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## BANGLADESH FLOOD ACTION PLAN

FAP 14 / FAP 23

# FLOOD RESPONSE AND GUIDELINES ON PLANNING FLOOD PROOFING

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Prepared for :

The Flood Plan Coordination Organization (FPCO)

Ministry of Irrigation, Water Development and Flood Control

January 1993

**ISPAN**  
**IRRIGATION SUPPORT PROJECT FOR ASIA AND THE NEAR EAST**  
Sponsored by the U.S. Agency for International Development

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**FLOOD RESPONSE AND GUIDELINES ON PLANNING FLOOD PROOFING  
(DRAFT - 15 January 1992)**

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Flood Response and Planning Guidelines for Flood Proofing

*PREAMBLE*

*i) Floods and the Flood Action Plan*

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<sup>2</sup>), 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<sup>2</sup>), 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.

Following the 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).

## ii) *Flood Response and Flood Damage Mitigation*

*Flood Response* consists of all measures taken by individuals, families and communities to prepare for, cope with and recover from floods. Mitigation measures taken in response to floods, depend on the resources and understanding available in a particular flood prone environment and comprise of both technical (physical alterations or adjustments to prevailing conditions) or social (mobilization of family networks, friends, patrons, jobs, credit etc.) measures. Understanding the way people respond to floods under existing conditions is an essential prerequisite for planning of future interventions that are designed to mitigate the effects of floods.

Possible flood damage mitigation measures undertaken by individuals, families and communities include *flood proofing*, *flood protection* and *flood preparedness*.

*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



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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.

### *iii) 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.



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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.

#### *iv) FAP 14: Flood Response Study*

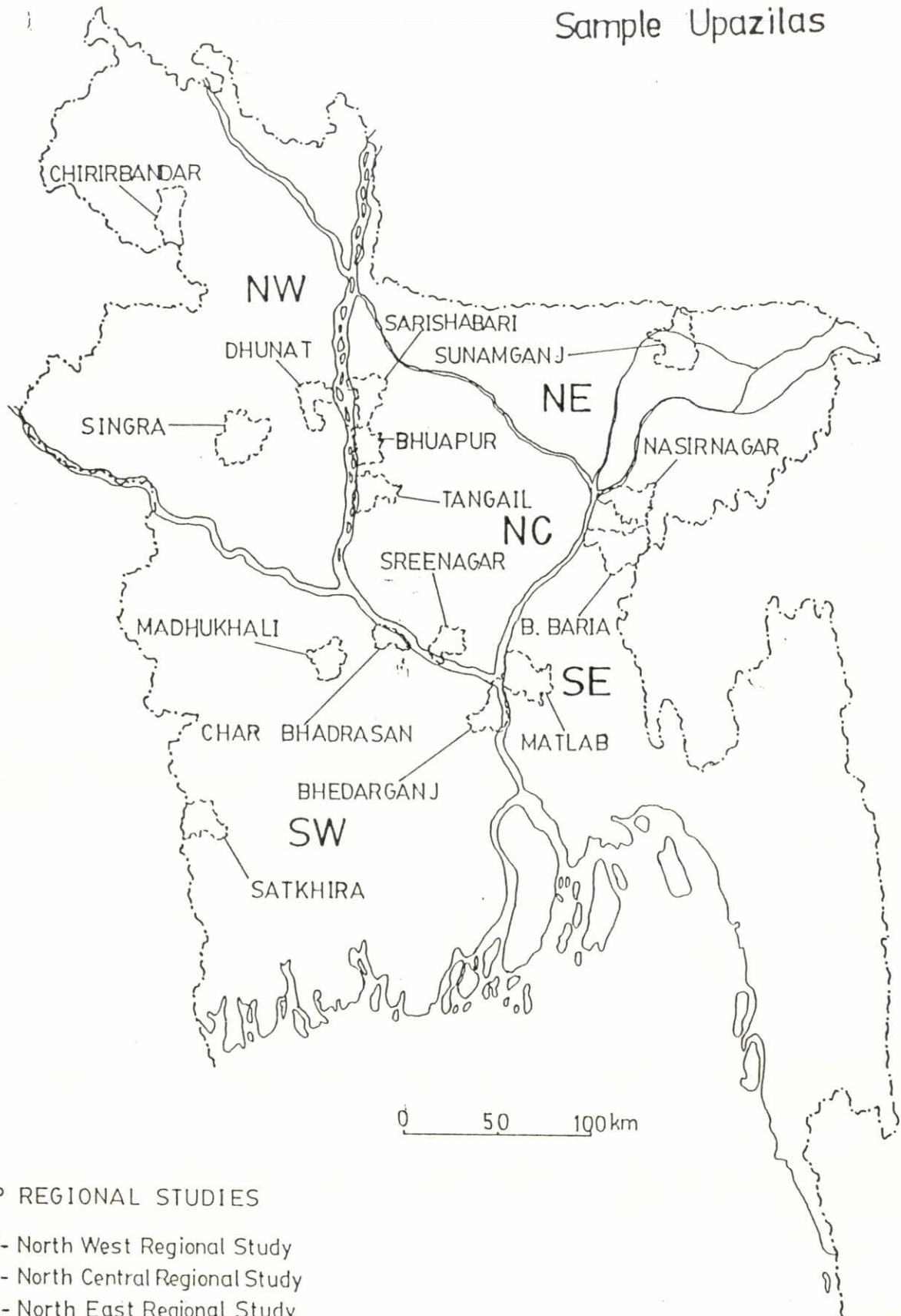
The FAP 14 Study investigated patterns of flood response in 30 villages located in eight different flood environments<sup>1</sup>. The sample villages represented the physical, social and economic conditions in each environment. Villagers were surveyed to determine their response to damaging floods, their preference for different flood mitigation measures, the effectiveness of services provided by different institutions, and the potential for more effective coping and mitigation measures. One of the most important findings of the Study is that flood responses, including flood proofing, are dictated not only by the characteristics of the flood environment, but also by the preferences and resources of the individuals, households and communities living in a particular environment (ISPAN 1993). There is not a single uniform set of responses that are applicable throughout even one flood environment, and hence planning and design of flood mitigation measures must take account of local responses to floods in particular locations and not be based on generalizations of flood responses. As each FAP region has a variety of different flood environments and projects may encompass several flood environments, it is important that all aspects of flood response are considered during the preparation of regional and project feasibility studies.

