FLOOD PROOFING

INCEPTION REPORT

FLOOD ACTION PLAN
Supporting Study No. 23

Eastern Waters Initiative
ISPAN Activity No. 710C

July 1991

ISPAN

IRRIGATION SUPPORT PROJECT FOR ASIA AND THE NEAR EAST

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ACRONYMS

ADAB	Association of Development Agencies in Bangladesh
ADB	Asian Development Bank
BADC	Bangladesh Agriculture Development Corporation
BARC	Bangladesh Agriculture Research Council
BIDS	Bangladesh Institute of Development Studies
BIWTA	Bangladesh Inland Water Transport Authority
BPDB	Bangladesh Power Development Board
BSCIC	Bangladesh Small & Cottage Industries Corporation
CIDA	Canadian International Development Agency
crore	10 Millions
DANIDA	Danish International Development Agency
DPHE	Department of Public Health Engineering
EEC	European Economic Community
FAP	Flood Action Plan
FCD/I	Flood Control, Drainage/Irrigation
FFW	Food for Works
FPCO	Flood Plan Coordination Office
GIS	Geographic Information Systems
GOB	Government of Bangladesh
ISPAN	Irrigation Support for Asia and the Near East (USAID)
JICA	Japan International Cooperation Agency
km^2	square kilometers
km/h	kilometers per hour
lakh	100,000
LCG	Local Consultants Group
m	meters
MCC	Mennonite Central Committee
MIDAS	Micro Industries Development Assistance Society
MPO	Master Planning Organization
NGO	Non-government Organization
NORAD	Norwegian Agency for International Development
OECF	Overseas Economic Cooperation Fund (Japan)
PDB	Power Development Board
PWD	Public Works Department
REB	Rural Electrification Board
RESP	Rural Employment Sector Programme
SIDA	Swedish International Development Authority
SMEC	Snowy Mountains Engineering Corporation
SPARRSO	Space Research and Remote Sensing Organization
Tk	Taka (Bangladesh Currency)
TOR	Terms of Reference
TTB	Telephone and Telegraph Board
UK	United Kingdom
UN	United Nations
UNO	Upazila Nirbahi Officer
USA	United States of America
USAID	United States Agency for International Development
WB	World Bank

EXECUTIVE SUMMARY

Findings to date indicate that flood proofing holds the potential of substantially reducing damage and human suffering caused by major floods. This is especially true in areas that are not covered by the various FAP projects, or even in protected areas which still carry a finite risk of incurring flood damage at any given time. In many cases, this can be accomplished at greatly lower cost, and with markedly faster implementation times, than complementary or alternative measures that require major structures and, consequently, long.er implementation times and greater costs. Other measures will require concerted, coordinated effort by local and central government agencies to ensure that public infrastructure remain operational during floods. Many actions taken in Bangladesh by individuals, local government and nongovernmental organizations (NGOs) provide evidence of the effectiveness and practicality of measures that have been adopted as national policy in other locations.

This Inception Report presents the results of preliminary activities by the Study Team in assessing the needs for, and scope of, systematic expansion of flood proofing as a damage-avoidance strategy; it describes the philosophy and aims of the study and presents a work plan for implementing the balance of the work and describes potential studies and Pilot Projects. Based on findings of the field work and Workshop, Pilot Projects will be identified and terms of reference prepared for examination of the effectiveness and implementation requirements of flood-proofing measures.

A set of data field data will be developed by rapid-survey methods for the flood-response and loss-avoidance mechanisms of urban residents and property owners. The survey will canvass both individuals and institutional representatives. ISPAN has tentatively selected the following sample locations:

Upazila	District	Region	Features
Bhola, S	Bhola	SW	Cyclonic, tidal
Bramanbaria, S	Bramanbaria	NE	Flash floods, FAP 14
Tangail, S	Tangail	NC	Compartmentalization, FAP 14
Sirajgang, S	Sirajgang	NW	Bank erosion
Sunamganj, S	Sunamganj	SE	Haor, Flash Floods, FAP 14
Faridpur, S	Faridpur	SW	NGO activity, Riverine

Flood Proofing as defined for this study (see Chapter 3) includes all actions by individuals, small groups, and by public- and private-sector institutions to reduce flood damage to their properties. The field work for this study concentrates on the flood response of urban residents and property owners. A companion project, the Flood Response Study (FAP-14), examines the flood response of rural populations. Special attention is to be given in this study to measures

that result from individual initiative and private-sector actions, preferably involving high public participation and low capital expenditure.

Flood-proofing activities have three potential targets: **public infrastructure, private capital properties,** and **personal livelihood and income.** Prospective actions to serve these targets can also be classified as management measures like government policies for encouraging and managing the wise use of flood plains, or as physical measures like minor or major structural changes that property owners and public infrastructure operators can take to reduce risk to, and exposure of, their assets. Several organizations, identified in Chapter 3, have already started work in implementing such management and physical measures on a systematic basis in their particular fields of interest.

Certain actions must be taken at the national level to support individual, private sector, and local government flood-proofing activities. Thus, before flood proofing is undertaken at any level, a reliable assessment of flood hazard (the location and frequency of occurrence of floods of various severity - water level, depth, and duration) incurred by the individual and his property must be available. Hence a nation-wide compilation and dissemination of such flood-hazard information must be performed. This will allow the individual or institution to assess his flood risk, and implement flood proofing measures commensurate with the risk. Using the same information, flood-plain management policies can be formulated by local governments to prevent unwise or unprotected development to take place on the flood plains.

Once flood-hazard information is available, a great range of flood-proofing activities are available, depending on the type of asset being protected. The study will use the rapid-assessment field study to determine the types of flood proofing that have been practiced in urban and periurban areas, and incorporate the best and most promising methods and ideas in a range of Pilot Projects and Pilot Studies designed to assess some of these ideas. The relative merits of these measures will be assessed by estimating indicative costs and benefits to be realized by carrying out such Pilot Projects, and by extrapolating these to estimate potential benefits to be reaped by a nationwide implementation of the activity.

Pilot Projects and Studies tentatively identified at this Inception stage are listed in Chapter 4 of this Report. Some of these items can serve as stand-alone Projects and Studies. Others are designed to be elements of larger projects. Still others, such as hydrological information dissemination, can and should be implemented immediately, as they are required for planning other Pilot Projects. The Study Team will convene a workshop to present these ideas and will then incorporate comments and suggestions in Terms of Reference (TORs) for Pilot Projects. Implementation of these Pilot Projects will take place during Phase II, upon identification and commitment of other donors.

Chapter 1

PROJECT SCOPE AND WORK PLAN

1.1 Study Scope

1.1.1 Goals

The overall goals of this study are to identify and examine prospective flood-damage abatement measures that are likely to prove: (a) *effective and economically justified*, (b) *suited to rapid implementation by private individuals or business concerns or local government units without major funding or significant control by central government*, and (c) *essential for implementation nation-wide by local and central government agencies for protecting public works and infrastructure.*

1.1.2 Objectives

As immediate objectives, ISPAN will examine the justification and implementation requirements for potential flood-proofing Pilot Projects and develop Terms of Reference (TORs) for their evaluation or implementation (Phase I). Pilot Projects will be tailored to meet the specific needs of individual areas. During Phase II, the Pilot Projects will be completed by other donors.

To identify prospects and collect information on their performance, the study complements the field investigations of FAP-14 (Flood Response Study). The Study Team will examine the flood response of affected people in urban areas that will range from medium-sized villages through some divisional cities. The study excludes Dhaka (FAP-8A and -8B) and cities under the Secondary Towns Protection Study (FAP-9). The target population for the study includes:

- flood-affected private individuals: their properties and livelihood
- private-sector businesses, industries, and other economic activity
- services and facilities of local and central government agencies

The response of agricultural communities to floods, and a study of how individuals within these communities cope, are to be covered in the Flood-Response Study.

1.1.3 Strategy

The emphasis of ISPAN's studies will be to identify options for ***avoidance*** of future flood damages, using a mixture of management practices, low-cost and low-technology structural means (eg. building modifications to existing and future private and public properties and infrastructure), and public infrastructure improvement through proper hydrologic planning.

1.2 Activities

During Phase I, ISPAN will determine the response of urban property owners and officials in dealing with unusual flooding. Phase I activities include the following tasks:

1. Perform a Data Review to gather as much information as practicable on the wide variety of subjects that Flood Proofing encompasses;

2. Design, execute, and evaluate results of a **rapid-appraisal type Survey** to identify the perception of, damages by, and response to floods by the various affected parties located in areas noted above. This enables the study to address problems local people consider important;

3. Devise a consistent means of quantifying preliminary, indicative, estimates of potential **Benefits and Costs** of various flood-proofing activities, taking into account considerations of equitable distribution of benefits and costs, and of the sustainability of such measures;

4. Convene a **Workshop** to present the results of the data review and field study, and to present a preliminary list of candidate measures for Pilot Project implementation in Phase II;

5. Identify, evaluate, and prepare **Pilot Project Designs**, considering suggestions and comments generated by members of internal work groups and various participants during the workshop; and

6. Identify **Potential Donors** that will funding one or more Pilot Projects or pieces thereof.

1.3 Investigations

1.3.1 Data Review

The first activity in Phase I is the data review to gather as much information as practicable on the wide variety of subjects that this study is to encompass. This will be an on-going activity that will dominate much of the first half of the project, until the field data are available. The review will include examination of reports, meetings, interviews, and a search of relevant background information obtained from GOB sources, donor agencies, NGOs, concerned scholars and citizens, and technical consultants employed by these agencies. The findings, preliminary flood-proofing possibilities, and work plan will be presented in the Inception Report (this document).

1.3.2 Survey

The data review leads directly to the design and execution of a rapid appraisal to assess the perception and response of individual respondents living in

predominantly urban and periurban areas. This field survey also includes extensive interviews of government officials who are intimately involved with flood-related activities to assess the institutional response to floods.

This survey is expected to identify measures that people and agencies have used in the past to protect themselves and their properties from flood damages, what they think they could do in the future, and what they think should be done by others to help them in the future. Given the short time span allotted for the field work (about one and a half months), the field study is more an urban version of a "rapid rural appraisal" survey than a formal, rigorous survey like that being undertaken for the Flood Response Study (FAP-14). The methodology for the field study is covered in the section entitled "Survey Method".

In addition to the field survey, brief visits will be made to selected areas directly affected by the April 1991 Cyclone to investigate opportunities for flood proofing in zones vulnerable to cyclone damage.

1.3.3 Benefits and Costs of Flood Proofing

The Study Team will, for each of the potential Pilot Projects identified, assess indicative costs and benefits. It also will estimate the costs and potential benefits of the pilot activity should the activity be put into practice nation-wide.

It is expected that evaluation of the benefits of flood proofing will be especially difficult, as benefits will not necessarily be equal to the value of the *quantifiable* losses prevented. The additional security felt by individuals and communities by protecting themselves against floods of known severity cannot be quantified easily. The benefits of community participation and initiatives in carrying out flood proofing activities is yet another difficult item. It may be that the index for assessing the benefits of flood proofing to be developed by FAP-23 may involve subjective, non-numerical criteria for assessing the intangibles.

Equitable distribution of benefits and costs, as well as project sustainability, are supplementary concepts to be considered in ranking the relative desirability or effectiveness of alternative flood-proofing activities. The ability of a community to maintain flood-proofing measures year after year minimal outside assistance is an important consideration in evaluation of potential measures.

1.4 Project Outputs

1.4.1 Reports

The Inception Report presents the outcome of preliminary activities performed during the early months of FAP-23. The report sets out the criteria and objectives of the field study, and presents a preliminary list of possible Pilot Project Activities. The organization of this Inception Report is presented at the end of this Chapter.

