Plan

Following these devastating floods of 1987 and 1988, the need for more comprehensive planning of flood mitigation measures was apparent and the Flood Action Plan was launched at the request of the Government of Bangladesh to formulate and implement technically, financially, economically and environmentally sound solutions to flooding problems in Bangladesh.

The Flood Action Plan (FAP) comprises of a number of studies and pilot projects. In the first two years of the Plan, 1990-92, Regional Water Resource Development Planning Studies are being undertaken to identify and assess various water resource management strategies for different regions of the country. These regional studies will be followed by feasibility studies of priority investment projects. In addition, a number of complementary social, economic and environmental studies are being undertaken to improve the understanding of the impact of flooding and of flood control, drainage and irrigation projects, and to develop guidelines and planning criteria for use in the preparation and implementation of the Flood Action Plan studies.

Two of these complementary studies are the Flood Proofing Study (FAP 23) and the Flood Response Study (FAP 14). In the Flood Proofing Study, individuals, government and non-government agencies, and industrial and commercial establishments located in small urban areas (pourshavas) were surveyed to determine their responses to flooding. Flood proofing measures suitable for implementation by individuals or communities will be identified and pilot flood proofing programs were developed for different areas. In the Flood Response Study, the response of rural people to floods were surveyed to improve the understanding of how people cope with floods so that future flood mitigation measures can be designed to fit more closely with local needs.

1.3 FAP 23

1.3.1 Terms of Reference

The Flood Proofing Study (FAP 23) is divided into two phases. Phase I is a preparatory phase to evaluate current performance of flood proofing measures, while Phase II is focused on detailed planning and implementation of flood proofing measures.

Under Phase I, reports and empirical data on flood proofing measures in Bangladesh and elsewhere are reviewed and evaluated to identify possible measures and develop a strategy for a flood proofing program to be implemented under Phase II. In addition under Phase I, a field survey is undertaken to determine the response to flooding of people and institutions in urban areas.

The Terms of Reference for Phase I are given in Appendix A.

1.3.2 Project Activities

A field survey was undertaken during the period June-July 1991 to determine the response of individuals, government and non-government agencies and industrial and commercial establishments to the 1988 flood and the impact of the flood on their activities. Respondents were also asked to identify possible flood proofing measures that could be taken in future. The survey found that many flood proofing measures have been developed and successfully implemented. However, further development of flood proofing measures was found to be constrained by the lack of systematic exchange of information and promotion of flood proofing concepts, present centralized government policies, lack of trust between officials and residents, and limited coordination between government ministries.

The survey undertaken by FAP 23 was complementary to the surveys conducted for the Flood Response Study (FAP 14) which focused on determining the response to floods of individuals and communities in rural areas. Findings of the Flood Response Study have been used to develop flood proofing strategies for rural areas.

A two-day workshop was conducted on 25-26 September 1991 to discuss flood proofing concepts in general and to discuss specific flood proofing measures in detail. Workshop participants were mainly from other FAP studies and government technical personnel. Representatives from local government officials, non-government organizations, private companies and industries were also present.

A second workshop was held on 10 November 1992 to present the findings of the (draft) Issues and Interim Reports and the draft Guidelines on Flood Proofing. Following the workshop, an additional field survey was undertaken to identify appropriate flood proofing measures in specific locations.

1.3.3 Project Reports

The Inception Report for FAP 23 was prepared and submitted for review by the Flood Plan Coordination Office (FPCO) in July 1991 (ISPAN 1991)

The findings of the FAP 23 field survey were given in the Briefing Notes prepared for the Flood Proofing Workshop in September 1991 (ISPAN 1991). General concepts related to flood proofing and specific flood proofing measures were also discussed in the Briefing Notes which were circulated to all workshop participants.

The findings of the FAP 23 and the FAP 14 field surveys and issues discussed by workshop participants were used in the preparation of the draft Issues Report (ISPAN 1992) in which flood proofing measures already practiced in Bangladesh were discussed along with the components of a possible flood proofing program. The Issues Report (dated August 1992) supersedes the FAP 23 Issues Report (draft) dated December 1991.

An draft Interim Report was also prepared to detail the requirements and terms of reference for Phase II of the Flood Proofing Study (ISPAN 1992).

Draft guidelines were prepared on the application of flood proofing to the FAP feasibility studies (ISPAN 1992) and submitted to FPCO for discussion.

This Issues Report (dated August 1992) has been expanded for the revised draft Issues Report to incorporate comments and suggestions forthcoming from the second workshop on Flood Proofing held on 10 November 1992.

1.4 Organization of this Report

The objective of this Report is to discuss issues related to flood proofing including measures already being practiced in Bangladesh and recommendations for a flood proofing program to be planned and implemented under Phase II of FAP 23. In Chapter 2 of this Report, flood proofing is defined and the application of flood proofing in Bangladesh and elsewhere is discussed in general. Specific flood proofing measures already practiced in Bangladesh are described and discussed in Chapter 3. The findings of the field survey of appropriate flood proofing measures of specific locations are given in Chapter 4 and the development implications of flood proofing are discussed in Chapter 5. The possibilities for a flood proofing program to be implemented under Phase II of FAP 23 are discussed in Chapter 6.

Chapter 2

APPLICATION OF FLOOD PROOFING

2.1 Definitions

Possible flood damage mitigation measures include flood proofing, flood protection and flood preparedness. These measures are interrelated and are defined as follows:

Flood proofing is the provision of long-term, non-structural or minor structural measures to mitigate the effects of floods. The objectives of flood proofing are to avoid the loss of human life and reduce the disruption to normal activities during and after a flood, and provide people with the security and motivation necessary to make and sustain improvements in their economic and social welfare and achieve prosperity in an environment that frequently floods.

Structural flood proofing measures include raising floor levels of homesteads and industrial facilities above flood levels, provision of refuge areas or flood shelters, ensuring that water supplies and other health related facilities operate throughout floods, designing roads to be above peak flood level, provision of additional bridges or culverts to improve water flows through an area and also to ensure embankments or structures are not washed away. Non-structural measures include institutional measures to coordinate development activities related to flood control and drainage, planning developments in flood-prone areas to take account of prevailing hydrological conditions, and ensuring hydrological data and analysis are available to those involved with design and construction of infrastructure and other facilities.

Flood protection is the provision of major long-term structural measures that physically prevent some or all flood water from entering a designated area. Under the Flood Action Plan, flood protection does not necessarily mean complete protection from floods is provided but can also mean the provision of controlled flooding and drainage. The objective of flood protection is to ensure normal or improved social and economic activity can continue within the designated area during and after a flood event. In Bangladesh, flood protection measures involve the construction of earth embankments and appurtenant structures or improving the flow in drainage channels, as there is no potential for mitigating flood damage by the provision of storage reservoirs.

An essential component of flood protection measures is effective operation and maintenance of the facilities constructed. Operation and maintenance procedures include the development of effective institutional arrangements, the allocation of the funds required to ensure the integrity of facilities, and continuous assessment of the performance of facilities during floods (for example patrols to identify erosion of the embankments).

The main purpose of most existing flood protection projects in Bangladesh is to protect and improve agricultural production. Secondary benefits include flood protection of the life and property of communities within the embanked area and utilization of the flood embankment as a refuge by those people not within the protected area.

Flood preparedness is the provision of short-term measures for individuals, families, communities and other institutions to undertake with the objective of reducing the disruption and damage caused by floods. Flood preparedness is primarily the development of service delivery systems for people or institutions to use before, during or after a flood event. Flood preparedness measures are designed to ensure the readiness and ability of a society to forecast and take precautionary measures in advance of a flood and to respond to and cope with the effects of a flood by organizing and delivering timely and effective rescue, relief and other appropriate post-disaster assistance. Flood preparedness measures include the development and regular testing of both flood forecasting systems (prediction of the timing, magnitude, duration and location of floods) and flood warning systems (delivery of usable and credible advance information on expected flooding) to inform people of an impending flood event. The latter systems would also include plans for evacuation or other activities to be undertaken during a flood alert period; the education and training of officials and the population at risk; the establishment of policies, standards, organizational arrangements and operational plans to be applied following a flood; the securing of resources (possibly including the stockpiling of supplies and the allocation of funds); and the training of intervention teams. Flood preparedness measures are being identified and developed under FAP 11.

2.2 Discussion of Flood Damage Mitigation Measures

An important difference between flood proofing and flood protection is the area over which the respective measures have an impact; flood proofing is focused on local measures that affect one or several households, a village, small urban areas or specific infrastructure facilities while flood protection provides protection for all social and economic activities and infrastructure within larger areas ranging from a number of villages to parts or complete unions, thanas or even districts. Successful flood proofing requires public participation and low capital inputs from either the public or private sector or combination of both. Flood protection also requires public participation but tends to require high capital investment from the public sector.

Flood proofing and flood protection are complementary as flood proofing is applicable both within and outside areas 'protected' by major physical structures. In addition, within all flood affected areas, there will be areas not suitable for flood protection for physical, hydrological, social or economic reasons and flood proofing measures can be used to reduce the damage and disruption caused by floods and improve the living conditions for the people not within the protected area. Furthermore, flood protection and flood proofing are not mutually exclusive. Flood protection measures are designed to give protection from specific flood events, but homesteads and other essential social and economic facilities and infrastructure within a protected area may require protection from more extreme floods during which the larger protection measures may no longer be effective. The additional protection required for specific facilities and infrastructure can be provided by appropriate flood proofing measures. Flood proofing may also be used as an interim measure during construction of more extensive flood protection facilities.

Flood preparedness measures are required for all flood affected areas, whether or not flood protection or flood proofing or both are available.

People who experience frequent flooding already use their personal resources to implement many flood proofing measures but a shortage of resources or information about the changing characteristics of floods may mean that people are unable to provide effective flood proofing. The purpose of a flood proofing program would be to combine the information, resources and technology available to individuals, communities, and government and non-government agencies to make individual or community actions more effective.

2.3 Application of Flood Proofing

The objective of flood proofing is to avoid the loss of human life, reduce the disruption caused by floods and improve normal social and economic activities during and after a flood. Flood proofing activities are focused on finding ways for people to live and improve their lives in an environment that frequently floods.

Flood proofing measures can be grouped as (a) measures that are focused on saving human lives and reducing human suffering, (b) measures that are focused on reducing the disruption caused by floods, namely measures affecting incomes and livelihood, and (c) measures relating to public utilities, infrastructure and services. Some flood proofing measures related to each of these groupings are discussed below:

a) Saving Human Life and Reducing Suffering.

Floods can extract a toll on human life and cause severe disruption to social and economic activities both in terms of people being drowned and people not being able to sustain normal life during and after a flood because of the lack of basic necessities such as clean drinking water, food, fuel, or income to purchase these essentials. Damage or loss of shelter and shortage of necessities can lead to deterioration of the health and physical condition of those affected which will impair their ability to earn once employment again becomes available.

Loss of peoples' private property and capital assets also causes considerable suffering during and after floods. Private property includes houses, homesteads, and commercial and industrial premises. Capital assets include personal possessions (family heirlooms, jewelry, clothes), household furniture and utensils, tools, commercial and industrial equipment (weaving looms, fishing nets), livestock and fodder, agricultural supplies (seeds, fertilizers etc.), food and other consumable items.

In a flood proofing program, measures would be identified to reduce the risk to human life and decrease the suffering caused by floods. Such measures may include raising of hand tubewells and house floor levels above peak water levels to ensure clean drinking water and shelter are available throughout a flood. Protection of homesteads from floods is of particular importance to women as their daily activities are centered around homesteads and they have to carry out their normal activities (food preparation, cooking, child minding, animal husbandry etc.) at all times.

Flood proofing programs would also include measures to protect private property and capital assets from damage or loss during floods. Traditionally, individuals and families have depended on their own flood proofing initiatives to protect their properties and possessions from flood damage. Measures that are commonly

undertaken are raising of floor levels of houses and protection of side slopes of homestead areas from wave action. However, changes in flood characteristics may mean that people's traditional flood proofing efforts may be less effective. Possible flood proofing measures could include identifying homesteads that are vulnerable to flooding, and determining ways to ensure there is sufficient flood-free area to store the family's capital assets (for example by raising floor levels or providing materials for roof-level storage). Similarly, measures to protect houses from damage during the flood could be identified.

b) Incomes and livelihood.

During and after floods, the main hardship suffered by many people results from the disruption of the local economy and the resulting shortage of employment opportunities and absence of income. Most poor people have few reserves of food or money to survive without a regular income from self-employment or wage and the lack of income can lead to devastating social and economic losses that can result in severe malnutrition, homelessness, and displacement.

In a flood proofing program, measures would be identified and implemented to improve employment opportunities in flood-prone areas and sustain them during and after a flood. Suitable flood proofing measures include improvement of the yield of flood tolerant crops such as deep water aman, protection of seed and fertilizer godowns and the identification and support of alternative employment activities that can continue throughout a flood. Flood proofing measures would also include ensuring access to and protection of commercial facilities and necessary support services so that employment activities are unaffected by flooding. Overall, the impact of flooding on economic activities should be assessed as an integral part of national, regional and local development planning.

c) Infrastructure and public services.

Public utilities in rural areas are rural water supplies by tubewells and handpumps, and, in some locations, the electricity supply. In urban areas, public services may also include piped water and gas supply. Infrastructure includes roads, ferries, railways, irrigation, flood control and drainage facilities and marketing facilities. Public services include education and health services, postal and telephone services, and administrative services such as police and land registration.

Many problems communities face during and after floods stem from disruption of public utilities and services, and damage to public infrastructure. In a flood proofing program, communities would identify critical public services and infrastructure and government agencies would be responsible for ensuring that facilities were designed and constructed to provide consistent and agreed upon standards of usability and accessibility to the public throughout flood events.

Ensuring that essential infrastructure remains operable throughout a flood would allow the free flow of materials and information between flood affected areas and the rest of the country. Goods and services could still be supplied to affected areas and markets could still operate to distribute them; scarcity should be avoided and prices should be more stable.

2.4 Related Flood Action Plan Studies

Flood proofing is one component of the flood mitigation measures being considered under the Flood Action Plan. The FAP studies of most relevance to the Flood Proofing Study are:

FAP 10 Flood Forecasting and Warning Project.

FAP 11 Disaster Preparedness (of which flood preparedness is part. The Inception Report of the team formulating the project was submitted in June 1992 (Mott MacDonald 1992)

FAP 14 Flood Response Study (survey of flood response in rural areas. The draft Main Report of this study was submitted to FPCO in October 1992.)

The FAP Regional Studies (FAP 2: North West Regional Study, FAP 3: North Central Regional Study, FAP 4: South West Area Management Study, FAP 5: South East Regional Study and FAP 6: North East Regional Study) will consider flood proofing as a component of flood mitigation strategies for the different areas. Flood proofing measures will also be considered in FAP 20 Compartmentalization Pilot Project. Cyclone Protection is being studied under FAP 7. Flood protection for Dhaka and the main urban centers are being studies under FAP 8 and FAP 9 respectively. Flood Modeling/Management Project (FAP 25) will calculate flood water levels resulting from different development options. The institutional aspects of implementing flood mitigation measures under the Flood Action Plan will be considered under FAP 26.

All the Flood Action Plan Studies are given in Table A.1 of Appendix A.

2.5 Flood Proofing Activities in Bangladesh

People in Bangladesh have always accommodated floods and have applied the principles of flood proofing within the resources and understanding available. Villages are located on the higher ground (often old river levees), homesteads are raised above normal flood levels and house near river banks subject to erosion can be easily dismantled. People have practiced flood proofing because the option of flood protection has not been generally available. Their efforts to protect themselves from floods sometime fail for a number of reasons including the lack of resources to implement effective flood proofing measures and a lack of understanding or information on changes in the larger hydrological processes affecting floods in their locality. Flood proofing measures that have been applied in Bangladesh are discussed in detail in Chapter 3.

2.6 Flood Proofing Experience Elsewhere

Flood proofing measures have not been systematically applied in the neighboring countries or in the region. Most countries have basic disaster legislation and some countries also have building codes, but, as in Bangladesh, the approach to flood proofing has been to leave local people to implement measures on their own initiative and with their own funds. Even where there are provisions for non-structural flood proofing measures, governments find them difficult to enforce. Occasionally, governments have taken a more active role in implementing flood proofing measures but their involvement has often been in response to local disasters after they have occurred.

India. There has been a program of constructing cyclone and flood shelters in coastal areas (such as Tamil Nadu, Kerala, Andhra Pradesh, Orissa and West Bengal) vulnerable to cyclones and flooding. The number of shelter constructed has not been sufficient for the needs of the local people and the planning and construction process followed have not always ensured the long-term viability of the shelters constructed. In many areas, there is a cyclone warning system to complement the shelters.

In Nepal, town planning authorities have restricted the expansion of housing in lowlands close to rivers, but enforcement is week.

Philippines. Land use planning and land zoning regulations are defined. For example, in town planning, studies should be undertaken of to assess the adequacy of roads, water works and sewerage systems in areas vulnerable to floods. There is also provision for structures to be a minimum of 10 meters from shorelines, or riverbanks. However, enforcement of these regulations seems to be weak.

There is a central agency to review and evaluate land use plans and zoning ordinances of local governments. The agency also assists areas in formulating development plans and also enforces guidelines, standards, and regulations for land use development including housing. The administration and enforcement of the related regulations lies with the regions and municipalities, with local zoning administrators deputized for the purpose.

There is also a program for the construction of cyclone-resistant core shelter units. The units are built on a self-help basis, with the beneficiaries themselves pooling their labor resources and contributing indigenous materials under the supervision of locally hired foremen. The modular design of units enables their easy upgrading and expansion as the socio-economic conditions of the owners improve. By 1991, 14,000 units had been constructed. (Brown and others 1991)

United States. Numerous large and small-scale structural measures (dams, levees, and channel modifications) were implemented during the period from 1930 through the mid-1960's, but damages from flooding increased at a rate to show that structural measures alone were not sufficient. Consequently, planners and interest groups with other priorities for public expenditure pressed for alternatives to capital intensive flood control projects (Marshall and Ashton 1974)

The main result has been a combination of regulatory, incentive and management measures, aimed at preventing or reducing flood damage. Efforts to increase public awareness of flood hazards and to provide information for individual decisions and actions have comprised an important part of the process (Tettemer 1983).

One of the measures promoted was federally subsidized insurance coverage for existing property conditional upon enactment and enforcement of local land-use regulations that preclude development or rehabilitation of structures in the active flood plain except for limited cases where compensatory measures were undertaken. Insurance is offered by private companies to individuals or private and public bodies in compliance with local control requirements that include zoning and other management practices based on the 100-year flood event. Insurance premiums are based on the risk of flood damage at a particular location (depth and velocity of flooding etc.).

Maps and other flood hazard information are prepared for use in planning future development and to identify existing properties that are exposed to a high flood risk. Such properties must be improved to reduce vulnerability. While locally enforced, these measures are backed by federal legislation that provides administrative and technical consistency and legal backing should enforcement be required.

Flood plain management in the United States was recently comprehensively reviewed (Natural Hazards Research 1992). One of the main findings of the Review was as follows:

> *'Over the past 25 years, floodplain management has matured from a focus on reducing flood losses by using structural measures to a broader approach that incorporates structural and non-structural measures for flood loss reduction and also takes into consideration the protection of the natural and cultural resources of the floodplains.*

Australia. Flood plain information programs similar to the United States have been adopted and implemented in Australia. For each community, the 100-year flood levels are computed from historical flood data and communities use this information to prepare local building codes that ensure new buildings are flood proofed either structurally or by location outside areas subject to flooding. The characteristics of flooding in Australia are similar to those in the United States, which accounts for the similarity of approaches to flood proofing.

The trend in many parts of Australia is for local codes to require that, prior to building permits being issued, individual buildings or entire development areas are raised to some predetermined level above expected floods. Several studies have been undertaken on the economics of relocation, house raising and individual response. (for example Penning-Rowsell and others 1987).

England. District councils regulate urban and rural development and they are advised to liaise with the National Rivers Authority who are responsible for collection and analysis of river flows and levels. There is however no legal requirement for the local planning agencies to incorporate the advice from the National Rivers Authority in their planning activities. Limited land space and development pressures create an atmosphere favoring development of flood plains, which in turn necessitates remedial flood protection measures.

There is some renewed emphasis on the role of flood forecasting and flood warning as a non-structural flood damage mitigation measure. The technology of flood warning dissemination, however, is not as advanced as the technology available for forecasting the floods and hence render this alternative to structural measures relatively unreliable in some parts of the country.

Chapter 3

FLOOD PROOFING MEASURES IN BANGLADESH

3.1 Introduction

The objective of flood proofing is to avoid the loss of human life, and reduce the disruption caused by floods by improving the resilience of the society and its economy and infrastructure to flooding. Flood proofing measures are focused on allowing people to live and improve their lives in an environment that frequently floods. Flood proofing activities have been practiced by the people of Bangladesh since the time of the first settlers of the region because floods have always been a prominent feature of the natural environment.

There are several different types of floods in Bangladesh: floods resulting from drainage congestion of local rainfall, floods from overbank spillage of rivers, flash floods and tidal and cyclonic coastal floods. Each type of flood is caused by different factors and has different impacts. Floods have to be viewed in the environmental context in which they occur in order to understand the flood proofing measures already adopted by local people and to be able to identify possible measures that could be introduced. The characteristics of floods in Bangladesh are discussed in Appendix B.

Flood proofing measures implemented by individuals, local communities and public agencies vary with the nature of flooding in a particular locality. In the FAP 23 and the FAP 14 field surveys, various flood proofing measures already practiced by local people and government agencies were identified, along with further measures that could be introduced.

The effectiveness of particular flood proofing measures needs to be considered with respect to their place within a comprehensive flood mitigation strategy in all flood-affected areas, flood preparedness is an essential complementary activity. The requirements for flood proofing will be different in areas where flood protection is available from non-protected areas because of the differences in the characteristics of flood events for which flood proofing measures are being taken.

In this chapter, flood proofing measures already adopted in rural and urban Bangladesh are identified and discussed. The measures are grouped together with respect to those that: (a) save human lives and reduce suffering (housing, flood shelters, water supplies and sanitation); (b) affect incomes and livelihoods(agriculture, industry, livestock, fisheries, , markets); and (c) affect public utilities, infrastructure and government services (roads, railways, public buildings, government services, electricity supply). The different measures discussed are not mutually exclusive as particular measures can have multiple impacts and benefits.

Reference is made where appropriate to the findings of the field surveys of FAP 23 and FAP 14. The findings of the FAP 23 field survey are detailed in Appendix C of this Report. The findings of the FAP 14 Survey are given in the FAP 14 Main Report (ISPAN 1992).

3.2 Housing

Houses are an essential component of all societies as houses are used for many necessary functions including shelter from the weather, security and privacy, cooking and eating, rearing children, sleeping, and storing capital assets and personal possessions. Many human activities are focused on houses and access to adequate housing is necessary for peoples' well-being and self-esteem. Flooding of peoples' houses can severely disrupt their daily lives, resulting in distress and financial loss both in the short-term (as people take measures to adapt to the loss of this basic facility) and the long-term (as people try to recover their position).

The majority of rural households (84 percent) live in simple huts (jupris), and of the remainder, about 11 percent live in huts of non-durable construction (Islam 1990). The mean floor area is about 27.9 m^2 (300 ft^2) and construction materials cost in the range of Tk 3,000 ($US 80).

Rural houses (*jupris*) are made predominantly from either light-weight timber frames or massive mud-walls. Floors are made of earth. Roofs are mainly thatched although corrugated iron sheets are used by more affluent households and is becoming more common in many areas. Wall cladding is either matting made from bamboo, jute sticks or similar materials, or corrugated iron sheets. In urban areas, houses are more likely to be constructed with bricks, and sometimes with a reinforced concrete frame. Brick house in rural areas are still very rare. The non-durable huts of many poor and landless people in both urban and rural areas are made from various materials such as bamboo, leaves, plastic sheet, branches etc. The frail construction of these huts makes them especially vulnerable to flood damage.

The planning, design and construction of rural housing has traditionally been left to individual families, but recently the government has been more active in trying to improve the standard of rural housing. Three models have been developed for rural low income housing including units with: (a) Reinforced concrete pillars with corrugated iron sheets for side and roof cladding (floor area of 26.8 m^2 (288 ft^2) and costing Tk 11,600), (b) Reinforced concrete pillars with ferrocement roof (floor area 19.50 m^2 (210 ft^2) and costing Tk 15,600), and (c) Pre-stressed concrete pillars and roof (floor area of 16.3 m^2 (176 ft^2) and costing Tk 12,400). (HBRI 1989) Model (a) is the most popular, but, since income levels of most landless rural people are considerably below the level needed to finance any of these proposed models, there is still a need for housing designs more affordable for the rural and urban poor.

Several non-government organizations have implemented successful housing programs. For example, Grameen Bank has actively promoted housing loans for the rural poor. The loan is given to purchase four concrete pillars and corrugated iron sheet for roof cladding which is sufficient for a one-room house costing from Tk 7,000 to 12,000. The program has been very popular and is a key area for future lending by the Bank. Other non-government organizations who are active with housing programs are Service Civil International (SCI), Mennonite Central Committee (MCC), Rangpur Dinajpur Rehabilitation Service (RDRS), Proshika, and Bangladesh Rural Advancement Committee (BRAC).

In the urban sector, the House Building Finance Corporation (HBFC) has given loans for construction of new houses or for rehabilitation of flood-damaged

houses. However, no new loans have been made for three years. Bangladesh Bank has a special project for to finance rural housing but that is also dormant at present.

3.2.1 Flood Damage to Housing

Floods can affect houses in a number of ways including preventing access, inundation of floor areas, erosion of the plinth and foundations, washing away roofs, walls and structural components, and deterioration of construction materials during prolonged inundation.

The 1988 flood caused extensive damages to the housing sector in many areas. Housing losses accounted for 65 percent of the total estimated damages caused by the 1988 flood (Siddique 1989) and 44 percent of the losses in rural areas (Hossain 1989). Damages to urban housing were considerably less, being only 12 percent of the damage in urban areas, because of their better location and more durable construction (BBS 1989). An estimated 7.2 million dwellings were completely destroyed or partially damaged (MOI 1988). In the Dhaka, Narayanganj, Keraniganj, Savar, and Tongi areas, an estimated 120,000 houses were destroyed while an estimated 150,000 homesteads were damaged. The total value of all housing damage in those areas was estimated to be Tk. 386 million ($US 10.15 million) (JICA 1991).

During the 1991 cyclone, an estimated 626,000 rural homes in 16 districts were destroyed at an estimated cost of Tk 2526 million ($US 66.5 million) (Haider and others 1991). Houses constructed with stronger and more durable materials such as bricks or concrete were able to withstand the prevailing conditions and provided safe refuge for many people. (UNDP 1991, BCAS 1991)

After floods recede, rural families replace or repair their houses on their own initiative or with relief/rehabilitation assistance from government or non-government organizations.

Many of those houses that were destroyed were located in the active flood plains or in neighboring older flood plains. The houses were swept away by rapidly flowing flood water or were lost when the land upon which they were built was eroded away.

3.2.2 Flood Proofing Measures

People have traditionally constructed their houses on the highest land available and if this has not been sufficient to keep their houses dry during floods, people have raised the floor or plinth levels of their houses or the level of the complete homestead area. Floor levels raised above level of the most recent flood in the hope that future floods will be less severe. If a more severe flood does occur, floor levels will be raised accordingly. As most floors are made from earth raising floor levels usually involves piling more soil onto the existing floor.

Another flood proofing measure is improving the standard of house construction to prevent physical damage by flood water. Protective embankments have also been used on a small scale but disposal of drainage water accumulating inside the embankment makes this option more complicated. For the protection of personal possessions, people install raised storage areas (machas) within their houses or move more valuable items to a higher floor or onto the roof.

Even though the raising of floor levels is technically straightforward, many of the rural and urban poor do not have the resources (neither access to materials nor labor) to be able to carry out the work required. Some form of external intervention may be required to flood proof their homesteads. For example, the non-government organization Mennonite Central Committee (MCC) have funded the raising of homestead ground of a flood-prone sweeper colony where the people did not have sufficient resources to undertake the work required themselves.

Mennonite Central Committee (MCC) and another non-government organization Service Civil International (SCI) are implementing a house building program in which construction materials (8 concrete pillars, roof timbers and corrugated iron roof sheeting) are supplied at the cost per house of about Tk 10,000 ($US 263.00) Fifty (50) percent of this cost id repaid by the householder over 2 years. The money repaid goes into a fund for further development. About 150 houses have been constructed during the three years of the program. In addition, MCC have a separate program to raise the plinth levels of houses and to provide hand tubewells and sanitation facilities (Gomes 1991).

In many areas, particularly the low-lying haor areas of the north-east, homesteads are vulnerable to erosion from waves and flood proofing measures include the planting of vegetative material on the side slopes of homestead mounds to dissipate the energy of the waves and protect the soil. In the haor areas, high land is at a premium and homesteads are grouped together in linear settlements which is in part to reduce individual exposure to wave action during floods.

People living in areas liable to erosion by rivers may limit their investment in raising floor levels because of the risk that their whole house may be lost. Houses in those areas are designed to be easily dismantled so that houses can be moved quickly moved when erosion is imminent. Noticeably in char areas, where there is a high risk of erosion, people living on more mature char areas that have been there for many years have raised their homesteads higher than those living on land that has more recently emerged from the river. The latter group are waiting to see if the homestead site they have selected will be sustainable in the long-term before they invest more in flood proofing their homesteads.

On riverbank land adjacent to the mainland and on char land, people who lose homesteads to erosion often resettle on flood protection embankments, if available. This resettlement is 'unofficial' but is tolerated by the authorities as they can do little to prevent it happening. BWDB, the responsible authority for most flood protection embankments, dislike settlements because settlers sometimes physically damage the embankment during establishment of their homestead. This problem could be overcome by having a more formal relationship between BWDB and the settlers by for example, allowing the settlers to stay on condition they maintain the design section of the embankment at all times. On the coastal island of Sandwip, provision was made in the design of embankments for settlement to take place on the landward side. During the cyclone of 1991, in several locations where settlements were established, the embankment survived the ravages of the storm better than sections without settlers.

Consolidation of the rural populations into *linear villages* along embankments may be the way some rural areas will develop but widescale formal resettlement

on embankments of people vulnerable to erosion would be a major task fraught with difficulties. For example, if embankments were enlarged to accommodate settlers there would be competition for the space from other landless people which would make the allocation of space on the embankment liable to manipulation and corruption. Also land acquisition along the alignment of embankments is a contentious issue which is being studied by FAP 15. Embankments enlarged to accommodate settlers would require even more land to be acquired and hence result in more landowners being affected. In the north-east, *linear* or *group* settlements are found in the deeply-flooded haor areas where high land is at a premium and people have grouped together to reduce their exposure to some flood-related problems.

3.3 Flood Shelters

If resources are not available to flood proof individual houses or homesteads, an alternative measure is to provide community flood shelters. The purpose of flood shelters is to provide temporary refuge to people whose own dwellings are unable to give them protection from a flood.

Community activities are not strongly developed in Bangladesh and flood shelters have not been a traditional flood proofing measure. Flood shelters have been introduced by government and non-government agencies during the past thirty years. The initial shelters were mainly buildings or raised earthen platforms (called *killas* in coastal areas) constructed to be above highest flood level. Communities tended not to be involved in their construction and responsibility for their subsequent care and maintenance was often unclear. Some shelters served as union parishad headquarters or schools during non-flood times and hence received some maintenance but many became dilapidated and no longer can be utilized effectively.

More recently, water supply (usually hand tube wells) and sanitation facilities (pit latrines) have been constructed as part of flood shelters and the whole facility has been clearly linked for use as a school or other community purposes.

Following the 1974 flood, the government proposed to construct 100 flood shelters beside the Brahmaputra/Jamuna river, but the actual number of shelters constructed is not certain. Of the three shelters constructed in Kurigram district, part of one is still being utilized as a school and is available for use as a shelter when required. Of the other two, one has been lost to erosion and the other has deteriorated and is no longer being used. In Sharishabari upazila, Jamalpur district, two flood shelters still remain. The materials of another two shelters were removed for use elsewhere. The shelter located at Baura Hat is also used as a school and has undergone considerable physical change since it was constructed. One of the original four shelter buildings has been replaced by a more substantive building while the three other shelter buildings have been removed and re-constructed elsewhere. The hand tubewells and latrines have also been removed for use elsewhere.

The government is presently involved with new shelter construction on two donor funded projects. As part of the general move to make diversify Food for Works activities away from road construction, CARE have recently constructed a flood shelter in Khazipur upazila in Bogra district, using ODA wheat. The location of the shelter was selected in consultation with the Upazila Chairman, who observed that people were using road embankments constructed under the Food

for Works Programme as flood shelters. As the first stage, an earthen mound was constructed in 1991/92. Additional facilities may be added in subsequent phases.

The Rural Employment Sector Programme (RESP) funded by SIDA and NORAD and implemented by the Local Government Engineering Bureau have also constructed one shelter on charland in Kurigram District to serve about 5000 people. The flood shelter comprises of an earthen mound (150 m by 110 m and about 2.1 m above ground level), one building (7.3 m by 36 m), 2 hand tubewells and 2 latrines. The building is to be used as a school. Tree planting and turfing of side slopes have also been done. The cost of the complete shelter is Tk 1.2 million ($US 31,600)

Non-government organizations have also undertaken the construction of flood shelters specifically for people living in char areas. Rangpur and Dinajpur Rehabilitation Service (RDRS) have constructed about 4 flood shelters on raised platforms as part of their Char Development Programme in 5 upazilas of Kurigram District. The platforms are 60 m by 21 m (200 ft by 70 ft) and 2.4 m (8 ft) above normal flood level. The shelters have been designed to accommodate 100 families plus their possessions and livestock. On the platform, there is one building, hand tubewells and sanitation facilities. The building is also used as a school. The cost of one complete shelter is about Tk 400,000 ($US 10,526).

Service Civil International (SCI) have constructed about 13 flood shelters in the chars of Bhuapur upazila in Tangail District. Funds for the shelters were provided by the Mennonite Central Committee (MCC). The shelters also serve as schools and offices for other SCI development activities. Local people benefiting from the shelter contribute to its cost by working on its construction at below-market rates. The land for the shelter is identified by the union parishad. The shelters usually comprise of a raised earth platform which is 1.5 m above the 1987 flood level. The dimensions of the mound are about 90 m by 75 m by about 2 m above ground level and there are two or three buildings plus hand tubewells and sanitation facilities. The side slopes are planted with vegetative matter to prevent erosion. Two of the shelters have been lost to erosion but the construction materials for the buildings were salvaged and re-used for flood shelters at different locations.

In coastal areas, the government has been more active in the construction of shelters, due in part to large numbers of people who are drowned during the worst of the cyclones. In the 1970 cyclone, an estimated 170,000 people perished, while in the April 1991 cyclone 139,000 people were killed. Numerous more people have been killed in smaller cyclones in between.

In the 1960's, government started a program to construct 2000 two-storied coastal community centers and single-storied sub-community centers. The centers were to be used as union parishad offices in normal times and cyclone shelters when required. The program was stopped after the construction of about 100 centers.