#### *v) FAP 23: Flood Proofing Study*

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<sup>1</sup> The 30 sample villages were distributed throughout the six FAP geographical regions. Regional planners may refer to the final report of FAP 14 for information about specific villages or thanas in a region, and the findings about specific flood environments found in the different regions. The location of the sample villages are shown in Figure 1.

BANGLADESH  
FAP-14 Flood Response Study  
Sample Upazilas



FAP REGIONAL STUDIES

- NW - North West Regional Study
- NC - North Central Regional Study
- NE - North East Regional Study
- SW - South West Regional Study
- SE - South East Regional Study



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The Flood Proofing Study (FAP 23) is divided into two phases. Under Phase I, reports and empirical data on flood proofing measures in Bangladesh and elsewhere were 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, two field surveys were undertaken. One field survey was undertaken to determine the flood response of individuals, government and non-government and commercial establishments in municipal areas to the 1988 flood and the impact of flooding on their activities. Respondents were also asked to identify possible flood proofing measures that could be implemented to reduce the impact of floods on their activities. Another field survey was undertaken to determine the flood response and flood proofing measures implemented by specific rural communities. The FAP 23 surveys were designed to be complementary to the FAP 14 survey.

The main findings of Phase I of the FAP 23 Study were that a range of flood proofing measures have been implemented by individuals and communities, and public and private institutions. Their efforts are generally successful for normal floods, but are often inadequate for more severe floods, leaving people vulnerable to varying degrees of distress and hardship during and after such events. Development of more effective flood proofing measures was constrained by the lack of systematic dissemination of information and promotion of flood proofing concepts, centralized government planning and implementation policies, lack of understanding and cooperation between officials and the public, limited coordination among government agencies. 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 making local and national economies more resilient to flooding. Investment in flood proofing would allow the economic and social development of the country to proceed smoothly without catastrophic interruptions from floods (ISPAN 1992).

#### *vi) Discussion of Flood Proofing Measures*

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.



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Loss of peoples' private property and capital assets also cause 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 before, 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.*



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Public utilities in rural areas are rural water supplies by tubewells and handpumps, and, in some locations, 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.

### *vii) National Policy Issues*

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:

- o More comprehensive approaches to resources management, including multidisciplinary planning teams and multimeasure interventions should be promoted
- o Administrative actions that encourage intensive interagency coordination, dissemination of flood hazard information, and initiation of effective local participation.
- o 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.
- o 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.
- o 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.

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- o Effective flood and storm warning systems should be developed throughout the country
  - o Beneficiaries should contribute to the cost of flood control and drainage projects to enhance local commitment to operation and maintenance of facilities
  - o All government agencies should have contingency plans to ensure that they can function throughout floods. The necessary funds should also be made available.
  - o 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)
  - o Local formal and informal groups should be encouraged to prepare for and respond to floods.
  - o 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
  - o Local initiative infrastructure projects should be designed to avoid interfering with flood flows or drainage
  - o Local programs to improve flood response and flood proofing, including training for these measures, should collaborate with non-government organizations wherever possible.
  - o 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.
  - o The district and thana levels should be mandated to improve coordination among national departments or agencies such as BWDB, LGED, DPHE, Agricultural Extension Directorate, Fisheries Directorate, and Public Health Directorate.
  - o 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 the national policy on flood plain management.



15 January 1993



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FAP 14 and FAP 23  
Flood Response and Guidelines for Flood Proofing

## 1. Introduction

The objectives of flood plain management are to avoid the loss of human life, reduce adverse impacts on health and nutrition, and sustain and improve normal family and community activities during and after severe floods, while protecting environmental and social values. The requirement is to plan and implement development so that people, businesses and government agencies can continue their activities during floods and economies can function and grow without interruptions and setbacks from lost production, relief and rehabilitation.

### 1.1 Scope and purpose of Note on Flood Response and Guidelines on Flood Proofing

Flood Response and Guidelines on Flood Proofing have been prepared from the findings and recommendations of the FAP 14 Study and FAP 23 Study. The objectives of the Guidelines are to assist planners with the integration of flood response and related minor structural and non-structural flood proofing measures with flood control and drainage measures such as embankments, polders and drainage systems being planned as part of the Flood Action Plan.