The results of the survey and some preliminary ideas and tasks for Pilot Studies will be presented in a Workshop Paper, which will serve as the catalyst for discussions and feedback from the various participants in the Flood Proofing Workshop.

The final "deliverable" of this project will be the Phase I Report, which will, in effect, be the final report for this phase of the report. It will contain an overall report for the project, identify prospective Pilot Projects for Phase II, and present the TORs for these Pilot Projects.

1.4.2 Workshop

The Workshop is expected to last for one to two days, with invited guest speakers presenting important findings and concepts for next steps, followed by discussion and input from all participants. The Study Team expect the Workshop to generate insights and suggestions that will enhance and shape the "seed" concepts for Pilot Projects presented in the Position Paper and identify additional potential Pilot Projects that the participants feel are feasible and appropriate for future implementation.

The topics that may be covered in the Workshop include flood-hazard assessment and floodplain-management issues, interaction of various "flood preparedness" issues with flood proofing, and specific flood proofing measures that could be implemented as institutional, community, or personal actions. Questions of the relative benefits and costs, equity, and sustainability are expected to be featured among the Workshop topics.

1.4.3 Pilot Projects

Based on the field study, a series of work group meetings with Study Team staff and invited specialists, and on the feedback from parties that attend the Workshop, the Study Team will examine and select a variety of candidates for Pilot Projects and Pilot Studies. These will be described in a series of short project descriptions that outline the objectives, proposed methodology, an indicative estimate of man-months and costs, and a proposed implementation schedule in the Phase II period. For a selected few projects, the Study Team will prepare more detailed draft Terms of Reference (TORs) for adoption and execution by donors. The TORs are expected to be documents with more detailed proposed scopes of work and task lists, and have indicative manpower and budget requirements.

These candidates are expected to range from technical and sectoral studies ("Pilot Studies") to action plans ("Pilot Projects") that physically implement, on a trial basis, some of the flood-proofing and floodplain management concepts and methods. The information and findings from the Pilot Studies will lead directly to implementation in Pilot Projects that will be designed during these Studies.

Implementation sites and donors will be selected, as far as practicable, using criteria similar to those described below under "Survey Method." A geographical

profile of each selected upazila site will be prepared. Measures that are appropriate for each locale will be recommended.

The Study Team will identify Pilot Projects to evaluate or demonstrate those flood- proofing measures that might be implemented with low public capital inputs and high public participation, recognizing that flood proofing in some circumstances could be a collective effort by the entire community. Other possible Pilot Projects will involve a concerted effort by government agencies to floodproof infrastructure in order to ensure the provision of services during floods.

1.4.4 Prospective Donors

The Study Team will seek to identify and inform potential donors who may be interested in funding various Pilot Projects. Potential donors may be those who are already involved in aiding community-based projects through NGOs, infrastructure improvement through local government, or in funding other physical facilities through public- or private-sector institutions.

1.5 Survey Method

The study has two dimensions. One dimension relates to the individual property owner in the upazila towns and other urban areas; another relates to institutions.

The aims of both the individual and institutional surveys and analyses are to:

1. Obtain information on the nature of flood damages and suffering normally experienced by individuals and organizations;

2. Survey major flood-proofing measures adopted by individuals and organizations (public or private) to:

   - assess the effectiveness and cost of flood-damage mitigation and flood-proofing measures;

   - assess the requirements for regional or national adoption of these measures.

   Questions will be adapted to fit the particular institution or professional specialty of the respondent as it relates to flood proofing; and

3. Obtain information to help identify potential organizations or agencies for execution or funding of pilot flood-proofing activity.

Questionnaires have been designed to elicit this qualitative information from both private and institutional respondents. The forms comprise basic data-gathering instruments to which will be added group-, application-, or institution-specific questions, as judged best during the actual field interview.

The institutional and individual questionnaires were field-tested and revisions incorporated in June-July 1991. The field study will commence in July 1991, and is expected to be completed by mid-August 1991.

The study will cover urban areas located in at least six upazilas. Each upazila will be selected from one of the most flood affected districts in the 1988 flood. Further criteria for selection are that at least one upazila from each FAP region be chosen, and of these:

- one from a predominantly char area,
- one from a flash flood area, and
- one from a haor area.

A list of candidate sites, including the tentatively selected ones, is shown in Table 1. Given the limitations of timing and scale of the study, individual respondents will be selected based on a stratified sampling methodology that identifies respondents who can supply the most and best information. In an upazila town, the population primarily consists of such socio-economic units as craftsmen, merchants, professionals, religious, and political groups. The study will select respondents randomly from each of these groupings. In determining the number of respondents from each socio-economic group, private-sector organizations will be given greater weight, because they comprise the source of most of the economic activity at the local level.

Due to time and resource constraints, the number of individual respondents from each upazilas will be limited to nine persons distributed as follows:

- three in the wholesale businesses (one each from: timber or wood furniture, medicine, and stationery)
- three from among shop owners (on each from: medicine shop, food items shop, and house construction materials); and
- three professionals (one teacher, one lawyer, and one *imam*).

Among the professional respondents, a positive attempt will be made to include female respondents in the sample. Thus, the total number of respondents in six upazilas will be 9 x 6 = 54. This sample size is considered to provide an adequate cross section of the target urban population for this "rapid-appraisal" level of effort.

At the upazila level and below, the institutional study will include interviews with concerned and knowledgeable local government officials and local elected representatives such as the union parishad or upazila parishad chairman. The Study Team also will conduct interviews with selected, concerned and knowledgeable officials at central level of relevant Ministry, department, or directorate units.

FAP-23 will obtain useful information from the experience and activities of NGOs active in areas affected by riverine floods and cyclones. The experience of the NGOs and, most importantly, the people they work with, in coping with floods

Table 1 List of Shortlisted Upazila Study Sites

UPAZILA	DISTRICT	FAP REGION	FLOODING FEATURES
Bramanbaria (Sadar) **	Bramanbaria	NE	Flash Floods, FAP 14
Kamalganj	Moulavi Bazar	NE	Flash Floods
Bhairab Bazar	Kisahareganj	NE	Bank Erosion
Jamalpur (Sadar)	Jamalpur	NC	Compartmentalization
Dhamrai	Dhaka	NC	Urban riverine
Mirzapur	Tangail	NC	Compartment., FAP 14
Tangail (Sadar) **	Tangail	NC	Compartment., FAP 14
Chowhali	Sirajgonj	NW	Char
Sirajgonj (Sadar) **	Sirajgonj	NW	Bank Erosion
Kurigram (Sadar)	Kurigram	NW	Riverine
Chandina	Comilla	SE	Riverine, Flash Flood
Chandpur (Sadar)	Chandpur	SE	Riverine
Faridpur (Sadar) **	Faridpur	SW	NGO Activity, Riverine
Shariatpur (Sadar)	Shariatpur	SW	Riverine
Gopalganj (Sadar)	Gopalganj	SW	Riverine
Kushtia (Sadar)	Kushtia	SW	Riverine
Satkhira (Sadar)	Satkhira	SW	Tidal/cyclonic, FAP 14
Sunamganj (Sadar) **	Sunamganj	NE	Haor, FAP 14
Bhola (Sadar) **	Bhola	SW	Char, Cyclone, Tidal

NOTE: ** - Sites tentatively selected for field study

(before, during, and after) will be gleaned and compiled as part of this FAP. Private cottage industries and donors also will be covered at this level. Non-government and government agencies likely to be covered by the study are shown in Appendices B and C, respectively.

The results of the survey will be analyzed qualitatively to sample actual responses to floods by urban individuals and urban-based institutions. Flood-proofing and damage mitigation measures used by the various respondents will be classified according to the type of respondent, the particular field the respondent represents, and the type of flood-proofing undertaken. Also classified will be the improvements or techniques they propose to implement the next time they are called upon to work on flood-proofing properties and facilities. Also, from an institutional viewpoint, assessment will be made of

what respondents perceive to be the duties of other agencies for flood-damage mitigation, supplementing the respondents' own efforts.

1.6 Coordination with Other FAPs

The Study Team will interact with a number of other closely-related FAP projects, as permitted by the timing of the various activities of this study and those of the others.

They will rely heavily on input from the Flood Response Study (FAP-14), for flood-response and flood-proofing activities in rural households and small communities. Of particular interest are the early returns and preliminary results of analysis of the field survey. Input also will be sought from the activities of the FCD/I Agriculture Study (FAP-12), taking advantage of the expertise of that project staff's experience in flood-proofing management activities.

Two other FAP studies have objectives closely related to the overall objectives of this study, including Flood Forecasting and Early Warning (FAP-10) and Disaster Preparedness (FAP-11). Early warning of floods at the local level is instrumental in implementing many individual and local flood-preparedness activities in a timely fashion. The Study Team has interacted with experts assisting in the TOR preparation for the latter study. Flood-proofing measures are typically planned hand in hand at the community level with flood preparedness activities. A further possibility for interaction with FAP-11 is noted in Chapter 2.

Information from the Cyclone (FAP-7) and Flood Modelling and Management (FAP-25) studies will be used in conjunction with previous MPO studies such as flood-frequency analyses (MPO Technical Report 11) to help derive flood hazards of different hydrologic regions. Input also may be sought from the latter study, in the form of technical advice, training, and computer simulation runs to extend available hazard information.

The use of the GIS facilities to be developed in the Geographic Information Systems Study (FAP-19) may be programmed into the flood-hazard information dissemination activities of this study, including possible concurrent execution of Pilot Projects to demonstrate hazard information.

As the study proceeds, information will be exchanged with the Regional Studies (FAP-1 through -6) and Town Protection projects (FAP-8 and -9) as required, and with relevant supporting studies (FAP-12, -16, -17, -18, and -20, for example). In particular, the experience of FAP-8A in the production of useful supplementary topo maps, preparation of a floodplain management program, and delineation of flood boundary-depth-duration maps will be especially useful.

The input of knowledgeable specialists at the various universities and government organizations will be sought as required in the course of the flood-proofing study and pilot project implementation. As part of the project, the Study Team will interview and maintain liaison with selected NGOs and government organizations that are active at the upazila level and below. We expect that Pilot

Project TORs will include those identified through active participation of NGOs and local government officers in the selection of prospective flood-proofing activities.

Table 2 FAP-23 Man-month Allocation

Staff Category	Position	Original (man-mo)	Proposed (man-mo)
Expatriate	Team leader	6	8
	Other specialists	5	3
	SUB-TOTAL	11	11
Local Consultant	Sr. Institutional Specialist	7	8
	Economist	1	3
	Institutional Specialist	-	3.5
	Engineer/Hydrologist	7	3.5
	Others	4	1
	SUB-TOTAL	19	19
	TOTAL	30	30

1.7 Staffing

The Study Team will include the Team Leader, Senior Advisor (Institutional Systems), and three support staff members with backgrounds in economics, geography or hydrology, and public administration. These specialties will encompass the range of fields needed for interview of survey respondents, evaluation of review and survey findings, and scoping of the TORs.

The three support staff members, assisted by field enumerators, will be primarily responsible for conducting the interviews and analyzing the results. The Team Leader and the Senior Advisor (Institutional Systems) will supervise and coordinate the field study and report writing, and they also will conduct selected interviews at both local and central levels. Specialist support and supervision will be provided by the Senior Advisors for Water Resources and for Public Administration.

The total allocated man-months for this project are 11 expatriate man-months and 19 local professional consultant man-months. The original distribution of man-months has been reallocated as shown in Table 2. The total man-months allocated to the project is not expected to change.

1.8 Schedule

The project task and staffing schedules are shown on Figure 1. The principal expatriate and Bangladeshi staff and their time commitments also are shown on the chart.