Following the 1970 cyclone, a multi-purpose cyclone shelters project was funded by IDA and executed from 1972 to 1979 by the Public Works Department. Under the project 238 rectangular, three-storied cyclone shelters were constructed. The shelters were constructed with reinforced concrete frames (footings, columns, beams, slabs and stairs) with brick walls and wooden doors and windows. The second floor was located between 4.12 m (13.5 ft) and 5.18 m (17 ft) above ground level. The floor area was 7.3 m by 18.3 m (24 ft by 58 ft). Each floor was divided into 2 rooms. On the roof there was a parapet wall to protect people from high

winds. Assuming an occupancy of 1 person/0.26 m^2 (2.8 ft^2), the number of people who can be accommodated is about 1500, including those on the roof.

During the 1980's, non-government organizations became involved in the construction of cyclone shelters. From 1985 to 1991, 62 two-storied shelters were constructed by the Bangladesh Red Crescent Society and 8 shelters were constructed by Caritas. The Red Crescent shelters are reinforced concrete framed 'arrow' shaped buildings. The second floor is 6.9 m (22.5 ft) wide and a total of 24.4 m (80 ft) on one side and 18.3 m(60 ft) on the other. The floor area is 104 m^2 (1120 ft^2) and the roof area is 180 m^2 (1938 ft^2) One main staircase goes from ground level to the second floor and two staircases go from the second floor to the roof, where there is a 0.75 m (2.5 ft) high parapet wall. The capacity of the shelter is estimated to be about 800 people. The Red Crescent shelters cost about Tk 2.2 million ($US 58,000). In addition, a few shelters were constructed under donor funded projects such as the Land reclamation Project funded by the Netherlands.

Beside some shelters, earthen mounds or killas have been provided as a place of refuge for livestock. In low lying areas, the top of the earthen mounds were constructed to be about 5 to 6 m (16 to 20 ft) above existing ground level. The mounds constructed in the 1970's are reportedly to be in very poor condition and many have been abandoned. More recently, the Red Crescent have tried to construct mounds but their attempts have not been too successful due to problems of land acquisition.

During the cyclone of April 1991, cyclone shelters made a significant contribution to saving lives in those communities which were fortunate enough to have a shelter nearby. Occupancy of some shelters were reportedly 3-5 times their design capacity as people crowded in to avoid the rising water. Some Red Crescent shelters that were designed for 800 people were reportedly occupied by about 2000 people.

Following the 1991 cyclone there has been considerable interest by many donors (including World Bank, European Community, Germany, Saudi Arabia) to fund the construction of more cyclone shelters. Funding for about 945 shelters and 40 killas has been committed. The condition of existing shelters and the total requirement for of additional shelters and their design have been investigated as part of the preparation for a Multipurpose Cyclone Shelter Programme to be funded by the World Bank, UNDP and other donors (BUET/BIDS 1992).

3.3.1 Planning and Design of Shelters

The purpose of shelters is to provide safe refuges for people during flood events. The main requirement is to give people a safe place above peak water level for the duration of the flood. However, the design requirements for shelters from cyclonic surges or river floods are similar. The main differences are that for cyclones people need protection from high winds and the duration of river floods are longer as river floods tend to happen over a period of weeks or months while cyclonic surges happen over a period of hours (see Appendix B). The initial cyclone shelters were designed as single reinforced concrete or brick buildings with floor levels above peak surge level and people crammed into the building for the duration of the cyclone. Following analysis of activities during and after recent cyclones, it became apparent that people need to preserve more than themselves to enhance their long-term recovery. One major factor influencing

the utilization of shelters was that people were unwilling to leave their possessions unguarded for fear of being looted and someone was usually left behind to guard their homesteads. Unfortunately many of those left behind were subsequently unable to reach the shelters when the enormity of the cyclonic surge became apparent. Therefore, current thinking is to provide an refuge area for people plus their possessions including livestock so that people can save their main assets and are less dependent on relief after the cyclone. Refuge areas would be a mound of earth raised above peak water level plus freeboard with single storied wind resistant buildings and space for livestock on top. This design would cost about 40 percent less than reinforced concrete framed buildings presently being constructed.

Both those shelters built inland and those on the coast were planned and designed with little involvement of the communities in which they were located. Shelters have not been used because people were afraid thet they would have to pay 'rent' to unscrupulous government officials (Haque 1988). Following completion of the shelters, responsibility for their operation and maintenance was unclear and many fell into disrepair, while some were taken over by local influentials for their own use. By the 1980's the problems of utilization and maintenance of shelters were recognized by non-government organizations and construction of new shelters was accompanied by programs to develop the use of shelters as community centers. As shelters are by far the most expensive building in their locality, it is essential that full use is made of the facility for economic and social reasons, because very few if any communities will be able to afford or have the opportunity to construct any other building of similar design or standard. Existing community buildings or facilities such as schools, health centers, mosques, eid gardens (*eid gah*), or markets could be adapted for use as flood shelters.

Other important considerations in the design of shelters in addition to community involvement in planning and siting, are the distance from homesteads to shelters, access to shelters when a flood is occurring, access to the shelter after the flood for relief and other services, the length of time a shelter may be occupied, provision of water and sanitation facilities, access to food and fuel for those taking shelter, provision of cooking facilities, storage of livestock, feed and other valuables.

3.4 Land Use Control

As a complementary measure to flood proofing house and flood shelters, land use controls can be used to regulate settlement or land use in flood-prone areas in order to reduce the vulnerability of people, crops and property to flood damage or loss. Regulations can also be used to prevent land uses and activities which interfere with the passage of floodwater in river channels, between embankments or along designated floodways.

3.4.1 Land Use Zoning

Land use controls can be used to prevent people from living on flood-prone land where floods would endanger lives and property and where rescue and relief operations might be difficult. The active flood plains of the major rivers and coastal areas exposed to cyclonic surges would be places where land use controls could be justified for such reasons but it would be impractical to prevent people from occupying and farming such land as there is insufficient land available on

which to re-settle the existing population which includes more than 1 million people in char areas and more than 10 million people in coastal areas.

Land use zoning can also be used to designate agricultural practices that contribute to flood proofing. For example, in the coastal area, there is discussion within the Cyclone Protection II Project about developing mangrove forests on the shoreline to protect embankments constructed further inland. Similar measures are being used inland where vegetation (trees, bushes or grasses) is being planted as embankment protection.

Zoning and other regulations could be instituted to ensure that reasonable land uses are chosen for new investment. Flood plain zoning supported by regulations could be used to prevent people from placing facilities on land where society has judged the risk to be too great to be acceptable for that use. The criterion of reasonable risk must be based on the culture and values of local people, with the objective of creating new conditions for a better life in the future.

Another place where land use zoning could be considered is inside flood protection embankments. For example, there has been an unauthorized sprawl of settlements and industry onto flood-protected land within the area of the Dhaka - Narayanganj - Demra project. The flood protection facilities of the project comprise of an encircling flood protection embankment and a pumped drainage system to evacuate rainfall falling within the embankment. The new settlements and industrial units have been built without the traditional high plinths because the settlers apparently feel confident that they will be protected from flooding by the project facilities. Sudden breaching of the embankment when there is an elevation difference of several meters between the external river and the land inside the embankment can result in catastrophic inflow of water into the protected area. Such a disaster was narrowly averted in the project during the 1988 flood by the timely action of project residents who prevented overtopping by placing sand-bags on threatened embankments sections. (Brammer and Khan 1991)

A similar situation has occurred in other flood control projects such as Zilkaor Haor in Sylhet district. The project has provided some protection to housing and commercial infrastructure, but the floods in 1988 caused more damage to infrastructure inside the protected area than outside. This may be because those inside the protected area had established buildings in low-lying areas that they believed were not at risk, while people outside still built on high ground. (Huntings 1992)

3.4.2 Floodway Protection

Drainage channels in floodplain areas are widely used for cultivation and for fishing, both during the monsoon and the dry season. Cultivation practices can involve placing embankments across the channels to pond water for irrigation, or growing long-stalked crops such as jute. Fishing practices can involve the construction of large bamboo-framed structures to support nets in the channel or barriers to direct the movement of fish towards nets. Such fishing and cultivation practices impede drainage and accelerate siltation of the channel which reduces the capacity of channels.

No national land use regulations exist to prevent fishing or agricultural practices that interfere with flows, although regulations exist to restrict the cultivation of

certain crops on land between flood embankments on some rivers in the eastern part of the country. Proscribed crops include tall, closely spaced monsoon season crops such as sugarcane, and jute which retard water flow and induce sediment deposition. However, these regulations have not been enforced on a sustained basis

3.4.3 Upazila Land Use Planning

Local governments, both urban and rural have the authority to make land use plans and impose land use or building regulations. However, these powers are little used in part because of traditional methods of reconciling conflicts of interest without recourse to the law.

Land use planning is one of the four components of the Upazila Plan Book that is prepared by upazila staff with guidance from the Local Government Engineering Bureau (LGEB). The Upazila Plan Book is the successor to the Thana Plan Book and the Thana Irrigation Plan which was initiated as part of the Comilla model for rural development in the 1960's. The other components of the upazila plan book are roads, drainage and embankments, and irrigation (LGEB 1990).

In practice, many of these plan books are incomplete for a number of reasons including the poor quality of maps available and uncertainties over funding. The roads component is usually the only part that is completed because roads are politically the easiest component for elected officials to select and hence most of the resources available to local governments have been spent on roads. By almost exclusively being involved in roads, upazila and LGEB staff have limited experience with the other components.

The absence of up-to-date and accurate maps is a major constraint in developing spatial plans. The GIS systems being developed under FAP and other programs may be useful for planning in Dhaka but most upazilas are basing their planning on revenue maps dating from the British period. More modern or more detailed maps are not generally available because of old-fashioned concepts of national security and centralization of decision making. For example, there are contour maps (at scales 1 : 15, 840 and 1 : 7,920) of many areas of the country but these are rarely available to upazila staff except where there are specific donor-funded projects. The absence of good maps contributes to the poor planning and design of many rural roads, and the subsequent flooding and drainage problems that occur.

There are several LGEB projects to improve upazila planning including the Rural Employment Sector Programme (RESP) (funded by SIDA and NORAD) and the Improvement of Planning and Implementation Capability of the Upazila Infrastructure Programme (funded by UNDP/ILO). In the latter program, an up-to-date upazila map showing the main physical features and existing infrastructure is being prepared for distribution to each of the 460 upazilas in the country.

3.4.4 Flood Insurance

Insurance can be used to encourage present or prospective floodplain occupants to undertake measures to reduce flood damage or to deter certain types of development in flood-prone areas. The primary role of flood insurance must be to facilitate recovery from flood loss, but it is possible in principle for it to be integrated into more general flood-plain management strategies. Flood insurance

can help the policy holder who suffers damage covered by a policy in force to recover from losses sustained from flooding. If properly implemented, coverage can also serve as a vehicle to force the owner of insured assets to flood proof those assets to a degree commensurate with the risk of flooding in any given area before the asset can be insured.

Insurance is not a widely used service in Bangladesh. Individuals who earn enough income to be covered by the Bangladeshi tax laws are generally aware of life insurance, and many take out such policies. Only businessmen, traders, industrialists or importers and exporters who take credit and loans from banks deal with general insurance, as it has been made compulsory by commercial banks. After the 1988 flood and 1991 cyclone, insurance companies in Bangladesh have attached a special clause for flood and cyclone insurance to general fire insurance policies.

At present, flood insurance (and cyclone insurance) is available only as a rider to fire-insurance policies. This is because the policies of European and American reinsurance firms will cover flood insurance only as a rider to such policies and will not reinsure policies written specifically to cover flood or cyclone losses. Another institutional constraint is that flood insurance, as a separate insurance category, is not recognized under the insurance rules set by the Ministry of Commerce and hence policies cannot be written against only flood loss.

Assuming that flood insurance was acceptable to the Ministry of Commerce and foreign reinsurers agreed to underwrite flood losses, Bangladeshi insurance firms would still require sufficient clients to cover operating costs and insurance claims payments from the premiums collected. This could be brought about by a combination of government subsidies on premium rates for compulsory flood insurance on certain categories of assets or, perhaps, government assistance in payment of claims that exceed some agreed-upon amount.

Currently, insurance companies define "flood" as the overflowing or deviation (erosion included) from their normal channels of either natural or artificial water courses and any flow or accumulation of water on the ground except when such flow or accumulation be water emitted from water supply main, tap, pipe, valve or similar.

Current flood and cyclone insurance premiums are provided only with fire insurance policies. For fixing cyclone insurance premiums, insurance companies divide Bangladesh into two zones namely, South of Latitude 24^0 N, and North of Latitude 24^0 N. This classification depends solely on the risk of cyclone hazards, and it is not related in any way to the flood hazard in the particular area. Hence, flood-insurance premiums are not set according to the risk of flooding at the insured site. Prior to more comprehensive insurance being available, flood-hazard maps with probabilistic water-surface elevations, flood-depth and duration information would be required to assess the risk of local flooding properly.

3.5 Water Supplies and Sanitation

Many parts of Bangladesh are fortunate to be underlain by shallow fresh water aquifers that yield good quality water suitable for domestic use. The government has successfully promoted hand tubewells for rural domestic water supplies and over 57 percent of households have access to potable water (BBS 1989). In urban

areas, groundwater is also the main source of domestic water supplies because minimum treatment is required. Most pourshavas have piped distribution systems of varying sizes and extent.

The government has tried to improve sanitation facilities in rural and urban areas by promoting water sealed latrines. Although some progress has been made, most rural homesteaders still use service latrines or surrounding fields and only about 12 percent of households have sanitary water sealed latrines. In urban areas, water sealed latrines are more numerous. Piped or enclosed trench collection systems for waste water are limited and there are no treatment facilities.

3.5.1 Flood Damage

Extreme floods in Bangladesh are accompanied by disease outbreaks and other health problems that occur due to lack of access to reliable water-supply, sanitation, and public-health facilities. The Department of Public Health Engineering (DPHE) estimated that about 240,000 hand-pump tubewells and 170,000 latrines were affected by the floods of 1988 (Siddique, 1989). The repair and replacement of affected facilities would cost an estimated Tk 100 million.($US 2.63 million)

3.5.2 Flood Proofing Measures

Rural water supplies can be flood proofed by raising the height of the discharge pipe, riser pipe and the operating mechanism of hand tubewells above peak flood level. Water enters a tubewell horizontal from the underlying aquifer and if the top of the well is sealed no floodwater should be able to enter the well directly to contaminate the supply. The discharge pipe can be raised by adding to the length of the riser pipe from the well. The materials required are extra sections of pipe and a spanner, costing about Tk 1000 ($US 26). Installation of the additional pipe sections is fairly easy and well owners can be trained to do this prior to the flood.

Sanitation during floods can be improved by more widespread use of water sealed latrines. Covering of rubbish dumps would also reduce the amount of debris carried by flood water.

In urban areas, service points (standpipes), wells and water treatment facilities should be located above flood levels or have adequate flood protection. Initially it may be more practical to improve designated wells and latrines and direct people to use them during floods. Consideration could also be given to backup power supplies for emergency use but standby generators are expensive and more analysis is required to ensure this measure is economically sound. Refuse dumps should also be secured from flood water. Chemicals for water treatment (for example bleaching powder, and alum) should also be stored and distributed during emergencies.

A recent innovative project by the non-government organization Concern is aimed at improving sanitation in poor urban areas. Funding is provided to replace systematically all service latrines by water-seal latrines. The municipality give credit to local people to replace the latrines and the recipients repay the loan over a fixed time period. Following the replacement by water sealed latrines, there is much less waste matter floating around during floods. Therefore, the risk of infection from contaminated water is greatly reduced and areas are less

affected by flooding -that is the project contributes to flood-proofing of urban communities. The project has started in Mymensingh and Saidpur.

3.6 Income and Livelihood

Local economies are disrupted during floods, and the resulting shortage or absence of income generating opportunities becomes a major problem for the rural and urban poor. During severe floods of active floodplain areas, local economies can be dormant for periods of 6-8 weeks Poor people have few resources of food or money to survive without a regular wage and the lack of income can result in devastating social and economic losses including malnutrition, displacement and homelessness. The survival options available to the poor are to sell what few assets they have and then to borrow money which further increases their dependency and indebtedness

3.6.1 Agriculture

Agriculture dominates rural economies and there is scope to make agricultural practices more resilient to flooding. Village surveys after the 1988 flood found that 41 per cent of the losses in rural areas were in agriculture (Hossain 1989). In the 1987 flood, the rice production lost was estimated to be 0.8 million tons, while in the 1988 flood the rice production lost was estimated to be 2 million tons.

Farmers in Bangladesh have adapted their farming systems to account for seasonal flooding and have adapted their crops, crop varieties, cropping patterns and cultivation practices to the flood characteristics in their local area. Farmers have also adopted new agricultural technologies that have been developed in the last three decades, especially high yielding varieties and irrigation. The recent rapid expansion of small scale irrigation is in part a response to the 1987 and 1988 floods when farmers suffered serious crop losses. Farmers have switched their main production from the flood-prone monsoon period to the dry season when irrigation is required. Thus, farm incomes are less dependent on the vagaries of the monsoon rainfall and the related floods.

Farmers are skilled at adapting to floods and they are being supported by various measures to reduce their exposure to floods, with the purpose of making floods less disruptive to local economies. Some of the measures being promoted include new high yielding rice varieties, and small-scale structural interventions to improve local hydrological conditions. Other measures that could be tried include dissemination of information on different local flood proofing measures throughout the country, and improving farmers access to credit and seeds after floods.

Crop varieties can be improved using plant modern plant breeding techniques to make crops less susceptible to floods. Present research efforts are being directed in a number of ways, including quicker maturing varieties of boro paddy which would reduce the risk of crop loss from early monsoon flooding, higher yielding varieties of deep water aman and aman varieties suitable for late planting and with longer seedlings which would reduce the risk of crop loss to late monsoon flooding. The number of improved rice varieties now available means that farmers can select improved varieties to suit their specific needs.

Small scale flood control and drainage schemes are being implemented as part of the Rural Employment Sector Program (RESP) funded by SIDA and NORAD and

being implemented by the Local Government Engineering Bureau (LGEB). Economically feasible schemes with benefited areas ranging from about 100 ha to about 1000 ha have been implemented in Kurigram and Greater Faridpur districts. Some of the schemes are located outside the main flood protection embankments and have successfully survived through the 1987 and 12988 floods. Farmers and local bodies have been involved in the planning and design of schemes undertaken, and ways to involve farmers the operation and maintenance of completed schemes are being developed. Small scale flood control and drainage schemes were seen as a major component in the Rural Works Programme started in the 1960's but unfortunately the program became preoccupied with the development of roads to the exclusion of all other activities (see Section 3.4.3). The Local Government Engineering Bureau is presently looking at ways to expand its small scale water resources program nationwide.

3.6.2 Industry

The pace of industrialization in the past two decades has been slow and employment opportunities in industry have not increased sufficient to absorb the rapid rise in population, causing unemployment and under-employment in the agricultural sector. In 1988, only 1.5 percent of employment was in the formal (modern industrial) sector, and 7.3 percent was with the informal (small and cottage industrial) sector. The informal sector is located mainly in urban and semi-urban areas. Overall, the industrial sector comprises 8 percent of national GDP. Of this, public sector companies contribute 35 percent while the remainder is generated by the private sector. Future economic growth in Bangladesh will be heavily dependent on the growth of the industrial sector.

During the 1988 floods, more than 1,000 medium and small industries were estimated to have been damaged (MOI, 1988). The total damage to industry was estimated to be about Tk 2.36 billion ($US 62-million) (World Bank 1989)

Industrial premises are often located on ground which has been filled to be above flood levels. Further analysis of the risk and consequences of flooding could prevent flood damage from floods of unexpected severity. Possible measures include raising of floor levels, locating electrical and other water-sensitive equipment on raised plinths or on upper storeys of buildings, provision of small protective embankments around industrial premises (and provision of pumped drainage within the embankment).

Following the 1988 flood , the non-government organization MIDAS undertook a program to rehabilitate flood-damaged enterprises. After careful assessment of the extent of damages, MIDAS adopted the following measures (a) extended the loan period by three years, (b) reduced service charges, (c) gave free consultancy, and (d) arranged working capital at special interest rates (MIDAS 1989).

3.6.3 Livestock

Livestock are an important source of cash income for rural people and often their main monetary asset. Cattle provide the draft power for many agricultural and transport operations and in many areas are the only source of draught power available for land cultivation.

Floods cause production losses in agriculture and impact diets as animal protein is less available. In addition, productive employment opportunities in goat sheep and poultry rearing are substantially reduced for a considerable period after floods have receded because of the shortage of breeding stock.

In the 1988 floods, livestock losses were estimated to be about 172,000 large and small ruminants and about 410,000 poultry (MOI 1988). In the 1991 cyclone, losses were estimated to be 224,000 cattle, 218,000 goats and sheep and 2.4 million poultry.

In addition to the direct loss of livestock, floods wash away or damage rice straw which is the main source of feed for livestock. In the 1991 cyclone, the value of the feed lost was estimated to be worth about Tk 22.8 million ($US 0.6 million). Livestock diseases also seem to be more prevalent during floods.

During floods, government support services are disrupted by damage to veterinary dispensaries and the loss of power to keep vaccines refrigerated.

Flood proofing measures for livestock include the provision of refuges to keep them and their feed dry during floods (see Section 3.3), improved availability of vaccines and veterinary practices to prevent disease and sickness after the flood, economic support for poor families to purchase replacement livestock. An additional benefit of refuges for livestock would be that mass vaccination of the livestock could take place, thereby reducing the likelihood of disease.

3.6.4 Fisheries

Fish are an important component of the diet of rural and urban people as fish are the source of about 80 percent of their animal protein. In addition, fish are important in the economy in terms of income and employment generation and the export of fish and prawns for foreign currency earnings. Fisheries contribute nearly 6 percent to the gross domestic product and produces more than 12 percent of the export earnings of the country.

About 80 percent of inland fish production comes from open water capture fishing from rivers, seasonally inundated flood plains and perennial water bodies in deeper depressions within the flood plains However, yields from open water fishing have been declining in recent years. The exact reasons for this decline are not certain as there is a shortage of reliable long-term data on fish production but some of the contributing factors may be man-made changes in the flood plain hydrology particularly the prevention of overbank spillage during floods by flood protection and road embankments, loss of habitat to agriculture, improved drainage of floodwater from the land and over fishing.

In past years, the government has primarily promoted pisciculture in small tanks (ponds) and other confined bodies of water. the Department of Fisheries estimates that there is in excess of 1.28 million small and medium-sized ponds in Bangladesh covering a total area of about 147,000 ha. Ponds have been categorized on their usage as follows: cultures ponds in which fish production is being practiced in an organized manner (52 percent of the total area), culturable ponds in which fish production is on an informal, traditional or sporadic basis (30 percent of the total area) and derelict ponds in which some fish may be produced but on an insignificant scale (18 percent of the total area). In spite of various government programs and the efforts of various non-government organizations, the fish production potential of tanks in rural areas is not being realized. There are a

number of reasons for this including fragmented ownership of ponds leading to disputes in management, and lack of complementary organizational, managerial and technical support services.

The affects of floods on open water fisheries and on cultured fisheries are different. Floods are an integral part of the life cycle of many open water fish as spawning and early development takes place on the flooded floodplain and the mature fish return to the rivers as the floods recede. One compensation resulting from severe floods is the plentiful and widespread supply of fish.

In contrast, fish tanks in which intensive fish culture is practiced, need to be protected from flood water to prevent the ingress of predator fish and other undesirable species, and also the inflow of contaminated floodwater. Most ponds are recharged from rainwater or from groundwater seepage. The embankments surrounding ponds have usually been formed from the spoil excavated to make the pond and the height of the embankments are designed to be above flood level. However, many ponds were initially excavated to supply the earth used to raise homestead sites and fish production was of secondary importance. Such ponds tend to be prone to inundation during floods which reduces their productivity.

Flood proofing measures are taken also in low-lying beel areas where fish production is enhanced by the construction of embankments to control water levels and the flow of water. The construction of embankments by fishermen often causes problems to adjacent farmers but a more formal agreement between the two parties and technically improved facilities could result in increased production from both activities.

3.6.5 Markets

Markets can be either hats or bazaars. Hats are fixed sites with or without permanent structures where trading occurs once or twice a week. Bazaars operate daily and most have some permanent structures. Rural markets are administered by the upazila and a market committee. The upazila leases the operation of markets to contractors who are responsible for collecting rent from shop and stall owners and maintenance of the market. Contractors who take leases for markets often enjoy very high returns from lease operations.

Funds from leasing the markets are used to finance public works projects such as refurbishment of schools and operational support to schools. Improvements to markets such as improved drainage facilities, all-weather road surfacing, drinking water, sanitation facilities and new buildings are funded by union or upazila parishads, usually with funds allocated from central government. In sadar upazilas, markets are administered by the pourashava or municipality. Of the revenues earned by pourashavas from the leases, 25 percent are spent on maintenance, and 70 percent on general activities and the remaining 5 percent is deposited in the central government treasury.

In 1982, the Planning Commission prepared a national program for the improvement of 1408 markets and designated the selected markets as growth centers. The intention was that the growth centers become the focal point of all types of development in their locality. There was 3 or 4 growth centers in each upazila depending on the size of the upazila and marketing patterns. The government has focused many subsequent rural development programs around

these designated growth centers, particularly the construction of roads and improvement of market facilities. (see Section 3.7.1).

Government has also implemented programs to improve the network of food storage facilities (mainly for rice and wheat) and their efforts have been reasonably successful because food prices have not rise too much even during the severe floods, although locally there may have been shortages.

To combat local shortages, the non-government organization Grameen Bank initiated a food security scheme for its members. In the scheme, rice was exchanged with farmers for irrigation water supplied from deep tubewells owned and operated by Grameen Bank. The rice received was stored for the duration of the monsoon. If there is a food shortage during this period, rice is distributed to its members on credit. If there is no food shortage, the rice is sold on the open market after the monsoon when rice prices are traditionally higher; theoretically, the incremental price difference over the monsoon should be sufficient to pays the storage costs.

During floods, the supply of commodities falls below the demand as normal marketing channels are disrupted when the transportation routes become inoperative and prices of commodities rise. In addition, people lose access to market places because either the market place is flooded or the paths and roads leading to the market become flooded and there is no alternative means of transport. If markets fail to function, income is lost to those whose livelihoods depend on market activity (porters, rickshaw drivers, fishermen, petty traders etc.).

Many market places are located on higher ground especially on river banks and the level of markets can be raised as a flood proofing measure. Alternatively, market places can be adapted for use as flood shelters which would serve the additional purpose of providing a place for economic activities to continue throughout a flood. During floods, people often have to sell personal possessions of value (jewelry, paddy etc.) to purchase food and other essential items and hence, in each locality, there should be a flood-free place for marketing.

3.7 Infrastructure

3.7.1 Roads

Roads are the key component of the government's transport policy and considerable public funds have been invested in road construction during recent years.

Roads in Bangladesh are classified as national highways, regional highways, district road, feeder road (type A), feeder road (type B), rural roads and pourashava roads.

National highways connect Dhaka with the main administrative centers, large cities, seaports and international highways. Regional highways connect different regions and district headquarters with the national and regional highways. Feeder roads (type A) connect upazila headquarters with the regional road network, and feeder roads (type B), connect important markets (growth centers), with the regional road network or with upazila headquarters. Rural roads

interconnect union headquarters, markets, villages and upazila headquarters. Roads within municipal areas are designated as pourashava roads.

The road network comprises of approximately 2,800 km of national highway, 1,200 km of regional highway, 6,300 km of feeder roads and 144,000 km of rural roads.

The Roads and Highways Department (RHD) is responsible for the planning, design, construction and maintenance of the national and regional roads and feeder roads (type A) .Roads under the jurisdiction of Local Government Engineering Bureau (LGEB) are feeder roads (type B) (also referred to as growth center connecting roads), rural roads, and pourashava roads.

In general, roads are damaged by floods in a number of ways including erosion of embankments by rainfall, wave action and passing flood water, and erosion and undermining of foundations of structures (culverts, bridges etc.) when there is insufficient open area to allow the passage of floodwater. Rigid pavements (concrete) are damaged when flood water scours soils beneath the edge of the road. Flexible (bituminous) pavements are washed away in places where there is edge erosion and subsequent undercutting. Pavements also disintegrate if subjected to long periods of inundation. Both types of pavement are damaged if heavy traffic loads pass over flooded sections where the sub-base is saturated.

An additional benefit of roads is that, in major floods, villagers take refuge on road embankments as they are often higher than their homesteads. Utilization of elevated road embankments as refuges has contributed to reducing the number people drowned and the loss of personal possessions during many floods.

In both the 1987 and 1988 floods, an estimated 3,000 km of national roads, 10,000 km of rural roads and 900 structures were damaged (World Bank 1989). The estimated cost of damage to roads was Tk 4500 million ($US 120 million) which was about 10 percent of the estimated total damages.

The design of many roads, particularly rural roads, does not take adequate account of the complexity of flood flows in many areas, with the result that roads are often severely damaged by floods. Funds are more readily available for earthworks (through Food for Works) rather than for structures, and the result is that many roads embankments are constructed without adequate structures to allow floodplain flows to pass. Road embankments can be designed to be either (i) impervious (minimal cross flow), (ii) porous (free cross flow), or (iii) gated (controlled cross flow), and the embankment and the extent and location of structures should be designed to fit local conditions and the water management requirements of local farmers.

The cost/meter length of reinforced concrete bridges is about 50 times more than the cost/meter length of paved road. The high cost of larger structures combined with the difficulty of determining the contribution of overland flow to flow through structures, results in a tendency to under-estimate the size and number of structures required on many roads. In addition to impeding drainage, underestimation of the requirement for structures can contribute to the failure of structures during floods which makes roads unusable after the flood has receded. Furthermore, the high cost of replacement structures often means that funds for the replacement of structures may not be available for several years. This is the

case on the main road from Tangail to Jamalpur where many of the structures damaged in 1988 have not been replaced almost 4 years later. Until their replacement, the utility of the road is greatly diminished and there is only partial return from the large investment made in the road.

Other flood proofing measures for roads include constructing embankments with an adequate cross-section, protecting embankment side slopes from erosion, selection of appropriate materials for embankments and pavements, ensuring embankments are compacted during construction, leaving adequate berm widths between embankments and borrow pits, provision of sections of embankment with lower elevations to ensure overtopping takes place at designated locations (sometimes refered to as *embankment fuse plugs* or *fail-safe provisions*), and effective maintenance programs.

3.7.2 Railways

The railway network comprises of 1,820 km of meter-gauge and 970 km of broad-gauge lines.

During the 1987 floods, an estimated 698 km of embankment and 166 structures were damaged. In 1988, the damage was more severe with 1300 km of embankment and 270 structures being damaged during the flood.

Damage was caused by exceptional amounts of overland flow of floodwater being constrained behind embankments, resulting in many bridges and culverts being washed out and railbeds being damaged or destroyed when embankments were overtopped.

The requirements for flood proofing railways are similar to the flood proofing requirements for roads; The main flood proofing measures are ensuring embankments are above flood level and ensuring there are sufficient structures to allow the passage of flood water. As with the design of roads, there is a need to relate the level of embankments and the size and location of structures to prevailing flood flows and levels (see Section 3.7.1)

3.7.3 Boats

Boats are an important part of rural transport systems. During the monsoon large areas of the floodplains are flooded and the option of road or land-based transport is not available in many areas. In addition, boats are also important as they are used for shelter or evacuation of flood affected households in char areas (FAP 14 Main Report, ISPAN 1992).

There is an absence of integrated transport planning, as resources have been provided for the development of roads (and flood protection facilities) without adequate recognition being given to the importance of boat transport (Jansen and others 1989. Palmer and others 1992). Boat transport has been severely disrupted by the proliferation of embankments that have been constructed during recent years. Very few embankments have been designed to take account of the need for boats to pass through the embankment. The elevation of the decks of the structures that are provided tend to be too low to allow boats to pass during floods. The lack of provision for boat transport often results in transport services declining after embankment construction (Huntings 1992). Out of frustration,

boat owners sometimes cut embankments unofficially to make a passage for their boats.

During the 1987 and 1988 floods, there was a shortage of boats to meet the needs of communities and of government institutions (see Appendix C). To meet the apparent demand for more boats in rural areas, the non-government organization MCC has started a credit program for the purchase of boats.

On some projects provision has been made for boats to pass through embankments. For example, in BWDB's Shanghair Haor Project, flood control structures were designed with removable decking to allow the passage of boats during floods when water levels were high (FIP 1990). Unfortunately, the provision of facilities for boats to pass through embankments is rare. In the FAP 12 survey of existing flood control projects, boats declined as a mode of transport following the construction of embankments in many areas (Huntings 1992).

3.7.4 Public Buildings

The government has made significant investments in public buildings during the past decade. Public buildings include government offices and staff quarters, schools, health centers, police stations, and food storage godowns. During the 1980's, most of the funds allocated to decentralization of the administration were spent on the construction of new buildings for government offices and staff quarters at district and thana levels.

Public buildings damaged during the 1988 flood included 45 hospitals, 1400 health centers, 19,000 schools and colleges (including private and religious institutions). In the April 1991 cyclone, public buildings damaged included 7 hospitals, 50 upazila health complexes, 371 union health centers, 9259 schools and colleges, and 1 university.

Public buildings are usually constructed with a reinforced concrete frame (foundations, columns, beams, roof and floor slabs and staircases) and brick walls, although many schools are constructed of less durable materials. The planning and design of many public buildings is done by the Public Works Department (PWD), although some ministries (for example the Ministry of Education) have their own facilities departments to look after their building requirements. Local Government Engineering Bureau (LGEB) design their own district office and laboratory facilities, other upazila and union buildings, such as food grain stores and union parishad offices, and buildings and other facilities in market places (growth centers).

The different agencies involved with design of buildings have their own design standards relating floor levels of buildings to flood levels (see Table 1). The main problems with the application of these design standards are the lack of reliable information on floods levels and limitation in the resources available for construction. Designs are often made based on levels related to a local datum and not the national datum. National flood level information is expressed with respect to the national datum and hence comparison between design levels and national flood level data is not possible. Furthermore there is a lack of coordination between different government departments. BWDB collect and analyze flood level data nationally but the information is rarely available locally. BWDB design their own facilities in central design offices in Dhaka and their local staff do not have flood level information readily available as they only supervise the construction.

Table 3.1
Design Specifications for Public Buildings, Infrastructure and Utilities

Description	Agency or Department	Component	Specification	Freeboard
ROADS				
National Highways	RHD	embankment	HFL determined from average HFL of last 10 years	3 ft
		structure		IWTA spec. for navigation
Feeder Roads	RHD/LGEB	embankment	HFL - 1 in 20 years	0.6 m
		structure	HFL - 1 in 20 years	1.0 m
BUILDINGS				
Upazila Health Complex	PWD	buildings	Finished ground level (FGL) 6 inches over 1988 HFL.	Plinths 1-2 ft above FGL
Upazila Facilities	PWD	buildings	Finished ground level (FGL) 6 inches over 1988 HFL.	Plinths 1-2 ft above FGL
Food storage godown	LGEB		HFL 1 in 20 years	1 m (minimum)
Food storage godown	PWD		Finished ground level (FGL) 6 inches over 1988 HFL.	Plinths 2 ft above FGL
Schools	Facilities Dept. Min. of Education	Primary School	HFL fixed from highest flood level since 1947	Plinth height is min. 1 ft above HFL or 1 ft above crest level of nearest main road
Pourashava	LGEB	Pourashava buildings	as specified by owners	
UTILITIES				
Transmission Lines	PDB	0.4 kv line	Pole height 7-8 m	
		11 kv line	Pole height 8.8-9.6 m	
		33 kv line	Pole height 11.2-12.8 m	
		River Crossing	IWTA Specification	Min. 40 ft from sag
Transformer Station	PDB	Distribution Transformer Sub-stations	Encouraging pole mounted fittings	
			base height fixed above 100 year flood level (max)	0.5 m

Source: Respective Government Departments and Agencies

In addition, BWDB has contour maps (at 1:15,840 and 1:7,920 scales) but these are not readily available for use by other agencies (see Section 3.4.3).