The purpose of the Guidelines is to assist planners of flood control and drainage projects to:

- enhance the beneficial effects of investments made in or near FAP projects;
- specify measures that will minimize the adverse impact of full or partial flood control and drainage facilities during severe floods; and
- assist in the planning and implementation of remedial measures that will assist those living in areas likely to be adversely affected by flood control and drainage projects.

The Guidelines follow a comprehensive approach to flood plain planning and are applicable not only to FAP projects but also to:

- the planning, design and management of embankment projects by local and municipal governments;
- the planning and design of non-FAP khal excavation and rural road projects;
- the planning, design and management of integrated rural development projects and programs undertaken by government and non-government agencies;
- agricultural and infrastructure developments in flood prone areas where major flood control measures may not be technically or economically feasible; and
- projects and programs in areas where major flood control measures are feasible but cannot be undertaken in the near term owing to institutional or resource constraints.

The background to the Guidelines is given in the Preamble.

## 1.2 Other FAP Guidelines

This Note on Flood Response and Guidelines for Flood Proofing are designed to be used with other FAP guidelines, namely the Guidelines for Project Assessment (GPA), the guidelines for Environmental Impact Assessment (EIA) and the Guidelines for Peoples Participation (GPP).

In the Guidelines for Project Assessment (GPA), uniform procedures are given for economic appraisal of FAP projects within the framework of multi-criteria analysis (FPCO 1992).

In the Guideline for Environmental Impact Assessment (EIA), the methodology for evaluating the environmental consequences of proposed FAP projects is given (FPCO 1992). The EIA facilitate the planning and design of environmental mitigation measures and the formulation of an environmental management plan for proposed projects.

Both the GPA and the EIA Guidelines are oriented towards the evaluation of projects which contain one or more major flood control or drainage structure.

The Guidelines for People's Participation provide a set a standards and requirements for people's participation in all phases of project planning. the GPP provides specific instructions about the composition and qualifications of planning teams.



## 2. FLOOD RESPONSE AND FLOOD PLAIN PLANNING

In the FAP 14 and FAP 23 Studies, individuals and households in rural and municipal areas were surveyed to determine their responses to flooding. Several of the findings from the surveys can be generalized and are appropriate for use during the planning of flood mitigation measures and general development planning covering flood plains.

Patterns of flood response are influenced by the characteristics of prevailing floods and the socio-economic condition of the those affected.

Many flood related problems are related and their solutions should be considered in the context of the economic development goals of individuals, communities and the nation as a whole. The flood response or the way in which individuals or communities prepare for and cope with floods is directly influenced by the economic and other resources available to support their activities. The net result is that those with the fewest resources are the most vulnerable to disastrous economic loss during floods. Problems related to unemployment or inadequate income are the root cause of many difficulties faced by those most affected by floods. Increased availability of income generating activities and credit opportunities would help mitigate flood damage and reduce the economic disruption.

### 2.1 Characterization of Flood Environments

Flood response by individuals, households and communities are influenced by the characteristics of the prevailing floods, and each flood environment has an associated set of specific needs. Some common characteristics of different flood environments are as follows.

#### Main Rivers

There are three main rivers: Jamuna, Padma and Meghna. Flooding is typically of moderate duration (weeks rather than months) during the period June to September. Land close to the main rivers is at risk from erosion. This environment comprise of a wide range of flood experience, as well a diversity of preparation and response measures. Crop production along main rivers is fairly reliable and cropping patterns depend upon land elevation, flood duration, and availability of flood protection facilities. Many areas are protected from floods by embankments but the facilities constructed are not always too reliable. Many people in this environment would like to eliminate the effects of severe floods but have adjusted their activities to accommodate average floods and normal rainfall. Households within protective embankments often make few preparations for floods, and when they are affected by floods (either because of the embankments breaching or overtopping), their properties and possessions can suffer major damage.

#### Secondary Rivers

Cropping patterns like those for Main Rivers, depend on land elevation, flood duration, and level of flood protection. Secondary rivers often tend to flood from local rainfall and drainage congestion, as well as from spill from the main rivers.



## Chars

Chars are located within the active floodplain of the major rivers on relatively recently accreted land. Chars are a complex flood environment as the land form is constantly changing due to erosion and deposition of sediments by the rivers. People living in char areas are often impoverished, agricultural productivity is low because soils are predominantly sandy with low fertility and poor water retention characteristics. Public facilities are almost non-existent and education levels are low. Many families have to move their house and possessions frequently as land is lost to erosion. Houses are constructed from light-weight materials to facilitate dismantling and movement to safer locations. Temporary platforms (or *machas*) are constructed inside houses so that families can continue to use their house after flood water has inundated the floor. Householders are unwilling to invest their scarce resources to raise the floor level of their house due to the constant threat of losing the homestead land to erosion. In more severe floods, families have to evacuate their houses and move onto flood embankments or other high ground on adjacent main land. People prefer to stay close to their property, and hence there is a demand for flood shelters scattered throughout char areas and located close to peoples' normal place of residence. Improved dissemination of information on the timing, extent and duration of flood is required. Boat transport is in often in short supply and expensive during floods. The small boats owned by most householders are unsuitable for use when river flows are high or when the weather is windy.

## Beels and Haors

Beels are low-lying depressions that are frequently deeply flooded throughout the monsoon season. Floods are caused by inflow from rivers or from rainfall and drainage congestion. Haors are deeply flooded tectonic depressions in the north eastern part of the country. Haor areas are often flooded for long periods (from May/June to October/November).