The Flood Proofing Team Leader (Yamaguchi), Senior Water Resources Advisor (Aten), and the Senior Advisor-Institutional Systems (Choudhury) started FAP- 23 in April 1991 after a one-week reconnaissance visit by the Team Leader to Dhaka

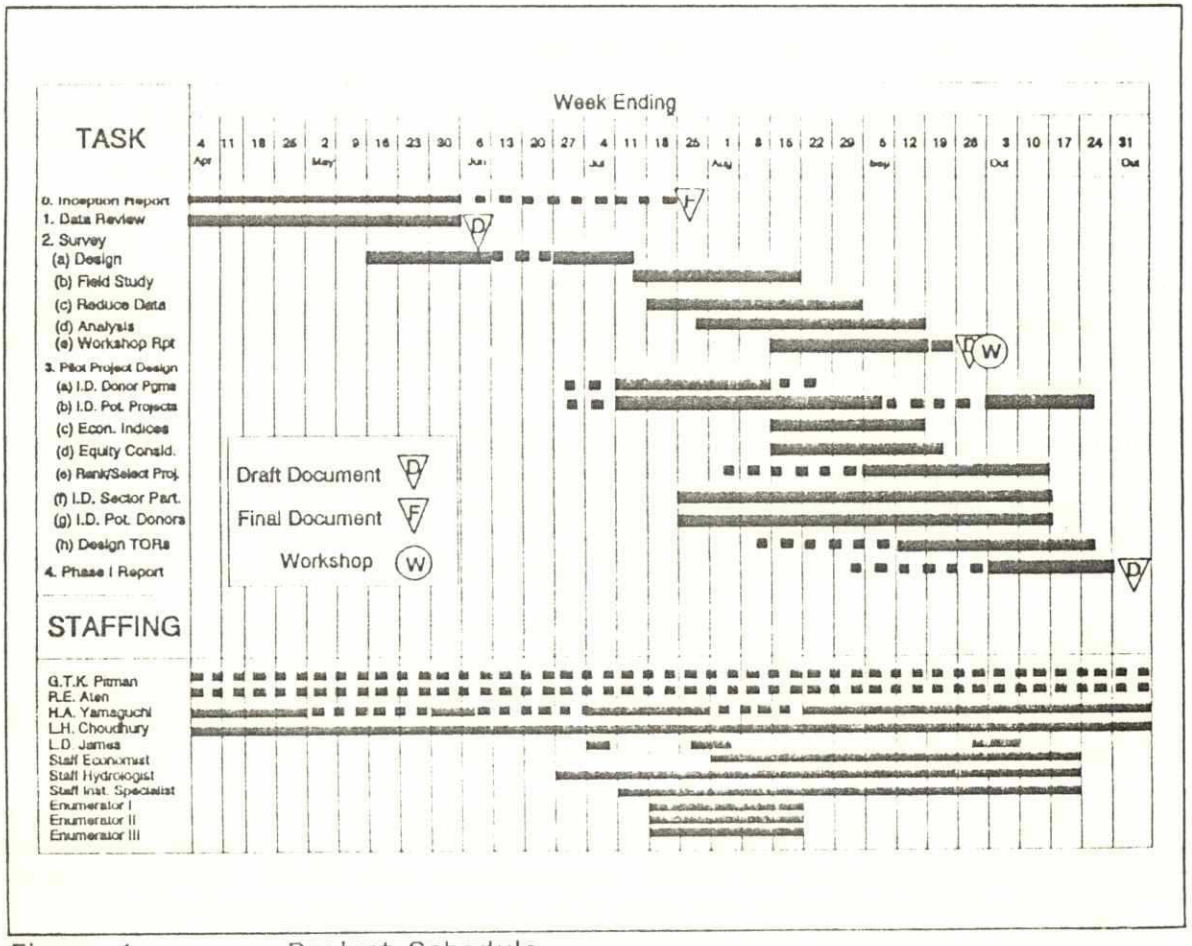

Figure 1 Project Schedule

in January 1991.

The project is expected to last for approximately seven months, with a projected completion of the Phase I Report and Pilot Project TORs in November, 1991.

Project milestones are as follows:

1.	Inception Report Draft	May 1991
2.	Inception Report Final Draft	July 1991
3.	Issues Report (Workshop Paper)	September 1991
4.	Flood Proofing Workshop	September 1991
5.	Draft Phase I Report	November 1991
6.	Final Phase I Report	December 1991

The expatriate Floodplain Management and Economics Specialist and the local Institutional Specialist, Economist, and engineering hydrologist will commence work on the project approximately according to the schedule shown in Figure 1-1, timed to provide key inputs at the field study survey and in preparation for the Flood Proofing Workshop

1.9 Organization of This Report

This is the Inception Report of FAP-23, Flood Proofing. Chapter 1, this chapter, presents the organization and work plan for the project, as well as the structure of the Inception Report.

Chapter 2 presents the general background for this project. Included are a discussion of flooding in Bangladesh, the unusual floods of 1987 and 1988, estimated damages incurred in those events, and the need for local and individual measures to avoid damages in future floods. A brief description of the institutional setting in Bangladesh for flood proofing is followed by a general introduction to the Flood Action Plan.

Chapter 3 defines the term "Flood Proofing" as applied in FAP-23. It describes briefly some potential measures that could be included within the definition, and presents some instances of flood proofing that were locally initiated in Bangladesh. The chapter concludes with a comparative description of flood proofing and floodplain management measures currently in practice abroad.

Chapter 4 presents some candidate flood-proofing activities that have been identified thus far. For each activity, a brief description of the activity and the affected population is provided. Some indication of the likely major tasks and the entities responsible for implementation and maintenance are also tentatively identified.

The Appendices present detailed information on selected topics. Appendix A provides a list of selected references examined to date. Appendix B presents a list of NGOs active in flood preparedness and flood proofing activities. Appendix C lists involved government agencies that are potential survey targets. Appendix D provides more information on types of flood-hazard information. Finally, Appendices E and F provide the questionnaires to be used to interview institutional, private citizen, NGO, and commercial and industrial interests that will be interviewed and studied in the field study.

This Inception Report was compiled by Howard Yamaguchi, Team Leader, with major input on institutional matters by Dr. Lutful Huq Choudhury, Senior Advisor (Institutions), NGO activities by Mr. Nayeem Wahara (Institutional Specialist), and on rural-household response by Dr. Md. Alamgir, Team Leader, Flood-Response Study (FAP-14).

Dr. L. Douglas James (Utah State University) provided detailed guidance on the general philosophy of flood proofing, economics, and flood hazard mapping. Dr. M. Shamsul Alam (Jahangirnagar University) and Mr. Tom Wagner (FAP-19) provided valuable insights on flood hazard mapping possibilities. Mr. Dick Aten, Chief of Party, provided useful comments and suggestions and, with Dr. Keith Pitman, Program Manager, reviewed early drafts. Assistance and cooperation also were provided by Dr. Stan Hirst and Mr. Tim Martin, Team Leaders for the Environmental and GIS Studies (FAPs -16 and -19).

Chapter 2

INTRODUCTION

2.1 Background

The Flood Action Plan (FAP) was conceived to provide an integrated, coordinated approach to mitigating the effects of flooding in Bangladesh after the great riverine floods of 1987 and 1988 riveted the attention of the world to the problems in Bangladesh. The Flood Proofing Study (FAP-23), was conceived as a supporting study concentrating on flood preparedness and floodplain management in the predominantly urban areas, complementing the rural study emphasis of FAP-14 (Flood Response Study). The overall history of the FAP and the place of FAP-23 in the FAP is described in "Relationship to the Flood Action Plan" below.

The devastating cyclone of April 29-30 1991 emphasized the vulnerability of the inhabitants of coastal areas of Bangladesh to another, much deadlier, type of flood hazard. The original riverine emphasis of FAP-23 may be shifted to include more cyclone-oriented flood-proofing and flood-preparedness activities within the overall framework of the U.S. studies as conceived under the Eastern Waters Initiative.

2.2 Flooding in Bangladesh

The annual occurrence of high water in all parts of Bangladesh is a normal part of the lifestyle of the population. In most parts of the country, people adjust their activities to accommodate these "normal" water-level rises, usually referred to as "inundation." Inundation (*bharsha*) is perceived as a beneficial phenomenon. When the water reaches abnormally high levels, causing damage, loss of life, or unusual hardship, the event is referred to as a "flood" (*bonna*).

There are four major types of floods in Bangladesh: rainfall-induced floods, monsoon riverine floods, flash floods, and coastal floods, both tidal and cyclonic. Each differs in timing, severity, and cause. Together with many other hydrologic and land-form characteristics, this variety of flood types gives rise to a complex environment for evaluation of flood hazards and planning of protection works or programs.

2.2.1 Rainfall-Induced Floods

These floods are caused by excessive precipitation ranging in duration from a few days to up to two weeks. Runoff from these rains causes normal inundation in many areas of the country. Unusually high rainfall amounts, intensity, or unusual combinations thereof may overwhelm the capacity of the local drainage network to carry the runoff, particularly if the natural drainage system has been seriously impeded by new infrastructure that was not provided with adequate cross-drainage facilities. In fact, observations in the field by various workers indicate that the recent spread of rural infrastructure with inadequate cross-

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drainage facilities has increased the frequency and severity of rainfall-induced flooding in many areas of the country. In the Northeast, runoff from early-season events collects in low-lying, slow draining (haor) areas which may remain inundated for the duration of the monsoon season with total crop loss.

2.2.2 Riverine Monsoon Floods

These floods are caused by overspill from the major river systems, which carry snowmelt and monsoon runoff from virtually the entire watershed, with most originating in India with contributions from Nepal and Tibet, as well as from local runoff events. River stages rise and fall relatively slowly, over time periods that range from several weeks to a month. Large areas (50% of the land area in 1988) are inundated by the monsoon floods, and the situation is generally disastrous when all rivers reach peak stage a the same time. Peak flows in the Brahmaputra (July-August) normally precede those in the Ganges (August-September).

2.2.3 Flash Floods

These floods, caused by rains in the hilly and mountainous areas surrounding Bangladesh to the northeast, east, and southeast, as well as the Rajshahi High Barind in the west, are marked by rapid rise of floodwater and an equally rapid recession. Steep stream slopes and small times of concentration characterize the upper catchments of the areas vulnerable to flash floods. These typically start in April and May, and they can cause damage by rapidly rising stage, high velocity flow, or sediment deposition. No systematic estimate of damages has been reported, but press reports state that recent flash floods (early April 1991) in Sylhet and elsewhere have inundated over 2,100 square kilometers of cropland.

2.2.4 Coastal Floods

In addition to riverine floods floods in coastal areas result from (a) flooding (inundation) caused by the extreme high spring tides usually occurring during the Monsoon season and (b) extremely damaging storm surges occurring during the cyclones that sweep in from the Bay of Bengal. Most of the existing coastal embankments were designed to provide agricultural lands with protection from saltwater inundation during the extreme Monsoon high tides and, hence, can provide only limited protection to people and property during cyclones.

Bangladesh has about 700 km of coastline vulnerable to cyclonic storms that occur in April or May or during the period from September through December. Cyclones (known as *typhoons* or *hurricanes* elsewhere) form in the southeast portion of the Bay of Bengal, and move in a northerly or northwesterly direction, turning northeasterly or easterly toward the southeast and east coasts of Bangladesh. Damages are caused by violent winds (as much as 240 km/h), wind-generated waves, bore, and storm surges. Flood levels are known to have reached elevations of 10 to 15 m above mean sea level when coincident with high tide (Kampsax, 1990).

Extremely heavy loss of life is commonplace, with 19,000 dead in May 1965, 870 in December 1965, 850 in November 1966, 250,000 to 500,000 in November 1970, 4,300 in May 1985, and as much as 138,000 in April 1991. Corresponding losses of property and public infrastructure also occur during these storms.