Resources allocated for the construction of buildings are based often on a standard cost for the building throughout the country. It is not possible for local engineers to adjust design floor levels to the height required by local conditions if funds are not available for raising the plinth above some national average.

As a way of improving community facilities, the non-government organization CARE has allocated resources under the Food for Works Programme to raise the ground levels at schools in Tangail district.

The quality and performance of public buildings (and of private buildings) could be improved by introducing consistent building codes to establish the required standards of safety and in this case flood proofing. There are however persistent problems in establishing building codes. They may be based on precedents that relate to a different culture or more developed country, resulting in increased costs of construction that may be unacceptably high. In addition, there are problems with enforcing such codes, but, as a first step, the government could implement uniform building codes for its own buildings and hold those responsible for the planning, design and construction accountable if, for example, a building was flooded when it was meant to have been flood proofed.

3.8 Government Services and Public Utilities

The disruption caused by floods to public services and public utilities is not well documented as flood damage is usually assessed in terms of the damage done to the physical components used by the services (buildings, roads etc.). As public services and utilities are essential to the functioning of communities, they should be flood proofed to ensure that the public receive the services throughout floods.

As part of the FAP 23 survey, staff of some government departments were interviewed to determine the impact of floods on the services they offer, their response to the floods and their suggestions on measures that could be taken to flood proof their services. The departments surveyed were:

-Fisheries
-Livestock
-Land Registration
-Health and Family Planning
-Postal Service
-Telephone and Telegraph

Staff of the public utility, the Power Development Board, were also surveyed. The findings of the survey are given in Appendix C.

The services offered by the departments surveyed were are often disrupted by floods for a number of reasons including flooding of offices, staff unable to reach their workplace, and shortage or absence of appropriate transport for staff. Flood related problems of some government services are discussed in Appendix C. Flood proofing measures proposed by the staff of the different services are also given in Appendix C.

3.8.1 Electrical Supply

Electricity is supplied to consumers by either the Power Development Board (PDB) or the Rural Electrification Board (REB). The government with donor support has been actively promoting rural electrification.

During the 1988 flood, numerous power lines and transformers were disabled by submergence, disrupting communications, water supply, and normal business activities in many areas. The damage was reported to include about 2,000 kilometer (km) of 11 kilo-volt(kv) lines, 6 sub-stations of 132/33 (kv), 11 sub-station of 33/11 (kv) and 4,000 distribution transformers plus significant quantities of conductors, poles, cables and meters were damaged during the 1988 flood (World Bank 1988). Financial loss was estimated at Tk 1052 billion ($US 32 million).

Other flood-related problems identified by PDB staff included increased theft of transmission lines as the high water levels made the lines were more accessible from boats, inadequate transport to carry out repairs, and insufficient clearance between power lines and the flood water. The staff's proposals for flood proofing the service from future floods are given in Appendix C.

3.8.2 Health and Family Planning

At present, 351 upazila health complexes have been completed out of the 397 upazila health complexes planned by the Ministry of Health. There are also 2,100 Union Health and Family Welfare Centers under the Family Planning Wing of the Ministry of Health and 1,275 union-level dispensaries that were previously functioning under the Health Wing but are now under the Population Wing for gradual upgrading and conversion to Union Health & Family Welfare Centers.

In the 1988 flood, about 230 Upazila Health Complexes, 100 Maternity & Child Welfare Centers, 45 District Hospitals, 900 Union Health & Family Welfare Centers, 172 Rural dispensaries, and 19 Training Centers were reportedly damaged (World Bank 1989). Damage to health facilities accounted for about 1.2 percent of the total flood damages (Siddique, 1989).

Floods cause major health problems due to the contamination of drinking water by flood water which results in increased diarrheal disease, dysentery, hepatitis, lymphoid and skin and worm infections. Other diseases like measles, acute respiratory infections (mostly pneumonia), and malnutrition also show a high incidence during and after floods.

During the 1988 flood, some of the problems encountered by health workers included, difficulties in finding and reaching patients of immunization programs, absence of staff who were looking after their own affairs, diversion of staff to assist in relief activities, and shortage of vaccines, medicines and oral rehydration solution. In addition, many upazila and union health facilities were flooded. Suggestions from the staff for flood proofing the health service are given in Appendix C.

3.9 Flood Preparedness

For flood proofing to be effective there must be a complementary flood preparedness program. Flood proofing measures are not designed to eliminate floods, and people will still need to prepare for approaching floods so that they can take appropriate action to minimize its effect on their daily lives. For

example, families whose houses are not flood proofed will have to prepare to move to shelters.

Flood forecasting and warning systems are part of flood preparedness measures. The present flood forecasting and warning system is described in Appendix C, along with a discussion of their effectiveness during the 1988 flood and suggestions for their improvement. The effectiveness of warnings during the April 1991 cyclone is well documented elsewhere (NEMAP 1991, CDR 1991).

One common problem with the present warning system is that people cannot relate the flood warning information to what may happen in their own area, and hence the warnings are not useful. Flood indicator posts could be installed in each community to assist people to interpret flood warnings. The posts would be established in a central location such as the school or mosque or market place. The peak stage of recent floods would be marked on the post to give people a point of reference. Water levels at nearby gauging stations used for flood forecasting would be correlated to levels at the post so that people could relate flood warnings to possible water levels in their locality. Increasing the availability of level information in villages would also assist engineers in checking where new or existing facilities were with respect to flood levels. At present flood level information is not readily available and engineers often use local rather than national datums for design. Both of these factors contribute to many buildings and embankments being vulnerable to inundation during floods (see Section 3.7.4).

A comprehensive study of flood preparedness is being undertaken as part of FAP 11.

3.10 Conclusions

Effective flood proofing measures have been implemented by individuals, communities and public and private institutions. Their efforts are generally successful for normal floods but for more severe floods, many existing flood proofing measures are inadequate, leaving people vulnerable to varying degrees of damage during such events.

A flood proofing program, based on comprehensive application of flood proofing principles, would yield substantial benefits in terms of saving human life, reducing suffering and make local and national economies more resilient to flooding. Investment in flood proofing would allow development of the country to proceed smoothly without catastrophic interruptions from floods.

Chapter 4

CASE STUDIES OF FLOOD PROOFING REQUIREMENTS

4.1 Purpose of Case Studies

Case Studies were undertaken to illustrate the range of flood proofing measures that are appropriate for a number of specific locations. The Case Studies were limited to showing what is involved in planning and designing flood proofing measures for households and communities, and discussing some of the issues that need to be investigated and resolved during the preparation of a flood proofing pilot project.

The Case Studies were prepared from rapid rural appraisals of the selected areas. The field surveys were undertaken in late November and early December 1992, by one team comprising of an Economist, a Water Resources Engineer, a Rural Planner and a Gender Specialist.

The areas selected for the Case Studies were previously surveyed during the FAP 14 Flood Response Study (ISPAN 1992) and were located in two different flood environments, namely a deeply flooded beel area and a char area. For the beel area, two villages in Singra Thana, Natore District was selected. In the char area, the villages selected were located in Bhuapur Thana, Tangail District that was also included in the FAP 14 survey. However, the villages selected for the Case Studies were not the FAP 14 survey villages in order to show the flood proofing measures already implemented in char areas by a non-government organization.

The approach followed during the field surveys was to determine local flood characteristics, and local response and needs during the time of floods. Based on the information collected, flood proofing measures were identified and discussed with villagers.

The Case Studies are summarized in this Chapter and are discussed in detail in Appendix D.

4.2 Description of the Areas Studied

4.2.1 Pakisha and Ichhalbaria Villages, Singra Thana

Singra thana is located in Natore District and is within the North West FAP Study Region (FAP 2). The thana is in Chalan beel, the largest natural depression in the country and part of the flood plain of the Atrai river and its tributaries including the seasonal Nagor and Barnai rivers. Water levels in these rivers tend to start rising in June and peak during August or September. Throughout this monsoon period, most of the agricultural land in the thana is normally deeply flooded, and the expanse of water is broken by only a few small scattered islands of high ground occupied by settlements. Broadcast aman (deepwater rice) is the crop that can be grown during this monsoon period. By November, rivers and khals are starting to dry out and most of the land can be accessed to prepare for the planting of boro.

Numerous flood protection embankments have been constructed along the banks of main rivers. Those outside the protective embankments have felt aggrieved by

their continued exposure to flooding and consider that the flooding has been made worse by the embankments. Farmers not protected reduce water levels by breaching the embankments to flood the area inside. The net result is that since their construction, the impact of the flood protection embankments on agricultural production has been limited.

Flooding in Chalan Beel results from the combination of the low-lying topography of the beel, insufficient capacity of the rivers draining the beel and backwater effects from the Jamuna river. The FAP 2 North West Regional Study concluded that flood protection in the beel was not viable for social and technical reasons and the Study recommended that existing flood protection facilities should be modified to allow controlled flooding of the land inside the embankments (Mott MacDonald 1992b).

During 1987 and 1988, most of the thana was severely affected by floods and many more houses were flooded than was usual. Breaches in the protective embankments caused particular problems for those inside because the rapid ingress of water gave the people inside too little time to respond to the rising flood water. The regional road to Bogra and Natore was flooded in parts which disrupted marketing and the transport of relief supplies into the thana.

Two villages were surveyed for the Case Studies. Pakisha village is located in the north-west of the thana towards the edge of the beel, while Ichhalbaria is located on the eastern side of the thana, closer to the middle of the beel.

Pakisha village has a population of the village is 1000. and a land area of 182.2 ha. of which 169.5 ha. is available for cultivation[1]. The village is located towards the northern side of Chalan Beel and 97 per cent of the land is classified as F_2 and F_3 and only 3 per cent as F_1[2]. The layout of the village is shown in Figure D.2. Homesteads in the village are located on highland formed with soil excavated from adjacent ponds.

The main occupations in the village are agriculture (38%), day laboring (23%), business and trading (5%), and fishermen (8%). For women, the main occupation is household work (98%).

There is one primary school in the village. The school has one new building and one building which lost its roof in a recent storm. There is also about 10 bighas of land next to the school which is used as a playing field. There is also a pond with an area of about 1 acre. The school and its associated grounds and ponds were given to the village by a *zamindar* many years ago and is now run by a school board. There is no restriction on access to the school grounds. The pond is leased out for about Tk 12,000 per year which is far below the potential productivity of the pond. Villagers consider education to be important and about 86 per cent of villagers send their children to school, although it is not clear for how long.

Houses in Pakisha are made of mud and mud bricks for the walls and corrugated iron sheet or thatch for the roof. Some of the houses on the higher ground are almost 100 years old. Mud is the preferred building material because (i) bamboo

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[1] Data and information given in this Section are from the draft Main Report of FAP 14 (ISPAN 1992) and from files of FAP 14 Survey held in ISPAN, Dhaka.

[2] Land classification categories are defined in Appendix B.

and timber are not readily available and hence are expensive, (ii) beel areas are very windy, especially during the monsoon and mud walls keep out the winds much better than bamboo matting or other similar materials, and (iii) soils found in the beel area are very suitable for house construction due to their high clay content.

There are no health facilities in the village. There is a charity dispensary about 3 miles away in Kaliganj and the nearest hospital is at Singra about 10 miles away.

There is a Feeder Road B or Growth Center Connecting Road (GCCR) passing beside the village (see Figures D.1 and D.2). The road connects the market and growth center at Kaliganj (2.5 miles to the north) to Singra market and thana headquarters. The road embankment was constructed about 5 or 6 years ago but about 5 to 10 structures are required to complete the road. The road is passable by trucks during the dry season when the khals and rivers have dried out. An additional benefit of the road is that the embankment is used as a refuge for livestock during floods.

Ichhalbaria village has a population of 224. The land of the village is classified as F_2 and F_3. Homesteads in the village are located on high mounds that have been constructed with soil taken from adjacent ponds. The mounds rise 6-8 m above the surrounding land.

During normal and severe floods when the beel area is filled with water, the mounds are subject to erosion from waves. Villagers have to maintain the mounds constantly and this ties up many of their surplus resources. The result is that the highland area of the village is limited. New highland is too expensive to construct and maintain. Separate mounds are more exposed to erosion by waves. One homestead was constructed on some lower land beside the khas land to the north of the village but the buildings were severely damaged during the 1988 floods and have not yet been rebuilt. As with Pakisha, houses in Ichhalbaria are constructed with mud walls and corrugated iron or thatched roofs.

The main occupations in the village are agriculture (47%), day laboring (17%), and business and trading (10%). For women, the main occupation is household work (95%). Villagers have been diversifying their activities to business and trading because of the high risks and the decreasing returns from agriculture.

There are no feeder or other substantial roads close to the village, and land transport has to take tracks that are available only during the dry season. Difficulties in access between the village and the main markets is reflected in the high cost of land transport by bullock cart (Tk 25/maund) compared to the cost of boat transport (Tk 5/maund). Villagers would like a feeder road to be near the village to reduce transport costs of their produce and agricultural inputs.

There are 10 hand tubewells in the village, mostly in the homesteads of wealthier families. Poorer families would like additional wells for their own use.

Villagers complained that it was difficult to get any government services. It took villagers a long time and much effort to get an electricity supply installed. There are no roads and few schools in the union. Most village children (rich and poor) start school which is located about 1 mile away. Parents are concerned for the safety of their children traveling to school during the monsoon and also for the

well-being of older girls as they travel to school. Hence the drop-out rate from school is high.

Non-government organizations are not active in either village.

4.2.2 Char Land in Bhuapur Thana

Char land is very young alluvial land within the active flood plain. Char land has complex patterns of ridges and inter-ridge depressions, in-filled channels and cut-off channels. Char land is liable to change by river erosion. Sediments are deposited to form new char land and to bury older land. In some years, new deposits can be as deep as 2-3 meters or even more in certain places.

Bhuapur thana is located in Tangail District and lies mainly in the active flood plain of the Jamuna river. The thana is subject to constant physiographic transformation caused by the changing course of the Jamuna river. The shifting and braiding of the river has created a wide range of char lands in the thana.

The thana is within the North Central FAP Region (FAP 3), and to the south of the FAP 3.1 Jamalpur Priority Project area. The char area adjacent to the FAP 3.1 area was surveyed during the preparation of the feasibility report for the project (Sogreah 1992). The resources of the char land along the Jamuna river from the Indian border in the north to its confluence with the Padma in the south is being surveyed as part of FAP 16: Environmental Study. The draft report of this latter survey is due at the end of 1992 (ISPAN 1992).

The population of the thana is 135,851. People living in the char area are at risk from river erosion and the constant changes in topography result in many households having to move as char land appears and disappears. The river was tending to move eastwards over the past decade but during the last two years more active channels have reappeared on the western side of the thana. Most of the char land is flooded each year and settlements are on the available high ground. The residents on the more stable char land invest in trying to ensure that their houses are above flood levels. Residents on the more recently-formed chars do not construct their houses above flood level because they consider the risk of erosion does not justify the investment.

There is single cropping on most of the char land, with millet being the main crop. The soils are very sandy and are unsuitable for boro and only a small amount is grown with irrigation. In the monsoon, most of the land is flooded and some broadcast aman is grown. There are few other income earning activities available to farmers during the monsoon season, although fishing is an important activity throughout the year.

Transportation in the char area is by boat during the monsoon and by walking and boat during the dry season. Most households have at least a small boat but there is serious shortage of larger boats to carry livestock or materials for house construction and other large or heavy items. Ownership of larger boats is very profitable. The shortage of suitable boats limits the movement of people especially during the monsoon when they may have to move quickly to avoid losing their possessions to flood water or erosion. Furthermore people are unable to exploit the fishery resource. Boats can be used for about 9 months of the year although many are used only during the monsoon months when the river is high. most of the boats are rented and crew are hired to work on the boat.

Government services are very sparse within the char area, and government offices are remote from many villages due to the difficulty of traveling within the area for most of the year. Conversely, government staff often claim that lack of transport limits their ability to offer effective services to villagers in the char.

There are three non-government organizations working in the thana, of which Service Civil International (SCI) is the largest. SCI are implementing a comprehensive development program for people living in the chars in Bhuapur (see also Section 3.3). SCI are currently working with about 120 groups (35 female and 85 male groups) in 40 villages. Each group has about 20-25 members. The purpose of the groups is 'health, wealth and training'. Development activities include compulsory saving schemes, group loans, housing loans, health programs, afforestation, income generation (agricultural extension including advice on crop diversification, and support to purchase seeds, treadle pumps and other inputs, reclamation of land etc.), raising of house plinths (beneficiaries contribute some labor), improving drinking water (hand tubewells) and sanitation (water-sealed latrines). SCI also purchased two large boats (70 ft length and 7 ft berm width) and on-loaned the boats to two groups. The boats cost Tk 75,000 each (including an engine) and the groups repay Tk 3,000 per month. The boats are used to transport fertilizers and evacuating people. SCI have also promoted the planting of catkin grass which has a number of values including for sale as fodder or thatching and its own seed etc. Catkin grass is tolerant to a range of drought and flooded conditions and its thick foliage accelerates siltation which improves fertility of the soil and reduces erosion risk. It takes about three years for the new char land planted with catkin grass to become suitable for other crops.

SCI have constructed about 13 flood shelters since 1988. Two of these have been washed away, and a third at Rajapur will likely be washed away during the coming months.

The Rajapur shelter has an area of 1.72 acres (300 ft by 250 ft) and was raised about 6 ft above ground level. The earthworks for the shelter cost about Tk 50,000. There was two buildings at the shelter, one school and one health service center. A number of SCI group members constructed house at lower elevations adjacent to the shelter.

In May of 1992, the nearest active river channel was about 300 m away from the shelter. However, the people living beside the shelter were apprehensive that the river was moving eastward and soon the shelter would be lost to erosion. On this basis, they were unwilling to invest the resources in flood proofing their own homesteads by raising the plinth levels of the buildings. They were reliant on the flood shelter if a severe flood occurred.

By November 1992, following a monsoon season when floods were minimal, the active channel had moved to within a few meters of the shelter and the shelter stood on top of 7 m high cliffs of alluvial soil with water flowing on two sides. SCI have moved the buildings and other facilities from the shelter to other locations, but some families are still staying close to the shelter, although they expect to have to move before the onset of the next monsoon.

Comprehensive flood protection embankments have been constructed along the right bank of the Jamuna, although in recent years the embankment has been

breached by river erosion. Flood protection embankments on the left bank are more fragmented at present, as portions of protective embankments have been constructed at different times. People in the char areas are concerned that flooding on their land may become worse if embankments are constructed on both sides of the river. The backwater effect of the proposed Jamuna Bridge may also significantly affect flooding in the char areas.

4.2.3 Impact of Floods and Needs Assessment, Pakisha Village

Houses

About 30-35 per cent of the houses in Pakisha were flooded during 1988. Some of the houses collapsed and have since been rebuilt with higher plinths.

After the flood, about 40-50 per cent of flooded households raised their floor levels. During the post-flood period, the men of many households were too busy earning wages and hence re-building of houses was often left to the women who had to fit this in with their other household activities. After the flood, there was a shortage of mud to rebuild damaged houses and suitable mud had to be imported by boat which increased the cost of rebuilding and many were unable to afford it.

There has been little community effort since the flood to help those affected by the flood and individuals have been left to develop their own recovery strategies. Richer members of the community have rebuilt their houses using their own resources. For example, one family has spent about TK 60,000 on reconstructing their house about 5 ft above its former level. The reconstructed house and courtyard has an area of about 80 ft by 40 ft.

Flood Shelters

Those people who had to abandon their houses took refuge during the flood on the high ground adjacent to the school. Polythene sheet were provided to make temporary shelters. The school ground remained about 4 ft above peak flood level.

The landless and poor whose houses were under threat of flooding initially sent their children, elderly and possessions to the flood shelter at the school.

The most serious problems at the shelter were:

- lack of drinking water
- shortage of adequate sanitation facilities. Males and females had to use the same latrines and there was long queues
- access was difficult between the shelter and tubewells that were operating elsewhere. Boats were too expensive for many to hire and the only alternative was to use rafts made of banana stems.
- there was an acute scarcity of fuel for cooking. Many families had to make do with cooking only once per day. The cooking facilities also had to be shared which caused a problem between the Hindus and the Moslems. As one of the villagers remarked 'We can live in the same village but we cannot cook together or eat at the same table'
- the shelter was 'too open' and lacked privacy. This seemed to be a problem mainly for the better off families who are more inclined to be more strict about purdah.

People stayed at the shelter for about 15-20 days, although the school was closed for about 2 months.

Some better-off people did go to the shelter but many went to their flood-free neighbors or to stay with their relations in places not affected by the floods.

Marketing

Marketing was a major problem during the 1988 flood. Access to the nearby market at Sthapandighi, about 1 mile to the south, was difficult and this resulted in increased transport costs. The market place was also partly flooded and some traders carried out their business from boats attached to the bankside.

Marketing was difficult for about 6 weeks. Since the flood, the villagers have been trying to establish a weekly market on some high ground adjacent to the village and next to the feeder road.

Water Supply and Sanitation

There are about 60 hand tubewells in the village of which 40 are privately owned and 20 are publicly owned. About 95 per cent of these tubewells remained above flood level and hence potable water was generally available throughout the flood, although as mentioned above, there were no hand tubewells at the school and access to potable water was a problem for those using the shelter.

There is serious shortage of drinking water during the dry season because the discharge of many tubewells declines or stops as the water table falls below the operating range of tubewells for about 4 months. During these months, two deep tubewells near the village and several shallow tubewells are used for the supply of drinking water.

Health

During the flood, there was no loss of life because the flood water moves slowly near the village. Furthermore, the children are exposed to flooding every year and most can swim. However, after floodwater receded, there was an outbreak of diarrhea in the village and, although no one died, many were weakened and unable to help in reconstruction activities. The reason for the outbreak is not clear as potable water was supposedly widely available.

About 95 per cent of the latrines in the village are 'katcha'. Some of these were raised during the flood but the structures were rather insecure and using them was rather risky because of the likelihood of collapse.

Productive Activities

A flood protection embankment along the left bank of the Nagor River was constructed as part of BWDB's Nagor Valley Project. The embankment was designed to protect agricultural land from flooding during the monsoon, thus allowing farmers to grow transplanted aman. However, the embankment has not performed well due to farmers on the other side of the river cutting the embankment to relieve flooding on their side. Poor re-construction of the embankments have caused subsequent failures. When the embankment fails (due

to public cuts or otherwise) water levels rise rapidly around the village ('the height of a man overnight') and the aman crop is drowned.

At present the main problems for farmers are related to siltation of the khals and rivers near the village. Siltation impedes drainage and result in more overflow of floodwater. Navigation is also impaired and the time when boats can reach the village is now much shorter than before. Also, the amount of water available for irrigation in the khals and rivers available for irrigation is reduced. The farmers consider that collapsed embankments have contributed to the siltation.

Many of the villagers would like the feeder road next to the village to be completed to reduce transport costs. Villagers pay about Tk 20-25 / maund to transport their aman by road as compared to Tk 5/maund by boat.

The availability of all types of fish has declined since the construction of the embankments and fishermen have to go further afield to catch the same quantity of fish.

4.2.4 Possible Flood Proofing Measures for Pakisha Village

The main problems faced by the villagers in Pakisha during floods are related to the flooding and destruction of some houses, the absence of adequate shelter for those flooded and difficulties with marketing.

Possible flood proofing measures that could be taken by villagers include:

- **Raising of house plinths and homestead land** on the western side and near the center of the village where houses are more vulnerable to flooding.

- **Provision of hand tubewells and sanitation facilities** at the school. Also repair of existing buildings and construction of new buildings at the school. If the raising of house plinths is completed, the need for a shelter may be reduced if not eliminated. However the measures proposed would be available to the school during most of the year and could be financed partly out of making more efficient use of the school pond.

Measures that could be taken by the union or district include:

- **Completion of the growth center connecting road** to improve marketing at all times including floods and assist in bringing in relief if required during or after severe floods.

- **Raising of the nearby market at Sthapandighi** to ensure marketing can continue during floods.

- **Desilting nearby khals and rivers.** This activity could be undertaken in conjunction with raising ground levels in the nearby market place. The soil excavated during desilting of khals is usually placed on adjacent land, making it unusable, and often the soil is washed back into the khal during subsequent rains. Additional payment would be required to carry the excavated soil from the khal to the market. Combining khal excavation and raising of market places would also avoid the need to use agricultural land for borrow pits for the latter measure.

4.2.5 Impact and Needs Assessment of Ichhalbaria Village

Housing

In 1988, about 15 out of the 33 households in the village were flooded and 9 of those flooded were destroyed completely. The village mosque was also flooded and collapsed. Due to the restricted high land available within the village and the expense of constructing new high land, many houses in the village have two stories. Such houses are more likely to collapse when the walls are flooded because of the additional weight of the second floor.

The flooded houses were mainly damaged by wave action. Villagers tried to protect their properties by constructing barriers made from banana stems and water hyacinth. Some of the more wealthy villagers constructed small 'verandahs' around their properties (see Figure D.3). This was expensive to do once the flood had started as suitable soil had to be imported by boat. One household paid about Tk 20,000 to construct a one such 'verandah.' After the flood, several householders added these verandahs rather than raise the floor levels of their houses as the latter would require the whole house to be reconstructed.

Flooded houses had to be abandoned for about 4 week. The flooded houses that did not collapse took about 15 days to clean and make habitable again. For the houses that did collapse, the process of rebuilding took much longer and 5 of the collapsed houses have not as yet been replaced. Floor levels of rebuilt houses have been raised by 3-5 ft.

After the 1988 flood, wealthy villagers paid for the water in the communal pond to be pumped out and all villagers were allowed to excavate soil (mud) from the pond for use in re-pairing or re-building their houses.

About 20 per cent of village buildings are affected by flood water in normal years. This year was abnormal and the affects of the flood were minimal.

Houses on the periphery of the village are mainly occupied by the landless and poor and their houses are most exposed to waves. These houses on the periphery also tend to be at a slightly lower elevation and hence are more vulnerable to inundation.

Flood Shelters

In 1987, people from the village took shelter on higher ground at the school in Byas which is about 1 mile away. Initially, people were apprehensive to move to the shelter because of the fear of contracting cholera. The shelter was arranged by the Upazila Nirbahi Officer (now the Thana Nirbahi Officer). There was reportedly about 10,000 people at the shelter.

The people from Ichhalbaria who went to the shelter experienced problems with:

- inadequate sanitation facilities. There was only 3 latrines for use by both males and females and hence there was always long queues for their use.
- insufficient supply of potable water.
- insufficient privacy
- shortage of fuel.

People came to the shelter from many of the nearby villages and arrangements were chaotic and anarchic which led to a constant feeling of insecurity. There was no 'community feeling'.

In 1988, wealthy people in the village suggested that poor families affected by the flood should go to relations in Bogra, ten miles to the north, rather than go to the flood shelter in Byas. The poorer people could not afford to disregard this suggestion and hence many families went to Bogra, even though it was further away. People whose houses are flooded usually want to stay as near as possible to their houses so that they can know what is going on and can check the prevailing conditions. Some villagers preferred to go to Bogra because they could take their valuable possessions with them. The lack of security at the flood shelter in Byas meant that it was inadvisable to take valuables there. Wealthy families contributed towards the transport costs of the villagers who went to Bogra.

Water Supply and Sanitation

There are about 10 hand tubewells in the village but all of them were flooded during the 1988 flood. At the time, villagers were desperately trying to save their houses and did not worry about ensuring adequate water supplies. During the peak flood, waves were too strong to allow drinking water to be fetched from other places and villagers had to drink flood water. Since the flood, all but three of the tubewells have been moved to higher ground, but during the dry season the water table drops below the operating range of hand tubewells and locating tubewells too high in the village will make them more likely to run dry. Villagers may need two tubewells-one low level tubewell for the dry season and one high level tubewell for use during the monsoon

There are no water sealed latrines in the village and most of the katcha latrines are located around the pond in the center of the village. All these latrines were flooded in 1988. Although sanitation was a problem during the flood, villagers have not changed the sanitary facilities. They seem to be unaware about the availability and advantages of water sealed latrines, which may be a reflection of the poor government services in the area.

Health

The main health problems occurred after the 1988 flood when diarrhea took its toll. No one in Ichhalbaria died from diarrhea but reportedly children in neighboring villages were not so fortunate.

Marketing

Marketing is a major problem during floods. Movement to and from the village is often severely restricted because the small boats owned by villagers are cannot be used when there is too much wind and the waves are too large. Hence Larger boats that are unaffected by the waves are scarce and expensive if available.

There are few marketing facilities close to the village and villagers use the market in Bildahar about 6 miles away or Singra about 9.5 miles away. Few petty traders visit the village.

Due to the problems with transport, villagers have to purchase bulk items such as fertilizer, seeds etc. during the monsoon when water levels are high and boats can access the village. The villagers would like to have a road nearby and are interested in the Singra to Tarash road being constructed.

Economic Activity

In 1988, the floods disrupted the local economy for 2 to 3 months, as the aman crop was completely destroyed by the rapid rise in water levels during the early part of the flood. There are few alternative income generating activities during the monsoon season.

There was a shortage of water this year and a few farmers irrigated their aman crop. During the dry season irrigation using shallow tubewells is difficult because the water table falls to 50 ft below ground level which restricts the use of shallow tubewells. The ponds also tend to lose their water during the dry season which limits fish culture.

The limited extent of this year's flood has resulted in a shortage of fish, even for local consumption.

Other issues

Storage of grain and other commodities was a problem for all villagers and on a community basis, the villagers hired a boat to take their grain for storage in Bogra district.

Security is a major concern during floods as dacoits raid the village from boats.

Fuel was not in short supply during the flood as villagers had sufficient fuel stockpiled to last for its duration. However, for those who went to the shelter, fuel was difficult to find and they had to obtain fuel from relations who lived near to the shelter.

Many trees and other vegetation including mango and palm trees died after the 1988 flood probably because of extended water logging of their root systems. The loss of the trees has left the village more exposed to wind and, wave erosion.

4.2.6 Possible Flood Proofing Measures, Ichhalbaria Village.

The main recurrent problem faced by villagers during floods is the erosion of their homestead area by waves. Erosion has restricted the villagers capability of expanding their village area as their resources are utilized in maintaining the existing mounds. If the erosion threat could be removed, poorer villagers may be able with some help to reconstruct their houses above highest flood level.

There are also serious problems with water supplies and sanitation during floods.

Possible flood proofing measures that could be taken by villagers include:

- protection of the village from wave action. Appropriate measures would require identification of suitable vegetation to dissipate the wave energy. Suitable vegetative matter may include catkin grass.

- provision of separate tubewells for dry season and wet season use.

Possible flood proofing measures that could be taken by the union or district include:

- repair of nearby primary school and providing adequate high ground beside the school to be used for a flood shelter. Also provision of sufficient water supply and sanitation facilities for when the shelter is in use.

- re-excavation of nearby khals

4.2.8 Impact of Floods and Needs Assessment, Char Areas

Houses

Houses on char land have a high risk of loss to erosion. House owners close to the Rajapur flood shelter raised there plinths levels by about 2-3 ft and hence were still subject to periodic flooding. They did not raise their plinths higher because they considered the risk to be too great and not worth the investment. The char at Rajapur shelter has been there for about 7-8 years and hence the residents are unsure how long the char will remain. They were correct in their risk assessment because six months later several of the houses had disappeared and the shelter will likely disappear during the next few months! Shortage of funds to raise plinths is another constraint. In adjacent 'older' chars, householders have raised their house plinths above flood levels because they consider that the investment is worth while. Some of the residents at Rajapur are thinking about moving to more mature char land across the other side of the river channel.

House holders tend to construct *machas* so that they can stay in the house after the flood water has risen above floor level, but as there is limited space, livestock, grain and other bulky possession are sent to safety on higher ground.

Flood Shelters

In the 1988 flood, people moved their livestock and poultry to available shelters. The problems people faced at the shelter included:

- inadequate sanitation facilities
- insufficient water supply (there was only one hand tubewell)

The children and elderly are moved to the shelter first. During the day, young women whether married or unmarried will come to the shelter to cook for the family and look after their children and possession including livestock. At night, many women return to their houses to stay on the *macha*, with their husbands or parents, as they did not feel safe in the shelter along with young men from other households. Women also like to maintain *purdah* even during floods. Older women and men stay at the shelter to look after the children and their livestock and other possessions. Prior to the flood, they had stored fuel. Generally there is no shortage of fuel in the char areas.

During floods, there seems to be little difference between the response of the wealthy and the poor. Everyone sends their possessions to the flood shelters or other high ground.

Water Supply and Sanitation

During floods, many of the tubewells become flooded and supply of potable water becomes difficult. Women in both villages had to use river water when tubewell water was not available. River water was also used for household work. They thought that water purification tablets should be more readily available during and after floods.

Income Generating Activities

There are very few income earning opportunities during the monsoon. Non-government organizations have tried to introduce alternative activities but the options are few and include petty trading and livestock fattening. Men often have to go to the main land to find work.

Other Matters

Education is seen as important to many of those interviewed but in the char areas, there are few schools and schooling is not possible for most of the children.

4.2.9 Issues related to Flood Proofing Measures in Char Areas

Char areas are a difficult and complex environment in which to live because of the changing landscape resulting from the erosion and deposition of river sediments. As with the coastal areas threatened by cyclones, the approach to maintaining and supporting those people who live in char areas has to be considered carefully to avoid communities or government supporting flood proofing measures that are not self-sustaining. Flood proofing is based on the principle of making individuals or communities independent of both floods and continuous external support whether from government or non-government sources (except for flood warnings).

Two basic issues need to be addressed when considering flood proofing measures for the char areas:

(i) how can flood proofing assist the general development of people living in char areas, and

(ii) how can flood proofing assist to minimize the affects of further riverside flood protection embankments or other developments (such as the Jamuna Bridge) that will affect flows and water levels in the Jamuna.

Most people living in char areas have few resources and hence have limited capacity to cope with floods. Some people have responded by migrating around char areas, moving as land appears and disappears. Others move once when they lose their land to erosion and wait for their land to reappear. Possible flood proofing measures for the former group (those who regularly expect to move) are discussed below.

- *Housing.* Traditionally houses are constructed with soil floors, timber or bamboo wall frames with mat cladding and thatched roofs. In some cases,

roofs are made of corrugated iron sheet. Housing design has been adapted to flood environment by (i) making the structure of the house easy to dismantle in case erosion forces the owners to move the house to another location, (ii) using soil to raise the floor level above ground level, and (iii) constructing a platform or *macha* inside the house above flood level. Investment in (i) and (iii) can be retained if the homestead land is lost to erosion. In contrast, investment in (ii), raising the floor level, is lost if the homestead site is lost to erosion. Raising floor levels of houses is not a sustainable flood proofing measure in many char areas, as each year the investment has a high risk of being lost. In the long term, either the local people or an external agency (government or non-government) may be locked into an endless expenditure without receiving a significant return.