Although beel and haor areas are deeply flooded for long periods during most years, the populations in these environments are permanently settled in specific locations, and houses are more sturdily built than houses in the chars. Boro is the main crop and the deep and prolonged annual floods allow limited scope for changing agricultural practices. Yields of boro are relatively high, but yields of aman, where it is grown, are much more variable as crops are frequently lost due to the floods coming too early or the rate of rise of flood water being too fast or flood levels being too high. In haor areas, improved dissemination of information on floods would allow farmers to expedite harvesting prior to the land being inundated by flood water. Drying and storage of grain is often difficult due to the shortage of high land. Land transport in these areas is constrained by the absence of suitable roads and trading of agricultural inputs and produce is much more active during the monsoon season when boats can reach interior villages. These areas have some prosperous large landowners who could contribute financially to improving flood mitigation facilities.

## Flash Flood Areas

Flash floods occur in areas which are close to the hills surrounding the north eastern part of the country. Flash floods happen suddenly and are difficult to predict. Their effects can be very destructive. Those who are subject to the effects of flash floods are interested in improved flood and storm warnings.





## Semi-saline Empoldered Areas

Floods in semi-saline or empoldered areas are result primarily from waterlogging, or drainage congestion. In this environment, households prepare less for floods than households in other flood environments. Floods are typically of short duration and occur infrequently.

In some areas, there are conflicts between agricultural farmers and shrimp farmers because of their different water management requirements. Due to the higher value of shrimp cultivation, the needs of shrimp cultivators often dominate at the expense of agricultural farmers.

## 2.2 Appropriateness of Different Mitigation Measures

In general, people in all flood environments want the impact of flooding to be reduced, although there is a widespread acceptance of normal monsoon conditions and peoples' greatest concern is to reduce the effects of severe floods. Of course, the flood-related needs and interests of local communities depend on the characteristics of the prevailing floods and local consultation is required to discern local support for particular flood damage mitigation measures.

Inhabitants of different flood environments have distinct flood protection requirements. People living in chars want to be free of floods, although some farmers would be happy to reduce or delay normal floods. People flooded by main rivers require protection from severe floods. In contrast, those in secondary river areas were more concerned with modifying or reducing the rate of rise of floods, rather than being fully protected from all floods. Similarly, farmers in beel areas wanted protection from rapidly rising flood water rather than protection from all floods. In haor areas, farmer preference are for improved drainage to increase the growing season and submersible embankments rather than for full flood protection. People in flash flood areas wanted normal inundation delayed a month and only those whose homes were flooded wanted full protection from floods. Households often express a willingness to pay for flood protection facilities if their reliability can be guaranteed.

In those areas most frequently affected by floods, namely chars, beels and haors, there is an acute shortage of high ground above flood level. Available high ground tends to be occupied by homesteads, and there is definite need for flood-free temporary shelters to accommodate those displaced by floods. Public shelters are also in demand in other flood environments except flash flood areas where floods, although destructive, are of short duration and do not require people to move from their homesteads for extended periods.

Access to drinking water are often a problem during floods, and , while important in all areas, was of particular concern in villages where there are few tubewells. Sanitation facilities are often inadequate or not available.

Improved flood warnings and flood information are required in most areas. The relevance of present flood warnings given on the radio is difficult for most people to determine as they cannot relate the information given to their local conditions. More local information on floods is required.



### 2.3 Flood Responses of Vulnerable People

Flood responses are influenced by the social and economic condition of individuals and households. Vulnerable households with low income, few resources and few opportunities survive precariously at the best of times and the flood-related needs of vulnerable groups such as landless, small farmers, fishermen and female headed households should be considered as part of the planning process.

Women have few opportunities to change their condition because of their status in society, and their flood-related needs should be given particular attention. The scope of women's responsibilities mean that their activities are often severely disrupted by floods. Women's activities are mainly focused around the household, and include cooking, obtaining water and cooking fuel, maintaining grain stores, drying grain and feeding and tending livestock. All these activities become much more difficult during floods.

The needs of female headed households, who generally have fewer resources at their disposal and have to function without male support in a traditionally male-oriented society, require even more attention. Female headed households support themselves through paid employment or produce from their lands, but many experience food shortages during the rainy season because of the lack of money resulting from the inclement weather or slack periods in the agricultural cycle.

Valuable assets owned by women include cooking pots and other vessels, animals, tools or equipment, and houses and land. The extended family tends to be their most important social asset. Non-kin ties with neighbors, patrons, and local groups are also social resources that can be used during floods. Even with these social resources, many women suffer significant losses during floods and either have to sell or mortgage their physical assets or borrow money. The main reasons for selling assets or borrowing money are to purchase food or repair houses.

By the nature of their profession, fishermen live close to rivers, and hence their homesteads are often more exposed to floods. Fishing is practiced throughout the night, and security at their homes is sometimes a problem. During floods, marketing of fish is difficult as access to markets for both the fishermen and buyers may not be possible.

During floods, there are very few income earning opportunities for landless households, most of whom depend on day laboring in agriculture for their income. Many families find it difficult to procure even the minimum subsistence food. In addition, the standard of housing of landless tends to be poor and their houses are vulnerable to damage by floodwater. Improved drainage would assist landless households as land would become cultivable more quickly following floods.