2.3 Recent Events

The two greatest recent monsoon floods occurred in Bangladesh in 1987 and 1988. The occurrence of these floods in consecutive years, along with the unusual severity of the 1988 flood, precipitated the formulation of the FAP.

The cyclone of April 1991 emphasized the country's vulnerability to a far deadlier natural hazard.

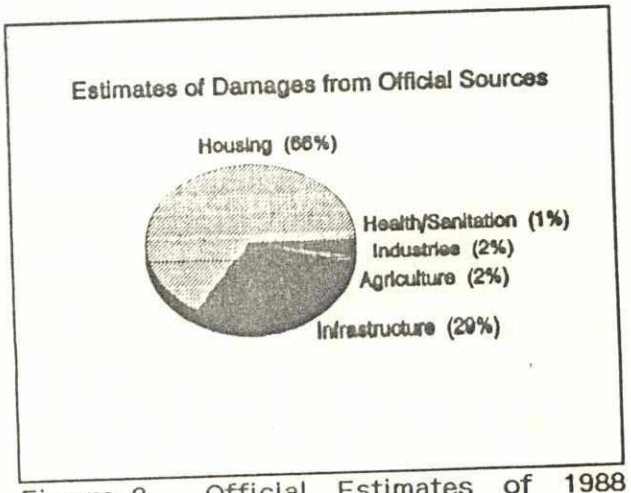

Figure 2 Official Estimates of 1988 Flood Damage

2.3.1 1987 Flood

In 1987, extensive rainfall in Bangladesh as well as in the surrounding upper catchment areas of West Bengal and Bihar, Bhutan, Nepal and Assam caused extensive rainfall-induced floods. Regions normally affected by flash floods also were hit during these floods. Return periods of these events ranged, for different locations, from 20 to over 100 years. The high water levels and overspill from the main rivers exacerbated backwater conditions in the smaller streams draining local runoff, prolonging inundation. The record high peaks in the major rivers coincided with spring tides, further worsening the flood situation. Approximately 57,000 square km of land was inundated.

2.3.2 1988 Flood

In 1988, heavy flash floods in late June and flood peaks in the Meghna basin in early July, and Brahmaputra basin flood peaks in mid- to late July left much of Bangladesh and its upstream catchment areas with the usual very high antecedent moisture conditions by late August. The heavy rains of mid- to late August occurred mostly in the upper catchment areas of Tibet and India. The resultant floods, in which the Ganges and Brahmaputra peaked simultaneously, and in which extensive local runoff events exacerbated conditions, caused extensive inundation throughout the country, with estimates of flooded areas ranging from 76,000 to 82,000 square km.

Damages from the 1987 and 1988 floods have been estimated to total slightly over $1,000 million, and deaths totalled more than 2,000, although natural mortality during the flood period might account for most of the total. Figure 2 shows 1988 flood-damage estimates from official sources. The information from official sources (Siddique, 1989) indicates that overall, housing comprised 66 percent of

the damages during the 1988 floods. Various public works infrastructure, both urban and rural, made up most of the rest (29%) of the overall damages.

From surveys performed at the village level (Hossain, 1989), housing losses accounted for the largest single group of losses. The second largest group accrued to farmers (agricultural crops, livestock, and aquaculture, with some losses in stored crops and goods). Rural infrastructure comprised the third largest group of losses. Figure 3 illustrates these findings.

The sectors showing damage in Figures 2 and 3, particularly those of public infrastructure and private properties such as housing and industry, stand to benefit from a systematic program of flood-proofing and floodplain-management activities. The distribution of damages for the 1988 flood from both these estimates suggest the great potential of such carefully thought-out, locally initiated, self-sustaining flood-proofing programs.

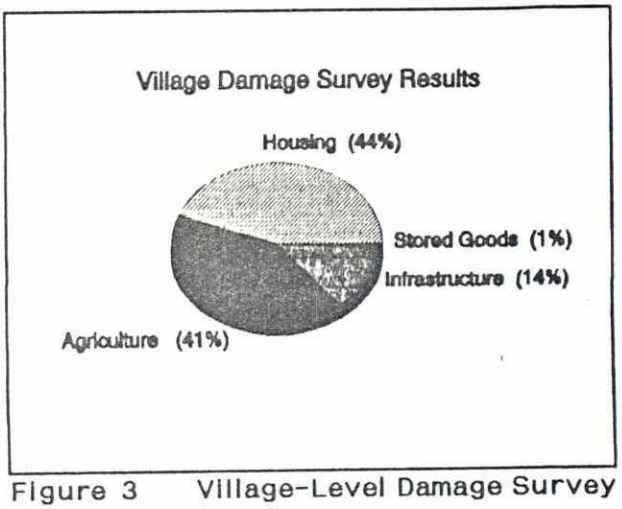

Figure 3 Village-Level Damage Survey Results

2.3.3 Cyclone of April 1991

The April 1991 cyclone devastated the southeastern coast of Bangladesh, claiming, according to official estimates, 138,000 lives. Worst affected were the coastal cities of Cox's Bazaar and Chittagong, as well as the innumerable villages in the vicinity of these areas. The islands of Kutubdia, Maheskhali, and Sandwip, as well as other islands nearby, were ravaged by winds and surges during the cyclone, and the effects of saline inundation of agricultural lands and fish cultivation ponds in the aftermath of the storm. Maximum wind speeds are estimated to have been 225 km/h at Sandwip, 185 km/h at Cox's Bazaar, 180 km/h at Kutubdia and Bhola, and about 160 km/h at Teknaf and Chittagong (Kibria, 1991).

The existing system of coastal embankments, dilapidated or non-existent in places, were designed to protect coastal agricultural areas against extreme spring high tides that occur during the Monsoon season. These embankments offer some protection during cyclone events, but are not designed to withstand the forces that manifest themselves in the path of a cyclone.

Damage during the 1991 cyclone resulted from extremely high winds and consequent surge, probably with bore intensification, at least locally. Greater losses are considered likely had the storm come ashore at high tide or had the GOB warning system not resulted in evacuation of more than one million people. Quantification of damages is taking place at the present, with various

government, NGO, and private-sector organizations compiling losses from the cyclone.

2.4 Relationship to The Flood Action Plan

The extreme floods of 1987 and 1988 stimulated the Government of Bangladesh (GOB) and several donors to conduct comprehensive reviews of flood-protection policies and programs. A number of studies were completed and, in June 1989, the GOB requested that the World Bank (WB) coordinate the development and implementation of a five-year Flood Action Plan (FAP, 1990-95) as the first of several stages in the GOB's long-term flood control program. The need for coordinated international action, in support of the GOB, to find solutions to the flood-damage problem that are technically, financially, economically and environmentally sound was endorsed at the G-7 Summit in Paris in July 1988. GOB oversight of FAP study, design and implementation activity is being provided by the newly-established Flood Plan Coordination Office (FPCO).

The GOB sought an approach which would provide a comprehensive and permanent solution to the recurrent flood problem and so create an 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, including major embankment and river training works, and a set of eleven principles to guide future development.

The principles include a number of so-called "soft" approaches to flood protection and mitigation, 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
- increased local and individual participation in all aspects of flood control and drainage works.

Minor local works also are to be considered.

These soft approaches are intended to apply to all Bangladesh floodplains, which occupy about 60 percent of the net cultivated area and total about 100,000 of the 144,000 square kilometers (km^2) of Bangladesh's area. 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;

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- substantial areas that may eventually be provided with protecti
  remain unprotected for 20 years or more during the implementation
  finally,

- all protected areas will remain vulnerable to damage during catastrophic failure or overtopping of structures during floods of greater than design protection level (flood recurrence interval).

The FAP comprises eleven major components for identification and planning of structural flood-control facilities and fifteen Supporting Studies. Flood Proofing (FAP Study No. 23), is one of the Supporting Studies. Flood Proofing includes most of the items on the list of "soft" flood protection activities, covering floodplain areas listed above. Flood-proofing measures should be relatively low-cost, non-structural or minor-structural, locally-initiated, and sustainable.

Preliminary accounts concerning the April 1991 cyclone indicate that either the magnitude of loss or the poor performance of some protection works provides sufficient cause for many elements of the FAP to be reconsidered, perhaps most of all FAP-23 Flood Proofing. Hence, this study will address not only riverine flooding effects, but also measures that would include some level of preparedness and loss avoidance from cyclones.

2.5 Institutional Considerations

Incentives and support by central- and local-government authorities of locally-initiated efforts are key components in successful individual and institutional flood-proofing programs.

2.5.1 Central and Local Governments

At present central government, donors, and NGOs all have become more conscious and aware of the need for mitigation measures to prevent and reduce property loss, damage, and human suffering due to floods. During the floods of 1987 and 1988, and after the cyclone of 1991, the Ministry of Relief and Rehabilitation (MRR) took the main responsibility in disaster-relief efforts. They were assisted by other line ministries, local-government bodies (Union Parishad, Upazila Parishad and Pourashavas), international agencies, NGOs, and community groups.

After the 1988 floods, many government agencies other than the MRR developed relief and investment programs. Line ministries that have provided for relief and flood-preparedness programs include agriculture; irrigation, water resources and flood control; fisheries and livestock; industries (particularly small and cottage industries sector); forestry and environment; communications; and local government and rural development; and health and education, as well as separate departments and semi-autonomous units, including housing, water supply, and power.

The role of local government bodies such as Union Parishad, Upazila Parishad, and Pourashava in initiating and implementing flood-proofing measures with local resources, local support, and local participation will be explored in this study. These organizations, which form the crux of the effort to decentralize decision-making and development activities in Bangladesh, could play a key role in any flood-proofing effort.

2.5.2 Community Groups and Non-government Organizations

The recent study entitled Disasters and Development (BIDS, UNDP, 1988) shows the type of community groups and the degree of participation of each group in flood and rehabilitation activities. Community groups consisted of social, professional, private voluntary, cultural, political, commercial, educational, and religious groups. Social organizations constituted more than a quarter (26%) of the total, followed by professional bodies (18%). NGOs constituted 16% while political parties and their affiliated front organizations constituted 12%. A number of private business enterprises (5%) also took part in the relief and mitigation measures. See Figure 2-2.

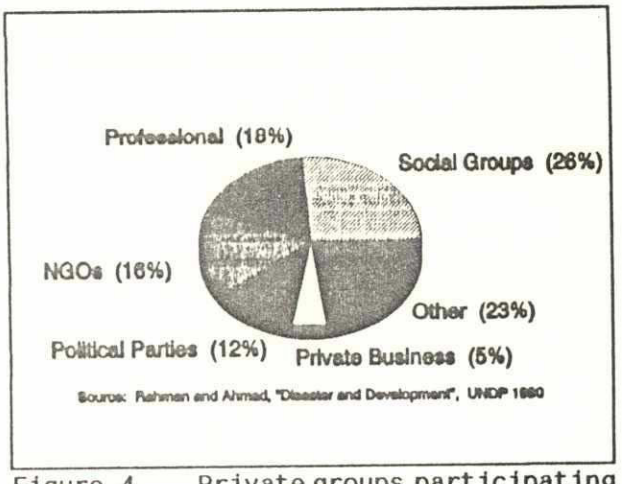

Figure 4 Private groups participating in 1988 flood relief and rehabilitation work

Disaster-mitigation programs also occupy a prominent place in donor assistance and NGO programs. The participation and involvement of NGOs in flood relief and mitigation efforts and activities were very prominent. They appeared to be the only organizations working closely with the villagers. NGOs' management flexibility, coupled with their experience of working directly with people at the grassroots level, put them in an advantageous position to undertake local mitigation measures. (Furthermore, the experience of working closely with the affected peoples makes the NGOs and other organizations valuable repositories of folk wisdom in avoiding hardships and needless damage during floods.)