An alternative approach is to develop measures that allow all house construction materials to be movable. One such way is to construct the house with a suspended floor - that is with a permanent *macha*. Many people around the world live in houses with floors suspended on 'stilts' over water. Consideration would have to be given to the design of the structural columns for the house to ensure that they were sufficiently lightweight to be easily transportable and yet strong enough to support the raised structure. The columns would have to longer than those presently being used and if made of concrete may be too heavy to move easily.

- *Boats* are an essential component of life on the chars, and yet many of those living there have limited access to boats either in terms of owning one or being able to afford to hire one. Many of the boats owned by char dwellers are small and suitable for use only in slow moving water without waves. During the monsoon, when boats are most needed, winds are frequent, making it unsafe to use small boats. Boats have traditionally been neglected in transport planning and this trend continues despite efforts to raise awareness the importance of boats to local and national economies. (Jansen and others 1989; Palmer and others 1992)

  Better access to boats would certainly increase the independence of char dwellers and allow them to survive better during floods. Programs to increase boat ownership in the chars should be investigated. Such programs may involve credit to purchase boats and management training to help the owners to run the boat profitably. Developing utilization of house boats may be a solution to the housing and transport problems.

- *Land ownership* is a critical factor in settlement patterns on the chars. People who loose land to erosion often stay as close as possible to the lost land to ensure they can reclaim the land if and when it reappears. Concern over establishing land rights is a major factor for people staying on exposed char land even during extreme floods. There seems to be informal system by which people settle and re-settle on land. Institutionalizing land ownership would allow people to move away to safer ground without having the fear that by doing so they would loose their ownership rights. Careful consideration would have to be given before instituting changes in land registration and ownership as the present system does work to some extent and care would have to be taken to ensure that changes would be for the better of the people most affected by erosion.

- *Flood shelters* In the absence of flood proofed housing, there is a need to provide flood shelters where people can take refuge when there houses are flooded. As with housing, flood shelters need to be carefully sited to avoid being lost to erosion. The problems of finding suitable sites can be illustrated by SCI's experience wherein they have lost 3 of their 13 shelters in 4 years. The number of sites where the land is more stable is limited. For example, the Union Parishad chairmen of Arjuna Union, in northern Bhuapur, estimates that about 4 villages are located on stable old char land and about 25 per cent of the unions population live in these villages. Thus, 75 per cent or about 15,000 people live in more vulnerable areas where flood shelters may be lost within a few years of construction.

  As with cyclone shelters, there are many issues related to the provision of flood shelters that need to be resolved including their utilization at other times, their cost effectiveness compared to other interventions such as improved housing, boats etc., and design issues such as density of their location, extent of facilities at the shelter etc.

- *River Training.* Catkin grass is used by local people to stabilize char land. The grass can be sold as fodder or thatching and can be grown with few inputs other than labor for planting and harvesting. The grass can be grown from seed and is planted in August/September and harvested in April. The income from one acre of catkin is about TK 15,000 and the labor to harvest coast about Tk 2,000 per acre. Once established, the grass can be cut annually. Further research should be undertaken to investigate the effectiveness of catkin grass (and other vegetative or low cost measures) in stabilizing char land. This could be undertaken by FAP 21 and 22.

- *Change in Water Levels.* There is concern amongst those working in the char areas about increased flood levels resulting from additional embankments being constructed to stop flooding from the Jamuna river, but it is not clear exactly how increased water levels would affect those living in the chars. For example, how would increased water levels affect those people who presently have to abandon their houses during floods?

Overall, improved understanding is required of the social, economic and physical environments of the char areas to enable appropriate and effective development and flood proofing programs to be developed and implemented. Non-government organizations have done undertaken programs in some areas and their experience should be utilized where possible.

4.3 Conclusions from the Case Studies

The main conclusions from the case studies are

- each household and community have their own unique set of assets and resources that they use to mitigate the effects of floods.

- flood proofing measures need to be designed to fit with the needs of local households and communities.

- small flood proofing interventions would reduce the hardship and suffering of many people at a small cost.

- houses of poorer families tend to be at slightly lower elevations and thus they are disproportionately more vulnerable to flood damages. In contrast, better-off families have tended to use their resources to flood proof their homesteads and they are less affected by floods.

- communities should be encouraged to carry out an assessment of their own flood proofing requirements.

- Development programs should be formulated for the char areas, on the basis of equitable distribution of government resources and utilization of the resources of the country. There are an estimated 1.2 million people living in the char areas of the Jamuna River (ISPAN 1992). In the FAP 3.1 area, there are almost the same number of people living in the char areas as there are living inside the proposed protective embankments (SOGREAH 1992). The char areas are productive and contributing to the national economy and ways to increase their productivity and improve the lives of people living there should be considered as part of national planning.

CHAPTER 5

DEVELOPMENT IMPLICATIONS OF FLOOD PROOFING

5.1 Requirement for Flood Proofing

Flood proofing is an integral part of the government's present initiative to improve flood plain planning. Flood proofing together with flood protection and flood preparedness are complementary components of the flood damage mitigation measures being planned and implemented under the Flood Action Plan. The requirement is to move away from the present 'laissez faire' or unrestricted planning to more comprehensive flood plain planning aimed at reducing the disruption caused by floods.

The type and extent of flood proofing measures required for a particular area will depend on whether or not flood protection facilities are available but in all flood-affected areas, some degree of flood proofing will be required.

People will continue to live outside protected areas and comprehensive planning and implementation of flood proofing measures can reduce the negative impact of floods and improve their standard of living. If more flood protection embankments are constructed or existing embankments are made to function more effectively under the Flood Action Plan, those living outside protected areas will be subjected to increased depths and duration of flooding. Communities which are presently not too affected by floods may become more vulnerable to flooding. Planning of effective flood proofing measures in advance of the construction or improvement of flood protection facilities will lessen the impact of increased flooding on these communities and should be an integral part of planning of flood protection projects.

The extent of possible increases in flooding depths in non-protected areas resulting from proposals being made by FAP studies and other government projects are being calculated by the Flood Modelling and Management Study (FAP 25).

Flood protection facilities are designed to protect areas from floods up to a specific flood event (for example, the 1 in 100 year river flood or the 1 in 20 year flash flood). For people living inside protected areas, the flood proofing measures required will depend on the design and the reliability of the protection offered. For example, in coastal areas, embankments are designed to give protection against high spring tides and not from cyclonic storm surges. Therefore, in coastal areas, appropriate flood proofing measures are cyclone shelters and making basic infrastructure (roads, schools etc) resilient to storm surges. Similarly for flood protected areas inland, the requirement is to flood proof basic facilities from more extreme floods or from catastrophic failure of the protection facilities. One complicating factor inland is that different design criteria are applied to different flood protection projects. For example, in the lower Atrai basin in the North West, projects on the right side of the Atrai river have been designed to give protection from 1 in 100 year floods while on the left bank, projects have been designed to give protection from the 1 in 20 year flood (EIP 1990). Flood proofing requirements will be different on either side of the river, although local people have resolved this inequitable distribution of resources by

cutting the larger embankment during high river flows, thus making the flood proofing requirements the same on both sides.

Another factor influencing the selection of flood proofing measures in protected areas is the reliability of the flood protection. During the 1988 flood, 1,990 km of flood protection embankments were damaged and facilities inside those embankments were not protected from the flood. The findings of the FAP 12 and other studies indicate that a number of existing flood protection projects are unreliable (Huntings 1992, Gisselquist 1991). Some projects have failed during floods against which the protection facilities were designed and the effectiveness of several projects was diminished by the lack of adequate resources and institutional support for operation and maintenance. The net result is that those inside embankments are sometimes more at risk to flood damage than those outside because the consequences of failure of flood protection facilities tend to be severe. Water levels within the protected area rise rapidly when the protection fails, giving people inside limited time to respond. In addition, those inside are often less prepared for inundation (see Section 3.4.1).

The reliability and availability of flood protection facilities may improve after the implementation of the Flood Action Plan but it will probably take several years before the institutions have been developed and resources identified for effective operation and maintenance to be established. Furthermore, new or improved flood protection facilities constructed under FAP may take several years to complete. In both cases, flood proofing measures could mitigate floods until the new facilities are complete and are operating effectively.

5.2 Impact of Flood Proofing on Development

5.2.1 Social Impact

About 85 per cent of the population in Bangladesh live in rural areas, and 60 per cent of rural people are classified as landless who own less than 0.5 acres or no agricultural land. Furthermore, 12 per cent of landless have no land on which to build their own house. During the 1988 flood,about 92 per cent of the people who suffered disruption and damage were landless. (UNCHS, 1988). Therefore, floods disproportionately affect landless people and floods reinforce their poverty. During floods of extended duration, poor people suffer more in rural areas due to isolation, unwillingness to move to higher ground for security reasons, lack of transport to replenish potable water, lack of fuel, and lack of livestock feed. Urban people have better access to water, fuel and public services except for squatters who live in vulnerable sites.

Flood proofing measures are focused on allowing people to live and improve their lives in an environment that frequently floods. Unlike flood protection measures which primarily benefit landowners and larger farmers (Thompson and Penning-Rowsell 1991 and Hunting Technical Services and others 1992), flood proofing measures can directly assist the rural and urban poor. For example, a program to flood proof poor households will improve the self esteem and self-confidence of the householder. Flood proofing houses will allow people to become more able and less dependent on relief. Similarly, a derived benefit of flood shelters is the confidence that a well-constructed and well-kept shelter creates in the local populace because the shelter will be present in times of need. The productive implications of such confidence while difficult to describe in

quantitative terms should not be underestimated. The shelter allows local people to overcome the fatalism that is inherent in flood-prone societies.

5.2.2 Impact on Women

Women face many problems during floods. As many activities of women are centered on their houses and houses are particularly vulnerable to floods (see Section 3.2), floods can cause particular hardships to women. Amongst the problems faced by women during floods are the lack of access to dry space, shortage of potable water, inadequate sanitation facilities, shortage of fuel, and restricted space for child rearing. Flood proofing houses would directly benefit women. Flood proofing water supply and sanitation facilities would also benefit women as they are primarily responsible for collection of potable water and they have more sanitation problems during floods due to social customs.

Another major impact of floods on women is caused by the shortage of income earning opportunities for family members. The burden of internal adjustments required to be made due to the shortage of cash and food seems to fall disproportionately on women, particularly by eating less and going hungry. This tendency has been observed in even more prosperous households (Hunting Technical Services 1992). Flood proofing incomes would remove this burden.

5.2.3 Environmental Impact

Flood proofing should be planned and implemented so that people act to protect themselves and their actions are coordinated to make sure that the self interest of one party does not harm others. Local actions must be reviewed to make sure that they do not make matters worse at higher/larger levels

Flood proofing measures are minor structural interventions and the scale of flood proofing measures usually means that they have a neutral impact on the physical environment and a positive impact on the social environment.

Possible impact of flood proofing measures on the human environment may be:

-employment (improved employment opportunities)
-community/social benefits(improved community facilities, markets, schools, health centers as well as flood shelters)
-water supply and sanitation(improved health)
-nutrition(improved health and welfare)

Possible impacts on the physical environment include

-forestry (use of trees etc for hydraulic protection)
-fisheries (use of borrow pits as fish ponds)
-livestock (sustainability during floods)
-surface drainage
-loss of land for soil to raise house floor levels or flood shelters

Guidelines for Environmental Impact Assessment have been prepared for use by the FAP studies (FPCO 1992)

5.3 Economics

Losses from flooding reduce the pace of sustained economic development and are a heavy drain on domestic resources. The resulting suffering is great, especially for the poorest strata in the population. The problem in applying economic evaluation to flood proofing is that it is difficult to quantify and monetarily value the most significant benefits such as reduced anxiety, anguish, and suffering, improved health, stability and security.

Some flood proofing activities do provide measurable economic benefits in terms of reducing loss of property or income which will be discussed subsequently. However, other benefits of flood proofing measure fall under the category of providing imprecisely defined, but nonetheless commonly acknowledged, minimum necessities of life such as adequate food, shelter, drinking water, sanitation, and security of families. Expressing the economic benefit of such minimum necessities is impossible, and attempts to do so trivializes them.

In contrast to the 'economics' of flood proofing, the 'economics' of flood control and drainage (FCD) projects can be determined fairly precisely, following well-established methods of analysis. Estimated benefits comprising mainly of changes in agricultural production and income are relatively straightforward to estimate, and viable alternative investments which will increase agricultural production and/or income can be identified. Benefits are also economically quantifiable. Economic analysis serves the purpose of helping to identify and choose those investments of greatest benefit to Bangladesh[3] which is why, in the Flood Action Plan, proposed FCD projects are subjected to economic justification following a rigorous benefit/cost analysis (FPCO 1992a). Economic analysis of flood proofing is much more complicated as what is the alternative or the economic benefit of access to food, potable water, and shelter from rain?

Costs of many structural flood proofing measures are fairly straightforward to calculate, and indicative costs and benefits of some measures are shown in Table 5.1. One particular measure, the raising the plinth or floor level of houses, requires mainly earthwork and a range of indicative costs for raising individual houses and homestead areas (houses plus courtyards) are given in Table 5.2.

Benefits of flood proofing can be analyzed to some extent by combining a mixture of a) qualitative discussion, b) quantitative assessment, and c) partial economic evaluation, as discussed in more detail below.

a) Qualitative Discussion

The benefits of such things as keeping the family together, privacy, reduced fear of danger to personal safety or loss of belongings, are real, and more important, than more quantifiable benefits. Such benefits should be identified and discussed in terms of what those people affected by floods have experienced, and how their situation will be improved by the proposed flood proofing measure.

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[3] Economic analysis is concerned with evaluating alternative investments in terms of national income. Costs of resources used in a project are valued at their opportunity cost, which is the income they would generate if invested in the next best alternative to the project under consideration. In contrast, financial analysis is done at market (nominal) prices showing the expected actual expenditures and receipts from the perspective of an individual, firm or institution.

b) Quantitative Assessment

Benefits such as the saving of human life, or the provision of basic necessities (food, potable water, fuel, and shelter) should be quantified by expressing them in non-monetary units of measurement under conditions with and without the proposed flood proofing measure. For flood proofing measure providing necessities like potable water, fuel supplies, meals, and sanitation, the number of households affected and period of deprivation can be quantified under the without condition to illustrate the benefit of the proposed measure.

The number of lives lost under past floods, and the estimated savings of lives should be expressed, without attempting to economically value human life[4]. Except for floods caused by cyclones, or severe river floods in certain isolated, newly accreted char areas, the loss of life from drowning during floods is relatively rare. The reported loss of life from drowning in the 30 villages surveyed by the FAP 14 Flood Response Study over the period 1982-91 was five persons in 1984, 71 persons in 1987, 64 in 1988, and five in 1991 (ISPAN 1992a). The loss of life was mainly in three char villages, Shibsen in Bhedarganj Thana, and Gopalganj and Jangipur of Bhuapur Thana. In the other 27 villages, four people drowned in 1987, and fourteen in 1988. In contrast to relatively few human deaths, 712 head of cattle were lost in these villages during 1987, and 509 head in 1988. Apparently people were usually able to escape with their own lives, even though the floods of 1987 and 1988 were so sudden and severe as to cause huge losses of cattle.

The potential for loss of life during floods is serious in char areas . In the 1988 flood, there were an estimated 596 deaths by drowning in the char lands of the Jamuna River between the northern border of Bangladesh and its confluence with the Padma. For comparison, in this char land area with a total population of 2.2 million, and estimated 802 died in 1988 of epidemic diseases such as cholera and dysentery. In the three years since 1988, 128 people have drowned during floods (ISPAN 1992).

c) Economic Benefits

Although the most important benefits of flood proofing are not amenable to economic quantification, it is possible to make a partial assessment of economic benefits

Generally, the procedure for estimating the economic benefits from flood proofing involves estimating damages at different levels of flooding, estimating the probabilities of such floods, and using the probabilities as weights to calculate the average annual expected value of damages. Damages include physical loss of homesteads, structures, household property, and financial loss of income from economic disruption. Flood

[4] As part of the Multipurpose Cyclone Shelter Programme, economists at the Bangladesh Institute of Development Studies used the 'residual cost-effectiveness approach' to estimate the economic value of human life based on the cost of treating various life-threatening diseases in Bangladesh. (BUET BIDS 1992)

proofing benefits are the difference in flood damages between pre-and post-flood proofing conditions.

Flood damages are classified as physical damages or losses, income losses, and emergency costs. Each activity affected by a flood experiences looses in one or more of these

Physical damages

Damage to buildings and their contents including furnishings, equipment, stored food and fuel, clothing, bedding, and decorations; loss of livestock; and loss or damage to infrastructure; roads, bridges, power lines, etc.

Income loss

Loss of wages or net profits to business over and above physical flood damages resulting from a disruption of normal activities. Increased costs to businesses or households caused by higher market prices for supplies is included under this heading.

An example of this type of damage is delay in post-flood planting because of a lack of access, shortage of inputs such as seeds and draft animals, or the necessity of re-establishing homesteads. Another example is the higher prices of commodities and services caused by transportation problems, inundated markets, closure of rice and flour mills[5].

Emergency costs

Emergency costs including those expenses resulting from a flood that would not otherwise be incurred, such as the costs of evacuation and reoccupation, storage of food and personal effects, flood fighting, and disaster relief; increased costs of normal operation during the flood; and increased costs of police or military patrols.

As many flood proofing measures are implemented by individual households or communities, the time and resources required to undertake a rigorous assessment of benefits for each case would not be justified. Furthermore, the resources available to different individuals and communities varies considerably, and care should be taken in generalizing the benefits of any one particular flood proofing measure.

An alternative way of assessing the value of flood proofing is to consider other benefits of flood proofing measures. For example, community flood shelters can serve more than one purpose. Where shelters are used for some other purpose such as a school or health center, or market, the cost of the shelter can be allocated between the multiple purposes to help decide whether the incremental investment in flood proofing is justified. Considering the case of shelters-cum-schools, the costs of land, tubewells, sanitary facilities, and the buildings, which serve as both shelter and school, could be allocated entirely to education, and only

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5 The FAP 14 Institutional Survey found that the prices of a wide range of essential commodities increased significantly during floods. Details are on file at ISPAN, Dhaka.

the costs of raising the elevation of the structure above flood level could be allocated to the flood proofing function.

Another important economic aspect of flood proofing is the question of equity. It is a well documented fact that expenditures for flood control and drainage projects are regressive in nature. That, is, the increases in income from such projects accrue largely to the owners of land and therefore, the more land you own, the larger your share of benefits.

On the other hand, the poorest, most vulnerable people however classified (landless, small farmers, fisherman, day laborers, or by gender) are those least able to protect themselves from floods and most likely to benefit from flood proofing measures. Therefore, with respect to flood proofing programs, government and donors are not saddled with the unpleasant paradox of using public funds and subsidies to further enrich the wealthiest class of society - large landowners.

5.4 Financing

Flood proofing has several features that permit much easier and more flexible financing. Flood proofing measure tend to be small scale, and hence can be implemented incrementally over a period of time. They are more divisible. Half a flood protection embankment provides no benefit, but raising a plinth of one homestead provides a full and immediate benefit to that household. Undertakings can be quite small and fragmentary. Thus, they can be financed in smaller packages, which increases the number of possible sources of funds.

Cost sharing is also much easier to achieve with flood proofing because the investments are small, benefits are immediate, and easily identifiable by the beneficiary. Contributed labor can account for a large share of the cost. For example, the raising of house plinths requires only earthwork. Beneficiaries can can contribute by providing labor which is the only contribution the poor can offer. The non-government organisation, SCI pay Tk 400/1000 ft^3 of soil moved for raising plinths as against a market rate of Tk 600-700/1000 ft^3. Unlike FCD projects, potential beneficiaries can be excluded from sharing in the benefits of flood proofing measures if they fail to contribute their share of the cost, thus giving them a clear incentive to participate.

Flood proofing interventions should be designed with active participation of individuals and local communities so that they can identify the main needs, contribute to construction costs and take responsibility for operation and maintenance of completed measures. Contributions from local communities could be complemented with funds provided from government (in the form of cash or grain) or from non-government organizations, some of whom have implemented flood proofing programs successfully (see Sections 3.2 and 3.3).

5.5 Institutions

Individuals and communities implement their own flood proofing measures, but flood proofing measures have not been applied systematically to ensure social and economic activities can be sustained during and after floods. The concept of flood proofing needs to be integrated into the planning, design and implementation of all national and local activities. Floods and other natural disasters are to some

extent predictable and the requirement is to minimize the disruption caused by their occurrence. The basic questions that need to be considered are:

> *"How does flooding (or other natural disaster) affect this activity/individual/community and what measures are required to sustain or improve this activity/individual/community during and after a flood?"*

At present there are no formal institutional arrangements for the promotion and implementation of flood proofing measures and institutional arrangements required to increase the resilience of individuals and communities to flooding need to be developed. Effective flood proofing involves many sectors and agencies, and it is essential to clearly demarcate the roles, responsibilities and management functions of different institutions including central ministries, local government institutions and non-government organizations.

While considering the institutional arrangements for flood proofing, it should be remembered that flood preparedness or disaster management is an essential complementary activity. Disaster Management may be viewed as an immediate short-term reactive strategy to cope with problems caused by floods. On the other hand, flood proofing is long term proactive approach to reduce flood damage and human suffering.

So far there has been little national institutional effort to plan and implement flood proofing programs. Flood proofing should be considered as an essential part of development planning and should be integrated into all national development strategies and plans.

Coordination of the planning of flood proofing at a national level should be undertaken by the Planning Commission. Standards, procedures, guidelines and criteria relating to flood proofing should be developed by the Planning Commission and incorporated into their regular planning process. The Planning Commission should also be responsible to review the state of flood proofing measures taken by various ministries in their regular development programs.

Each ministry such as agriculture, fisheries, livestock, small-scale industries, education, health, roads and highways should develop and implement appropriate flood proofing plans to ensure their services and development activities are not interrupted by floods. To promote awareness of the importance and benefits of flood proofing, Public Administration Training College and other training institutions of the various ministries should have flood proofing training modules as part of their basic and refresher training courses.

As flood proofing requires effective cooperation and collaboration from different ministries, a high-level inter-ministerial body should be established to ensure proper ministerial participation and coordination. To make its operation effective, it is desirable that this body be located near the seat of the chief executive, the prime minister. In view of this , it is proposed that a National Disaster Management and Flood Proofing Council be formed to provide policy directions and guidelines and to coordinate ministerial efforts. Disaster management and flood proofing are interrelated and a single higher council responsible for giving directions for disaster management and flood proofing would reinforce the complementarity of the flood mitigation measures.

The National Disaster Management and Flood Proofing Council should be chaired by the Prime Minister and the Cabinet Secretary should act as member-secretary. All relevant ministries should be represented by their respective ministers and secretaries. The Armed Forces should also be represented as they can play an important role in relief operations. The Council should be supported by two separate inter-ministerial committees, one dealing with disaster management and the other dealing with flood proofing. The inter-ministerial flood proofing committee should be chaired by the secretary of a lead ministry, while the Cabinet Secretary will act as its vice chairman. Involvement of the Cabinet Secretary is necessary to ensure operational linkages with the field administration through the district commissioners. Secretaries of all relevant ministries will be members of the Flood Proofing Committee, and the Secretary of the lead ministry will act as member Secretary. Details of the proposed inter-ministerial committee on Disaster Management are given elsewhere (Mott MacDonald 1992b).

The responsibility for managing flood proofing should be with a lead ministry having relevant normal responsibilities with adequate organizational structure at all levels of administration. The following ministries were considered:

Ministry of Relief and Rehabilitation (MRR)
Ministry of Irrigation Water Development and Flood Control(MIWDFC)
Ministry of Local Government, Rural Development and Cooperatives (MLGRDC)

The main focus of the Ministry of Relief and Rehabilitation is the coordination of disaster-related relief activities. The activities undertaken by MRR are primarily orientated to relief rather than development. The capability of MRR to handle disaster management is being improved under FAP11, and in the proposed project, the emphasis is on improving the coordinating role of the Ministry and the Ministry's ability to implement non-structural measures (Mott MacDonald 1992b). As flood proofing involves the implementation of minor structural measures as well as non-structural measures, the MRR in its present and proposed form is not suitable to be responsible for promoting and implementing flood proofing measures.

The Ministry of Irrigation Water Development and Flood Control (MIWDFC) have in the past mainly focused on large-scale flood control and drainage projects and do not have the organizational set-up to undertake small-scale individual or community based flood proofing measures. Projects undertaken by the Ministry tend to focus on the impact of floods on agricultural activities rather than on the impact of floods on other individual or community activities, utilities and infrastructure, which are the focus of many flood proofing measures.

The Ministry of Local Government, Rural Development and Cooperatives (MLGRDC) have traditionally supported the planning, design and implementation of rural works, rural water supplies and rural sanitation in villages, unions and thanas and in municipalities. Rural works have in the past included minor flood control and drainage projects but their activities during recent years have been dominated by the construction of roads. However, the Ministry has several programs at present to improve its support to all physical works being undertaken by local government institutions (for example, see Section 3.4.3).

Therefore, the Ministry of Local Government, Rural Development and Cooperative is considered to be the most appropriate ministry to act as lead agency to promote and implement flood proofing.

Institutional arrangements for flood proofing homesteads and communities should involve local government institutions supported by central and field administrations, and non-government organizations. At household and village level, non-government organizations and private voluntary agencies have implemented flood proofing such as building and flood and cyclone shelters and providing special credit for repair/rebuilding private houses. Local government institutions with technical support from Local Government Engineering Department (LGED) and Department of Public Health Engineering (DPHE) should undertake flood proofing measures such as community shelters, roads and other physical infrastructure. Both local government institutions and non-government organizations should promote activities to enhance public awareness about flood proofing.

Flood proofing measures should be tailored for the particular needs, characteristics and traditions of individuals or communities and hence they must be involved in the identification, planning, design and implementation of appropriate flood proofing measures. The institutional framework should allow for the integration of local initiative and technical expertise that is provided by public, private or non-government organizations.

Local government institutions should have the major responsibility for planning, implementing and coordinating flood proofing activities undertaken by individuals or communities. Inter-agency coordinating committees may be formed at thana and district level from representatives of local government institutions, field administration and non-government organizations, private sector, women's groups and other interested groups.

5.6 National Development Considerations

Flood plain planning and implementation of flood proofing measures needs to be carried out within the framework of national policy on flood plain management. Some of the issues that should be addressed in the national policy on flood plain planning include:

- More comprehensive approaches to resources management, including multidisciplinary planning teams and multimeasure interventions should be promoted

- Administrative actions that encourage intensive interagency coordination, dissemination of flood hazard information, and initiation of effective local participation.

- All development programs and projects particularly in the areas of rural development, physical infrastructure and service infrastructure should include appropriate provisions for flood plain management, including flood proofing and flood preparedness measures. Feasibility, project appraisal and post-evaluations of projects and programs should incorporate flood proofing and flood preparedness measures.

- Hydraulic and hydrologic planning and design criteria should be prepared to guide future interventions and rehabilitation of existing public infrastructure and to guide private investment in flood prone areas.

- Relief and flood recovery programs should give special consideration to the needs of economically disadvantaged groups to help them avoid selling or mortgaging basic assets (such as land, tools or livestock). As the poor are often most affected by floods, programs should be supported that involve employment, credit, rescheduling loans, outright grants, and insurance compensating losses of the poor.

- Effective flood and storm warning systems should be developed throughout the country

- Beneficiaries should contribute to the cost of flood control and drainage projects to enhance local commitment to operation and maintenance of facilities

- All government agencies should have contingency plans to ensure that they can function throughout floods. The necessary funds should also be made available.

- Increased agricultural activity within protected areas should be encouraged including the involvement of farmers in internal water management (for example, drainage system improvements or controlled flooding)

- Local formal and informal groups should be encouraged to prepare for and respond to floods.

- The role and responsibilities of the union parishad in preparing and dealing with floods should be strengthened. In this effort, technical and logistic support to them from all relevant national government agencies should be ensured. they should be empowered to raise revenue for undertaking local flood preparedness and flood proofing measures. Union parishads may be encouraged to prepare and implement local development plans incorporating flood proofing measures

- Local initiative infrastructure projects should be designed to avoid interfering with flood flows or drainage

- Local programs to improve flood response and flood proofing, including training for these measures, should collaborate with non-government organizations wherever possible.

- Static and mobile health care education available in the thanas, unions, wards and villages should be improved. There is a great need to provide adequate emergency medical supplies, such as anti-diarrhea rehydration therapy and water purification tablets. The development of mobile health teams should also be encouraged to help deal with the medical situation during and after floods.

- The district and thana levels should be mandated to improve coordination among national departments or agencies such as BWDB, IGFD, DPHE,

Agricultural Extension Directorate, Fisheries Directorate, and Public Health Directorate.

- Greater collaboration and cooperation between non-government organizations and local voluntary groups on one hand and local bodies and central government agencies on the other should be promoted.

Appropriate legislation should be formulated to implement national policy on flood plain management.

Chapter 6

APPROACH TO A FLOOD PROOFING PROGRAM

6.1 Purpose of a Flood Proofing Program

People and institutions in Bangladesh already use their own resources to undertake flood proofing measures. The purpose of a flood proofing programme would be to use the resources and technology available to the government to make individual, community and institutional actions more effective, and to oversee their actions to ensure that they do not harm the physical, social or economic environment.

6.2 Components of a Flood Proofing Programme

Flood proofing is the provision of long-term non-structural and minor structural measures to mitigate the effects of floods. There is no 'definitive list' of flood proofing measures because effective flood proofing is based on local needs. Identification of local needs

Possible non-structural flood proofing measures can be grouped together and could include the following:

a) **Legal Measures** comprising of planning controls and building codes. Land -use planning and zoning laws could be used to restrict development activities on land where the risk of flooding is too high or where the activities interfere with flood flows. Building codes would be established to specify required standards of safety and also serve to develop public awareness.

b) **Provision of Incentives** to encourage people to adopt flood proofing measures. Grants could be paid to private firms or individuals to flood proof their houses or buildings. Tax incentives could be used in a similar way.

Insurance could also be used to spread risks and providing funds to enable owners to re-build after floods.

c) **Training and Education/Information Dissemination** could be used to show people how to integrate flood proofing into their daily lives. Training programs could be developed for public officials, technical students, small builders and craftsmen and school children.

d) **Public Awareness** could be promoted by government to demonstrate sound flood proofing measures by ensuring public buildings, public infrastructure and public services can function throughout floods.

e) **Institution Building** would play a vital role in various aspects of flood proofing such as promoting public awareness programs, training at community levels, linking government resources to individuals, communities and the private sector and implementing flood preparedness programs including flood forecasting and warning systems.

Possible structural flood proofing measures could include:

raising floor levels of houses/homesteads
improving the quality of housing
provision of flood or cyclone shelters
provision of storage areas (for personal possessions, fuel, grain, fodder etc.) above flood level
local small-scale flood protection and drainage schemes
protective embankments and drainage for small urban areas
protection of commercial premises
raising ground levels at markets, schools and other communal areas
ensuring key infrastructure (roads, railways, public buildings etc) are above specific flood levels
ensuring different modes of transport can operate effectively during floods

6.3 PLANNING OF FLOOD PROOFING MEASURES

Flood proofing measures should planned to fit the needs of individuals and communities during flood events. the needs of local people should be determined through people's participation in the planning process. Thus the planning of flood proofing involves:

- o identification of local flood characteristics
- o evaluation of impact of floods locally and needs assessment
- o identification of appropriate flood proofing measures including arrangements for financing the construction and operation and maintenance of measures.

During the planning process, special attention should be given to those disadvantaged groups who are likely to be most affected by floods including the rural poor, ethnic groups, minorities, women, and those dependent on marginal or fragile resources. People belonging to different social groups should be able to voice their own perceptions of the existing problems, potential solutions, including their ideas about the feasibility and implications of technical solutions. Measures should be conceived designed and implemented on the basis of basis of complementary needs of local people and/or reconciliation of the competing interests of different groups.

The planning process should determine whether the measures identified are:

- o compatible with the expressed needs and wishes of the local people and takes account of social and environmental imperatives
- o likely to be institutionally and administratively practicable
- o capable of being implemented without creating major social disruption or irretrievable damage to any social group, particularly those already disadvantaged.

6.4 Recommendations for Phase II

A comprehensive flood proofing program would make a significant contribution to the success of flood damage mitigation measures being implemented under the

Flood Action Plan. During Phase I of FAP 23, the broader aspects of flood proofing have been considered and existing flood proofing measures have been reviewed. The requirements for Phase II is to apply the principles of flood proofing in a number of areas on a pilot basis. The pilot projects would be aimed at developing flood proofing measures that could be adopted by individuals, commercial and industrial enterprises, and government and non-government institutions, using private, commercial and public funds. Detailed Terms of Reference for the Phase II Flood Proofing Pilot Project are given in the FAP 23 Interim Report.

APPENDIX A

FAP 23
TERMS OF REFERENCE

1. BACKGROUND

1.1 The disastrous floods of 1987 and 1988 stimulated the Government of Bangladesh to carry out a comprehensive review of flood policy. A number of studies were undertaken and, in June 1989, the GOB requested that the World Bank (WB) coordinate donor activity on flood-control assistance.

1.2 The need for coordinated, international action, in support of the GOB, to find solutions to the flood problem that are technically, financially, economically and environmentally sound was endorsed at the G-7 Summit in Paris in July 1989.

1.3 In December 1989, the WB proposed the development and implementation of a five-year Flood Action Plan (FAP, 1990-95) as the first of several stages in a long-term flood control program. The FAP, later endorsed by the donors, consists of project-oriented studies in all the country's main regions and supporting activities to promote improved project design and execution and use of non-structural measures.

The GOB seeks an approach which will provide a comprehensive and permanent solution to the recurrent flood problem and so create and environment for sustained economic growth and social improvement. The flood policy that was adopted incorporated a long-term plan of major physical works to control flooding that originates from the main river system and a set of eleven principles to guide future development. The principles include a number of non-structural approaches to flood protection and mitigation (as well as structural measures such as major-embankment and river-training works), including effective land and water management, strengthened flood preparedness and disaster management, floodplain zoning, coordinated planning of roads and related rural infrastructure to ensure unimpeded drainage, and increased local and individual participation in all aspects of flood control and drainage works. Minor local works also are to be considered.

The Flood Policy provides a long-term framework and a plan for physical works, that are to be implemented in stages. To meet the short-term need (to mobilize resources , provide as effective flood-protection and mitigation as possible in the shortest time and to begin work on the priority elements), the World Bank (WB) , in collaboration with several donors and the GOB, prepared a Flood Action Plan (FAP) covering the five year period 1990-1995. Coordination of the FAP within the Government of Bangladesh is being undertaken by the newly established Flood Plan Coordination Office (FPCO).

1.4 Land annually flooded to a depth of more than 0.3 m occupying about 6 million hectares or almost 65 percent of the net cultivated area of Bangladesh. At present, about 30 percent of this area is either partly or fully protected against floods. For the remainder, even with full implementation of flood-control projects as outlined in the FAP, about 30 percent will remain unprotected;

substantial areas that may eventually be provided with embankments will remain unprotected for 20 years or more during the implementation period; and all protected areas will remain vulnerable to damage during catastrophic failure or overtopping of structures during floods of greater than design recurrence interval.