Potters suffer during floods because of shortages of necessary inputs such as fuel and clay. In addition, there is the shortage of high land on which to prepare pots for firing and store fuel or those pots that have been fired. Marketing of their produce is also difficult. Similarly weavers are affected by the lack of markets and shortages in basic materials.



## 2.4 Local Needs During and After Floods

After immediate physical safety, the most pressing needs of those living in flood prone areas are as follows:

- Storm and flood warning
- Emergency shelter (which allows sufficient privacy)
- Fuel for cooking
- Safe drinking water
- Access to food
- Cooking and eating facilities
- Sanitation facilities
- Animal care
- Fodder supply
- Protecting crops and pond fish
- Grain storage/drying facilities
- Receiving timely inputs to plant/replant crops
- Repairing homes
- Employment continuity
- Road, embankment and other infrastructure repair
- Access to health care facilities



Other issues of concern during floods included security, midwifery. Some needs are more prevalent during severe floods, while others are seasonal problems for many families, especially the poor. The interests of men and women on each of these points may be different to some extent, and the concerns and problems should be discussed with each group separately.

Many of these needs are interrelated and are applicable to all flood prone areas including those with partial or full flood protection facilities. Therefore, these needs should be explicitly addressed in regional studies and also in feasibility or detailed design studies. A project that set aside these issues, even if, for example, it increases agricultural productivity, will be seen by its intended beneficiaries as having limited usefulness.

The importance of different needs in different flood environments is shown on Table 1. The importance of the different needs are reflected in the degree of adoption of different preparatory measures taken by households in different flood environments, as shown on Table 2.

## 2.5 Institutions and Specific Needs Check List

In the past, institutional response to floods has been very variable. There is a great need for institutions to improve the collaboration and coordination of their activities. Furthermore, institutions need to devise and implement their own flood preparedness programs that are designed to meet the needs and aspirations of the different socio-economic groups receiving their services before, during and after floods.

The activities and responsibilities of different institutions during floods should be identified during the planning process. The potential responsibilities of different institutions for preparatory and coping measures during floods are shown in Table 3. The needs and priorities of a particular area during floods should be determined and the table can be used as a check list to determine the institutions that could provide support services for each measure.

**Table 1**  
**Importance of Different Needs in Different Flood Environments**

Specific Need	Chars	Main Rivers	Secondary Rivers	Semi-Saline Areas	Haors/ Beels	Flash Flooding	Breach Locations
Storm and flood warning	***	***	**	*	**	**	***
Emergency shelter (with privacy arrangements)	***	***	**	*	***	**	**
Cooking fuel	***	***	***	*	***	*	*
Safe drinking water	***	***	**	*	***	**	*
Obtaining food (a problem of lack of money/unemployment)	***	***	**	**	***	**	**
Cooking and eating	***	***	**	**	***	*	**
Sanitation facilities	***	***	**	**	***	*	*
Animal care	***	***	**	**	***	*	*
Fodder supply	***	***	**	*	***	*	*
Protecting crops and fisheries resources (pond fish)	*	***	***	*	**	***	***
Grain storage/drying facilities	**	***	**	*	***	*	*
Receiving timely inputs to replant after crop loss	**	***	***	*	**	***	*
Repairing homes	***	***	**	**	**	***	**
Employment continuity	***	**	**	**	***	**	**
Road, embankment, or other infrastructure repair	*	***	**	**	**	**	***

\*\*\* major importance

\*\* minor importance

\* not important

Source : FAP 14 Household Survey/Institutional Survey



Table 2

Checklist of Recommended Preparatory and Coping Measures  
by Type of Measure and Institutional Source

Type of Measure	Neigh- borhood	Union Parishad	Upazila Parishad (Thana)	District	NGO
<b>Preparatory Measures</b>					
Flood Warning	***	*	*****		
Arrange for Shelter	*	**	***		**
Reinforce Houses and Homesteads	**	****	****		
Arrange for Flood-Time Transport and Communication	***	*	****		
Arrange for Storage	***	***	****		
Protect Crops, Cattle, and Fisheries	****	****	****		
Repair/Construct Small Scale Embankments		*	***		**
Repair/Construct Roads		**	***		**
Improve Drainage		**	**		*
<b>Flood Coping Measures</b>					
<i>During Flood</i>					
Provide Shelter	****	***	***	****	*
Supply Drinking Water	****	****	****	****	**
Provide Emergency Relief	****	*****	*****	****	****
Provide Health Care	*	**	****	****	***
Supply Fuel	**	***	**	*	
Protect Crops, Cattle, and Fisheries	***	*****	****	**	
Protect Stored Food	**	***	****	*	
Provide Marketing Services	**	****	****	**	
Provide Credit			*		**
<i>After Flood</i>					
Repair/Construct Houses/Homesteads	***	*****	****	****	***
Provide Health Care	**	****	*****	****	***
Supply Agriculture Inputs	**	***	*****	****	**
Repair Infrastructure	**	*****	****	****	**
Provide Security	*				

Asterisks indicate the approximate magnitude of importance on a scale where one asterisk equals about 10 percent of either respondents from the Household Survey, or villages from the Institutional Survey suggesting the measure, up to a maximum of four asterisks, except where five are used to indicate exceptional support.