The cyclone of 1991 provides a case in point. The Red Crescent Society, through the network of staff workers and volunteers in the Cyclone Preparedness Program, enabled more than 350,000 people to reach the safety of public shelters and protected areas before and during the 1991 cyclone. About 100 Red Crescent workers and volunteers lost their lives in the process. 12 cyclone shelters were provided by Caritas, an NGO, for the people in the path of the cyclone. NGOs such as CARE and others were among the first to arrive at the site and commence relief operations in the areas affected by the cyclone of 1991. Coordinated relief activities, followed by rehabilitation activities, were implemented in the affected areas.

2.5.3 Needs

The relationship between central government, local government bodies, and NGOs must be strengthened. In many areas, NGOs and local bodies regard each other with suspicion, if not outright hostility. In reality, their roles need not be competitive, but complementary, in flood-proofing and flood-preparedness activities. There may be a need for a coordinating body to work among the affected line ministries, community groups, NGOs, the international community, and donors.

The Study Team will explore the mix and roles of the participating institutions in promoting and implementing flood-proofing activities. Among others, a possible output of this study will be to share some of the experiences of the NGOs and the people with government officials, perhaps through training curricula developed in FAP-11, Disaster Preparedness, and its bridging predecessor, UNDP Project BGD/91/021/B/13/31. The experiences of local people in flood proofing and preparing themselves, their households and communities, against floods and cyclones (and their aftermath), could potentially be disseminated widely throughout the country by training local government officials. The trained officials, in turn could advise and implement these local, village- and household level measures in their respective postings throughout the country.

Chapter 3

FLOOD PROOFING

3.1 Definition

The term "Flood Proofing", in its narrowest sense, refers to measures that alter structures and their contents so that water is kept out, or so that the effects of water entry are minimized (U.S. Army Corps of Engineers, 1972). This same reference also notes that "a main purpose of flood proofing habitable structures is to provide for early return to normalcy after floods have receded, rather than for continuity of occupancy." It further cautions against habitation of flood-affected structures during flood events.

At the other extreme, "flood proofing may be defined to include all actions by individuals or small groups within the flood plain to reduce flood damage to their property" (James and Lee, 1971). This broader definition could be interpreted to include structural measures noted above, flood fighting, flood-hazard information dissemination, flood preparedness and response, flood warning and forecasting, as well as non-structural floodplain-management practices that seek to avoid or reduce damages due to floods. These practices can be implemented either by government agencies or NGOs, as well as by individuals or privately-owned organizations, under this expanded interpretation of the James and Lee definition.

The Study Team recognizes the existence of an extremely wide range of possible damage-mitigation measures available to the variety of people and facilities affected by riverine and cyclonic floods. Consequently, for this study, we will adopt the latter, broadest possible, definition of Flood Proofing. It includes measures noted below, as well as elements, where appropriate, that are under investigation by a series of related FAP main and supporting studies, as discussed under "Coordination with Other FAPs", Chapter 1.

3.2 Planning

Planning for flood-proofing activities starts with the question, "what do we protect?" Flood damages or losses to be avoided or mitigated by flood proofing in Bangladesh potentially include those incurred by:

1. **Public utilities, infrastructure and other services.** These are services provided by public utilities and infrastructure (by ensuring that the utilities and infrastructure remain functional before, during, and after an appropriate design event). The actual damage to the physical facilities themselves also constitute damage to the capital assets of the public sector and of society as a whole;

2. **Capital goods and facilities.** This includes personal properties, houses, and facilities (capital goods) on private properties, commercial (business) and industrial premises and equipment. The definition is limited to private sector capital goods;

Table 3 Range of Assets Protected by Flood Proofing

ASSETS	SCALE	EXAMPLES
INFRASTRUCTURE & UTILITIES (Society's Capital Assets)	National	Trunk Roads/Railways
		Gas/Telecoms/Power
		Waterways
	Regional	Regional Roads
		ICFD Facilities
		Regional Power Grid
	Local	Add. Drainage Fac.
		Water, Health, Education
		Markets, Godowns, Flood/Cyclone Shelters
PRIVATE CAPITAL FACILITIES	National/Regional	Gas Companies
		Commercial Fisheries
		Commercial Tea Est.
	Local	Houses/shops
		Factories/cottage ind.
		Livestock, seed stock
INCOME AND LIVELIHOOD	National/Regional	Transportation Svcs Provided
		Health/education Maintenance
	Local	Agriculture/fisheries Workers
		Loss of Tools, utensils, services
		Livelihoods on Chars and marginal lands

3. **Income and livelihood.** For individuals and entire communities, both urban and rural, affected by floods, this is often a devastating social loss in addition to a quantifiable economic loss, resulting in homelessness, unemployment, and displacement.

4. **Personal Possessions.** These are goods owned by individuals as personal possessions, heirlooms, etc. Flood-proofing personal houses typically includes provisions for flood-proofing these items, although separate arrangements might be made by individuals as needed.

The selected flood-proofing activity must be worth doing. The cost of the activity must not exceed the benefits that would accrue. Hence the expected loss avoided by carrying out the flood-proofing activity must be identified, and a quantitative value or some qualitative index of the action's worth to the intended beneficiaries must be formulated.

Once the target to be protected and its value is determined, the decision must be made of an appropriate level of protection. The degree of protection must be commensurate with the perceived or actual value of the target to the individual or society. The decision of the level of protection is also tempered by the answers to the question, "what can we afford to protect against?" Many individuals and businesses, when confronted with putting up the cost of flood proofing, may resist protection to a high level of protection, but may settle for a lesser level. Whatever level of protection is selected, steps must be taken to ensure that personal safety is not threatened during large flood events.

The choice of a flood-proofing activity and the degree of protection it is to provide is the result of the complex interplay of the hydrologic, economic, social, and political situation of the government agency or the individual with properties, facilities, or livelihoods to protect. The answer typically differs from location to location, and from individual to individual, or from agency to agency, and society to society.

3.2.1 Infrastructure and Utilities

Many of the problems a community faces during flood stem from disruption of services provided by public works infrastructure (roads, government buildings, health and sanitary facilities,or power supply). Such infrastructure must be designed to provide consistent and agreed-upon standards of usability and accessibility to the public, so that disruption of services is either minimized or anticipated. Hence flood proofing involves action by local and central governments as well as action by individuals, businesses, and communities.

Infrastructure comprises the capital assets of Bangladesh as a whole. As will be noted in later in this chapter and the next, a consistent set of hydrological design standards is essential to the planning, design, construction, and operation of public infrastructure. Depending on the type of infrastructure, nationwide, regional, or local facilities must be protected from the effects of flood by using appropriate standards and local flood data.

3.2.2 Private Properties and Capital Goods

In the absence of, or to supplement, comprehensive engineering works to protect entire urban areas from the effects of flooding, property owners must depend on their own initiative for the most part to protect their properties from flood damage. This applies to private-sector, commercial and industrial interests as well as to residential property owners. Individuals and private-sector interests have greater flexibility than government bodies in generating the funds required for small-scale flood-proofing investments.

To a great extent, residents in small communities already practice flood proofing based on long experience with the effects of rising waters on their properties. In the 1987 and 1988 floods, many rural households were caught off guard by the rate and magnitude of the rise which, by not allowing time for preparation, caused greater damage than otherwise would have occurred. "Normal" levels of flood proofing and flood preparedness simply did not apply to these extreme events. Properly implemented, many flood-proofing activities could promote social well-being and beneficial change.

Areas usually not subject to inundation, such as upazila towns and pourashava areas, tend to be less prepared for flooding than the rural areas. Yet these areas have higher-valued capital assets. Protection of urban properties and facilities tends to insulate and broaden the occupational base of the area in and around the towns and fosters economic growth. Hence, flood proofing tends to earn higher quantifiable returns in these areas than in rural areas.

One of the greatest incentives for flood proofing private properties is ownership, whether of land on which the owner works (rural areas) or of the capital properties at risk (urban and other areas). Protection of individuals with no ownership stake in land or capital assets typically differs from that intended for owners. Flood proofing measures and associated planning and regulatory measures seek to protect capital assets of individuals and, as noted in the next subsection, those of the public sector. Section 3.2.3 below describes some measures for protecting an individual's income and livelihood from the consequences of flooding.

3.2.3 Livelihood and Income

"Income proofing" designates societal programs designed to protect individuals, especially landless and assetless ones, from unemployment, destitution, and displacement that follow as consequences of flood events. Flood proofing often refers to activities that would tend to result in capital assets that are planned, financed, designed and constructed so that damage and loss from flooding is reduced or minimized. Income proofing is an aspect of flood proofing that attempts to limit the adverse consequences of flood events to the livelihood and well-being of the most vulnerable individuals. An example of such a group is people that subsist on char land.

Income proofing could be some sort of income guarantee system or physical assistance for some limited period following flood events to allow individuals to re-establish themselves in their pre-flood vocations (rehabilitation), or it could include social and technological innovations that reduce the individual's vulnerability to the occurrence of annual floods. An example of the latter could include the dissemination and use of new crop varieties that allow harvesting before the traditional flood period, or could include increased use of tubewell irrigation that reduces a farmer's dependence on the annual rainfall cycle.

Much of the NGO relief and rehabilitation activities for the post-cyclone period in areas affected by the 1991 Cyclone are of the "income-proofing" variety. See "NGO Response to The 1991 Cyclone" below.

3.2.4 Planning and Regulation

The most cost-effective measures typically involve those which act to prevent or avoid flood damage through prudent application of hydrologic criteria during planning and design. Public awareness of the flood hazard through readily-available hazard information and properly-designed education programs are a necessary step toward implementing effective flood-proofing measures. Self-generated programs that involve the community actively in protecting itself are a first step toward the start of a flood-proofing program.

Regulatory actions that specify appropriate preventative measures can be applied to the financing and design of new construction projects to achieve reduction or elimination of future flood damage. Structural alterations can be used to retrofit existing properties to allow them to weather expected floods. These, however, typically are relatively costly but may be justifiable under special circumstances. The banking and insurance industry potentially could assist in limiting financing capital projects to those that are properly flood-proofed, and donor nations and the GOB treasuries could impose similar restrictions on projects financed by them.

Over the long term, management of private and public capital assets through floodplain management practices will minimize flood losses.

3.3 Potential Flood-proofing Measures

The Study Team will investigate past actions by affected parties to meet the challenge of protecting themselves and their properties from flood damage. From these, the Study Team will identify measures and conditions under which such measures have and have not worked (and why), and examine actions that *could* be taken in the future to better protect individuals and their properties, businesses, livelihood, and infrastructure. Pilot projects to implement and evaluate the various flood-damage reduction and floodplain-management concepts will be designed and carried out.

3.3.1 Types of Measures

In generating flood-proofing ideas and possibilities, it is useful to distinguish among:

- capital facilities, income, and infrastructure as protection targets;
- actions taken *before*, *during*, and *after* flood events;
- directly protecting people taking these actions and reducing externalities that harm people;
- flood zoning (controlling or changing land use) and flood proofing (altering occupancy or use conditions for a given use);

- separate zoning for different uses according to differences in appropriate risk;

- measures for protecting landowners' properties and those for protecting landless squatters' livelihoods (flood proofing vs income proofing);

At this Inception stage, some potential measures have been identified based on preliminary investigations, and are summarized in the following subsections. The individual measures are described in more detail in Chapter 4, and are arranged according to asset protected (public or private capital, possessions and livelihood), scale of coverage (national, regional, local), major tasks and work items, and possible choice of executing agency (GOB, NGO, individual)

Many of these and other possible measures could be on individual initiative, and most would be private sector actions for protecting personal properties and investments. If the flood-proofing activity is to be performed on a community-wide scale, decisions should involve a high level of public participation and a low level of public capital input. Others involve public expenditures to protect infrastructure and utilities.