1.5 Thus, it is important to examine flood-proofing measure that could mitigate flood damage to agriculture and to private and public property in unprotected floodplain areas. Potential measure might include the protection or raising of homestead mounds, refuge areas, roads, water supply and other health related facilities and commercial and industrial premises, as well as the provision of additional bridges, culverts in roads. Non-structural measures include institutional measures to coordinate development activities to control flooding and drainage, the provision of hydrological data to local government engineers so as to improve the design of roads, bridges, culverts, drains and small-scale embankments, the regulation of land-use in flood-hazard areas, and adjustments for the crop calendar to reduce risk. These approaches are a mixture of minor structural and non-structural measures that rely on high public participation, low public participation , low public capital inputs, and private investment. They focus on coordinated government policy to effect change and create incentives for beneficial private action,. They require high management and information inputs rather than large public expenditure on physical works.

1.6 USAID will finance this study and Supporting Study 14 : Flood Response. These two studies are complementary and between them encompass a study of non-structural and structural flood response and flood proofing in both rural and urban areas. As conceived in the FAP Report (December, 1989) , Supporting Study 14 was to be confined to a study of how people living in small rural communities on the active flood plains respond to floods. To simplify study design and management, USAID in collaboration with FPCO, propose to examine all the agricultural and small rural community flood response under Supporting Study 14, and confine study 23 to an examination of flood response of private industries and local and central government and actions to flood proof municipal and urban areas and public sector infrastructure throughout the country.

2 REGION

2.1 Flood proofing pilot study and implementation areas (possibly upazilas) will be selected to represent unprotected flood prone environments in all of the FAP regions.

3. SCOPE OF WORK

3.1 The overall objectives of this study are to identify and implement effective measures to avoid or reduce the adverse human, infrastructure and economic effects of flooding, particularly in unprotected areas. The study will be carried out in two phases. During Phase 1 (7 months) a study of how individuals, industrialists, local and central government respond to floods in rural towns/municipal areas, and for national infrastructure (roads, rail, power etc.) will be undertaken. The measures these entities have adopted to mitigate flooding, and new approaches that may be formulated will be examine,

successful measures categorized, and candidates for pilot flood-proofing identified.

During Phase 2, flood proofing measures will be tested in a series of small pilot activities. It is expected that flood proofing measures successfully tested and demonstrated during Phase 2 will be adopted by individuals, commercial or industrial firms, local governments and other institutions using private, commercial or institutional funds.

3.2 The studies will be carried out in two phases, as follows:

- a preparatory phase (Phase 1), lasting seven months; and
- an implementation period (Phase 2), including pilot activity period lasting 12 to 18 months and project execution of indefinite duration, but likely extending through 1995, with monitoring evaluation and training or education.

3.3 Emphasis has been given to the preparatory phase that is funded and will determine the detailed terms of reference (TORs) for later activities in Phase 2, for which finance is still pending.

3.4 Phase 1 will include a review of reports and empirical data and experience, evaluation of individual and local government initiatives and presentations of findings in a review workshop and report. Preparation activities will include efforts to obtain commitments for funding later phase.

4. TERMS OF REFERENCE

4.1 These TORs are intended to provide a framework for the study. They outline specific tasks, staffing requirements, schedules and products. More detailed work plans will be developed during study preparation to identify data requirements, data collection methods and report contents.

4.2 Phase 1

Task 1. Review existing studies and data (national and international) relevant for identifying appropriate flood-proofing measures which could be tested or implemented during Phase 2. This review will be supplemented by brief field visits to selected flood-prone areas.

Task 2. Based on the findings of Task 1, a systematic survey will be designed and carried out to obtain data on relevant aspects of rural housing and public health; agricultural livestock- and fisheries- production systems; (input from study 14) road, rail and waterway communications; and institutional, commercial and industrial infrastructure and enterprises in rural towns/municipalities. Particular attention should be paid to damage during the 1987 and 1988 floods;

Compile and analyze data on flood-affected households (inputs from FAP 14) and commercial / industrial activity. Determine hydrological parameters needed to forecast costs and benefits, estimate effectiveness of selected

measures (including social, economic and cultural acceptability) and identify practices for which further studies are justified;

Prepare a mid-term issues report to summarize findings, further data needs and prospective recommendations; and

Organize a workshop of Bangladeshi and expatriate specialists, including members of FAP panel of experts, to exchange and record experience and ideas on flood-proofing of rural property, infrastructure and economic production systems. One purpose will be to develop concepts and strategies for flood-proofing studies and activities to be carried out in Phase 2.

Task 3. From preceding activities, identify one or more representative flood-prone areas (total about 8) in which to carry out pilot studies of flood-proofing in Phase 2. Prepare geographical profiles of each selected area and plan phase 2 operations.

Formulate and adopt concepts for present or potential measures to reduce flood vulnerability:

- Establish and use quantitative and qualitative standards to evaluate prospective interventions for adjustment, where justified, of perceptions and responses to risk of flooding; seek to

  - establish consistent and thorough bases for measuring costs for damage and loss attributable to flooding

  - establish consistent and thorough bases for measuring benefits of interventions in terms of improved sustainability of agriculture, public health and economic output; and

  - identify actions needed to achieve reasonable equity in distribution of costs and benefits.

- Identify resources and roles of public and private sector organizations for implementation of measures found to be effective; and

Prepare an interim report giving detailed TOR's for the pilot activities. The report also should include arrangements for monitoring, evaluation and training activities. It will include definition of scope for selected flood-proofing measures to be carried out as pilot projects in the second phase and of practices shown to be effective and deserving of immediate implementation.

4.3 Phase 2

The TORs for these latter activities will be prepared during Phase 1.

4.4 Relationship with other Action Plan Studies[1]

[1] The complete list of Flood Action Plan Studies is given in Table A.1.

The study team will receive technical support from the team conducting the Flood Response Study (Activity No. 14) and will work in close consultation with the FPCO and with consultants or other institutions engaged on other FAP activities, especially Flood Forecasting and early Warning (Activity 10) and Disaster Preparedness (11) studies. Other include Regional Studies (2-6); Environmental Study (16); Fisheries Study (17); and Compartmentalization Pilot Project (20).

Coordination between this and other FAP studies to provide mutual support and avoid duplication of activities will be achieved through regular progress reviews arranged by the FPCO.

Table A.1
List of Flood Action Plan Studies

FAP Study Number	TITLE
1	Brahmaputra River Training Study
2	North West Regional Study
3	North Central Regional Study
3.1	Jamalpur Priority Project
4	South West Area Management Study
5	South East Regional Study
6	North East regional Study
7	Cyclone Protection Project
8a	Greater Dhaka Protection Project
8b	Dhaka Integrated Town Protection Project
9a	Secondary Towns Integrated Flood Protection Project
9b	Meghna LB Protection Project
10	Flood Forecasting and Warning Project
11	Disaster Preparedness Project
12	FCD/I Agriculture Review
13	O & M Study
14	Flood Response Study
15	Land Acquisition and Resettlement
16	Environmental Study
17	Fisheries Study and Pilot Project
18	Topographic Mapping
19	Geographical Information System
20	Compartmentalization Pilot Project
21	Bank Protection and AFPM Project
22	as 21
23	Flood Proofing Study and Pilot Project
24	River Survey Programme
25	Flood Modeling/Management Project
26	Institutional Development Programme

APPENDIX B

FLOOD CHARACTERISTICS

Floods in Bangladesh are a complex phenomenon as there are several different types of floods, with each being caused by different factors and having different impacts. Floods have to be understood in the environmental context in which they occur in order to identify appropriate measures to mitigate their effects.

B.1 Land Characteristics

Bangladesh is located astride the Tropic of Cancer at longitude 90°E and has a land area of about 145,000 sq km. About 80 per cent of the land is comprised of floodplains of the Brahmaputra, Ganges and Meghna and some smaller rivers, while 8 per cent is terraces (actually uplifted fault blocks) and 12 per cent is hills.

Gradients on the floodplain are generally low: the average gradient from the north-western part of the country to the coast is less than 20 cm/km; near to the coast gradients average about 1.6 cm/km.

Relief and soil patterns are often complex. The micro-topography of local floodplain areas often varies by more than 1 m, with permeable soils on the higher ground and impermeable clays on the lower parts. These small differences in elevation determine local differences in the occurrence, depth and duration of flooding and determine cropping patterns: small differences in elevation of as little as 30 cms can be highly significant for crops, crop varieties and rotations. The classification of land according to depth of flooding is shown in Table B.1.

Table B.1
Depth of Flooding and Land Types (1)

Description	Depth Flooded	Classification	Percentage of Total Land Area
Highland	Intermittent, above normal flood level	F0	17
Medium Highland	Seasonal up to 90 cm	F1	40
Medium Lowland	Seasonal 90 - 180 cm	F2	15
Lowland	Seasonal 180 -300 cm	F3	9
Very Lowland/ Bottomland	Perennial (mainly flooded > 300 cms)	F4	2
Settlements, water bodies		-	17

Notes: 1 Soil Resources Development Institute (SRDI) Classification as amended by the Master Plan Organisation (MPO)

B.2 Physiography

The floodplain is comprised of six physiographic units (MPO 1987; Brammer 1990).

Piedmont Plains. The piedmont areas are very-gently sloping outwash fans that form part of the *Terai* zone at the foot of the Himalayan region and adjoin Bangladesh's northern and eastern hills. Intermittently, these area experience flooding from local rainfall; in July-August 1987, and again in September, 1991, the area in the Northwest (NW) region was extensively flooded by rainfall over 500 mm above average. Locally, flooding has been worsened by drainage impedance due to construction of road and other infrastructure.

Active River Floodplains. The Active River Floodplain. are new alluvial land (chars) within and along the major rivers. They are seasonally flooded to depths of 2 to 5 m.

River Meander Floodplains. The River Meander Floodplain comprises older alluvial land formed by earlier river courses, comprising ridges (old levees), oxbows (baors), back-swamps (beels), and relic channels. Lands are seasonally flooded on ridges (1 to 2 m) and to much greater depths in depressions (3 to 5 m).

Major Floodplain Basins. The Major Floodplain Basins are areally-extensive depressions (haors) whose centers stay wet throughout the dry season. Most are deeply flooded (2 to 5 m) throughout the monsoon season

Estuarine Floodplains. Estuarine floodplains have almost level relief (less than two-meters) on deep silty alluvium with few or no through watercourses. Seasonal flooding occurs (mainly two- to five-meters deep), but flooding is shallower in the Southeast and near the coast. Parts of the region become saline in the dry season.

Tidal Floodplains. Tidal zones are almost level (relief is less than one-meter) and have predominantly clay alluvium soils. Most are drained by many tidal creeks. They are affected by shallow flooding (less than one meter) in the rainy season and at high tide in the dry season where not embanked. Most soils are affected by salinity, mainly in the dry season. During storm surges many areas are inundated by saline water which may adversely affect the soils though many soils are flushed without lasting damage during the following monsoon.

Within these physiographic units, flooding is not uniform and may occur from several different sources often at different times of the year.

B.3 Flood Characteristics

The catchment areas of the Brahmaputra, Ganges and Meghna rivers have a predominantly monsoon climate, with heavy rainfall concentrated in 3-6 months of the summer (May - October). Within Bangladesh mean annual rainfall rang s between 1250 mm to more than 5000 mm. There is significant variations in the monthly and annual rainfall occurring in different years, leading to considerable differences in peak flood levels and the extent of flooding each year.

The major rivers and their tributaries have their headwaters outside Bangladesh. Only about 7.5 per cent of their total catchment area of about 1.5 million sq km lie within Bangladesh. Similarly about 90 per cent of their annual flows originate outside the country.

Seasonal flooding in all areas except those close to major rivers and on the Piedmont plains is mainly by rainwater ponded on the land when drainage is blocked by rising water levels in the rivers. Silty river water only spreads more extensively over adjoining floodplain land in years when river levels.are high.

B.2.1 Types of Flood

There are four main types of flood in Bangladesh: flash, river, rainwater and storm surge (Brammer and Khan 1991).

Flash Floods. Flash floods rise and fall rapidly, usually within a few days and are caused by heavy rainfall occurring in the steep catchments of the neighboring upland areas. Flash floods may flow rapidly along river channels and over land Water levels in some rivers can rise by several meters within 24-48 hours. They occur most frequently at the foot of the northern and eastern hills. They are less common along the Teesta, Atrai and Little Jamuna rivers in the northwest.

The impact of flash floods is variable and depends on when they occur. Early flash floods (in April/May before the main monsoon) generally cause most damage by flooding boro rice. Flash floods occurring in the monsoon season generally cause less crop damage, but exceptionally high floods can damage aus and aman crops as they did in the northwest in 1987. In the post monsoon period (September-November), flash floods may affect transplanted aman.

Damage to property, especially road and railway embankments and bridges, and buildings alongside river channels occurs during exceptionally high flash floods. Flood embankments along some eastern rivers are breached almost every year. Cultivated land close to such breaches may be buried by infertile sand.

River Floods. River floods result from snow-melt in the high Himalayas and heavy monsoon rainfall over the Ganges-Jamuna-Meghna basin. River floods River floods particularly affect active river floodplains. In years when river levels rise earlier or higher than 'normal', river water also floods onto neighboring meander flood plains that are normally flooded by rainwater. In exceptionally high river floods as in September 1988, river flood water spreads over virtually the whole Jamuna and lower Ganges flood plain.and over parts of the Old Brahmaputra and High Ganges flood plains.

The annual floods passing down the Brahmaputra and Ganges rivers normally do little damage except by riverbank erosion. At an average interval of about 3-4 years, river floods extend beyond their active flood plains and damage crops on the adjoining meander flood plains, mainly beside distributor channels. The timing and duration of the flood are as important determinants of crop damage as is the absolute height reached by a particular flood. Sediments deposited in channels reduce the drainage capacity of minor rivers, roads and railway bridges and culverts, as well as irrigation and drainage canals. Severe floods which cause extensive damage to crops, and some damage to property and infrastructure occur at intervals of about 7-10 years. So-called catastrophic floods occur at intervals of about 20-50 years and cause almost total damage to crops on adjoining floodplains, as well as considerable damage to property and infrastructure. The 1988 on the Brahmaputra-Jamuna river was rated as a 1 in 50-100 year event.

Peak floods in the Brahmaputra-Jamuna river normally occur a month earlier than those in the Ganges, and floods may affect one river system without affecting the other. High floods in either of these rivers may cause damage downstream alongside the Padma or lower Meghna rivers. Overland flooding is particularly severe in years when high flood peaks in the two major rivers coincide, as they did in 1988.

Rainwater floods. Rainwater floods are caused by heavy rainfall over floodplains and terraces within Bangladesh. Heavy pre-monsoon rainfall (April-May) causes local run-off to accumulate in flood plain depressions and in the lower parts of the valleys within the Madhupur tract. Later (June -August) local rainwater is increasingly ponded on the land by rising water levels in adjoining rivers. Thus the extent and depth of rainwater flooding vary within the rainy season and from year to year, depending on the amount and intensity of local rainfall and on water levels in the major rivers which control drainage from the land.

Rainwater flooding is characteristic of meander floodplains, major floodplain basins, and old piedmont and estuarine floodplains. Interior parts of tidal and young estuarine floodplains are also flooded mainly by rainwater. The serious 1987 flood in northwestern parts of Bangladesh was mainly caused by excessive rainfall occurring over the north of the area throughout most of the monsoon season. The flooding was aggravated by flash floods in the Teesta and other rivers entering from the northwest, and by high river levels in the Jamuna and Ganges rivers. Drainage of overland flow was also impeded by road and railway embankments with inadequate bridges or culverts and silted-up minor drainage channels.

Storm surges. Storm surges are raised sea-levels caused by a combination of low barometric pressure and strong onshore winds associated with tropical cyclones. Storm surges cause sudden but temporary flooding of coastal areas with sea water or brackish estuarine water flowing inland for a few kilometers during the passage of cyclones. During storm surges, water levels can rise 4 - 6 m above normal high tide within a few hours. Exceptionally, as in May 1965, storm surges move to the interior of the country by passing up the Meghna estuary. Damages from storm surges are particularly heavy especially in terms of loss of human lives.

In addition to the main types of flood, there are floods cause by man-mad interventions to the natural hydrology and landscape. **Man-made floods** include floods resulting from breaches in embankments and floods resulting from water ponding behind embankments.

Sudden breaching of embankments at a time when there is a difference of several meters between the external river and the land inside the embankment can result in the catastrophic inflow of water into protected areas. Embankments can be breached by erosion from adjacent rivers, or due to cut being made by people who consider that the embankment is aggravating their own flooding.

Ponding of water behind road, railway and flood embankments following heavy rainfall is a common occurrence. The scale of flooding and damage will vary with rainfall intensity and the extent to which the natural floodway is being blocked by the embankment. The complexities of overland flow in floodplain areas makes the design of structures in embankments extremely complex

B.2.2 Timing of Floods

The normal sequence of floods starts with flash floods in the eastern hill streams during the pre-monsoon months of April and May. the onset of the monsoon generally occurs in June. The Meghna and the Brahmaputra rivers normally reach their flood peaks during July and August and the Ganges river during August and September. Severe flooding occurs if the peaks of the Ganges and the Brahmaputra rivers coincide.

The succession of two catastrophic floods, as happened in 1987 and 1988 is a rare event, though there was a similar succession in 1954 and 1955. Despite the two catastrophic floods of 1987 and 1988, there is no significant trend to increased flooding, either natural or man-made. However, over time, the extent of damage has increased as new development activities have become established on the floodplains (World Bank 1989).

B 3.3 Depth of Flooding

The difference in levels between floods of different return periods is not large as shown in Table B.2. However, given the topography of Bangladesh, even small differences in level can be significant in terms of the area affected and damage caused.

Table B.2
Flood Levels for Different Return Periods

Return Period	Ghagot River Water Levels (m)	Jamuna River Water Levels (m)
1 in 5 years	21.63	21.53
1 in 20 years	22.08	21.97
1 in 50 years	22.37	22.25
1 in 100 years	22.59	22.45

Source: North West Regional Study (FAP 2)

APPENDIX D
CASE STUDIES OF FLOOD PROOFING REQUIREMENTS

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APPENDIX C

FAP 23 SURVEY

METHODOLOGY AND FINDINGS

C.1 SURVEY METHODS

As part of the formulation of the Flood Proofing Pilot Project, people and institutions with recent flood experience were surveyed to determine their response to floods and to identify possible flood-proofing strategies and measures that might be adopted to avoid flood damage and loss by urban people, private industries, local and central government agencies, and non-government organisations. The survey focused on individuals living in small urban areas (pourashavas) and representatives of private-sector interests, non-government organisations, and local and central-government institutions located in sadar upazilas and in Dhaka.

The FAP 23 survey was carried out in small urban areas to complement the flood response survey of rural areas carried out under the Flood Response Study (FAP 14).

C.1.1 Scope

The general objectives of the survey were to:

- obtain information on the nature and type of flood damages, losses and inconveniences experienced by individuals and organizations during the extreme floods, particularly the 1988 flood;
- survey the major flood-proofing measures already adopted by individuals and organizations, both public and private, with a view to identifying the more effective and successful flood-damage mitigation and flood-proofing measures and requirements; and
- identify local organizations and agencies potentially interested in participation in Pilot Projects.

C.1.2 Procedure

The survey was conducted using rapid rural appraisal techniques. Information was gathered through interviews and discussions with concerned individuals and officials through the use of a questionnaire for individuals and an interview schedule for institutional representatives. Interviews were conducted during a seven-week period during June and July, 1991 by trained professional personnel under the supervision of the Senior Institutional Specialist of FAP 23.

In determining the number of respondents from each socio-economic group for the study on individuals, greater weight was given to private traders, commerce sectors and private professional groups as designated in the Terms of Reference (see Appendix A)

Due to time and resource limitations, the number of individual respondents from each study site was limited to nine (9) persons distributed as follows: three respondent engaged in small business (1 shop owner each of stationery, food items, and construction materials); three respondents engaged in trade or commerce (1

each for clothing, timber, and medicine), 1 teacher, 1 lawyer, and 1 Iman. Those surveyed included 1 female teacher or lawyer at each site.

The institutional survey covered a number of institutions in both the private and public sectors, located in sadar upazilas and district offices, as well as at the headquarters in Dhaka. The institutions surveyed included Upazila Parishads, pourashava banks, small enterprises, upazila and district offices of central ministries, corporations and non-government organisations. A total of 158 officials were interviewed. In addition, 17 government officials were interviewed in Dhaka.

C.1.3 Interview sites

People and institutions were surveyed in six regional towns. The towns were selected to represent severely affected areas of the 1988 flood and areas with different flood futures. Towns in each of the five FAP regional-study areas were included. The list and flood characteristics of the selected towns are given in Table C.1.

Table C.1
Flood-Proofing Survey Sites

Town & Upazila	FAP Region	Flooding Features	Population
Brahmanbaria	South East	Flash Flood	87,570
Tangail	North Central	Riverine - Rainfall	84,465
Sirajganj	North West	Riverine - Bank Erosion	106,774
Faridpur	South West	Riverine	66,579
Sunamganj	North East	Haor	18,782
Bhola	South East	Char, cyclone,tidal	102,944

C.2 SURVEY FINDINGS

The following sections present the findings of the field survey conducted by FAP 23. The survey focussed on determining the responses of both individuals and institutions to the 1988 flood and their suggestions for flood proofing measures to mitigate the effects of future floods. The findings are presented in the same order as the contents of Chapter 3 of the Main Report.

C.2.1 Housing

The FAP-23 survey focused on people living in privately owned urban houses in pourashavas.

Houses occupied by individual respondents were mostly timber-framed (30 out of 54) and brick (18 out of 54) structures. The number of rooms varied from 3 to 14 per house, and floor areas ranged from 16.9 m^2 (182 ft^2) to 338.6 m^2 (645 ft^2). The floor areas of 15 out of 54 houses were less than 46.5 m^2 (500 ft^2), while the floor area of 26 out of 54 was between 46.5 m^2 and 11.5 m^2 (500 and 1,200 ft^2). Most houses (46 out of 54) were single storied, and floor plinth heights ranged from several inches to four feet above ground level. Floors were made of concrete. Roofs of 18 out of 54 were made of reinforced concrete. The remainder had corrugated iron (CI) sheet roofs. Walls of 36 out of 54 houses were built with brick while 17 out of 54 house had CI sheet roofs.

Response to the 1988 Flood. Significant numbers (16 out of 54) of urban house owners suffered flood-damaged floors, walls, plaster and fencing. The majority of houses (28 out of 54) had water over the ground floor during the 1988 flood. The extent of damages to the houses surveyed are shown in Table C.2.

Table C.2
Damages to Houses in 1988 Flood

Nature of Damage	Dwelling Houses		Working Place	
	Number	percent	Number	percent
Floor Damage	11	20.4	4	7.4
Wall and Plaster Damage	12	22.2	4	7.4
Houses washed out	4	7.4	-	-
Other Unspecified Damage	3	5.6	-	-
Furniture Damage	15	27.8	-	-
Food Items	8	14.8	-	-
Poultry	12	22.2	-	-

Measures taken by individuals and institutional members to mitigate the suffering and to maintain their normal work during 1988 flood time included:

- non-government organisations and neighborhood groups supplied house construction materials to local people and also arranged for boats for shifting dismantled housing materials.

- individual residents of urban areas made raised platforms in their houses, kept furniture on brick blocks, and shifted valuable materials to upstairs and to relatives houses.

Generally, houses of the individuals surveyed were damaged during 1987 and 1988 floods and people needed funds for their reconstruction and repair. Of the sixteen respondents whose houses were damaged took loans, one took a loan of Tk 20,000 from a provident fund and another received a loan of Tk 40,000 from a close relative. Other respondents wanted loans from either commercial banks and the House Building Finance Corporation (HBFC) but both institutions had suspended giving loans for houses in upazilas three years ago.

Proposed Flood Proofing Measures The following flood proofing measures were proposed by those surveyed:

- staff of non-government organisation suggested that credit should be made available to purchase reinforced concrete pillars and CI sheet for house construction in flood prone areas. They also proposed the use of cement or earth and plaster for walls to improve their durability and concrete tie beams to protect plinths..

- Most individual respondents proposed raising the plinth, making brick boundary walls, providing raised platforms (macha) in houses, or construction of concrete roofs.

Participants of the FAP-23 workshop also emphasized the need for flood proofing the simple huts in which the majority of the population live. They suggested provision of raised floor sections (macha) to keep essential household materials above water levels. Participants also proposed flood proofing of some houses in a community for use as shelters by the community. Some asked for flood-proofed villages and proposed the use of village-level institutional buildings for multipurpose functions. Social structure and behavior should be considered carefully in the selection and design of those public buildings.

C.2.2 Industries

There was no heavy industries in the sadar upazila towns surveyed but there were numerous small and cottage industries. The managers of small and cottage industries were surveyed to determine the effect of the 1988 flood, how they responded to the challenge of keeping their businesses in operation during and after the flood, and how they proposed to flood-proof their industries in preparation for the next flood. The small industries surveyed include a biscuit factory, sawmill, rice mills, poultry farms and dairy-product plant. Staff of the Bangladesh Small and Cottage Industries Corporation (BSCIC), an umbrella organization that develops industrial estates and provides financial advice and technical assistance to small industries were also surveyed.

Response to the 1988 Flood Flood damaged capital equipment and also affected marketing activities of the firms surveyed, as follows:

- Four of the nine respondents were forced to halt production as the plant floor was inundated.

- Machinery, raw materials, and finished products were inundated, in some

cases at night when no labor was available to help shift threatened goods.

- Two of five respondents faced difficulty in procuring raw materials from the local market.

- Respondents could not sell their products through established distribution channels. In some cases, the channels could not be re-established after the floods had receded, resulting in financial losses. Sales sections failed to collect outstanding payments as road communications were disrupted.

The field activities of BSCIC officials suffered during the flood period. Public relations activities, scouting for potential entrepreneurs, and coordination functions with different district agencies were severely affected. Loan recovery was not satisfactory during that period. Only one BSCIC office was flooded on the ground floor; and important files, documents, and equipment were moved to the first floor. One office rented a boat to maintain contact with banks and entrepreneurs.

Individual entrepreneurs took several mitigation measures during the 1988 floods including:

- Moving their raw and finished goods to higher ground where possible;

- Uncoupling machinery and equipment from main power lines and moving them to dry areas;

- Draining floodwater from both factory and office buildings;

- Constructing brick flood walls in front of main gates and sealing all openings;

None of the respondents reported receiving any assistance or aid from any government organization except for restoring the electricity supply and telephone service.

Bangladesh Small and Cottage Industry Corporation (BSCIC), as a supporting agency to small enterprises, took the following steps:

- gave advice during the floods to take appropriate steps to shift their raw and finished products to a safe place; and

- after the floods, BSCIC staff made joint inspections of affected enterprises with the enterprises' credit-granting banks, and recommended that the entrepreneur apply to the bank headquarters for restructuring of their loans (including exemption of interest payments during the flood period and additional loans for working capital). None of the requests submitted were accepted by the banks:

For industrial and cottage industry facilities outside BSCIC industrial estates, BSCIC officials suggested that:

- enterprises and businesses that suffered 1988 flood losses must be surveyed thoroughly to determine the extent of losses attributable to the flood;

- defective construction of industrial plants must be corrected;

- the premises of the industrial concern must be raised above flood level;
- layout of the machinery should be rearranged for easy evacuation, and machinery should be placed on elevated pads or at a higher place whenever possible; and
- The main power connection line and inside electrical wiring should be waterproof.

After careful assessment of the extent of damages, MIDAS, non-government organisation assisting small-scale industries, adopted the following measures for its clients: (a) extended loan period for three years, (b) reduced service charges, (c) gave free consultancy, and (d) arranged working capital at special interest rate.

Proposed Flood Proofing Measures. Entrepreneurs who suffered loss of properties and capital assets during the 1988 flood proposed to flood-proof their plants in future by:

- raising the land above flood level or raise factory floor level, if funds are available at 'suitable' interest rate;
- building waterproof shelters and (shelves) for both raw and finished goods;
- building sluice gates to control flood water; and
- purchasing a small generator to provide power, thereby allowing production and flood-fighting efforts to proceed during floods.

BSCIC officials made the following suggestions for flood proofed industrial estates:

- local industrialists or entrepreneurs should be encouraged to establish their industrial plant at a flood-proofed industrial estate;
- plant floor levels should be raised above high flood levels., alternatively boundary walls of industrial estates should be designed to serve as flood protection walls and pumped drainage could be provided.to prevent flooding from internal rainfall. Within each plant, machinery and equipment should be raised above the flood water level;
- BSCIC should provide technical support for flood-proofed construction of the factory building;
- BSCIC, the local authorities, and owners should prepare flood disaster programs;
- on each industrial estate, there should be one speed boat for general use that is maintained by all establishments in the estate;
- storage areas should be designed to protect the raw and finished goods from damage by flood water; and
- waterproof bags should be stockpiled for covering machinery, office equipment, and all documents.

BSCIC, insurance officials, both private and government, other government officials, and private entrepreneurs all agree that some type of flood insurance for industry and business is needed. This could be made mandatory as it is now required for imported goods and machinery. MIDAS has been working to get "Reinsurance" of their clients' flood insurance policies.

All respondents agreed that information about expected floodwater levels, depth of floodwater and duration of flooding would be useful for determining flood proofing measures for their business.

BSCIC and commercial banking loan application forms must be reviewed and should include all information about the flood history of the area in which enterprises are to be established.

A concept for a "Model of Industrial Community" under the private sector was discussed in the FAP 23 Workshop. This idea did not receive much support from the participants who, instead, suggested that existing industrial estates developed by Bangladesh Small Cottage Industries Corporation (BSCIC) could be taken up as model flood proofed industrial communities.

C.2.3 Markets

The FAP-23 survey focused on markets in urban areas> The markets are administered by pourashava who is responsible for their operation, maintenance and development.

Response to 1988 Flood Individual respondents stated that markets were located within 100 m to 3 km from their household. Thirty-seven (37) respondents said that their their local hat was totally closed during the 1988 flood while 19 respondents said that their local bazaar was closed. Many had to use boats to reach local markets that were open.

In general, permanent structures constructed by pourashavas suffered less damage than structures with no permanent component constructed by private vendors. Collection of revenue from traders ceased when markets were closed and development activities, road repairs or cleaning of the drains were halted.

Individuals generally purchased their basic commodities from those shops who temporarily shifted their goods to nearby roads, embankments or boats.

On their own initiative, pourashava staff tried to control flood water by using sand bags to check the erosion of the river banks. They also raised the level of hand tubewells in markets and hired boats for public use to enable people to come to market. Pourashavas had their own sweepers clean drains and roads and spread bleaching powder for general disinfection of food-handling areas and polluted tubewells.

Staff of Sirajganj, Sunamganj and Faridpur Pourashavas obtained the assistance of local BWDB crews to check erosion of river banks.

Considering one commodity, domestic fuel, in more detail, individual consumers found that there was a shortage of common household fuels during the flood. Kerosene, fire wood, leaves, and twigs were scarce during high water. There was insufficient supply of kerosene resulting in average price increases of about one

hundred percent. In the case of firewood, 37 out of 54 respondents stated that supply was inadequate and the average price increased about seventy five percent. Price increases were attributed mainly to disruption of the transport system and partly to hoarding by opportunistic shopkeepers. Firewood prices were affected by inundation of normal sources of firewood and the resulting shortage of dry wood.

Possible Flood Proofing Measures

Many respondents proposed that hats and bazaars should be raised above 1988 flood level. They also wanted access roads to be raised above flood level, a godown to be constructed by the Pourashava for storing essential commodities, and a diesel-electric generator to be provided by the pourashava for each hat and bazaar, with maintenance to be done by the market committee. Officials of the pourashavas also suggested that the flood history be considered for the planning and selecting a new bazaar or hat facilities.

Some respondents suggested that kerosene shortages during floods could be eliminated through sales by government dealers in open markets, while others proposed establishing a local fuel depot for stockpiling needed fuels during such emergencies

C.2.4 Water Supply and Sanitation

The FAP-23 survey included pourashava staff and the Department of Public Health Engineering (DPHE). DPHE is primarily responsible for water supply and sanitation activities in rural areas, while pourashavas operate urban water supply, sanitation, and drainage facilities.

Response to the 1988 Flood The 1988 floods disrupted existing hand tubewells and municipal piped water systems extensively. A very common problem was inundation of the spout of hand pumps. Raising the spout was not always possible due to scarcity of spare parts and of engine boats for resupply.

In many municipal areas, water entered the premises of water-treatment plant, inundated pump houses, and otherwise forced the suspension of operations for some time. As water treatment plants (for removing iron) in some areas could not operate, raw ground water was supplied directly to the distribution network. Reduced operating pressure in distribution networks resulted in the entry of flood water and contamination of municipal systems. Water mains were damaged by heavy vehicular traffic passing on inundated roads. In addition, disruption occurred when the electric power supply to the treatment plant or pumping station was disrupted, forcing the facilities to shutdown. Few systems had standby power sources.

Of the 54 urban traders, commercial and professional respondents from the study sites, 36 were served by hand-pump tubewells, while the balance were served by public water supply systems operated by DPHE or municipalities.

Of those served by hand-pump tubewells, 9 respondents reported that their well was inoperative for some time, which ranged from 3 to 30 days, for an average of 13 days. Four of the respondents served by public water-supply systems reported that their supply was interrupted for 15 to 21 days, for an average of 20 days.

Sanitation systems of DPHE and municipalities were also disrupted during floods. In all six study Upazilas pits of sanitary latrines were flooded and, in some cases, slabs

were inundated. Floodwater undermined some latrines causing some to collapse. Surface drainage in municipalities areas also suffered due to inundation.

Disruption of communication systems and scarcity of transport compelled DPHE staff to suspend their public-education activities regarding installation and maintenance of sanitary latrines.

Amongst individual respondents, 44 had use of a sanitary water-seal latrine, while 10 used service (bucket) latrines. Respondents also indicated that, in 32 of 54 households, women faced problems in sanitation during the 1988 flood.

The extent of flooding and the physical damage sustained placed a great strain on pourashava and DPHE staff trying to maintain services during the flood. Staff installed hand tubewells in flood shelters, raised the heads of the affected tubewells above flood water level, installed hand-pump tubewells in areas where piped water-supply systems were out of operation, and along with non-government organisations and the civil surgeon, supplied bleaching powder to the public, for disinfecting tubewells. Staff also took action to prevent flooding of pump houses and godowns, by constructing masonry walls and other measures. Raw materials (cement, tubewell parts and accessories) were placed on platforms to keep them above flood level. Municipal authorities raised bib cocks (taps) used in household connections, advised the public about purification procedures, and distributed water-purifying tablets. They also established the Expanded Program for Immunization (EPI) on an emergency basis. DPHE was helped by non-government organisations (CARITAS and UNICEF) to sink tubewells at shelters and to purchase spare parts for raising tubewells. DPHE and municipality staff also provided sanitation facilities at flood shelters, and advised the public regarding abandonment and re-use of sanitary latrines that were affected by flood waters.

Proposed Flood Proofing Measures DPHE and municipal staff proposed that a stockpile of extra hand tubewells, auguring equipment, pipes, motors, and spare parts be established for emergency use and that local-level officials should have more flexibility to purchase and supply spare parts to the public during emergencies. For maintenance and repair of tubewells, an assured source of boats was needed. Almost all concerned officials suggested raising the floor of pump houses and treatment plants and the plinth level of godowns above HFL of sufficiently-great return periods, perhaps 30- to 50-years. For coastal areas, officials proposed that large ponds be excavated and finished with banks raised above an appropriate HFL to protect water from salinity and to ensure its use as drinking water supply immediately after disaster. Another important point mentioned by officials is that a chlorine injector should be supplied with each pump and that sufficient pumps should be available to ensure a continuous supply of water to the distribution network at sufficient pressure to prevent infiltration of polluted water into the system.