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**Table 3**  
**Degree of Adoption of Various Flood Preparatory Measures in Different Flood Environments**

Measure	Chars	Main Rivers	Secondary Rivers	Semi-Saline Areas	Haors/Beels	Flash Flooding	Breach Locations
Building water hyacinth barrier around house	**	*	*	*	**	*	**
Building barrier with soil around house	*	*	*	*	**	*	**
Reinforcing walls	***	***	*	***	**	*	*
Reinforcing corner posts	***	***	**	***	**	*	**
Reinforcing roof	***	**	*	***	**	*	**
Storing fodder	**	*	**	**	**	*	**
Raising stores of fodder	**	*	**	*	**	*	*
Storing food	*	*	*	***	**	*	**
Raising stores of food	**	*	**	*	**	*	*
Storing water	*	*	*	**	**	*	*
Preparing boat	*	*	*	*	**	*	*
Sell fish from pond	*	*	*	*	*	*	*
Check fish from escaping	*	*	*	*	*	*	*
Sell stored food for want of storage facilities	*	*	*	**	**	*	*
Buy and store household items	*	*	*	***	**	*	*
Store fuel	***	**	***	***	***	**	***
Raise floor	**	*	*	*	**	*	*
Prepare platform (macha)	**	*	**	*	**	*	*

\*\*\* high adoption (over 50% respondents adopting)  
 \*\* moderate adoption (20% to 50% respondents adopting)  
 \* low adoption (below 20% respondents adopting)

Source : FAP 14 Household Survey





### 3.0 Guidelines for Planning of Flood Proofing Measures

#### 3.1 Rational for Flood Proofing

Most of the physical and financial damages caused by floods are to individual houses. For example, in 1988, an estimated 7.2 million dwellings were damaged or destroyed and housing losses accounted for 65 percent of the total estimated financial damages. Although each house may have only a small monetary value, the financial damage to housing is so significant because of the large number of houses affected.

The flood protection measures being studied under the Flood Action Plan are focused primarily on protecting agricultural areas from flooding and increasing agricultural production. Except for specific urban areas, the benefits of flood protection on rural communities is not being considered, even though floods cause severe disruption to many communities and hardship for many families. Furthermore, in many areas, flood protection will not be feasible for social, technical or economic reasons.

Damage to houses and the impact of floods on families and communities can be significantly reduced by implementing flood proofing measures<sup>2</sup>. Overall, the purpose of flood proofing is to 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. Flood proofing measures include making adjustments to structures and to building contents to keep water out or to reduce water entry.

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.

Flood proofing measures should be implemented along with flood preparedness measures, as flood proofing and flood preparedness are complementary and both are required to realise the full benefits from flood proofing.

#### 3.2 Application of Flood Proofing

The type and extent of flood proofing measures required for a particular area will depend on local flood characteristics, the impact of floods on individuals and communities, and their traditional coping strategies including the measures that they adopt to mitigate the affects of the flood.

Flood proofing measures are required for areas both with and without flood protection. A large number of people will continue to live outside protected areas and comprehensive planning and implementation of flood proofing measures will reduce the negative impact of floods and improve their standard of living. If more flood protection embankments are constructed or existing embankments are made

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<sup>2</sup> Flood proofing and flood protection are defined in the Preamble to this guideline.



to function more effectively, those living outside protected areas are likely to 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 effective flood proofing measures in advance of the construction or improvement of flood protection facilities will lessen the impact of increased flooding on those communities and hence should be an integral part of planning of flood protection projects.

Possible increases in depths of flooding in non-protected areas resulting from proposals being made by FAP and other government projects are being calculated by the Flood Modeling and Management Study (FAP 25) and the respective FAP regional studies.

For areas with flood protection, people living and working within the protected area have to assess the reliability of the flood protection facilities being provided. 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). Unfortunately, the findings of the FAP 12, 13 and 14 studies indicate that on a number of existing flood control and drainage projects the facilities being provided are not reliable. On some projects, protection works have failed during floods against which the protection facilities were designed; the reason for failure of several of these projects was 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 those inside are often less prepared for inundation and when the protection fails, water levels within the protected area rise too rapidly, giving people insufficient time to take effective counter-measures.

The reliability and availability of flood control 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 control facilities constructed under FAP may take several years to complete and flood proofing measures can be implemented to reduce the effects of floods until the new facilities are complete. As part of a flood proofing program, consideration should be given to determine the reliability of the flood protection facilities and the requirement to protect some facilities within embankments from more extreme flood events.

### 3.3 Planning of Flood Proofing Measures

Flood proofing measures should be planned on the basis of the characteristics of prevailing floods, and the needs of individuals and communities during floods. The needs of local people should be determined through public 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.



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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, 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.

Possible measures and their impact is shown on Table 2. There is no 'definitive list' of flood proofing measures because measures that are 'appropriate' to specific locations will depend on local needs and local conditions which vary greatly throughout the country.

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TABLE 1  
INFORMATION REQUIRED TO DETERMINE  
APPROPRIATE FLOOD PROOFING MEASURES

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**FLOOD CHARACTERISTICS**

What were the features of the most recent severe flood(s) in the area?

- timing/frequency/duration
- rate of rise of water
- source and direction of flow
- depth of flood water

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**IMPACT OF FLOODING AND LOCAL NEEDS ASSESSMENT**

a) During and after floods:

- how many people were killed and why?
- how many families were displaced from their homes and why?