3.3.2 Potential Measures

Some potential measures set forth in Chapter 4 include:

- physical protection or raising of:

  - commercial and industrial premises
  - urban housing as well as *hat* mounds
  - refuge areas and individual or community storage areas
  - roads, railroads, communications, and other utilities
  - water supply, sewerage and other health related facilities
  - fisheries and livestock facilities, both private and commercial

  to ensure proper functioning of the services provided by infrastructure and capital facilities during flood events and to promote a quick return to normalcy in the aftermath;

- proper *planning* for the above that involves built-in flood-proofing measures;

- to enable the proper planning to take place, widespread public dissemination of upazila-level flood-hazard information, including:

  - historical or modelled flood-level frequency information
  - historical or modelled flood-depth-duration-frequency information
  - maps of floodplain boundary for appropriate seasonal floods of various frequency
  - maps of flood depth and duration for appropriate seasonal floods of various frequency

- maps of flood damage potential for floods of various severity

- integrated hydrological planning for providing additional bridges, culverts, or submersible bridges in rural roads;

- rational provision of commercial lending restrictions in floodplain areas and possible implementation of a government-sponsored flood insurance program;

- regulation of land use in flood-prone areas;

- identification of target groups for income protection;

- identification of possible types of income and livelihood protection for different target groups (see also Section 3.4.4);

- design, finance, and mplementation of such income and livelihood programs;

These are measures identified at this point. The reduction and analysis of the urban survey results are expected to produce more suggestions for flood-proofing activities that could and should be initiated at the local and individual level, with possible assistance and encouragement from NGOs and GOB. These and other measures will be discussed, refined, and formulated into a comprehensive program of flood-proofing Pilot Projects. These Pilot Projects will demonstrate the feasibility of protecting the assets identified above, and that cover the range of human response to flooding, responses that seek to avoid or ameliorate the adverse consequences of floods and other related disasters.

3.4 Local Initiatives

Some examples of the wide variety of flood-proofing initiatives undertaken by various organizations, to suit their own particular needs, are presented below. This is but a small sample of the activities currently underway, and presents some possibilities for widespread adoption in Bangladesh.

3.4.1 Mennonite Central Committee-funded Projects

An example of effective action is shown in local effort assisted by the Mennonite Central Committee (MCC) to raise neighborhood refuge areas using spoil taken from culture-fishery improvements. A school, mosque, or other public property is selected, and the ground raised to an agreed level to provide temporary shelter to bari or village residents within, perhaps, one to two kilometers distance. In addition to providing a safe haven during floods, the raised areas serve as community meeting and recreational grounds in daily use. Each raised area is provided with a tubewell and sanitation facilities.

The Bhuapur Project of Service Civil International (SCI), partially funded by MCC, implements shelter programs in char areas on the Jamuna River. The soil and land are provided by the char villagers, and a raised area is constructed to the level of the 1988 flood. The embankment of the raised area is protected by

Catkin grass and other indigenous species to provide some scour protection. Water-seal latrines, tube well, livestock shelter, storage locker, and a thatched-roof meeting house are provided on the raised mound. Plans are to use the meeting house as a school house for village children in the near future.

In the pond re-excavation program, a nearby existing tank is selected, leased from the landowner, and deepened to allow improved fish production and provide soil for the raising. The embankments have crest widths of 16 to 18 feet, and are raised to the 1988 flood level. This year, the local people are required to pay 10% of the costs of construction. Next year, their share will be increased to 15%. Inputs for fisheries are limited to advice and limited cash for stocking and improved fish feed material, and the land owner is reimbursed by a share of fish production. The slopes of the raised embankment are available for vegetable cultivation by the members of the community.

Credit for housing reconstruction is also provided under this community flood vulnerability reduction program. Of the 10,000 Tk required for a new house, 50% is made available as a grant, and the members of the community pay the balance back over a number of years. The house is a flood-resistant, elevated model using reinforced concrete corner posts.

Another project seeks to reduce the vulnerability of char residents to loss of cultivable land by planting the chars with catkin grass, a traditional grass variety that binds the soil and traps alluvium. Char areas thus covered with Catkin grass stand a better chance of resisting flood-induced erosion.

Other activities include provision of boats, both motorized and traditional, to various communities for communication and rescue purposes during the floods, and as revenue-producing rental boats during the rest of the year. Afforestation programs also seek to provide some means of livelihood to destitute women.

These projects, particularly the pond re-excavation and refuge area raising programs, build on existing raised areas, and do not create new raised areas that could obstruct local drainage patterns. The local NGOs that carry out these projects with MCC funding require that the local community decide what exactly will be carried out. These locally-initiated and locally-maintained flood-proofing projects provide to members of the community (a) flood preparedness, (b) some economic security, and (c) enhanced local knowledge of coping with flood events. The flood-proofing measures are intimately tied to income and job generation opportunities at each community.

This is a potential model of flood-proofing activities performed at the community level, where the non-flood period needs of the community as a whole are incorporated in the design and implementation of the flood-proofing and income-proofing activities. Active participation by all sections of the community ensures acceptance of the siting and construction of the various measures.

3.4.2 MIDAS

The Micro Industries Development Assistance Society (MIDAS), an NGO that finances new enterprise start-ups and provides follow-on management advice and services, responded to the plight of its flood-affected loanees by:

- fielding a damage survey team comprising a chartered accountant, civil engineer-architect, and a mechanical engineer to assess flood damages at each of their ongoing loans;
- providing loan repayment moratoria, flood recovery grants, debt repayment rescheduling, and other entrepreneur-oriented responses.

The key step was in MIDAS' quick dispatch of a damage survey team comprising qualified professionals as soon as the site became accessible to the team. This verified the damage claims of the entrepreneurs and suggested means of debt relief that would be most fair to the entrepreneur and to MIDAS. This set of steps was undertaken immediately after the 1988 flood, and again after the 1991 Cyclone.

Today MIDAS requires all new projects to be flood-proofed by ensuring and the factor floor level lies above a flood that is somewhere in between the normal flood level and the 1988 riverine flood level. Such organizations would definitely benefit from several types of hydrologic hazard information, as well as some criteria that would help avoid excessive damage during cyclones.

MIDAS' flexible response, both in damage assessment and debt rescheduling, will probably not be as easy to implement in the commercial and government banking. Most probably, structural changes in the individual banks as well as in government financial policies that govern the banking industry in Bangladesh. We will explore this and other banking issues related to floods in our field study.

3.4.3 BSCIC

Other organizations, such as the Bangladesh Small and Cottage Industries Corporation (BSCIC), are aware of flood hazards and the potential for losses to the numerous small and cottage industries under their wing, as well as to the industrial estates designed and operated by them. BSCIC requires some level of flood proofing in all new projects, and would like to require that their new industries be able to take out flood insurance. Flood proofing at this point depends on local knowledge of natural flood hazards, not on systematically produced flood-hazard information.

BSCIC is an example of a large-scale organization that is aware of the flood problems and potential measures that could be implemented to flood-proof their estates. They are in a position to provide advice to the numerous small-scale cottage industries for which they serve as technical advisors and occasional financiers. Flood-hazard information could be used advantageously by BSCIC and similar organizations in the design of new industrial estates and in implementing some additional flood-proofing measures to existing estates. As an umbrella

organization for numerous cottage industries, it could also serve as a funnel through which flood hazard data could be distributed to these predominantly rural industries to assist them assist themselves against flood damage.

3.4.4 NGO Response to the 1991 Cyclone

A brief description of the NGO response to the victims of the April 1991 Cyclone is provided here as an example of organized activities which illustrate two aspects of flood response and income and livelihood proofing. The first phase of activities was the two- to four-week emergency relief operation, and the second phase is the ongoing long-term rehabilitation phase.

Relief Activities

The various NGO's involved in cyclone relief activities convened to pool information and determine the various modes of relief operations to be conducted by the organizations. The cyclone-affected areas were divided into three categories: (a) worst-affected, (b) badly affected, and (c) affected. Initially, NGOs decided on a two-week emergency program, but the program continued for over a month in most areas.

Coordination with other relief bodies was accomplished by establishing an coordinating body in each upazila where they were operating. One NGO was selected as the lead NGO in the upazila, and the lead NGO provided the meeting facilities and an information clearinghouse. Weekly meetings have been held at the upazila and regional level to discuss operations, operational priorities, and collaboration with GOB agencies in the relief, and now, rehabilitation, activities. As many as 80 NGOs from different parts of Bangladesh participated in the emergency relief operation.

Rehabilitation

At present, the number of NGOs involved in the second, rehabilitation, phase number about 20 to 30. Most are involved in providing replacement housing for families that lost them. These houses, however, are not specially-designed, cyclone-resistant units. NGOs have formed a committee to review existing cyclone shelter and housing designs, and to develop potential designs for cyclone-resistant housing. NGOs also have plans to construct at least 200 cyclone shelters in the coastal areas and in offshore islands.

Other priority items identified for a comprehensive rehabilitation program to protect and re-establish people's livelihoods are:

- tree planting and nursery establishment to provide natural wind- and wave-breakers;
- dewatering and restocking of freshwater fish ponds that have filled with salt water;
- rehabilitation and flood-proofing of damaged roads;

- repair, rehabilitation, and installation of new tubewells;
- agricultural rehabilitation: seed and power tiller distribution;
- assistance to fishermen: provision of replacement boats and nets;
- reconstruction of schools and other rural facilities for use as cyclone shelters;
- books and other informational materials distribution.

These and other activities can form the basis of income proofing Pilot Projects by interested donors to reinforce, expand, and assist activities of NGOs and GOB agencies involved in flood and cyclone relief and rehabilitation. While FAP-11 will concentrate on strengthening the GOB's abilities in these fields, FAP-23 Pilot Projects could reinforce and expand the NGO and private sector efforts in these fields.

3.5 International Experience

3.5.1 United States

Since the late 1960's, flood-plain management and other damage-avoidance practices have been implemented nationwide with notable results.

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 flood damages grew at a rate that proved 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.

The main result has been a combination of regulatory, incentive and management actions aimed at preventative and hazard-reduction measures. Efforts to increase public awareness of hazards and to provide information for individual decisions and action have comprised an important part of the process.

Included in the program are 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 floodplain except for limited cases where compensatory measures are included. Insurance is offered by private companies to individuals or private or 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 risk (depth and velocity of flooding at each property).

Maps and other flood-hazard information are required to be used in planning future development, and they must be available to prospective buyers of affected property. The most exposed, existing properties must be improved to reduce vulnerability or exposure of damage-susceptible contents. While locally enforced, the program is backed by federal legislation that provides

administrative and technical consistency and legal backing should enforcement be required.

3.5.2 Australia

Similar flood plain information programs, adopted and implemented at the federal and state levels, are available in Australia. Historical floods, the 100-year and other floods are routinely computed on a community basis in Australia, using techniques similar to those practiced in the United States. Communities use this information to shape local building codes that ensure new construction be flood-proofed, either structurally or by location away from areas subject to flooding. Australia's flood situation is similar in many respects to that faced by the United States, and perhaps the similarity of response by the various state and local governments is not surprising.

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

Many of the flood plain studies formerly were carried out by the local sewerage authorities, whose work was succeeded by newly-organized local drainage authorities.

3.5.3 United Kingdom

In the United Kingdom, much of the flood plain information (hazard areas and flood emergency planning measures) is available at the various Water Authorities, under whose jurisdiction the regional water supply, sewerage, and flood control activities fall. The technical staff of engineers and hydrologists is available to the local District Council to provide advice on proposed development projects.

The District Councils, which regulate urban and rural development activities are advised to liaise with the Water Authorities to obtain and incorporate the information in a rational floodplain development program. There is, however, no legal requirement for the local planning agencies to incorporate the advice from the Water Authorities in their planning activities (Penning-Rowsell et al, 1988). Limited land space and development pressures create an atmosphere favoring development of floodplains, which in turn eventually necessitate remedial flood mitigation measures by the Water Authorities.