Individual respondents had similar suggestions, including the raising of the head of hand tubewells, raising the platform of tubewells, storage of drinking water for use in emergencies and raising the floor level of pump houses.

Pourashava and DPHE staff suggested that people should be educated and motivated to install latrines with the cover located above a reasonable high flood level. Additional rings should be installed if the ground level is not sufficiently high..

Municipal authorities try to provide proper drainage facilities and access roads for

public and private holdings. Pourashava staff proposed that pumps should be provided to remove stagnant water from low lying areas. Some officers suggested that storm-drainage operations be improved with sluices at the outlet to prevent back flow of water during floods.

A recent innovative project by the non-government organisation Concern, provides funding for improving sanitation facilities in poor urban areas. Credit is issued by the Mymensingh Municipality to systematically replace all service latrines by water-sealed latrines and recipients repay the loans over a fixed time period. Replacement of the latrines eliminates much of the floating fecal matter in flooded areas. By reducing the health risks, the project contributes to the flood-proofing of an urban community.

C.2.5 Government Services and Public Utilities

C.2.5.1 Electric Power

Electricity is supplied to consumers by either the Power Development Board (PDB) and the Rural Electrification Board (REB). For the six urban areas surveyed in this study, electricity is supplied by PDB.

Response to the 1988 Flood PDB surveyed attributed power outages during the 1988 floods.to:

- the height between power lines and floodwaters was insufficient, resulting in several accidents and electrocutions from high tension (33 kv) lines and increased theft of transmission lines;
- electric poles being knocked down by force of the flood water.
- substation equipment and transmission- and distribution-system poles being damaged after standing in flood water for long periods of time in the low-lying areas
- Lack of adequate water transport for PDB staff to undertake timely maintenance and repair.
- both poles and distribution transformer mounting pads being damaged by prolonged contact with water.
- the overhead clearance at power line river crossing suggested by the Bangladesh Inland Waterways Transportation Authority (BIWTA) being insufficient during periods of high river stage, causing vessels and debris snagging power lines.

PDB staff were faced with the task of maintaining services while minimizing the risk to the public of electrocution from severed lines. Some of the actions taken by staff included:

- boats were hired to carry crews for line maintenance and repair work.
- PDB advised consumers about the measures to be taken to avoid electrocution and other accidents. They also disconnected lines immediately after receiving message of damage at critical points.

- To continue work normally, PDB staff constructed brick-masonry walls at door openings to prevent entry of water into offices, shifted furniture from the ground flood to upstairs and built walls at office-compound gates using sand bags to retard the entry of water in the premises. In some cases, pumps were used to remove water from PDB offices.

Proposed Flood Proofing Measures Flood proofing measures suggested by PDB staff included:

- increasing the length of poles in low-lying areas, and where pole-mounted transformers are to be installed. The base and footings of these longer poles should be made using reinforced concrete, with adequate footing dimensions and foundation depth.

- installing precast concrete poles as they were more durable.

- at existing main distribution transformers sites, generating stations, and offices, yard areas and plinths should be raised.

- maintenance and repair crews should be provided with adequate water transport facilities during floods and equipped with portable light weight folding ladders for field use.

PDB officials expect that BIWTA should control the capstan height of vessels to avoid snagging high tension lines at river crossings. Conversely, a higher freeboard for high tension lines is necessary for river crossings.

Individual consumers had further ideas about measures to ensure an uninterrupted supply of electricity. Flood proofing measures proposed include power poles be made of concrete to reduce vulnerability to damage, the use of plastic insulators on the 11 kv lines, and raising the height of power stations premises, poles carrying distribution lines and the base height of distribution transformers.

A number of workshop participants proposed the stockpiling of fuel by the householders. They also suggested that PDB and REB stored adequate spare parts to repair flood damage and effect quick repairs of services.

C.2.5.2 Fisheries

Fisheries plays an important role in nutrition, employment, earning of foreign currency, and other areas of the economy. Fish is the greatest source of animal protein (about 80 percent). Fisheries contribute nearly 6 percent to the gross domestic product (GDP), and produce more than 12 percent of the export earnings of the country. The effects of floods on fisheries are extensive and numerous. Staff of the Fisheries Department were surveyed to determine how fisheries were affected by floods and to identify possible measures to protect fisheries production from the vagaries of floods.

Response to the 1988 Flood Upazila fisheries staff had the following observations on how the 1988 flood affected their operations:

- Some hatcheries were physically damaged by floodwater.

- Predator fish entered aquaculture ponds, and fish escaped from the ponds and hatcheries when the pond embankments were inundated by floodwater.

- Field supervision, conservation, and development activities were suspended due to scarcity of boat transportation.

- More time was spent in doing activities other than fisheries as desired by the Upazila Chairman and the UNO.

- In coastal areas, tidal flooding as well as storm surges brought saline water and other harmful elements into ponds and fresh water bodies.

Flood-Proofing Measures Based on their experience in the 1988 flood, upazila level staff of the Fisheries Department had the following suggestions for flood proofing their operations:

- raise pond banks above the 1988 flood level. Funds for raising embankments on publicly owned ponds could be provided by the Food for Work Program. For privately owned ponds, funds could be provided by Food for Works but pond owners would repay the cost to local authorities.

- Provide a reserve fund for district-level staff to meet emergency needs locally.

- Site hatcheries in less flood-prone areas.

- Reschedule the fish cropping calendar in flood prone areas to allow discharge of fingerlings in early September and harvest in late June.

- Provide special fingerling buffer stock ponds that will provide replacement stock for post-disaster rehabilitation efforts.

- Calculate and pre-plan disaster management and rehabilitation actions for fisheries.

- Provide additional boat transportation of officers, equipment and fish stock during and after the flood emergency.

- Keep emergency stocks of fish feed and lime (calcium hydroxide) for pond sanitation and rehabilitation.

- Design and implement round-the-year training on how to save fish in time of flood and how to clean or de-water the ponds after floods.

C.2.5.3 Livestock

Livestock are important to the economy as livestock account for about 6.5 percent of the GDP and about 13 percent of export earnings. Livestock also accounts for about 30 percent of the value of the inputs required for crop production. Staff of the Livestock Department were surveyed to determine their responses to the 1988 flood and their suggestions for flood proofing measures that would assist livestock production.

Response to the 1988 Flood. The 1988 floods affected everyday operations of the Upazila Livestock Officers (ULOs), as follows:

- meeting the danger of livestock epidemics during a flood event, as well as treating diseased cattle, frequently overtaxed the ULOs' ability to meet the needs of their clients' livestock.

- lack of water transport forced suspension of many services during floods.

- scarcity of shelter, fodder, and other animal feed made animals more vulnerable to disease.

- power outages during floods made it extremely difficult to preserve vaccines in active form.

- fodder cultivation suffered severe setbacks.

- relief activities took up much staff time, forcing suspension of many of their regular functions during floods.

- sales at the government poultry farms decrease during flood.

Flood-Proofing Measures. Based on their experience, the ULOs made the following suggestions for flood proofing livestock:

- establish well-organized community livestock shelters with feed and veterinary services. Possible variations included raising embankments of selected ponds or raising the height of a hat or bazaar for use as emergency livestock shelter. An additional benefit of shelters would be the opportunity to perform mass vaccinations of the livestock gathered.

- store emergency medicine, vaccine, and cattle feed.

- establish a small silage facility in each Union.

- build public awareness and motivation about the health conditions of livestock in flood time, including training and development of volunteers in every union and training of non-government organisation workers in the care of livestock.

- establish a direct, functioning information-sharing system on water borne disease among the ULOs. (have ULOs of upstream Upazilas inform their colleagues in downstream Upazilas)

- motivate people to flood proof their own cowshed by raising ground level.

- require cultivation of fodder, at least at the rate of three parts food crops to one of crop fodder crop.

- ban the export of paddy and wheat polish during the four months of the flood season

- provide for hiring of speed boats directly by ULOs to enable carrying out their duties during floods.

- provide for generator ownership by ULOs to keep the stored vaccine and semen live in the event of power failure.

- promote Napier and Para grass cultivation for fodder.

- provide an emergency fund at the district level to meet the needs of the flood emergency situation.

- prepare a livestock rehabilitation plan for use after a flood (need-based and tailored to the needs of individual upazilas).

Individual respondents suggested several measures to protect their livestock and poultry during flood including that pond embankments be raised for use as temporary shelters by both people and livestock, provision of storage places for fodder, and temporary shifting of livestock to shelters or other safe places such as high road embankments or other public places such as schools or colleges .

C.2.5.4 Land Registration

Staff of the Land Registration Office were surveyed to determine how vital office-based functions of key government agencies functioned during the 1988 floods.

Sub-registry officers (SROs) of the Land Registration Office are responsible for collection of fees and revenues related to land transfers. A significant part of government revenue comes from the sale of revenue stamps and through land transfer-deed registration. Transfer deeds and related documents must be preserved and protected as they are legal documents. The SROs activities were severely affected during the 1988 floods, temporarily depriving the government of land revenues. In addition, valuable title deeds and other documents were lost or damaged.

Response to the 1988 Flood Registry staff members were forced to make drastic adjustments to their daily routine during the floods. Some of the consequences of the flood were:

- Records (Balam Books) were damaged or destroyed by inundation or dampness when office floors and premises were inundated. Dampness and water-soluble inks rendered Balam Book entries illegible.

- Business relations with the public were extremely difficult, and registration of deeds mostly was suspended due to inundation of offices.

- Scarcity of water transport prevented many staff from reporting to duty.

- Records (Balam Books) were shifted upstairs or to elevated shelves, but where this was not possible records were shifted to other buildings, placing them out of the SROs control and rendering them vulnerable to theft, forgery, damage and loss.

- Insects destroyed pages and bindings of Balam Books

Proposed Flood Proofing Measures From the lessons learned in 1988, SROs recommended the following measures:

- Sufficient shelving must be provided to store documents, and steel shutters should be provided with the shelves for protecting documents from fire, water and theft.

- Water transport must be provided to allow access of officials and members of the public to the offices.

- Sub-register offices should not be established in rented premises, as that limits perforce of emergency modifications. They should be located on elevated areas with plinth levels exceeding the HFL.

- Pages and bindings of the Balam Book must be of a better quality to prevent damage by insects or dampness. Ink used for writing deeds and Balam Book entries must be specified for permanence, reducing the risk of illegibility in humid conditions during floods.

- Office buildings should be designed with provisions for vertical expansion.

While some of the above suggestions are specific for the Land registration Office, most of the measures are applicable for any government or private offices where valuable assets and records need protection from floods, and services need to be provided throughout a flood.

C.2.5.5 Health and Family Planning

Floods cause major health problems due to the contamination of drinking water by flood water which results in increased diarrheal disease, dysentery, hepatitis, lymphoid and skin and worm infections. Other diseases like measles, acute respiratory infections (mostly pneumonia), and malnutrition also show a high incidence during and after floods.

Response to the 1988 Flood The following were some of the ways, in which the 1988 floods affected the delivery of health services:

- Follow-up and extension of immunization programs suffered severe setbacks because under present rules, staff were not able to hire boats for water transportation. Also, mass migration of people moving away from river erosion and flooding meant that many of those due for immunizations could not be found.

- Locally-based extension workers had to leave work to tend to their own families or flooded properties.

- People put little or no priority on family-planning affairs during floods.

- Facilities on the ground floor of affected Upazila complexes (X-ray, pathology, stores) became inoperable because of flooding.

- Field health and family planning workers could not perform official functions as they were diverted to assist in relief activities organized by the district and upazila administrations.

- The supply of essential drugs and oral rehydration solution were not sufficient to meet the health needs of affected communities.

- Logistic facilities and support to deploy mobile teams were insufficient.

- There was a shortage of field health professionals to handle health problems sufficiently.

Individuals surveyed suffered in getting health services in several ways during the 1988 flood. Of 54 respondents, 35 complained that their family members suffered from different types of diseases like fever, diarrhoea, jaundice, and only 29 could consult a doctor. The total of affected family members families was 141, of which 68 were adult, 39 minor, and 34 infant. No deaths were reported in the families surveyed during the 1988 flood. Most of the respondents (52 out 54) observed that government or private health facilities were in operation but, due to disruptions of communications, traveling to the health center was difficult.

Field health officers increased the number of weekly immunization days (four days instead of two weekly) to cover the backlog. They also increased the number of satellite clinics at the field level, sent emergency medical teams into affected areas, and started health and hygiene education campaigns. At field level, officers performed surveys to derive authentic disease profiles of flood-affected areas and enlisted the assistance of non-government organisations in providing personnel, vehicles, and medication. They arranged boats from various sources such as non-government organisations, district administration, UNICEF, and Upazila Parishads to continue the immunization program. They also organized a central control room to monitor flood-time health hazards. Personnel of the health complex shifted documents, supplies and equipment to safer and drier places.

Proposed Flood Proofing Measures. Based on their experience of trying to provide essential health services during floods, health officials suggested the following measures for flood proofing their operations:

- Make official provision for hiring boats for use by supervisors, extension workers, and Immunization units.

- Adopt proper measures to store and issue emergency medical supplies.

- Provide a prompt and meaningful regional flood warning system

- Plan for combined emergency health program with non-government organisations.

- Establish an emergency upazila health fund that does not lapse at the end of June in each year.

- Implement crash immunization programs that are compulsory during and after a flood.

- Arrange timely information about the status of health conditions and of any waterborne diseases in upstream areas to aid local preparation.

- Maintain area-wise disease profiles.

- Provide specific and regular health education; ensure community participation in facing health hazards during and after floods.

- Store alum coagulant in household packets for water purification.

- Provide official guidelines for disaster management for each level of government officer, including provisions for recruitment and training of emergency volunteers to assist health officers during flood emergencies.

- Shift all stores and dental, pathology, and X-ray units to the first floor of the Upazila health office where possible, and construct Union welfare centers as two-storied buildings. Preset a duty roster for each employee to assign protection of equipment and documents during a flood emergency.

Individual respondents suggest mainly improved structural features of the health complex, including constructing multi-storied buildings for new premises with flood-sensitive equipment positioned above the highest flood level, and flood proofed storage facilities for emergency medicine, and installation of an electric generator for back-up power supply.

A disaster-management unit should be organised to provide mobile medical teams and supplies (for example, oral rehydration solution, bleaching powder, and essential drugs); prearranged logistics (e.g. field hospitals and epidemiological surveillance); training of health personnel; and organizing community awareness and participation. Reorganizing to fully integrate the Family Planning and Health Wings of the Department will also assist in the smooth implementation of such a program.

C.2.5.6 Postal Service

One essential community services is the Postal Service which is part of the Ministry of Post Services.

During and immediately following any natural calamity like a flood, cyclone or tornado; people tend to communicate more with their relatives, friends and acquaintances. Consequently, the post office handles a much larger than normal volume of mail during these periods. Foreign mail and postal money orders also increased greatly in volume during and after the 1988 floods. The Postal Service faced great difficulties in attempting to provide services to their users many of whom were flooded or has moved to flood shelters.

Response to the 1988 flood During the 1988 flood, Postal Service staff in the field could not maintain the normal, timely delivery of mails mainly due to the disruption of the road transport. After sorting and packing, it was difficult to dispatch mail through normal routes. Collection of mail from sub-post and branch offices was delayed for the same reason. Mail received was often wet and damaged and sometimes post offices were required to pay compensation to customers for damaged foreign mail. Many post offices in the flood affected Upazilas could not send daily reports and emergency messages to zonal offices. Services at post office counters was not normal due to lack of mail staff.

Post office buildings were sometimes closed to prevent flood water from entry into the building; occasionally, earth embankments were constructed in front of the main door to prevent water entry. In some cases, the postmaster shifted important postal documents, prize bonds, and savings bonds to a safer place at his own risk and initiative, or from lower shelves to upper shelves in flooded post offices.

Most pourashavas and union parishads provided material assistance to the Postal Services to enable it into sustain services during the flood emergency. In some cases they gave temporary space to the postal department for carrying out postal activities.

The Bangladesh Inland Water Transport Authority also gave the postal department some special services to carry mail at extra cost. The police also helped by sending and receiving radio messages.

Proposed Flood Proofing Measures Representative of the Postal Department at district and upazila levels suggested some flood proofing measures that would help in preparing the Postal Departments to operate normally during floods. Their suggestions include:

- Arrange for engine boats to be available for running normal postal activities during floods; some respondents suggest that these boats could be used by the police and ansars for security-patrols during normal time with control reverting to the Postal Department during floods.

- Raise the plinth of existing post offices above flood level. For new sub- and branch post offices, select a site not subject to frequent flooding. In addition, construct protective brick boundary walls.

- Expand and raise the floor level of existing storage space

- Supply a sufficient quantity of different sizes of polyethylene bags or other waterproof bags.

- Install fax machines for communications and transfer of money orders during floods.

- Register evacuated and displaced people so that a central address is available to contact them during and after flood emergencies.

- Provide a space at each flood shelter for postal-services.

After the 1988 flood, the Postal Department issued a departmental circular on flood proofing the postal service. In the circular, there are instructions on actions to take before, during and after floods and the duties and responsibilities of key officers are listed.

C.2.5.7 Telephone and Telegraph

Telephone and telegraph are other vital community services for information dissemination. The telephone service in Bangladesh is the responsibility of the Telephone and Telegram Board (T&T).

Response to the 1988 Flood The 1988 floods affected the telephone and telegraph services in much the same way as the floods affected the electric power utilities (see Section C.2.5.1). About 20,000 telephones were out of service for some time, depriving government, the public, private concerns and relief organizations of a vital communications and timely information (MOI, 1988). Interruptions also caused major, unrecorded loss to employers, employment and tax revenue by forcing private-sector activity to stop or curtail activity. Flood damage of telecommunications were estimated to be about Tk 480 million ($US 12.63 million) which was about 1.1 percent of total flood damage in all sectors (Siddique, 1989).

Disruption to the telephone and telegraphic services were worse in 1988 than in previous floods; causes of suspension of phone services during the floods included:

- Lines were put out of operation when telephone poles supporting trunk lines collapsed.

- Inundation of roadways allowed water to penetrate the phone cables, causing damage, short circuits, and disruptions in phone service.

- Switching connections shorted out when water entered distribution boxes.

- Microwave relay systems and switch-board functions were disrupted by flooding of equipment rooms.

- Numerous phone-lines were damaged due to the proximity of lines to the flood water in low-lying areas.

- Maintenance and repairs were delayed by lack of suitable water transport.

To maintain and restore telephone and telegraph services to their flood affected clientele, T&T field officers resorted to a variety of tactics:

- Circuit and switching panels in distribution boxes were raised to protect them from inundation. Sensitive equipment and records were moved to higher floors, where possible.

- Boats were rented to continue line maintenance services in Pourashava areas.

- Earth and masonry barriers were constructed to protect switchboard rooms from flood water.

- One innovative officer retarded leakage of water through office and equipment room floors with the help of soap bars.

- Bamboo poles were used for temporary reinstallation of fallen lines at river crossings.

Proposed Flood Proofing Measures Based on their experience of the 1988 flood, T&T staff suggested a wide range of measures to flood proof their facilities and equipment, including:

- Raise distribution boxes on concrete bases as well as the floors of switchboard and control rooms to above HFL and shift exchange, control room and microwave equipment to higher floors.

- Convert physical trunk lines (wire system) to a wireless system.

- Raise the telephone post height in low-lying areas for the existing overhead trunk lines.

- Install higher, sturdier poles at river crossings, and implement measures to prevent line and pole collisions and accidents involving boats.

- Improve construction and maintenance by relevant agencies in compacting roadways under which phone lines pass to prevent excessive seepage and underground water movement that affect the phone cables.

- Provide portable switching equipment and drop wires for emergency use.
- Provide water transport for line repair and maintenance work.
- Increase the number of supporting telephone poles per unit length of phone line to reduce sag and to strengthen the line.
- Use robust designs for towers and antennae used in trunk lines serving coastal areas to resist cyclone, storm surges and flood currents.
- Construct office floors and storerooms to prevent leakage of flood water into sensitive equipment areas.

C.2.6 Roads

The Roads and Highways Department (RHD) is responsible for the planning, design, construction and maintenance of the national and regional roads and feeder roads (type A) .Roads under the jurisdiction of Local Government Engineering Bureau (LGEB) are feeder roads (type B) (also referred to as growth center connecting roads), rural roads, and pourashava roads.

In general, roads are damaged by floods in a number of ways including erosion of embankments by rainfall, wave action and passing flood water, and erosion and undermining of foundations of structures when there is insufficient open area. Rigid pavements (concrete) are damaged when flood water scours soils beneath the edge of the road. Flexible (bituminous) pavements are washed away in places where there is edge erosion and subsequent undercutting. Pavements also disintegrate if subjected to long periods of inundation.. Both types of pavement also are damaged if heavy traffic loads pass over flooded road or those with saturated base soils.

Response to the 1988 Flood LGEB staff surveyed reported that there was widespread damage to rural roads constructed under the Food for Works Programme (FFWp) due to inadequate provision of cross-drainage structures. The shortage of structures prevented flood water from passing which resulted in water levels becoming higher on one side of the embankment than on the other. Eventually the embankment was overtopped and the resulting high velocities of water passing over or through the embankment caused severe erosion and scouring. In some areas of Tangail, road embankments were cut by local people to improve the flow of flood water.

The majority of individual respondents (30 out of 54) reported that they had suffered due to the disruption caused by submergence of the roads connecting their upazila headquarters or district headquarters. A number of respondents (14 of 54) faced difficulty due to a partial-submergence of the principal roads. A few respondents (10 of 54) found that the roads they mainly travel along were useable throughout the 1988 flood.

Flood mitigation measures taken by LGEB staff to maintain the operation of roads during 1988 included, for two of the six upazilas, replacing eroded earth fill on road embankments immediately using Test Relief funds. In Brahmanbaria, Test Relief activities were concentrated on the construction of erosion-protection (broaching) works.

Sand bag consolidation was a very common measure applied by RHD officials to protect bridge frames from scour and failure. Tree branches were found to be effective for protection from scour on some roads in Tangail and Sunamganj. Bamboo broaching was found suitable in Tangail. In the Faridpur area, heavy traffic was banned on submerged roads to prevent damage. Bailley-bridge sections were provided for damaged bridges in the Brahmanbaria area. Immediately after the flood; repair, reconstruction, and re carpeting work was taken up on an emergency basis in all areas. In some critical points of Tangail roads, brick-bat matressing with wire mesh was used to protect from scouring.

In pourashavas, the main measure adopted to protect roads was to prevent heavy traffic from passing on submerged sections.

Proposed Flood Proofing Measures LGEB staff proposed that adequate cross-drainage structures are provided for all roads and that the height of Feeder Roads be raised above the peak 1988 flood level. Staff in four upazilas (Tangail, Faridpur, Brahmanbaria and Bhola) proposed afforestation along road embankments to protect against erosion by waves or fast-flowing water (and rainfall). Staff also requested flood-hazard zoning and flood-depth maps and for improvement in water-borne transport.

RHD staff proposed raising the embankment height of national highways above the HFL of at least 50-year return period. For coastal areas, embankment heights should be over the HFL of 100-years return period. Staff of Sirajganj, Sunamganj, Faridpur and Bhola suggested afforestation along roads to protect embankments from wave action. Brick-bat matressing or concrete-block facing was proposed by officials from Sunamganj, Tangail, and Faridpur areas to protect embankments from scouring near structures.

Pourashava staff suggested several measures including concrete roads for low-lying areas as rigid pavements seemed to be more durable in such locations. In flash-flood zones, like Sunamganj and Brahmanbaria, guide walls along the edges of pavement were considered to be more effective than other measures to protect from scour and damage from high-velocity flows.

Individual respondents proposed raising the height of road embankments, provision of engine boats to carry goods and people during flood time, improved maintenance of roads and bridges (such as timely and proper repair of damaged road surfaces, bridges, and culverts.), and provision of adequate cross drainage,

Workshop participants suggested that possible flood proofing measures included the introduction of legislation to prevent road cutting during floods. Participants from different government agencies supported flood proofing of infrastructure, particularly for new or modified structures although there was some doubts about the extent to which existing facilities could be modified. Some participants highlighted the need for coordination between LGEB and other agencies during implementation of their development programs. Under existing law it is mandatory that BWDB approve the design of hydraulic structures of LGEB projects but this does not seem to be enforced.

Both those interviewed in the field and workshop participants stressed the importance of water transport. In 1988, disruption of road networks increased the demand of local-level officials for boats and the shortage of sufficient boats meant that rescue and relief operations could not be undertaken in a timely fashion.

Increasing the availability of boats would be a simple but effective means of flood proofing. Boat hire also creates employment for local boat owners and employees whose regular means of income otherwise are disrupted during floods. This measure thus provides flood proofed income for those individuals.

C.2.7 Flood Forecasting and Warning Systems

Flood forecasting and warning systems are an integral part of flood mitigation measures. For flood proofing to be effective, there has to be a flood forecasting and warning system implemented as part of the complementary flood preparedness program.

There are existing flood forecasting and warning systems operating in Bangladesh. The responsibility for providing flood forecasting falls on the national services concerned with meteorology, hydrology and hydrography and the dissemination of flood forecasts to the general public is the responsibility of government ministries and agencies, as well as local government authorities. Staff involved with flood forecasting and flood warning programs were interviewed as part of the FAP-23 field survey. The flood forecasting and warning systems are described in this section along with a discussion of their effectiveness and the possibilities for their improvement.

C.2.7.1 Existing Flood Forecasting System

Under the supervision of Surface Water Hydrology-2, the Flood Forecasting and Early Warning Division of the Bangladesh Water Development Board (BWDB), manages a Flood Information Center (FIC) that produces and disseminates measured daily river water levels and forecasts water levels for the following 24 and 48 hours through daily bulletins.

More than 48 rainfall and 60 river-stage stations are connected to FIC by wireless. The stations are well-distributed throughout the country. In addition, there are 13 boundary stations to record the inflow and outflow of the major river systems. The FIC also receives weather bulletins from the Meteorology Department and the Space Research and Remote Sensing Organization (SPARRSO).

Upon receiving the information from the field stations, FIC carries out flow-simulation runs and produces the results in a four-page bulletin. River stage and catchment rainfall information measured during the previous three days are also given in the bulletin. Information is presented for four basins: the Brahmaputra, Ganges, Meghna and Southeastern Hill basins. For comparative purposes, the record highest level at each of the river-forecast locations is also shown. A brief narrative description of the information is given along with forecasts of river levels for the next 24 and 48 hours.

River levels higher than the danger level are underlined in red in the bulletin. As defined in the FIC bulletin, "the danger level of river is a level above which it is likely that the flood may cause damages to crops and homesteads. In a river having no embankment, the danger level is about the annual average flood level. In an embanked river, the danger level is fixed slightly below the design flood level of the embankment. The danger level is defined for a particular measuring station for the hazards of the area in its immediate vicinity."

FIC distributes the bulletin to various government departments and ministries such

as Agriculture, Health, Relief and Rehabilitation, and the Presidential Secretariat. The bulletin is also made available to public media such as radio and TV. Some international agencies and research organizations like BARC, FAO, WHO, USAID, UNICEF, World Bank and ISPAN receive the bulletin by kind permission of BWDB.

C.2.7.2 Existing Flood Warning System

When the danger level is reached at a particular location, FIC forecasts are radioed to BWDB field officers who pass the information onto district staff of the various government departments and agencies.

In the case of the Agriculture Department, when the Director of Agriculture (Extension & Monitoring) receives a flood warning from BWDB or the secretary for Agriculture, he passes the information onto the Director General (Ag. Extension) who contacts the Directors or Deputy Directors (Agricultural Extension) in the threatened areas to ensure that they are aware of the flood warning. The Directors or Deputy Directors then inform respective Upazila Agriculture Officers who communicate flood warnings directly to the Union Agriculture Assistants or Block Supervisors, along with specific instructions on what they should do to inform the model or contact farmers in their union about the threat and possible actions they should take to reduce the effects of the flood on their crops and property. Two or three days may elapse under "normal" flood conditions before a flood warning reaches the farmers.

In coastal areas there is a more developed cyclone warning system operated by the Bangladesh Red Crescent Society for the Ministry of Relief. The warning system comprises of an extensive radio network and 20,980 volunteers whose task is to warn, then to evacuate the population at risk to the nearest cyclone shelter. During the April 1991 cyclone, the cyclone warning system played a crucial role in assisting an estimated 350,000 people evacuate to shelters. Unfortunately, 23 Red Crescent volunteers lost their own lives during the storm when they were trying to save the lives of others. The performance of the cyclone warning system in April 1991 is discussed in detail elsewhere (CDR Resource Group 1991).

C.2.7.3 Effectiveness of Flood Forecasts and Warnings in 1988

The severity of the 1988 flood caught most people by surprise. Both the magnitude and rate of water levels were rising up-stream areas were not communicated to downstream areas through the formal flood warning system. As part of the FAP-23 survey, institutional and individual respondents in urban areas were asked about local flood warning and flood information. Most people surveyed received little information on the impending flood.

In most cases, the common source of flood information was the broadcast media, namely radio and television, although almost 50 percent received flood information from other sources such as daily newspapers, neighbors, personal observation, and local media. Newspapers were often too slow (and sometimes misleading) about flood warnings.

Radio news bulletins, however, were neither specific nor clear enough for most listeners. They tended to provide only an overall description of the nationwide flood situation, based on information from the FIC bulletins. People were unable to translate the information and forecasts to local water levels. Hearing the forecasted stage for Bahadurabad did not help the workshop supervisor in Tangail to judge the likely depth of flood or timing of the peak which he needed to know to decide

whether to lay off employees or take other actions to avoid flood damage. At present, people rely on their own local knowledge and experience for flood preparation rather than on any external sources of information.

The findings of the FAP 23 survey confirm the results of the survey sponsored by Storms Memorial Foundation of Norway after the 1987 flood. Some respondents in that survey said that they received some flood warnings through the radio and through announcements with mobile public address systems. Those who heard radio bulletins said that it was difficult for them to understand, whether the announcer was talking about their area or another.

C.2.7.4 Suggested Improvements

The following are some of the improvements that were suggested by institutional and individual respondents interviewed during the FAP-23 survey and Workshop participants:

- Government should improve the flood warning system by involving the public in the process.
- Frequent, and meaningful announcements of flood warning and forecasts should be made using mobile public-address systems, Drum beating and leaflets. Announcements should contain information on expected water levels and the rate of increase, the area to be affected and the duration of the flood. The announcements should be made frequently to allow people time to react to impending floods.
- There should be flood-level indicator marks or posts in each flood-prone union so people can see the actual height to which a flood may come. The marks should be located in community areas such as mosques, schools or markets.
- Radio announcements should be area-specific and more easily understandable.
- Local government units like Union Parishad and Upazila Parishad could be involved in a community-based early warning system under which the Unions and Upazila in upstream areas send daily flood information to downstream unions and upazilas.
- Use of amateur (ham) radio systems should permitted and promoted for disseminating flood information.

With modern technology and international cooperation, forecasts based on conditions in India and Nepal may allow advance notice of major floods to be given earlier than now is possible. These forecasts, combined with accurate data on Bangladeshi rainfall and runoff conditions, widespread local data dissemination, and upazila and union-level water level indicators related to water surface elevations at key FIC forecasting points, would give urban and rural people yet another valuable means towards of realizing a flood-proofed community.

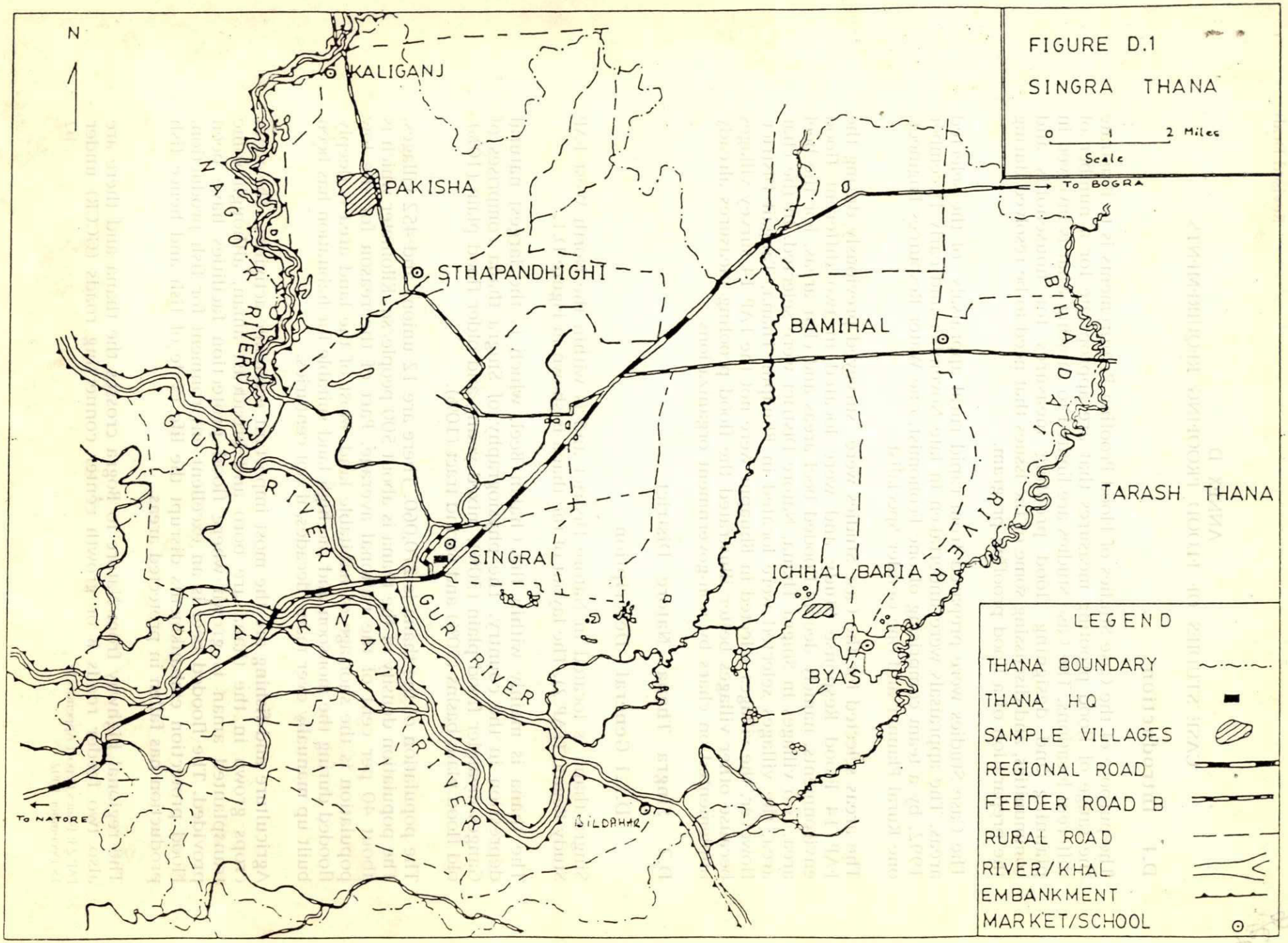


FIGURE D.1
SINGRA THANA
0 1 2 Miles
Scale
N
KALIGANJ
PAKISHA
STHAPANDHIGHI
BAMIHAL
TO BOGRA
NAGOR RIVER
BHADAI
GUR RIVER
SINGRAI
ICHHAL/BARIA
TARASH THANA
BARNAI RIVER
BYAS
BILDHAR
TO NATORE
LEGEND
THANA BOUNDARY
THANA H Q
SAMPLE VILLAGES
REGIONAL ROAD
FEEDER ROAD B
RURAL ROAD
RIVER/KHAL
EMBANKMENT
MARKET/SCHOOL

ANNEX D
CASE STUDIES OF FLOOD PROOFING REQUIREMENTS

D.1 Introduction

The purpose of the Case Studies of Flood Proofing Requirements is to illustrate the range of flood proofing measures that are appropriate for a number of different locations. The Case Studies are limited to showing what is involved in planning and designing flood proofing measures for households and communities, and discussing some of the issues that need to be resolved during the preparation of a flood proofing program.