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b) What caused the greatest suffering/hardship during and after the flood - absence of:

- shelter
- food
- potable water
- sanitation facilities
- fuel
- income earning opportunities

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c) What effect did the flood have on

- employment opportunities
- marketing
- transportation
- public utilities
- public/private services
- food preparation
- storage of fuel/food/valuables
- livestock/fodder
- fishponds
- other

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**APPROPRIATE FLOOD PROOFING MEASURES**

(see Table 2 for possible measures)

- who will own specific measures and who will be responsible for operation and maintenance?
  - what contributions will be made by the beneficiaries / community towards the cost of specific measures?
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**NOTES:**

The questions are designed to collect information on local needs during floods and identify appropriate flood proofing measures. A sketch map be prepared to show the location of community facilities (schools, mosques etc.) and those areas/homesteads most affected by flooding. Where available, the 1: 7920 (8 inch to 1 mile) Survey of Bangladesh topographic map should be used as a base map. After the information on flood characteristics, impact and local needs has been collected, various flood proofing measures should be discussed with respondents but care should be taken to avoid giving too much emphasis on a particular measure until the overall characteristics and impact of flooding is determined.



Table 2  
Possible Flood Proofing Measures

Flood Proofing Measures	Probable Impact		
	Saving lives and reducing suffering	Income and Livelihood	Infrastructure Services and utilities
Improved housing	***	**	
Raising floor levels/ homestead protection	***	**	
Flood shelters	***	**	
Water supplies	***		**
Sanitation	***		**
Transportation-roads, footpaths	**	***	***
Transportation-railways	**	***	***
Transportation-boats	***	**	**
Marketing	*	***	*
Protection of industrial/ commercial premises		***	
Provision of storage areas	*	**	
Local flood protection embankments	**	***	
Local drainage schemes	*	***	

Notes:

- \*\*\* indicates strong influence
- \*\* indicates medium influence
- \* indicates minor influence

### 3.4 Possible Flood Proofing Measures

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) *Human Lives and Suffering*

Peoples lives are centered on their homes and for people to continue their normal lives throughout a flood, they should be able to remain in their own homes and have access to food, water, fuel and other necessities. For people to do this, part of their houses have to be physically above peak water level and the house construction has to be able to withstand inundation and provide shelter from the weather. Possible flood proofing measures could include raising floor levels to be above flood levels, improving construction materials, provision of materials to construct an elevated storage space, raising water supplies above flood level etc.

If resources are not available to raise the level of individual homes or homesteads, an alternative measure is to provide community flood shelters. The purpose of such flood shelters would be to provide a place of refuge to which people could move along with some of their possessions prior to a flood event.. Community flood shelters may be the largest single public investment within a locality and should be designed for multiple use to maximize the benefits of the investment to the community. Existing community buildings or facilities such as schools, health centers, mosques, *eid gah* can be adapted for use as flood shelters. A further advantage of using flood shelters for other community activities is that responsibility for maintenance of the facility would be more widespread.

Important considerations in the design of shelters include community involvement in their planning and siting, the distance from homesteads to shelters, access to shelters when a flood is occurring, length of time the shelter may be occupied, provision of potable water and sanitation facilities, access to food and fuel, privacy and security of those taking shelter, provision of cooking facilities, storage of livestock and other valuables and flood preparedness measures available in the community.

Market places can also 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 items of value to purchase food and other essentials and hence, in each locality, there should be a flood-free place for marketing.

In areas where there is active river erosion, people face the additional hazard of physically losing their homestead and agricultural land. Riverbank erosion is a



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major reason for people becoming landless and homeless. In char areas, people who loose their homestead land often re-settle on newly formed land but the dynamic nature of the landscape means that their new homestead may be secure for only a few years. Under such circumstances, people are unwilling to invest many resources in flood proofing their property and community flood shelters may be a lower-cost solution.

On riverbank land adjacent to the mainland, 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 wide scale 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.

Possible flood proofing measures could include provision of adequate space for livestock and other capital assets at flood shelters. Provision of community facilities for grain drying and grain storage facilities above peak flood levels could also be appropriate measures. Community storage facilities may also be a possibility but ensuring the security of such facilities would be a major problem in many areas.

#### ***b) Incomes and Livelihood***

Absence of income-generating activities is a major problem for the rural poor during floods. As agriculture is the main economic activity in rural areas, possible flood proofing measures include identification and implementation of small scale flood control and drainage schemes. The benefited area of such schemes would be from about 100 ha to about 1000 ha. and schemes can be located either inside or outside the main flood protection embankments. A number of small scale flood control and drainage schemes have been found to be economically feasible and have been constructed by the Local Government Engineering Department (LGED) in Kurigram district.



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Improvement of local drainage close to homesteads could make land available for planting more quickly after the flood has receded, thus allowing households to re-start food production sooner and reduce their requirement to purchase food. Provision of seed beds above flood level would have a similar effect as transplanting of seedlings could take place as land emerged from the water. Dissemination of information on flood proofing measures practiced in different areas would be part of a flood proofing program.