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 4

ELEMENTS OF FLOOD-PROOFING PROJECTS AND STUDIES

4.1 Pilot Projects and Pilot Studies

During the inception phase of the Flood Proofing Study, numerous flood-proofing activities and activities were identified as candidates for incorporation into possible Pilot Project trials. Other topics and questions were judged to merit further study that would ultimately lead to nationwide implementation or Pilot-level trials.

Some of these activities already are under small-scale, highly-localized trial implementation by NGOs concerned with reducing flood vulnerability among members of the local communities, and may merit expansion nationwide. Others, identified based on an assessment of needs in Bangladesh and drawing on experience by others elsewhere, are proposed for study or Pilot Project implementation in Bangladesh.

The potential measures identified below will initiate the identification and evaluation process for potential Pilot Projects and Pilot Studies. The Flood Proofing survey currently underway will identify numerous useful, practical measures taken by urban populations and by local government officials. The Flood Response Study (FAP-14) will provide similar information from rural populations. The activities identified below, augmented by candidates identified through the field surveys by these two studies, will be presented at the Flood Proofing Workshop. Workshop participants will be invited to identify further candidates as well as to provide input to the ISPAN team for screening out less-effective candidates and for assigning priorities to the rest.

Candidate projects and studies will be selected to cover the diversity of local circumstances; to foster in-depth involvement of individuals, businesses, local governments, and NGOs; and to demonstrate and strengthen the concepts of continuing monitoring and financial arrangements for timely response to problems. All parties involved in a Pilot Project must fully cooperate from the start, and work towards ensuring that a self-sustaining, flood-proofed lifestyle and economic growth opportunities for the individuals and communities emerge from the project. Only then can an activity be deemed suitable for general nationwide implementation.

The potential activities are classified according to the scale of the activity. The three scales selected are:

- Individual and Community Measures;
- Local (Upazila) Government Measures; and
- Regional and National Measures.

Furthermore, each activity is either a potential Pilot Project activity suitable for field trial, or a Pilot Study requiring further investigations on certain subjects, as noted above. Others, like hydrological information dissemination, can and should be implemented immediately.

4.2 Individual and Community Measures

Individual and Community Measures are those that can serve individuals and small groups such as urban neighborhoods, housing clusters and villages. Many of these are suitable for trial implementation in local neighborhoods. These form the elements of a comprehensive flood proofing pilot projects, with the exact mix of the measures being dependent on the situation and characteristics of each locale.

4.2.1 Refuge Areas

These ensure that everyone has a place to go for ultimate safety during the worst possible flood or cyclone. These should be close enough and on a route that people can reach (by land or with available boats) during embankment or flood proofing failures. They should be provisioned with shelter, tubewells, sanitary facilities (separate men and women), and food storage to support the population using them for the needed time.

A parallel need is for livestock shelter sites that meet the same location criteria as people shelters. Feed pellets and other feed could be pre-stored. These can be guarded by owners or by upazila veterinary officers.

4.2.2 Secure Storage

These provide people a place where they can store possessions for long periods as needed without fear of damage or theft during floods and cyclones. Space for food, personal and household items, and other valuables could be provided. Many village homes store food between crops and seed for next season. It may be possible to establish community lockers at high elevations. Recent technological advances in low-cost, pre-fabricated storage tanks could serve this need. These could either be used after warnings for people to move their possessions when a flood is coming or on a permanent basis. Low-cost, secure storage may promote economic growth in other ways as well.

4.2.3 Theft Prevention

Observations during riverine and cyclonic floods is that many people do not evacuate to shelters until the last possible moment because they fear for the security of their personal goods that must be left behind. Some method must be found to secure property so that people can evacuate more freely, perhaps by boat patrols of police officers or neighborhood volunteers.

The threat of theft is a major deterrent to evacuation during life-threatening floods and can trap people in situations where their losses become much worse. A program of patrol with strong penalties for violators could be an effective form of flood and income proofing.

4.2.4 Wet Flood-proofed Buildings

Protection of private capital possessions, commercial and business premises, and personal possessions is a high priority item in any flood-proofing activity.

Low-cost measures are available to modify existing buildings so that they suffer less damages when inundated. Ventilation and other support to first floor levels, baffle walls, door sills, strengthening floors to prevent uplift pressures and water seepage from causing damage, providing platforms and raised areas to store raw and finished goods are examples of relatively simple measures that could be implemented at relatively low cost.

4.2.5 Secure Water Supply and Sanitation

It is imperative that everyone have access to safe drinking water during flood events and other emergencies. The placement of entire water supply systems outside the reach of floods may not be practical. Many people still carry and purify their water. It may be practical to secure certain wells at favorable locations against contamination, and have people use them during flood periods. Evacuation shelter areas must be provided with tubewells for use by evacuees. Upon receipt of cyclone warnings, rural inhabitants may be induced to bury young coconuts at a secure spot so that they could serve as temporary water supplies until relief supplies arrive and local tubewells can be rehabilitated.

In crowded flood and cyclone shelters, as well as in urban neighborhoods affected by floods, contamination of available water supplies by fecal matter and by local solid wastes could cause grave public health problems. Efforts to control contamination by fecal matter and solid wastes must be accorded high priority as part of an overall community flood proofing program.

4.2.6 Radio Communications

Information dissemination to give individuals, communities and businesses full access to information that they can use to reduce damages during flood periods is another high-priority item for flood proofing. This activity supplements the government flood warning system. The information exchange should be people-to-people to avoid the delays in having to go through a central agency, and should cover how the depth of flooding is changing upstream, locations of embankment failures and active bank erosion, where roads are open and closed, upstream health problems, and market information on where goods are available and where they are running short.

4.2.7 Embankment Surveillance

A community effort to watch for erosion, animal holes, settlement, and other disrepair, followed with quick corrective action as required, is a vital element in a community flood-proofing activity. High technology methods can be developed for full inspection before the beginning of the flood season and regular surveillance during events, and local people can be given ways to communicate

observed problems quickly. This participation by local people enables them to make an active, important contribution to protecting themselves and their community, and will cause the whole flood-proofing program to work better.

4.2.8 Boat Procurement

Perhaps the most effective way to ensure that flood-affected populations, government agencies, and even commercial interests operate at near-normal conditions during and immediately after floods is to provide boats. If the flood levels are extremely high, they can be used for transporting people and goods to shelters, and for relief operations afterwards. If the flooding is normal, they can be used to continue providing the transportation and other services during the times of high water.

This seemingly simple measure is emphasized here because many rural and periurban households which formerly possessed at least one boat have abandoned the practice following construction of embankments and roads. Thus when the flood control measure fails by breaching or by topping by an unusual flood, affected people behind the embankment are caught unprepared, and are trapped without transport.

Similarly, local government agencies are not provided with the means even of hiring boat transport during floods, so they are often incapacitated for providing services to flood-affected areas. This is especially critical for health and veterinary services, education, welfare, and family planning services, as well as the post and telecommunications services. Provision of boat services to government agencies is a simple, effective, means of flood-proofing by ensuring the continuation of essential services to otherwise isolated communities.

Boat hire would also have the effect of creating alternative employment opportunities for local boat owners, whose regular means of income are adversely affected by floods. This then becomes a possible "income-proofing" measure for those individuals.

4.2.9 Stockpiling Emergency Supplies

Community and neighborhood efforts to store sandbags, boats, supplies, plastic sheets and other equipment and supplies needed for dealing with floods to be sure that they are available during flood emergencies will help greatly in allowing a community to cope during those times.

4.2.10 Pilot House Construction

This activity, already underway by concerned NGOs and some government agencies, will construct physical models as demonstrations in local conditions that people can adopt or copy. Flood-damage-resistant houses could be promoted among people who are building or rebuilding. Engineer/architects could propose a flood resistant house design appropriate for Bangladesh conditions (flood-wise and financially). The ongoing UNDP project on housing rehabilitation (UNDP, 1990)

could provide relevant expertise. Innovation is needed so that people are not condemned by their flood hazard to dwelling in low standard housing permanently.

Cyclone-resistant housing typically comprise pucca houses, properly designed against wind loads and pressures, as well as hydrostatic and hydrodynamic loads, and situated above inundation levels. The high cost of such housing typically precludes mass construction of these houses.

4.2.11 Income Proofing Measures

Numerous changes are possible in the economic activities of individuals and communities that will assist in reducing their vulnerability to floods and their effects. The ongoing questionnaire surveys will define many of these potential measures for urban and rural contexts.

Measures to protect people's livelihoods include those classified under National and Regional Measures later in this chapter. Raising roads and other infrastructure enables those whose livelihoods depend on such infrastructure (bus and truck drivers and rickshaw drivers) to continue earning income during floods. Other measures include raising hats and bazaars, including access to the same, so that economic activity continues unimpeded. In an urban context, income and livelihood protection may comprise the continuation of economic activity through floodproofing vital commercial assets such as medicine, provisions, and other essential businesses. Floodproofing employers such as factories and shops also fall under this category, in addition to serving to protecting the capital assets of the owners of the facilities.

For Char dwellers and people who lose land due to river erosion, one could develop programs for income proofing that would find ways (sources of employment) to supplement incomes so that people who lose their lands during floods will not be made destitute. An alternative would be some form for income insurance like unemployment insurance that would give people an income while they try to become reestablished.

Another possible intervention would be market support activities to facilitate the activities of producers and wholesale businesses as they try to prevent prices from collapsing or rising inordinately during flood events. This could be at the local, regional, or national levels.

For agricultural areas, adoption of shorter-period crops of the same species, or adoption of alternative crops, may reduce the vulnerability of crops to damage by floods. Once such changes in cropping systems are made, insurance firms may be more inclined to participate in crop insurance programs, which will now be insuring crops that are likely to be damaged only in floods with only the most unusual timing characteristics. This in turn provides agricultural areas with more protection for their livelihoods in the event of these unusual floods.

4.3 Local (Upazila) Government Measures

The following measures are those which could be ultimately implemented at the upazila level, where the various government departments will serve as the implementing agencies. Some of these could be implemented immediately, while others, such as Floodplain Zoning, merits further study on what form this concept could be used in Bangladesh.

4.3.1 Disaster Management

This item seeks to organize facilities, supplies, and people for evacuation, flood fighting, and recovery activities to reduce damages. Many items can be arranged ahead of the flood events to reduce damages. Evacuation planning would organize routes and conveyance to transport for people and possessions for quick egress when embankments are about to fail. Resources for much of this activity already is available at the upazila level, with the establishment of flood operations rooms headed by the UNO, but most of the effort is directed toward relief and rehabilitation at the upazila level at this time.

Many additional measures to ensure smooth operation of services during floods could be instituted, with central government funding for such items as boat rental during floods for the health, education, welfare, and postal communications agencies to provide services to isolated communities. (See "Boat Procurement" above.) Much can be done in the public sector, but the largest reduction in the damages is achieved by motivating government officers and affected individuals to plan ahead.

FAP-11, Disaster Preparedness, aims to strengthen some of the public sector response through its long-term training process.

4.3.2 Floodplain Land Use

This activity calls for choosing land uses that are reasonable for the degree of hazard in a given area. Floodplain zoning provides rules that prevent people from placing activities on lands where society believes the risk to be too great for the use to be acceptable. The criterion of reasonableness must be based on the culture and values of the people of Bangladesh. The goal is not to preserve the conditions of the past but to create new conditions for better management of financial and human resources for a better life in the future. The concept is typically implemented and enforced at the local government level in Europe, the US, and in Japan. Possible application in Bangladesh is the subject of a potential Pilot Study and Demonstration Project.