The Case Studies were prepared from rapid rural appraisals of the selected areas. The appraisals were undertaken in late November and early December 1992, by a team comprising of one Economist, one Water Resources Engineer, one Rural Planner and one Gender Specialist.

The areas selected for the Case Studies were surveyed previously during the FAP 14 Flood Response Study and were located in two different flood environments, namely deeply flooded beel areas and char areas. For the beel area, two villages in Singra Thana, Natore District were selected. In the char area, the villages selected were located in Bhuapur Thana, Tangail District. However, the villages selected in Bhuapur were not the FAP 14 survey villages because other villages better illustrated the flood proofing measures already implemented on chars by non-government organizations.

D.2 Singra Thana, Natore District

D.2.1 General Description

Singra thana is located in Natore District and is within the North West FAP Study Region (FAP 2). The layout of the thana is shown in Figure D.1.

The thana is mainly within the Chalan Beel, which is the largest natural depression in the country. The physiography of Singra thana comprises of Ganges meander flood plain (30%), mixed young and older flood plain (10%), old flood plain basins (50%) and Barind tract (10%).

The population of the thana is 270,060. There are 12 unions and 452 villages. The population density of the thana is about 500 people/sq. Kilometer which is about 40 per cent of the national average. Part of the reason for the low population is the shortage of habitable land. Most of the land area is deeply flooded during the monsoon and the high land suitable for habitation has been built up manually over many decades, if not centuries.

Agriculture and fishing are the most important economic activities. The main crops grown in the thana are boro and broadcast aman, although some transplanted aman is grown where flood protection facilities have been provided. The flooded beel is an excellent environment for fish production. Flood protection embankments disrupt the life cycle of fish and hence fish production has fallen in protected areas.

The regional highway from Natore to Bogra crosses the thana and there are also two feeder roads B or growth center connecting roads (GCCR) under

Table D.1

Water Levels: Atrai River at Atrai Railway Bridge[1]
Maximum Levels (m) for Given Durations (days)

Year	1	5	15	45	90
1974	12.92	12.91	12.78	12.58	12.21
1975	12.18	12.17	12.02	11.70	11.65
1976	12.74	12.73	12.58	12.04	11.75
1977	12.45	12.44	12.28	12.15	11.85
1978	12.39	12.39	12.27	11.77	11.50
1979	12.44	12.43	12.28	12.09	11.77
1980	12.56	12.55	12.44	12.20	11.89
1981	12.48	12.48	12.37	12.12	11.68
1982	11.99	11.98	11.84	11.59	11.18
1983	12.65	12.64	12.51	12.09	11.41
1984	12.68	12.67	12.53	12.08	11.92
1985	12.58	12.57	12.37	12.09	12.02
1986	12.84	12.83	12.66	12.08	11.58
1987	13.02	12.99	12.90	12.77	12.03
1988	12.91	12.90	12.83	12.29	12.09
1989	12.43	12.42	12.28	11.94	11.80

For return periods (estimated by Gumbel Extreme Value Analysis)

return period					
5	12.84	12.81	12.69	12.31	11.97
10	12.91	12.89	12.77	12.45	12.06
20	12.98	12.95	12.84	12.57	12.15
50	13.07	13.04	12.92	12.73	12.25
100	13.13	13.10	12.99	12.85	12.33

[1] Source: FAP 2 North West regional Study

construction (see Figure D.1). There are a few rural roads that are flooded in the monsoon and are passable only in the dry season. Boats are the main mode of transport during the monsoon season, but their use at other times is being severely restricted by siltation of the main khals and rivers.

The main market of the thana is located at Singra, the thana headquarters. Singra is located beside the regional road and on the banks of the Gur river which is a main regional route for boat transport.

The locations of the two villages selected for the Case Study are Pakisha and Ichhalbaria and their locations are shown on Figure D.1.

D.2.2 Flooding Characteristics

Singra thana is within the flood plain of the Atrai river and its tributaries including the seasonal Nagor and Barnai rivers. Water levels in these rivers tend to start rising in June and peak during August or September. Throughout this monsoon period, most of the agricultural land in the thana is normally deeply flooded, and the expanse of water is broken by only a few small scattered islands of high ground occupied by settlements. By November, rivers and khals are starting to dry out and most of the land can be accessed to prepare for the planting of boro.

Data on water levels in the Atrai/Gur River for the gauging station at Atrai Railway Bridge, about 10 miles upstream from Singra, is given in Table D.1. The characteristics of water levels in Singra thana will be similar, although the north west of the thana will be influenced by flows in the Nagor river. The main features of the flood levels are:

- the difference between the 1 in 5 year peak water level and the 1 in 100 year peak water level is only 0.29 m (less than 1 ft).
- in 1988, the water level was within 0.10 m of the peak water level for 15 days and was within 0.82 m of the peak water level for 90 days. In most years, the water level stays close to the peak water throughout the monsoon season.
- water levels in 1987 were marginally worse than water levels in 1988. (Water levels in 1974 were of similar magnitude and duration)

Numerous flood protection embankments have been constructed along the banks of main rivers. Those outside the protective embankments have felt aggrieved by their continued exposure to flooding and consider that the flooding has been made worse by the embankments. Farmers not protected reduce water levels by breaching the embankments to flood the area inside. The net result is that since their construction, the impact of the flood protection embankments on agricultural production has been limited.

Flooding in Chalan Beel results from the combination of the low-lying topography of the beel, insufficient capacity of the rivers draining the beel and backwater effects from the Jamuna river. The FAP 2 North West Regional Study concluded that flood protection in the beel was not viable for social and technical reasons and the Study recommended that existing flood protection facilities should be modified to allow controlled flooding of the land inside the embankments (Mott MacDonald 1992b).

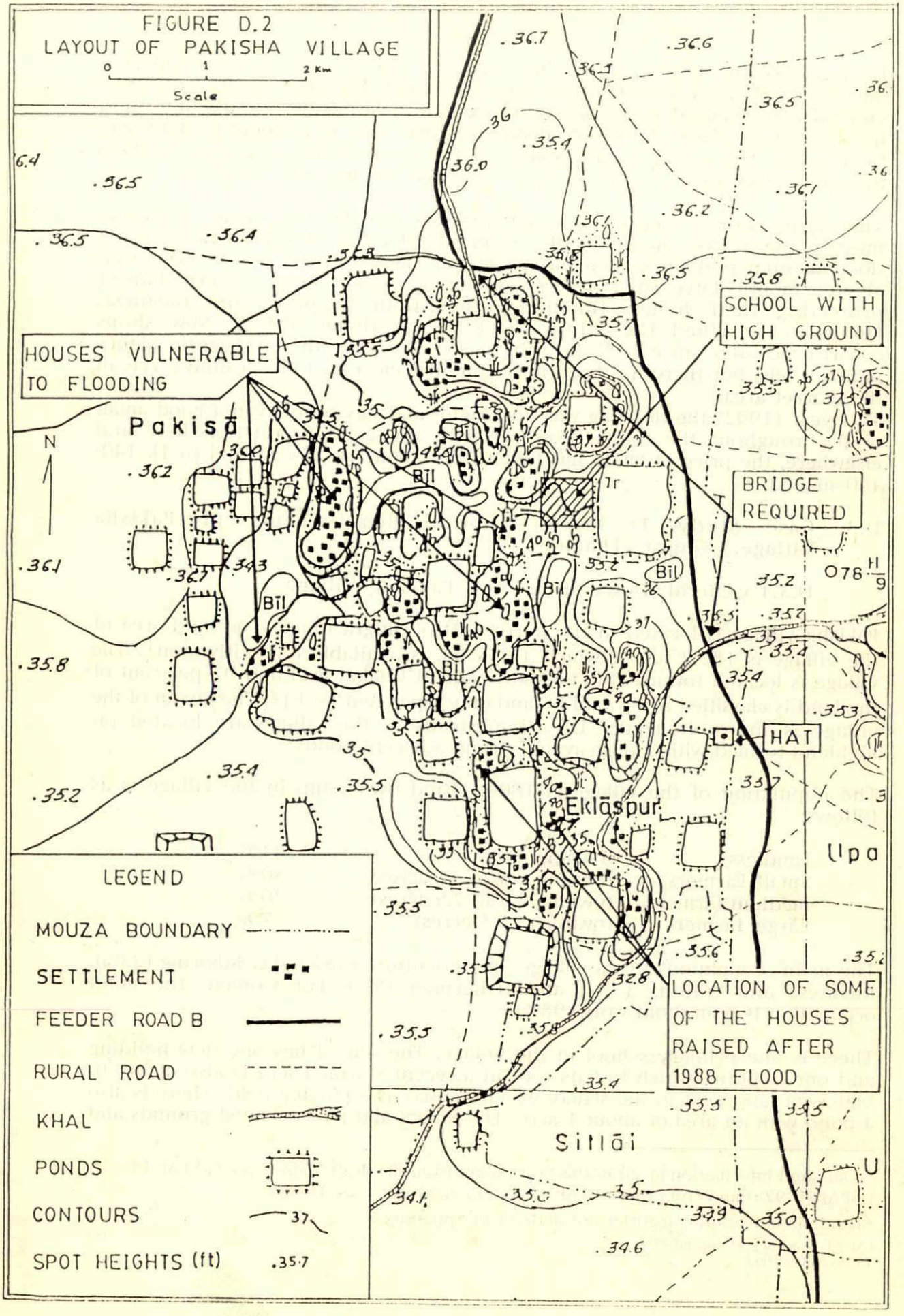


FIGURE D.2
LAYOUT OF PAKISHA VILLAGE
0 1 2 Km
Scale
HOUSES VULNERABLE TO FLOODING
SCHOOL WITH HIGH GROUND
BRIDGE REQUIRED
HAT
LOCATION OF SOME OF THE HOUSES RAISED AFTER 1988 FLOOD
Pakisā
Eklāspur
Sitlāi
Ilpa
N
LEGEND
MOUZA BOUNDARY
SETTLEMENT
FEEDER ROAD B
RURAL ROAD
KHAL
PONDS
CONTOURS
SPOT HEIGHTS (ft)

During 1987 and 1988, most of the thana was severely affected by floods and many more houses were flooded than was usual. Breaches in the protective embankments caused particular problems for those inside because the rapid ingress of water gave the people inside too little time to respond to the rising flood water. The regional road to Bogra and Natore was flooded in parts which disrupted marketing and the transport of relief supplies into the thana.

The urban area in Singra thana headquarters was flooded during 1988 and most of the market place was also shallowly flooded. Shops which were not flooded often remained open but trade was slack and did not recover until about 2 months later. Shop owners and employees were more concerned about protecting their homes flooding rather than in promoting business. Floodwater reached the plinth level of the thana offices. New shops constructed after since 1988 have been constructed with significantly higher plinth levels, but there has been no communal move to raise ground levels in the market area.
This year (1992) the flooding was 'just right' and has resulted in a good aman crop throughout the thana. However with the good production here and elsewhere, the price of aman has fallen from about Tk 210/maund to Tk 140-160/maund.

D.3 Case Study 1: Flood Proofing Requirements of Pakisha Village, Singra Thana

D.3.1 General Description of Pakisha Village

Pakisha village is located in the north-west of Singra thana. The land area of the village is 182.2 ha. of which 169.5 ha. is available for cultivation[1]. The village is located towards the northern side of Chalan Beel and 97 per cent of the land is classified as F_2 and F_3 and only 3 per cent as F_1[2]. The layout of the village is shown in Figure D.2. Homesteads in the village are located on highland formed with soil excavated from adjacent ponds.

The population of the village is 1000. Land ownership in the village is as follows:

Landless	(owning < 0.5 acre)	43 %
Small Farmers	(owning 0.5 to 2.5 acres)	30 %
medium farmers	(owning 2.5 to 7.5 acres)	20 %
Large farmers	(owning > 7.5 acres)	7 %

The main occupations in the village are agriculture (38%), day laboring (23%), business and trading (5%), and fishermen (8%). For women, the main occupation is household work (98%).

There is one primary school in the village. The school has one new building and one building which lost its roof in a recent storm. There is also about 10 bighas of land next to the school which is used as a playing field. There is also a pond with an area of about 1 acre. The school and its associated grounds and

[1] Data and information given in this Section are from the draft Main Report of FAP 14 (ISPAN 1992a) and from files of FAP 14 Survey held in ISPAN, Dhaka.

[2] Land classification categories are defined in Appendix B.

ponds were given to the village by a *zamindar* many years ago and is now run by a school board. There is no restriction on access to the school grounds. The pond is leased out for about Tk 12,000 per year which is far below the potential productivity of the pond. Villagers consider education to be important and about 86 per cent of villagers send their children to school, although it is not clear for how long.

Houses in Pakisha are made of mud and mud bricks for the walls and corrugated iron sheet or thatch for the roof. Some of the houses on the higher ground are almost 100 years old. Mud is the preferred building material because (i) bamboo and timber are not readily available and hence are expensive, (ii) beel areas are very windy, especially during the monsoon and mud walls keep out the winds much better than bamboo matting or other similar materials, and (iii) soils found in the beel area are very suitable for house construction due to their high clay content.

There are no health facilities in the village. There is a charity dispensary about 3 miles away in Kaliganj and the nearest hospital is at Singra about 10 miles away.

There is a Feeder Road B or Growth Center Connecting Road (GCCR) passing beside the village (see Figures D.1 and D.2). The road connects the market and growth center at Kaliganj (2.5 miles to the north) to Singra market and thana headquarters. The road embankment was constructed about 5 or 6 years ago but about 5 to 10 structures are required to complete the road. The bridge in nearby Sthapandighi village was recently constructed but with no wing walls and hence the embankment will need constant maintenance to connect with the bridge. The road is passable by trucks during the dry season when the khals and rivers have dried out. An additional benefit of the road is that the embankment is used as a refuge for livestock during floods.

Non-government organizations are not active in or near the village.

One of the landed farmers from the villagers is a former Union Parishad Chairman.

D.3.2. Flood Characteristics

The village is severely affected by flooding from the Nagor river. Water level in the river can rise rapidly following heavy rains in its catchment on the Barind Tract. Flood water also backs up from drainage congestion in the rivers in the southern part of the thana.

Flood water traditionally rises slowly but when the embankment on the Nagor River fails, water levels rise rapidly and the aman crop is drowned because the rate of rise of water is too fast. Failures of the embankment have been due to cuts by farmers on the opposite side of the river and poor re-construction of the embankment.

During 1988, water levels were at their peak for about 15 days but remained high for about three months (see Section D.2.2)

D.3.3 Impact of Floods and Needs Assessment

Houses

About 30-35 per cent of the houses in Pakisha were flooded during 1988. Some of the houses collapsed and have since been rebuilt with higher plinths.

After the flood, about 40-50 per cent of flooded households raised their floor levels. During the post-flood period, the men of many households were too busy earning wages and hence re-building of houses was often left to the women who had to fit this in with their other household activities. After the flood, there was a shortage of mud to rebuild damaged houses and suitable mud had to be imported by boat which increased the cost of rebuilding and many were unable to afford it.

Villagers do not want to leave their houses during floods but many have been unable to raise the floor level of their houses to ensure that their house are flood free because suitable soil for construction is scarce locally and many do not have adequate finance.

There has been little community effort since the flood to help those affected by the flood and individuals have been left to develop their own recovery strategies. Richer members of the community have rebuilt their houses using their own resources. For example, one family has spent about TK 60,000 on reconstructing their house about 5 ft above its former level. The reconstructed house and courtyard has an area of about 80 ft by 40 ft.

A common flood proofing measure was to protect the walls of their houses by adding a 'verandah' around the base of the walls (see Figure D.3). The floor inside the house was also raised to reduce the seepage into the house when the water level outside was higher than the floor level.

Raised platforms or *macha* are not used by villagers although they were aware that *macha* were used by people in the south of the thana (see Section D.4.3).

Flood Shelters

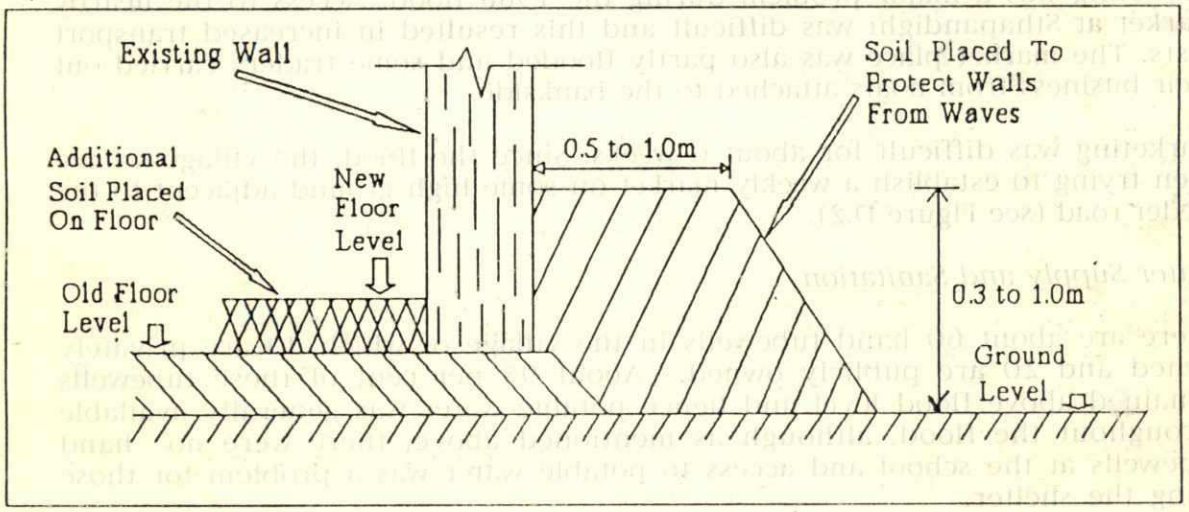
Those people who had to abandon their houses took refuge during the flood on the high ground adjacent to the school. Polythene sheet were provided to make temporary shelters. The school ground remained about 4 ft above peak flood level.

The landless and poor whose houses were under threat of flooding initially sent their children, elderly and possessions to the flood shelter at the school.

The most serious problems at the shelter were:

- lack of drinking water
- shortage of adequate sanitation facilities. Males and females had to use the same latrines and there was long queues
- access was difficult between the shelter and tubewells that were operating elsewhere. Boats were too expensive for many to hire and the only alternative was to use rafts made of banana stems.

Figure D.3
Wall Protection Detail



- there was an acute scarcity of fuel for cooking. Many families had to make do with cooking only once per day. The cooking facilities also had to be shared which caused a problem between the Hindus and the Moslems. As one of the villagers remarked 'We can live in the same village but we cannot cook together or eat at the same table'
- the shelter was 'too open' and lacked privacy. This seemed to be a problem mainly for the better off families who are more inclined to be more strict about purdah.

People stayed at the shelter for about 15-20 days, although the school was closed for about 2 months.

Some better-off people did go to the shelter but many went to their flood-free neighbors or to stay with their relations in places not affected by the floods.

Marketing

Marketing was a major problem during the 1988 flood. Access to the nearby market at Sthapandighi was difficult and this resulted in increased transport costs. The market place was also partly flooded and some traders carried out their business from boats attached to the bankside.

Marketing was difficult for about 6 weeks. Since the flood, the villagers have been trying to establish a weekly market on some high ground adjacent to the feeder road (see Figure D.2).

Water Supply and Sanitation

There are about 60 hand tubewells in the village of which 40 are privately owned and 20 are publicly owned. About 95 per cent of these tubewells remained above flood level and hence potable water was generally available throughout the flood, although as mentioned above, there were no hand tubewells at the school and access to potable water was a problem for those using the shelter.

There is serious shortage of drinking water during the dry season because the discharge of many tubewells declines or stops as the water table falls below the operating range of tubewells for about 4 months. During these months, two deep tubewells near the village and several shallow tubewells are used for the supply of drinking water.

Health

During the flood, there was no loss of life because the flood water moves slowly near the village. Furthermore, the children are exposed to flooding every year and most can swim. However, after floodwater receded, there was an outbreak of diarrhea in the village and, although no one died, many were weakened and unable to help in reconstruction activities. The reason for the outbreak is not clear as potable water was supposedly widely available.

About 95 per cent of the latrines in the village are 'katcha'. Some of these were raised during the flood but the structures were rather insecure and using them was rather risky because of the likelihood of collapse.

Productive Activities

The flood protection embankment along the left bank of the Nagor River was constructed as part of BWDB's Nagor Valley Project. The embankment was designed to protect agricultural land from flooding during the monsoon, thus allowing farmers to grow transplanted aman. However, the embankment has not performed well due to farmers on the other side of the river cutting the embankment to relieve flooding on their side. Poor re-construction of the embankments have caused subsequent failures.

Farmers in Pakisha view the embankment as a 'mixed blessing'. When the embankment fails (due to public cuts or otherwise) water levels rise rapidly around the village ('the height of a man overnight') and both the transplanted and the broadcast aman crops are drowned. Farmers complain that the sluice gates are too small to control either the inflow or outflow of water and there is no effective water control. The embankment is presently breached in several places. Past attempts to repair the embankment have not deterred farmers from re-cutting the embankment when flood waters start to rise the following year.

At present the main problems for farmers are related to siltation of the khals and rivers near the village. Siltation impedes drainage and result in more overflow of floodwater. Navigation is also impaired and the time when boats can reach the village is now much shorter than before. Also, the amount of water available for irrigation in the khals and rivers available for irrigation is reduced. The farmers consider that collapsed embankments have contributed to the siltation.

Many of the villagers would like the feeder road next to the village to be completed to reduce transport costs. Villagers pay about Tk 20-25 / maund to transport their aman by road as compared to Tk 5/maund by boat.

The low prices being paid for aman are not compensated by increases in yield. Input prices are steadily increasing and profit margins are being squeezed. Reportedly, prices have fallen to as low as Tk 100/maund in some places. More-wealthy farmers can afford to delay selling and wait for higher prices but poorer farmers do not have this option as they need the cash straight away.

During and after the 1988 flood, about 15 head of livestock died.

The availability of all types of fish has declined since the construction of the embankments and fishermen have to go further afield to catch the same quantity of fish.

D.3.4. Possible Flood Proofing Measures

The main problems faced by the villagers in Pakisha during floods are related to the flooding and destruction of some houses, the absence of adequate shelter for those flooded and difficulties with marketing.

Possible flood proofing measures that could be taken by villagers include:

- **Raising of house plinths and homestead land** on the western side and near the center of the village where houses are more vulnerable to

flooding (see Figure D.2). Raising of plinth levels may not always be straightforward as it may be necessary to dismantle the house and to re-construct on the new plinth. With mud-built houses, completely new houses may well have to be constructed.

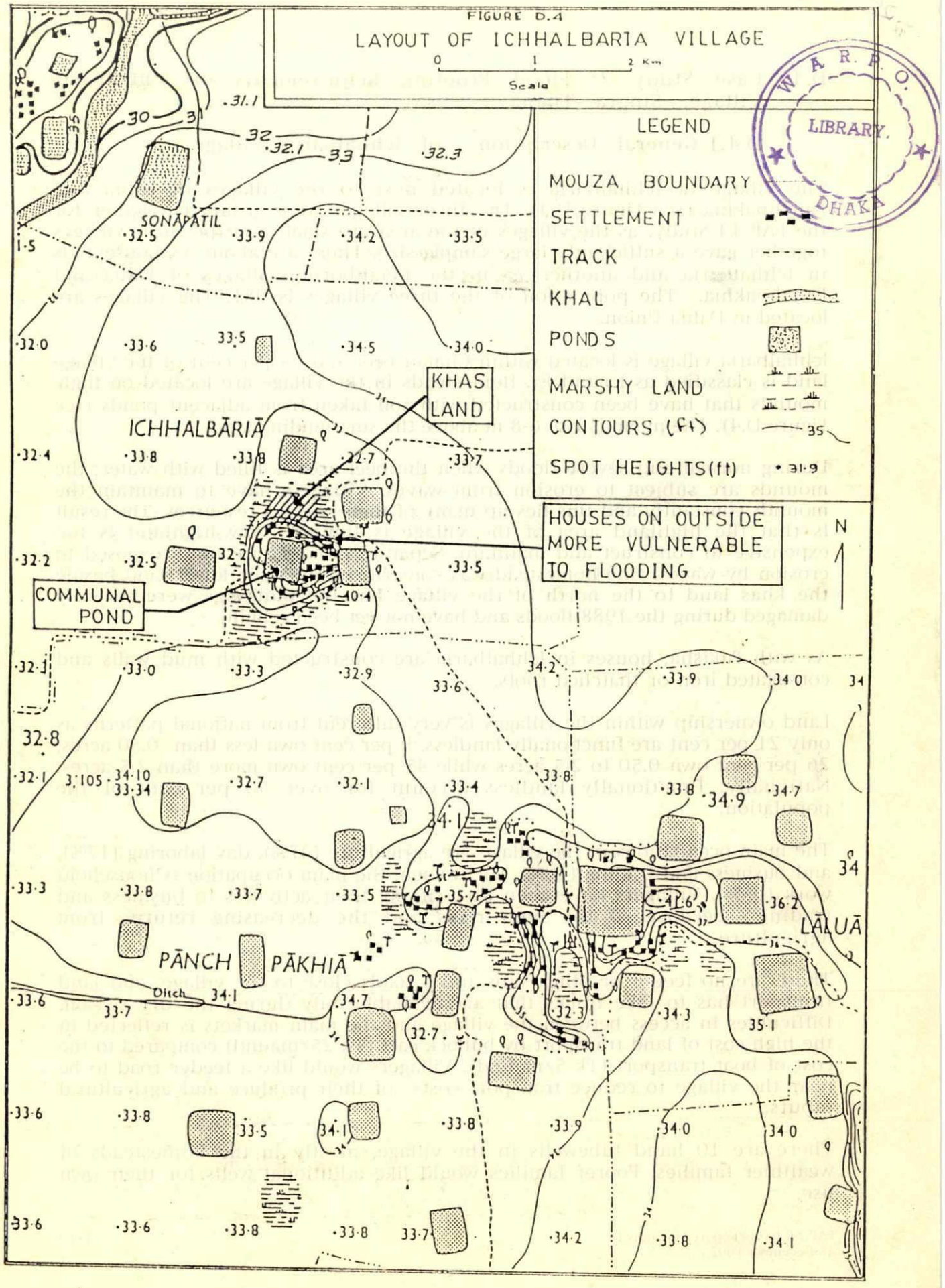
- **Provision of hand tubewells and sanitation facilities at the school.** Also repair of existing buildings and construction of new buildings at the school. If the raising of house plinths is completed, the need for a shelter may be reduced if not eliminated. However the measures proposed would be available to the school during most of the year and could be financed partly out of making more efficient use of the school pond.

Measures that could be taken by the union or district include:

- **Completion of the growth center connecting road** to improve marketing at all times including floods and assist in bringing in relief if required during or after severe floods.
- **Raising of the nearby market at Sthapandighi** to ensure marketing can continue during floods
- **Desilting nearby khals and rivers.** This activity could be undertaken in conjunction with raising ground levels in the nearby market place. The soil excavated during desilting of khals is usually placed on adjacent land, making it unusable, and often the soil is washed back into the khal during subsequent rains. Additional payment would be required to carry the excavated soil from the khal to the market. Combining khal excavation and raising of market places would also avoid the need to use agricultural land for borrow pits for the latter measure.

Indicative costs and some benefits of these various flood proofing measures are as follows:

Measure	Estimated Cost	Benefits
Undertaken by Villagers		
-raising house plinths and homesteads	Tk 1000 to Tk 2500/house (Total Tk 120,000)	direct benefit to about 60 households or about 300 people
-provision of hand tubewells at the school (4 No.)	Tk 7,150/HTW (Total Tk 30,000)	benefit school and about 300 people during floods
-provision of sanitation at the school	Tk 800/set (Total Tk 3,200)	benefit school and about 300 people during floods
Undertaken by union/district		
-completion of growth center connecting road	Tk 5,000,000	benefit people in three unions in Singra Thana and people in Raninagar Thana on the opposite side of the Nagor River
-raising of market place	Tk 200,000	benefit people in three unions
-desilting khals	Not possible to determine	benefit people in three unions



D.4 Case Study 2: Flood Proofing Requirements of Ichhalbaria Village, Singra Thana

D.4.1 General Description of Ichhalbaria Village

The village of Ichhalbaria is located next to the villages of Lalua and Panchpakhia (see Figure D.4). The three villages were grouped together for the FAP 14 Study, as the villages in the area are small and the three villages together gave a sufficiently large sample size. There are about 33 households in Ichhalbaria and another 75 in the neighboring villages of Lalua and Panchpakhia. The population of the three villages is 981. The villages are located in Dahia Union.

Ichhalbaria village is located within Chalan beel and 95 per cent of the village land is classified as F_2 and F_3. Homesteads in the village are located on high mounds that have been constructed with soil taken from adjacent ponds (see Figure D.4). The mounds rise 6-8 m above the surrounding land.

During normal and severe floods when the beel area is filled with water, the mounds are subject to erosion from waves. Villagers have to maintain the mounds constantly and this ties up many of their surplus resources. The result is that the highland area of the village is limited. New highland is too expensive to construct and maintain. Separate mounds are more exposed to erosion by waves. One homestead was constructed on some lower land beside the khas land to the north of the village but the buildings were severely damaged during the 1988 floods and have not yet been rebuilt.

As with Pakisha, houses in Ichhalbaria are constructed with mud walls and corrugated iron or thatched roofs.

Land ownership within the villages is very different from national patterns as only 21 per cent are functionally landless, 9 per cent own less than 0.50 acres, 26 per cent own 0.50 to 2.5 acres while 45 per cent own more than 2.5 acres. Nationally, functionally landless account for over 50 per cent of the population.

The main occupations in the village are agriculture (47%), day laboring (17%), and business and trading (10%). For women, the main occupation is household work (95%). Villagers have been diversifying their activities to business and trading because of the high risks and the decreasing returns from agriculture.

There are no feeder or other substantial roads close to the village, and land transport has to take tracks that are available only during the dry season. Difficulties in access between the village and the main markets is reflected in the high cost of land transport by bullock cart (Tk 25/maund) compared to the cost of boat transport (Tk 5/maund). Villagers would like a feeder road to be near the village to reduce transport costs of their produce and agricultural inputs.

There are 10 hand tubewells in the village, mostly in the homesteads of wealthier families. Poorer families would like additional wells for their own use.

Villagers complained that it was difficult to get any government services. It took villagers a long time and much effort to get an electricity supply installed. There are no roads and few schools in the union. Most village children (rich and poor) start school which is located about 1 mile away. Parents are concerned for the safety of their children traveling to school during the monsoon and also for the well-being of older girls as they travel to school. Hence the drop-out rate from school is high.

There are no professional fishermen in this village although some nearby villages are exclusively fishermen.

No non-government organizations are operating in this area.

The families living in the village own the land on which their houses are constructed.

There is some outward migration from neighboring low-lying villages where householders are unable to maintain there homesteads from wave erosion.

In Ichhalbaria, damage from floods are reportedly less than the damage in many of the surrounding villages including Panchpakhia and Lalua because the mounds of the other villages houses are lower. Because Ichhalbaria are higher, shelter is given to people from neighboring villages, as well as to flood affected people from the village itself.

D.4.2 Flood Characteristics

The beel in which the village is located, is extremely large and covers most of two unions. Flood water enters the beel through numerous khals connecting to the main rivers and water levels within the beel usually rises over 4 to 6 weeks. Rainfall contributes to the rising water.

The 1988 flood was unusual because the rate of rise of flood water was very rapid. The maximum rate was about 3 ft in one day and the whole area flooded in about 15 days. All the aman crop was lost during the flood.

In 1992, the amount of flood water was 'just right' for the aman crop although some farmers complained that there was insufficient water.

The main problem for villagers during floods is the erosion of the homestead mounds by waves. The waves are formed by winds passing over the open expanses of water around the village. There are only a few areas of high land above the water within the beel to interrupt the formation of waves.

Villagers would like an embankment to contain flood water in the rivers but do not want embankments within the beel.

Siltation of the main rivers and khals is causing major problems. There is limited time to undertake the re-excavation work required as available labor is occupied harvesting aman and planting boro from December until February. The population of the area is relatively low and labor comes from Rangpur, Kustia and Pabna to assist with planting and harvesting crops.

Normal floods last about 4 months from June to September, and most of the land in the beel has resurfaced again by late November, when preparation starts for planting of boro. The boro is usually harvested before water levels start to rise at the onset of the monsoon.

D.4.3 Impact of Floods and Needs Assessment

Housing

In 1988, about 15 out of the 33 households in the village were flooded and 9 of those flooded were destroyed completely. The village mosque was also flooded and collapsed. Due to the restricted high land available within the village and the expense of constructing new high land, many houses in the village have two stories. Such houses are more likely to collapse when the walls are flooded because of the additional weight of the second floor.

The flooded houses were mainly damaged by wave action. Villagers tried to protect their properties by constructing barriers made from banana stems and water hyacinth. Some of the more wealthy villagers constructed small 'verandahs' around their properties (see Figure D.3). This was expensive to do once the flood had started as suitable soil had to be imported by boat. One household paid about Tk 20,000 to construct a one such 'verandah.' After the flood, several householders added these verandahs rather than raise the floor levels of their houses as the latter would require the whole house to be reconstructed.

Flooded houses had to be abandoned for about 4 week. The flooded houses that did not collapse took about 15 days to clean and make habitable again. For the houses that did collapse, the process of rebuilding took much longer and 5 of the collapsed houses have not as yet been replaced. Floor levels of rebuilt houses have been raised by 3-5 ft.

After the 1988 flood, wealthy villagers paid for the water in the communal pond to be pumped out and all villagers were allowed to excavate soil (mud) from the pond for use in re-pairing or re-building their houses.

About 20 per cent of village buildings are affected by flood water in normal years. This year was abnormal and the affects of the flood were minimal.

Houses on the periphery of the village are mainly occupied by the landless and poor and their houses are most exposed to waves. These houses on the periphery also tend to be at a slightly lower elevation and hence are more vulnerable to inundation.

Flood Shelters

In 1987, people from the village took shelter on higher ground at the school in Byas which is about 1 mile away. Initially, people were apprehensive to move to the shelter because of the fear of contracting cholera. The shelter was arranged by the Upazila Nirbahi Officer (now the Thana Nirbahi Officer). There was reportedly about 10,000 people at the shelter.