Measures to ensure employment activities continued throughout a flood include raising of floor levels, provision of small protective embankments around industrial and commercial premises (and provision of pumped drainage within the embankment) or ensuring water sensitive equipment was above flood level on the first floor of the building, if available.

c) *Public Services and Infrastructure*

Flood proofing should be considered to ensure that the following public infrastructure is able to function throughout a flood:

- roads
- railways
- ferry ghats
- electricity supply
- water supplies
- sanitation facilities
- health centers
- government offices
- communications (telephone, postal services)

Infrastructure components that are critical to the economic and social activities of an area should be identified and assessed to ensure that essential services are available throughout a flood. For example, the government's rural development strategy is based on the development of growth centers and resources for infrastructure development in rural areas are concentrated towards their development. Feeder Roads Type B (sometimes referred to as growth center connecting roads) are constructed to connect growth centers to the main road network. Flood proofing would ensure that embankment levels of feeder roads were constructed to be above specific flood levels. In addition, sufficient structures should be provided to ensure roads are usable during floods.

Infrastructure and facilities constructed by government are meant to be designed to be above specific flood levels, but too often this is not done for several reasons including resource constraints, incorrect information on flood levels, not relating embankment levels or building floor levels to measured or predicted flood levels. Flood proofing would ensure that the relevant departments are responsible for following design standards and are accountable if infrastructure and facilities did not remain operable during floods.

Flood proofing also involves the identification of different modes of transport used in a locality and determining how each mode could operate effectively during floods. For example, boats are an essential form of transport during floods



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and flood proofing would ensure that the movement of boats is not hampered by road embankments or structures. Structures to allow boats to pass through embankments during floods may be provided where necessary.

### 3.5 Design Considerations

The critical parameter in the design of flood proofing measures is the expected depth of flooding at a particular location. Other parameters to be considered will include the timing and duration of flood events, the rate of rise of water levels, prevailing weather conditions, resources available to the local people, wave action, erosion potential, velocities of the flood water etc. Information on these parameter should be collected during the field survey discussed in Section 3.2.

Flood proofing measures should be designed to ensure protection against specific events. Specification of the level of protection for specific measures will depend in part on economic, financial and environmental considerations, but for planning purposes the following specifications are suggested:

Measure	Freeboard above highest flood level <sup>3</sup>
raising level of houses/homesteads	
area subject to erosion	0.3 m
other areas	0.5 m
Flood shelters	1.0 m
Raising ground level at	
main hats/market	1.0 m
minor hats/markets	0.5 m
schools	1.0 m
Feeder Road Type B	
embankment	1.0 m
structures	2.0 m
Food storage facilities	1.0 m
Fuel storage facilities	0.5 m

Information on the highest flood level is easier to obtain locally and hence the use of HFL in the design of flood proofing measures. The difference in water level between the 1 in 20 year flood and the 1 in 100 year flood is often about 0.5 m, and hence the use of highest flood level rather than a flood level with a specific return period will result in only a marginal increase in cost.

### 3.6 Institutions

Institutional arrangements for flood proofing have not been decided upon, but it is likely that flood proofing activities will be focused on the unions. The union parishad will be the main local institution for planning and implementing flood

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<sup>3</sup>The occurrence of Highest Flood Level will vary with different flood environments. For example, the highest flood level on the Jamuna occurred most recently in 1988, while on the Meghna, the highest flood level occurred in 1991.

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proofing measures. Flood proofing activities can be planned and implemented with assistance from thana level government staff.

Thana development plans of roads, irrigation facilities, flood control embankments, and water and land use are prepared by the thana staff of the Local Government Engineering Department LGED (formerly Local Government Engineering Bureau (LGEB) and presented in the Thana Plan Book. In reality, many thana plan books are incomplete. Formerly there was also union plan books but these have not been used for many years and present efforts are focused on developing thana plans. One major constraint on union and upazila planning is the poor quality of maps in most upazilas. The maps being used generally only show political boundaries, and some of the major infrastructure. There are a number of projects within LGEB to improve the maps for upazila and union planning and adequate maps may soon be available in many more places.

Some non-government organizations are actively undertaking flood proofing activities, and their experience should be used by involving them in future flood proofing activities where possible.

Community flood proofing measures considered to be appropriate and necessary should be an integral part of all rural and urban infrastructure development planning, including planning activities of FAP.

### 3.7 Economics

The economics of specific flood proofing measures should be assessed but, as the benefits of saving lives, reducing suffering and improving the quality of life in rural areas are difficult to quantify, it is not possible to be too precise about whether particular measures are economically justified. Furthermore, the assets of individual households tend to be quite small but it is the large number of households affected by severe floods that results in financial damages being so large.

The method for assessing the economics of agricultural interventions like flood control and drainage are given in the 'Guidelines for Project Assessment' (FPCO 1991).

### 3.8 Environmental Consideration

Flood proofing measures are minor structural interventions and the small 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 are:

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



Possible impacts on the physical environment include

- forestry (planting of trees etc. for hydraulic protection)
- fisheries (use of borrow pits as fish ponds)
- livestock (sustainability during floods)
- surface drainage
- loss of land for borrow pits to raise house/flood shelters(for material to raise ground levels)

### 3.9 Financing

Past government interventions in flood proofing have not been too successful for a number of reasons including the lack of involvement of local communities and unclear responsibilities for operation and maintenance of completed measures.

Flood proofing interventions should be designed with active participation of individuals and local communities so that individuals or communities can 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 wheat) or from non-government organizations, some of whom have implemented flood proofing programs successfully.

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