The people from Ichhalbaria who went to the shelter experienced problems with:

- o inadequate sanitation facilities. There was only 3 latrines for use by both males and females and hence there was always long queues for their use.
- o insufficient supply of potable water.
- o insufficient privacy
- o shortage of fuel.

People came to the shelter from many of the nearby villages and arrangements were chaotic and anarchic which led to a constant feeling of insecurity. There was no 'community feeling'.

In 1988, wealthy people in the village suggested that poor families affected by the flood should go to relations in Bogra, ten miles to the north, rather than go to the flood shelter in Byas. The poorer people could not afford to disregard this suggestion and hence many families went to Bogra, even though it was further away. People whose houses are flooded usually want to stay as near as possible to their houses so that they can know what is going on and can check the prevailing conditions. Some villagers preferred to go to Bogra because they could take their valuable possessions with them. The lack of security at the flood shelter in Byas meant that it was inadvisable to take valuables there. Wealthy families contributed towards the transport costs of the villagers who went to Bogra.

Landed families affected by the flood generally found shelter within neighboring houses not affected by the flood. Those who had to move to find refuge were assisted by the wealthy.

Villagers had heard that facilities at the flood shelter in Byas may be improved but so far nothing has been done.

There is a primary school located about a quarter of a miles away from the village but the buildings were destroyed during the flood and have not been replaced. The villagers had heard that funds were available for reconstruction but nothing has happened as yet.

Water Supply and Sanitation

There are about 10 hand tubewells in the village but all of them were flooded during the 1988 flood. At the time, villagers were desperately trying to save their houses and did not worry about ensuring adequate water supplies. During the peak flood, waves were too strong to allow drinking water to be fetched from other places and villagers had to drink flood water. Since the flood, all but three of the tubewells have been moved to higher ground, but during the dry season the water table drops below the operating range of hand tubewells and locating tubewells too high in the village will make them more likely to run dry. Villagers may need two tubewells-one low level tubewell for the dry season and one high level tubewell for use during the monsoon

There are no water sealed latrines in the village and most of the katcha latrines are located around the pond in the center of the village. All these latrines were flooded in 1988. Although sanitation was a problem during the flood, villagers have not changed the sanitary facilities. They seem to be

unaware about the availability and advantages of water sealed latrines, which may be a reflection of the poor government services in the area.

Health

The main health problems occurred after the 1988 flood when diarrhea took its toll. No one in Ichhalbaria died from diarrhea but reportedly children in neighboring villages were not so fortunate.

Marketing

Marketing is a major problem during floods. Movement to and from the village is often severely restricted because the small boats owned by villagers are cannot be used when there is too much wind and the waves are too large. Hence Larger boats that are unaffected by the waves are scarce and expensive if available.

There are few marketing facilities close to the village and villagers use the market in Bildahar which is about 6 miles away or Singra which is about 9.5 miles away. In the dry season, this involves walking for 1.25 hours one way to Bildahar or 2.5 hours one way to Singra and generally takes all day. Few petty traders visit the village.

Due to the problems with transport, villagers have to purchase bulk items such as fertilizer, seeds etc. during the monsoon when water levels are high and boats can access the village. The villagers would like to have a road nearby and are interested in the Singra to Tarash road being constructed.

Trading of grain is a problem. Transporting grain by boat costs about Tk 5/maund while transporting by bullock cart the only alternative costs about Tk 25 /maund.

Economic Activity

In 1988, the floods disrupted the local economy for 2 to 3 months, as the aman crop was completely destroyed by the rapid rise in water levels during the early part of the flood. There are few alternative income generating activities during the monsoon season.

There was a shortage of water this year and a few farmers irrigated their aman crop. During the dry season irrigation using shallow tubewells is difficult because the water table falls to 50 ft below ground level which restricts the use of shallow tubewells. The ponds also tend to lose their water during the dry season which limits fish culture.

The limited extent of this year's flood has resulted in a shortage of fish, even for local consumption.

Other issues

Storage of grain and other commodities was a problem for all villagers and on a community basis, the villagers hired a boat to take their grain for storage in Bogra district.

Although no-one died in this village during the 1988 flood, the absence of suitable burial places was of concern to villagers. In villages nearby, the more wealthy sent their dead to be buried in Bogra district while those who could not afford this, just had to let the bodies be taken away by the flood waters.

Security is a major concern during floods as dacoits raid the village from boats.

Fuel was not in short supply during the flood as villagers had sufficient fuel stockpiled to last for its duration. However, for those who went to the shelter, fuel was difficult to find and they had to obtain fuel from relations who lived near to the shelter.

Many trees and other vegetation including mango and palm trees died after the 1988 flood probably because of extended water logging of their root systems. The loss of the trees has left the village more exposed to wind and, wave erosion.

D.4.4 Possible Flood Proofing Measures

The main recurrent problem faced by villagers during floods is the erosion of their homestead area by waves. Erosion has restricted the villagers capability of expanding their village area as their resources are utilized in maintaining the existing mounds. If the erosion threat could be removed, poorer villagers may be able with some help to reconstruct their houses above highest flood level.

There are also serious problems with water supplies and sanitation during floods.

Possible flood proofing measures that could be taken by villagers include:

- protection of the village from wave action. Appropriate measures would require identification of suitable vegetation to dissipate the wave energy. Suitable vegetative matter may include catkin grass.

- provision of separate hand tubewells for dry season and wet season use.

Possible flood proofing measures that could be taken by the union or district include:

- repair of nearby primary school and providing adequate high ground beside the school to be used for a flood shelter. Also provision of sufficient water supply and sanitation facilities for when the shelter is in use.

- re-excavation of nearby khals

Indicative costs and some benefits of these measures are as follows:

Measure	Cost	Benefits
Measures undertaken by Villagers		
-Erosion Protection	Not possible to determine. Research project required to find suitable techniques	Low cost erosion protection would be beneficial to all communities in beel and haor areas.
-Tubewells	Tk 37,500	
-Improvement of Sanitation Facilities	Tk 24,000	
Measures undertaken by Union		
-Improvement of facilities at Byas	Not possible to determine	Benefit about 10,000 poor people
-Repair and improvement of primary school	Not possible to determine	Benefit people in the three villages - about 300 people.

D.5 Case Study 3: Bhuapur Thana, Tangail District

D.5.1 Introduction

Char land is very young alluvial land within the active flood plain. Char land has complex patterns of ridges and inter-ridge depressions, in-filled channels and cut-off channels. Char land is liable to change by river erosion. Sediments are deposited to form new char land and to bury older land. In some years, new deposits can be as deep as 2-3 meters or even more in certain places.

Flood protection facilities are not technically or economically feasible for char land due to its unstable nature. Flood proofing and flood preparedness are the only flood damage mitigation measures that can be considered. By their nature, flood proofing measures will not be able to impact the river morphology significantly and hence 'flood proofed' char land will still be liable to the process of erosion and deposition. Flood proofing on the chars should be aimed at sustaining and improving the life of those who live there and not be expected to alter the natural processes of erosion and deposition of land.

The case study of flood proofing requirements in char areas was undertaken to illustrate and discuss some of the issues involved in identification, planning and design of appropriate flood proofing measures in char areas. The Case Study is not intended as a comprehensive analysis of people living on char land and does not attempt to solve all their flood-related problems. The Case Study is focused on people who have lived in char areas for a long period and have to some extent adjusted their lifestyles to the environment.

There is another large group of people of people living in or beside char land who are not covered by this Case Study. They are those people whose land has been lost to river erosion and waiting for their land to reappear so that they can continue with their previous settled lifestyle in one location. This latter group of people have a different set of requirements from those char dwellers who expect to move as land appears and disappears (ISPAN 1992b)

The villages surveyed for the Case Study were different from the FAP 14 survey villages. Alternative villages were selected to show the flood proofing and general development activities of an non-government organization working specifically with people living in char areas.

The Case Study of the char areas follows a different format from the other two Case Studies, because the flood-related problems of people in char areas are more severe and less is known about how they respond to floods. People in both environments (beels and chars) are dependent on agriculture for their livelihoods but the land in beel areas does not change significantly between floods. In contrast, the land in char areas is constantly changing, and is liable to disappear altogether. Thus, the format followed for the Case Study of char areas is a description of some aspects of living in char areas, followed by a general discussion of issues related to flood proofing measures. An improved understanding of the way people live in char areas is required before specific flood proofing measures can be identified for particular communities.

D.5.2 Chars in Bhuapur Thana, Tangail District

Bhuapur thana is located in Tangail District and lies mainly in the active flood plain of the Jamuna river. The thana is subject to constant physiographic transformation caused by the changing course of the Jamuna river. The shifting and braiding of the river has created a wide range of char lands (see Figure D.5).

The thana is within the North Central FAP Region (FAP 3), and to the south of the FAP 3.1 Jamalpur Priority Project area. The char area adjacent to the FAP 3.1 area was surveyed during the preparation of the feasibility report for the project (Sogreah 1992). The resources of the char land along the Jamuna river from the Indian border in the north to its confluence with the Padma in the south is being surveyed as part of FAP 16: Environmental Study. The draft report of this latter survey is due at the end of 1992 (ISPAN 1992).

The population of the thana is 135,851 (1981 Census). There are 22,641 households living in 156 villages and 6 unions (see Figure D.5). People living in the char area are at risk from river erosion and the constant changes in topography result in many households moving as char land appears and disappears. The river was tending to move eastwards over the past decade but during the last two years more active channels have reappeared on the western side of the thana (see Figure D.6). Most of the char land is flooded each year and settlements are on the available high ground. The residents on the more stable char land invest in trying to ensure that their houses are above flood levels. Residents on the more recently-formed chars do not construct their houses above flood level because they consider the risk of erosion does not justify the investment.

Residents seem to have a clear understanding about ownership of the char land. Ownership is retained by continuing to pay land tax even when the land disappears. Ownership is then re-established when the land re appears.

There is single cropping on most of the char land, with millet being the main crop. The soils are very sandy and are unsuitable for boro and only a small amount is grown with irrigation. In the monsoon, most of the land is flooded and some broadcast aman is grown. There are few other income earning activities available to farmers during the monsoon season.

Fishing is an important activity throughout the year. Local fishermen complain about collection of freshly hatched fries of carp because many other species are killed in the collection process and this is leading to a serious decline in local fish production. The carp fries are exported to other districts. The government is considering banning collection of fries to ensure sufficient fish are available in the river.

Transportation in the char area is by boat during the monsoon and by walking and boat during the dry season. Most households have at least a small boat but there is serious shortage of larger boats to carry livestock or materials for house construction and other large or heavy items. Ownership of larger boats is very profitable. The shortage of suitable boats limits the movement of people especially during the monsoon when they may have to move quickly to avoid losing their possessions to flood water or erosion. Furthermore people are unable to exploit the fishery resource. Boats can be used for about 9

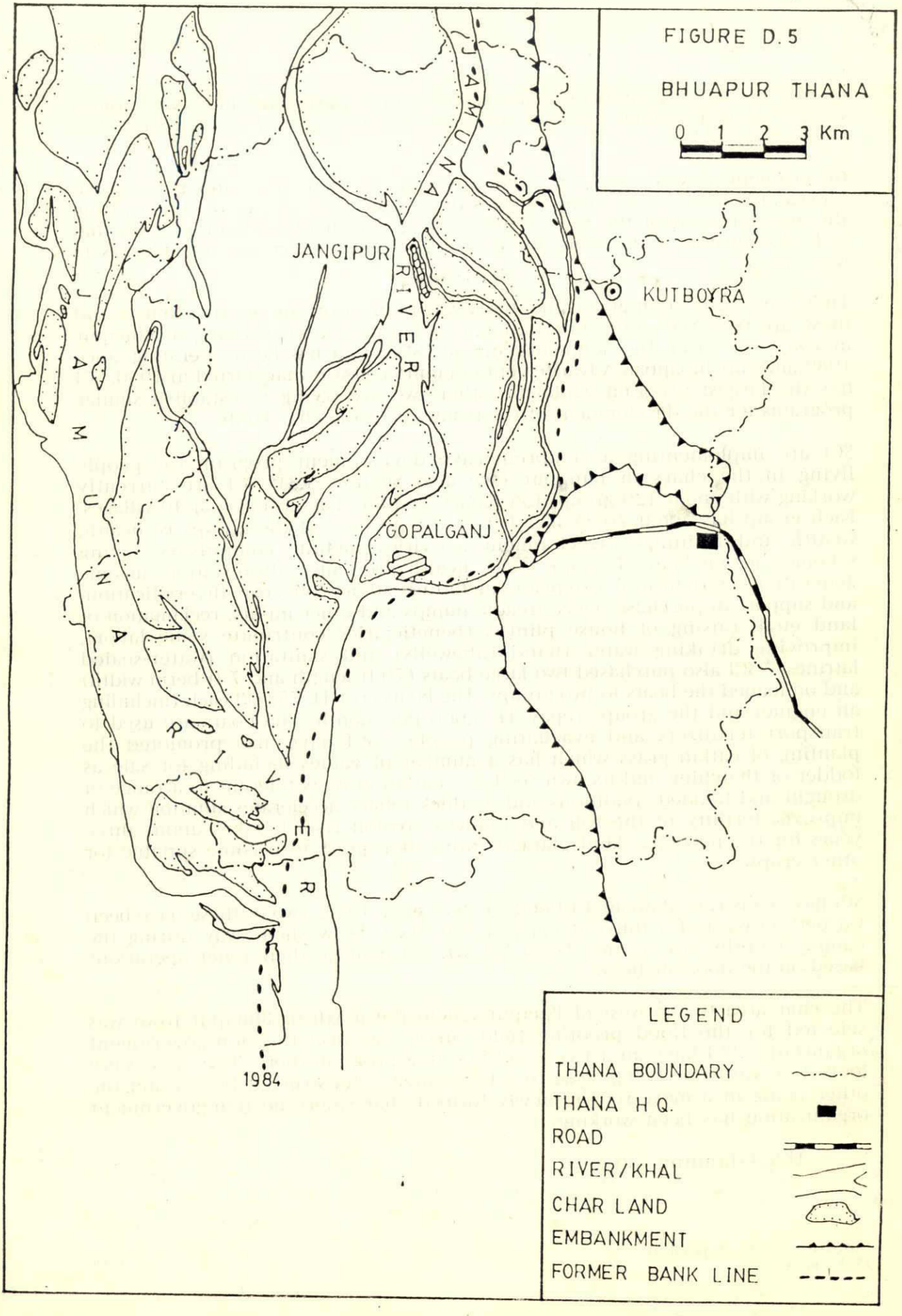


FIGURE D.5
BHUAPUR THANA
0 1 2 3 Km
JANGIPUR
KUTBOYRA
GOPALGANJ
JAMUNA RIVER
JAMUNA
POLDER
1984
LEGEND
THANA BOUNDARY
THANA H.Q.
ROAD
RIVER/KHAL
CHAR LAND
EMBANKMENT
FORMER BANK LINE

months of the year although many are used only during the monsoon months when the river is high. most of the boats are rented and crew are hired to work on the boat.

Government services are very sparse within the char area, and government offices are remote from many villages due to the difficulty of traveling within the area for most of the year. Conversely, government staff often claim that lack of transport limits their ability to offer effective services to villagers in the char.

There are three non-government organizations working in the thana, and these are (i) Service Civil International (SCI) that started working in Bhuapur in 1987, (ii) Social Development Sangsad (SDS) that has been operating since 1989 and (iii) Jubajiban Advancement Committee (JAC) that started in 1990. SCI has the largest program while the other two are trying to establish similar programs for the development of the residents of the char lands.

SCI are implementing a comprehensive development program for people living in the chars in Bhuapur (see also Section 3.3). SCI are currently working with about 120 groups (35 female and 85 male groups) in 40 villages. Each group has about 20-25 members. The purpose of the groups is 'health, wealth and training'. Development activities include compulsory saving schemes, group loans, housing loans, health programs, afforestation, income generation (agricultural extension including advice on crop diversification, and support to purchase seeds, treadle pumps and other inputs, reclamation of land etc.), raising of house plinths (beneficiaries contribute some labor), improving drinking water (hand tubewells) and sanitation (water-sealed latrines). SCI also purchased two large boats (70 ft length and 7 ft berm width) and on-loaned the boats to two groups. The boats cost Tk 75,000 each (including an engine) and the groups repay Tk 3,000 per month. The boats are used to transport fertilizers and evacuating people. SCI have also promoted the planting of catkin grass which has a number of values including for sale as fodder or thatching and its own seed etc. Catkin grass is tolerant to a range of drought and flooded conditions and its thick foliage accelerates siltation which improves fertility of the soil and reduces erosion risk. It takes about three years for the new char land planted with catkin grass to become suitable for other crops.

SCI have constructed about 13 flood shelters since 1988. Two of these have been washed away, and a third at Rajapur will likely be washed away during the coming months (see Section D.5.4 below). SCI manage their relief operations based on the flood shelters.

The char area to the west of Rajapur hat to the north of Bhuapur town was selected for the flood proofing field survey because the non-government organization SCI have an active flood proofing program there. Two areas were looked at, with one being close to a flood shelter constructed by SCI and the other being in a more remote newly formed char where no non-government organization has been working.

D.5.3 Jamuna River

The Brahmaputra-Jamuna is one of the largest rivers in the world. The main river flows through a wide and highly unstable braided channel, filled with islands and char lands.

Most of the char land in the Jamuna is flooded to some extent every year. Households are constructed on available highland but even many houses will be flooded in a normal year. However, the main problem of many households is the threat of river erosion and the loss of their land and homesteads when erosion occurs.

Data of water levels in the Jamuna River at its confluence with the Teesta river, 75 km. to the north of Bhuapur are given in Table D.2. The flood characteristics of the river do not change significantly over the 75 km. The main features of water levels during floods are:

- peak daily flood water levels can vary by over 2 meters.
- 1988 flood levels were significantly higher than the 1987 flood levels. Peak flood levels in 1974 and 1980 were also high.
- the difference between the 1 in 5 year peak flood level and the 1 in 100 year is about 1 meter.
- the difference between the 90 day maximum flood level and the 5 day maximum flood level is often more than 2.0 meters.

The variability in water levels in the Jamuna is much more pronounced than in the Atrai/Gur system (see Section D.2.2).

Comprehensive flood protection embankments have been constructed along the right bank of the Jamuna, although in recent years the embankment has been breached by river erosion. The right embankment is being studied under FAP 1, FAP 2 and FAP 25. Flood protection embankments on the left bank is more fragmented at present, as portions of protective embankments have been constructed at different times. The left embankments are being studied under FAP 3, FAP 3.1 and FAP 25. People in the char areas are concerned that flooding on their land may become worse if embankments are constructed on both sides of the river. The backwater effect of the proposed Jamuna Bridge may also significantly affect flooding in the char areas of the Jamuna.

D.5.4 Digri Char and Gokulganj Char

SCI constructed a flood shelter at Rajapur, about 1 mile from the embankment and on land that was about 7-8 years old (see Figure D.6). The shelter had an area of 1.72 acres (300 ft by 250 ft) and was raised about 6 ft above ground level. The earthworks for the shelter cost about Tk 50,000. There was two buildings at the shelter, one school and one health service center. A number of SCI group members constructed house at lower elevations adjacent to the shelter.

In May of 1992, the nearest active river channel was about 300 m away from the shelter. However, the people living beside the shelter were apprehensive that the river was moving eastward and soon the shelter would be lost to erosion. On this basis, they were unwilling to invest the resources in flood proofing their own homesteads by raising the plinth levels of the buildings. They were reliant on the flood shelter if a severe flood occurred.

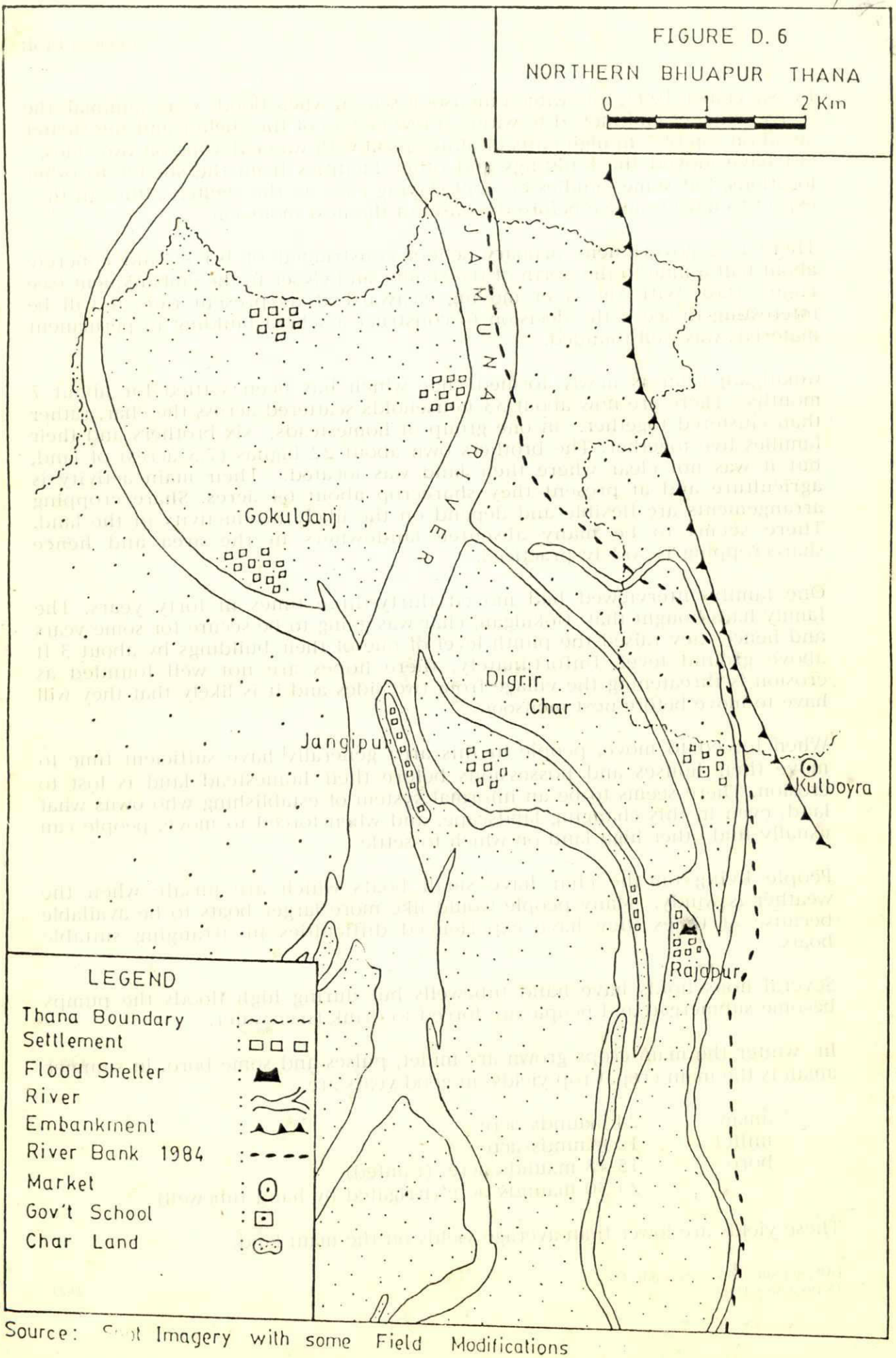
Table D.2
Water Levels: Jamuna River at confluence with Teesta River[1]
Maximum Levels (m) for Given Durations (days)

Year	1	5	15	45	90
1974	24.13	23.83	23.25	22.19	21.18
1975	22.89	22.69	22.39	21.73	21.37
1976	23.32	23.10	22.36	21.30	21.13
1977	23.37	23.23	23.03	22.31	21.86
1978	22.77	22.47	22.09	21.71	21.05
1979	23.03	22.92	22.67	21.85	21.44
1980	24.28	24.07	23.43	22.60	21.54
1981	23.28	23.07	22.47	21.96	21.23
1982	23.16	22.92	22.24	22.05	20.91
1983	23.48	22.90	22.15	21.74	21.39
1984	23.82	23.48	22.57	21.67	21.36
1985	23.27	23.01	22.67	21.74	21.23
1986	22.35	22.21	21.78	21.39	20.77
1987	23.69	23.50	22.61	22.11	21.83
1988	24.63	24.29	23.05	22.03	21.46
1989	23.40	23.25	22.96	22.27	22.14

For return periods (estimated by Gumbel Extreme Value Analysis)

return period					
5	23.79	23.58	22.96	22.16	21.60
10	24.04	23.80	23.13	22.29	21.76
20	24.27	24.00	23.29	22.41	21.89
50	24.56	24.25	23.48	22.57	22.07
100	24.77	24.44	23.63	22.68	22.19

[1] Source: FAP 2 : North West regional Study



Source: Satellite Imagery with some Field Modifications

By November 1992, following a monsoon season when floods were minimal, the active channel had moved to within a few meters of the shelter and the shelter stood on top of 7 m high cliffs of alluvial soil with water flowing on two sides. SCI have moved the buildings and other facilities from the shelter to other locations, but some families are still staying close to the shelter, although they expect to have to move before the onset of the next monsoon.

There is a government primary school constructed of bricks and concrete about half a mile to the north of the shelter and closer to the embankment (see Figure D.6). With the river moving eastward at its present rate, it will be interesting to see if the decision to construct a school building in permanent materials was well founded.

Gokulganj Char is newly formed char which has been settled for about 7 months. There are now about 33 households scattered across the char, rather than clustered together. In one group of homesteads, six brothers and their families live together. The brothers own about 22 bighas (7.3 acres) of land, but it was not clear where their land was located. Their main activity is agriculture and at present they sharecrop about 64 acres. Share cropping arrangements are flexible and depend on the likely productivity of the land. There seems to be many absentee landowners in the area and hence sharecropping is widely practiced.

One family interviewed had moved thirty-three times in forty years. The family had thought that Gokulganj char was going to be secure for some years and hence they raised the plinth level of one of their buildings by about 3 ft above ground level. Unfortunately, there hopes are not well founded as erosion is threatening the village from two sides and it is likely that they will have to move before next monsoon.

When forced to move, people in this area generally have sufficient time to move their houses and possessions before their homestead land is lost to erosion. There seems to be an informal system of establishing who owns what land, even in this changing landscape, and when forced to move, people can usually find other high land on which to settle.

People living on the char have small boats which are unsafe when the weather is windy. Many people would like more larger boats to be available because at times they have experienced difficulties in arranging suitable boats.

Several households have hand tubewells but during high floods the pumps become submerged and people are forced to drink river water.

In winter the main crops grown are millet, pulses and some boro. In summer aman is the main crop. Crop yields in good years are

aman	24 maunds/acre
millet	12 maunds/acre
boro	15-18 maunds/acre (rainfed)
	24-30 maunds/acre (irrigated by hand tubewell)

These yields are lower than average yields on the main land.

There are two hats nearby but access is difficult during floods and it takes all day to go there and come back. In the dry season, the markets are more accessible and can be reached by foot and short ferry crossings, in about 75 minutes,.

Fuel supply is not a problem. Sufficient fuel is stored and, if wet, can be dried out quickly.

There was a general feeling amongst the villagers that they received few services from the union parishad. The relationship was seen to be one way - 'we vote and get nothing in return.' During floods the villagers requested the union parishad to supply one boat to move their possessions but nothing happened.

D.5.5 Impact of Floods and Needs assessment

Houses

Houses on char land have a high risk of loss to erosion. House owners close to the Rajapur flood shelter raised there plinths levels by about 2-3 ft and hence were still subject to periodic flooding. They did not raise their plinths higher because they considered the risk to be too great and not worth the investment. The char at Rajapur shelter has been there for about 7-8 years and hence the residents are unsure how long the char will remain. They were correct in their risk assessment because six months later several of the houses had disappeared and the shelter will likely disappear during the next few months! Shortage of funds to raise plinths is another constraint. In adjacent 'older' chars, householders have raised their house plinths above flood levels because they consider that the investment is worth while. Some of the residents at Rajapur are thinking about moving to more mature char land across the other side of the river channel.

House holders tend to construct *machas* so that they can stay in the house after the flood water has risen above floor level, but as there is limited space, livestock, grain and other bulky possession are sent to safety on higher ground.

Flood Shelters

In the 1988 flood, people moved their livestock and poultry to available shelters. The problems people faced at the shelter included:

- inadequate sanitation facilities
- insufficient water supply (there was only one hand tubewell)

The children and elderly are moved to the shelter first. During the day, young women whether married or unmarried will come to the shelter to cook for the family and look after their children and possession including livestock. At night, many women return to their houses to stay on the *macha*. with their husbands or parents, as they did not feel safe in the shelter along with young men from other households. Women also like to maintain *purdah* even during floods. Older women and men stay at the shelter to look after the children and

their livestock and other possessions. Prior to the flood, they had stored fuel. Generally there is no shortage of fuel in the char areas.

During floods, there seems to be little difference between the response of the wealthy and the poor. Everyone sends their possessions to the flood shelters or other high ground.

Water Supply and Sanitation

During floods, many of the tubewells become flooded and supply of potable water becomes difficult. Women in both villages had to use river water when tubewell water was not available. River water was also used for household work. They thought that water purification tablets should be more readily available during and after floods.

Flood Warnings

People living on the char predict floods on the basis of assessing several factors including the weather (cloud formations, mists on the river etc.), the rate of change in river water levels.

Income Generating Activities

There are very few income earning opportunities during the monsoon. Non-government organizations have tried to introduce alternative activities but the options are few and include petty trading and livestock fattening. Men often have to go to the main land to find work.

Other Matters

Education is seen as important to many of those interviewed but in the char areas, there are few schools and schooling is not possible for most of the children.

D.5.6 Issues related to Flood Proofing Measures in Char Areas

Char areas are a difficult and complex environment in which to live because of the changing landscape resulting from the erosion and deposition of river sediments. As with the coastal areas threatened by cyclones, the approach to maintaining and supporting those people who live in char areas has to be considered carefully to avoid communities or government supporting flood proofing measures that are not self-sustaining. Flood proofing is based on the principle of making individuals or communities independent of both floods and continuous external support whether from government or non-government sources (except for flood warnings).

Two basic issues need to be addressed when considering flood proofing measures for the char areas:

(i) how can flood proofing assist the general development of people living in char areas, and

(ii) how can flood proofing assist to minimize the affects of further riverside flood protection embankments or other developments (such as

the Jamuna Bridge) that will affect flows and water levels in the Jamuna.

Development programs should be formulated for the char areas, on the basis of equitable distribution of government resources and utilization of the resources of the country. There are an estimated 1.2 million people living in the char areas of the Jamuna River (ISPAN 1992b) and in the FAP 3.1 area, there are almost the same number of people living in the char areas as there are living inside the proposed protective embankments. The char areas are productive and contributing to the national economy and ways to increase their productivity should be considered as part of national planning.

Most people living in char areas have few resources and hence have limited capacity to cope with floods. Some people have responded by migrating around char areas, moving as land appears and disappears. Others move once when they lose their land to erosion and wait for their land to reappear. Possible flood proofing measures for the former group (those who regularly expect to move) are discussed below.

- *Housing.* Traditionally houses are constructed with soil floors, timber or bamboo wall frames with mat cladding and thatched roofs. In some cases, roofs are made of corrugated iron sheet. Housing design has been adapted to flood environment by (i) making the structure of the house easy to dismantle in case erosion forces the owners to move the house to another location, (ii) using soil to raise the floor level above ground level, and (iii) constructing a platform or *macha* inside the house above flood level. Investment in (i) and (iii) can be retained if the homestead land is lost to erosion. In contrast, investment in (ii), raising the floor level, is lost if the homestead site is lost to erosion. Raising floor levels of houses is not a sustainable flood proofing measure in many char areas, as each year the investment has a high risk of being lost. In the long term, either the local people or an external agency (government or non-government) may be locked into an endless expenditure without receiving a significant return.

  An alternative approach is to develop measures that allow all house construction materials to be movable. One such way is to construct the house with a suspended floor - that is with a permanent *macha*. Many people around the world live in houses with floors suspended on 'stilts' over water. Consideration would have to be given to the design of the structural columns for the house to ensure that they were sufficiently lightweight to be easily transportable and yet strong enough to support the raised structure. The columns would have to longer than those presently being used and if made of concrete may be too heavy to move easily.

- *Boats* are an essential component of life on the chars, and yet many of those living there have limited access to boats either in terms of owning one or being able to afford to hire one. Many of the boats owned by char dwellers are small and suitable for use only in slow moving water without waves. During the monsoon, when boats are most needed, winds are frequent, making it unsafe to use small boats. Boats have traditionally been neglected in transport planning and this trend continues despite efforts to raise awareness the importance of boats to

local and national economies. (Jansen and others 1989; Palmer and others 1992)

Better access to boats would certainly increase the independence of char dwellers and allow them to survive better during floods. Programs to increase boat ownership in the chars should be investigated. Such programs may involve credit to purchase boats and management training to help the owners to run the boat profitably. Developing utilization of house boats may be a solution to the housing and transport problems.

- *Land ownership* is a critical factor in settlement patterns on the chars. People who loose land to erosion often stay as close as possible to the lost land to ensure they can reclaim the land if and when it reappears. Concern over establishing land rights is a major factor for people staying on exposed char land even during extreme floods. There seems to be informal system by which people settle and re-settle on land. Institutionalizing land ownership would allow people to move away to safer ground without having the fear that by doing so they would loose their ownership rights. Careful consideration would have to be given before instituting changes in land registration and ownership as the present system does work to some extent and care would have to be taken to ensure that changes would be for the better of the people most affected by erosion.

- *Flood shelters* In the absence of flood proofed housing, there is a need to provide flood shelters where people can take refuge when there houses are flooded. As with housing, flood shelters need to be carefully sited to avoid being lost to erosion. The problems of finding suitable sites can be illustrated by SCI's experience wherein they have lost 3 of their 13 shelters in 4 years. The number of sites where the land is more stable is limited. For example, the Union Parishad chairmen of Arjuna Union, in northern Bhuapur, estimates that about 4 villages are located on stable old char land and about 25 per cent of the unions population live in these villages. Thus, 75 per cent or about 15,000 people live in more vulnerable areas where flood shelters may be lost within a few years of construction.

  As with cyclone shelters, there are many issues related to the provision of flood shelters that need to be resolved including their utilization at other times, their cost effectiveness compared to other interventions such as improved housing, boats etc., and design issues such as density of their location, extent of facilities at the shelter etc.

- *River Training*. Catkin grass is used by local people to stabilize char land. The grass can be sold as fodder or thatching and can be grown with few inputs other than labor for planting and harvesting. The grass can be grown from seed and is planted in August/September and harvested in April. The income from one acre of catkin is about TK 15,000 and the labor to harvest coast about Tk 2,000 per acre. Once established, the grass can be cut annually. Further research should be undertaken to investigate the effectiveness of catkin grass (and other vegetative or low cost measures) in stabilizing char land. This could be undertaken by FAP 21 and 22.

- *Change in Water Levels.* There is concern amongst those working in the char areas about increased flood levels resulting from additional embankments being constructed to stop flooding from the Jamuna river, but it is not clear exactly how increased water levels would affect those living in the chars. For example, how would increased water levels affect those people who presently have to abandon their houses during floods?

Overall, improved understanding is required of the social, economic and physical environments of the char areas to enable appropriate and effective development and flood proofing programs to be developed and implemented. Non-government organizations have done undertaken programs in some areas and their experience should be utilized where possible.

Appendix E

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