4.3.3 Local Hydrological Planning

This activity seeks to plan the construction of roads, embankments, and other facilities so that they will not alter the local flood flow adversely and increase damages. Some way must be found in planning infrastructure to ensure that people who construct physical facilities do not impede drainage and increase

flooding. The same checks should be made for private buildings. In both cases, the designs of major areal or project development should be submitted and checked with either a mathematical or a physical model against floods of different magnitudes and coming from different source areas to make sure that they will not increase economic nor environmental damages.

When others would be harmed, the builders or government agencies should modify their designs to prevent the problem or, should it be more practical, pay compensation for the losses caused. For example, designs proposed by local interests under food for work programs should be reviewed and provisions should be made (a subject for discussion between flood control and transportation agencies) to finance the added costs to the roads to reduce flood damages.

Overall planning should be performed by setting up fine-resolution nested sub-models of the appropriate MIKE-11 regional hydrological models. These nested models will simulate the local river network and infrastructure so that additions or alterations could be tested for their impact on the local hydrological regime. One Pilot Project can demonstrate these concepts. Defining the appropriate technical institutional arrangements for field implementation of such a local planning system will be a key component of such a project.

4.3.4 Upazila Flood-hazard Information Center

This activity would establish a center of expertise with field agents that could distribute information on flood risks and suitable flood proofing alternatives that people can use. The two main needs here are collecting and organizing good information on the physical hazard, and getting that information to people and assisting them to use it.

A physical hydraulic model can aid both by faithfully determining the impacts of flows and erosion and depict it for visitors to see. People brought to see a physical model may understand their situation and be able to act effectively in ways that we do not anticipate. Problems caused by food-for-work roads and other embankments that redirect flood waters could be graphically demonstrated and change the minds of people who want to build them.

This information source at the upazila level will also serve as the repository of flood-hazard information (see "Regional and National Measures" below) for the upazila, containing stage-frequency-duration information for floods of different magnitudes, inundation maps for floods of different return periods, and other related information. Such information is useful for planning new facilities by local businessmen, commercial interests, and government development agencies. Its activities are also intimately tied to local hydrological planning noted above.

4.3.5 Char Area Administrative Land Reform

This activity will seek to define property boundaries for char and other similar areas in such a way that a person who loses property at one place could be given property emerging somewhere else. The losses (economic and social) caused by

migrating rivers would be greatly reduced by developing an effective scheme for directly redistributing land during the process of erosion and deposition along rivers.

Communities with limited quantities of surplus land found these area valuable to ease flood impacts. Implementing a way to protect emergent lands institutionally for redistribution to people who lost their lands locally may be difficult, because of entrenched interests, both institutional and social. This activity will initially start as a Pilot Study, defining the problem and suggesting viable, alternative solutions. A highly localized Pilot Project may follow, depending on the findings of the Pilot Study, delineating for sample areas a time series of loss and emergence, together with impacts of people.

4.4 Regional and National Measures

The measures listed below include possible Pilot Project and Pilot Study candidates that must be implemented at the national level in order for successful flood-proofing efforts to take place at the local and upazila levels.

4.4.1 Flood-hazard Information

In keeping with the overall goal of promoting local flood-proofing initiatives, information on flood hazards should be made available at scales appropriate to upazila-level planning, at least, and at more detailed scales for specialized users. This information needs to be made available to each Upazila Parishad as well as all upazila-level line ministry offices; it also should be made available to all NGOs, donor groups and monitoring agencies, and commercial and other lending and insurance institutions so that sound floodplain investment and engineering design decisions can be made. The various types of flood-hazard information are discussed in some detail in Appendix D.

Potential institutional and regulatory uses of the flood-hazard information include floodplain zoning, floodplain development criteria, flood insurance rate setting, and credit institution use for assessing hydrologic risks (exposure) of facilities to be supported by potential loans. Government agencies responsible for planning, designing, and constructing infrastructure will use these in conjunction with their hydrologic design criteria (see "Hydrologic Design Criteria" below) to design appropriate facilities for each locale.

Much of the generation of this information depends on integrating data obtained from the field through interviews of local residents and from the Upazila Plan Books of the upazila engineers with computer- or field-generated flood level information and Geographical Information System (GIS) or manual mapping facilities. Some of the information, such as the BWDB stream gauge stage-frequency data, is available immediately for dissemination from MPO reports (1991 update of Technical Report No. 11) or from recent work by the FAP-25 hydrologist. Other data must await the generation of design event water level data from the various regional MIKE-11 models. This is a tool so clearly effective that it should be implemented immediately without delay for Pilot Planning, etc.

The various types of data (Appendix D), once generated, must be disseminated to all levels of government and, most importantly, to the general population. The data must be customized and packaged by upazila, and must be made available to communities and to financial, commercial, industrial, and other business interests, as well as to all NGOs and donor groups operating throughout Bangladesh. Only then can individuals, government agencies, and NGOs make rational decisions in the face of flood risk and uncertainty.

Several Pilot Projects that generate a full set of flood-hazard data for selected upazilas can be implemented immediately. A companion Pilot Study could recommend the appropriate institutional and community measures for dissemination of the various types of flood-hazard information to as wide an audience as possible.

4.4.2 Integrated Hydrological Design Criteria

Each government agency charged with providing the public with services through physical infrastructure must flood-proof their facilities in a manner commensurate with the local flood-hazard and the value to society of providing that service unimpeded during the design flood event. This judgement on the part of the agency is usually expressed in the agency's hydrological design criteria for the particular infrastructure item in its charge.

For example, the main trunk roads may be designed to stay operational during the 50-year flood event or the 100-year flood event. However, a smaller feeder road may be designed to be passable at the 25-year flood event or smaller, given the relative importance of services to society in general provided by that feeder road. A power transformer may be elevated to above the 50-year flood level to reflect the relative importance of having an uninterrupted power supply to that region during a flood event.

A potential Pilot Study will examine the existing hydrological design practices of the government agencies, of NGO development activities, and major private sector projects, and recommend a unified, rational set of hydrological design criteria for public and private infrastructure projects. The institutional portion of the study will recommend procedures to ensure that each government agency adopt and implement these criteria for future planning projects and for flood-proofing existing infrastructure. These criteria could also be folded into donor nation aid and loan requirements as implementation criteria to ensure that donors' investments are well protected. Similar requirements could be adopted by the banking and insurance industries for their clients' project loans and insurance policies.

4.4.3 Flow Management

A detailed survey would show that almost every sizeable community has open places where water could be stored during flood periods. These should be identified and their use integrated into a plan for land and water management that controls movements of storm waters from where the precipitation falls to the sea. Some of the principles that should be used to guide the control are that water from different sources should be separated in time and space (early flooding can be

speeded downstream and later flooding can be detained to separate the hydrographs).

Embankments could be breached to control flooding within a program of water management for fisheries and infiltration enhancement within a conjunctive surface-groundwater management program and following operating plans worked out with the local people. In urban areas, it is important to infiltrate or pond storm runoff so that large impervious areas do not unduly add to the flood water.

Good flow management involves operations of the structural system, but an effective program also requires the local governments and the private sector to work together to reduce impacts on the private sector as part of a nonstructural or flood proofing program.

4.4.4 Flood Insurance and Finance

Credit institutions such as government, commercial, and NGO banks could promote rational floodplain development in several ways:

- by providing regulations prohibiting loans for projects that take place in the most hazardous portions of the floodplains;
- by requiring, as a condition of loan approval, flood-proofing measures to be built into new or ongoing projects.

Insurance agencies could also promote flood-proofing activities by offering flood insurance to qualifying properties and facilities, with flood-proofing being part of the qualifying criteria. Already, commercial banks are requiring that some form of flood insurance be taken out for commercial loans if loans involve construction or activities in flood-prone areas. In Bangladesh, where flooding is a regular occurrence, the government may have to subsidize rates, perhaps temporarily, for providing flood insurance in order to induce the private insurance sector to participate.

A candidate Pilot Study covers credit-giving institutions and the private and public insurance industries, examines the state of the two industries and the suitability of the current structural and institutional setup in promoting flood-proofing policies as noted above.

4.4.5 Model Industrial Plants

This series of activities seeks to establish physical models for local, flood-proofed industrial and business premises that new businesses could emulate. This could be a center of expertise that business men could visit for information and help in dealing with flood problems in their community. It could be part of a larger program of community industrial development, to sponsor a demonstration community built around a local industry that would demonstrate how to cope with flooding and simultaneously develop the economy and find a better life for its citizens. A donor country (or private business interests) may be persuaded to

show how economic productivity and improving life styles could evolve in towns on the Bangladesh flood plain.

4.4.6 Road Network and Railroads

Roads and railroads accounted for as much as 16% of the total damages in 1988. Although under different ministries and departments (Roads and Highways, Local Government Engineering Bureau, Railway Division of Bangladesh Railways, various food for work programs) road and rail systems have many characteristics in common. Both comprise mainly earthen embankments that cross numerous natural drainage channels, swales, and other geomorphological features. They both use cross drainage devices like bridges and culverts to provide safe passage of flood waters.

Pilot Projects involving improvement of road and railroad networks must be planned and performed with the above criteria in mind. Particular attention must be paid to use of consistent hydrological design criteria in all flood-proofing of existing roads and railroads, and in planning for future networks. The following are criteria needed in Pilot Projects and a nationwide program of flood-proofing:

- integrated hydrological design of all new embankments in rural areas
- additional hydrologically designed culverts and bridges, particularly in rural roads;
- use of flood-level, frequency information for raising existing roads to above predetermined flood levels, depending on the importance of the roads at the local level; and
- active consideration of the use of submersible road embankments, specially designed to withstand downstream and upstream scour; alternatively, consideration of the use of submersible culverts and bridges (known as fords or Irishman's bridge) instead of submersible embankment sections (SMEC, 1989).
- strict adherence to design and construction specifications;
- more robust structural designs, especially where brick structures are concerned; more appropriate geotechnical design of roads, given the local soils and drainage situations; due attention to wave protection criteria;

4.4.7 Waterways

The facilities under the jurisdiction of the Bangladesh Inland Water Transport Authority (BIWTA) suffered damages for which replacement costs were estimated at Tk. 55 million. The estimate does not include damages to village and locally-constructed and -administered shipping and mooring facilities.

Being situated in or on the major rivers, waterways facilities bear the brunt of the force of major flood waters. BIWTA facilities, by their very location, are exposed to riverbank erosion. Indeed, at Bhuapur, the entire bank area containing the ferry terminal building and all the various ghats and jetties were eroded away in the 1988 flood, undermining and destroying the structures concerned (SMEC, 1988).

Current practice provides for direct replacement of damaged or destroyed facilities, using more robust materials (such as concrete instead of wood) where possible. Preventive flood proofing under these exposed conditions makes hydrologic design of facilities a moving target, a desperate gamble in unstable riverbank areas. Where riverbanks are stable, use of design flood levels along with the expected flow velocities will enable a flood-proofed design of the various jetties and riverside structures, with integrated flood-proofing of auxiliary roadways.

Interviews with BIWTA personnel will highlight problems that could be encountered in inland waterways facilities design and flood proofing. Some of the current practices will be highlighted, and possible improvements will be brought out.

4.4.8 Water Supply, Sewerage, and Solid Wastes

Water Supply

According to the Department of Public Health Engineering (DPHE), about 240,000 hand-pump tubewells were affected by the floods of 1988, and 170,000 latrines were damaged (Rahman and Ahmad, 1990). Extreme floods in Bangladesh are accompanied by disease outbreaks and other health problems due to lack of access to reliable water supply, sanitation, public health facilities, and other elements of exposure and deprivation. Making these facilities accessible to the public during floods is a priority item in the flood proofing agenda. Current regulations from DPHE call for new hand pump water supply systems to be raised above the normal flood level (village house plinth level). At times of higher flood, there are kits to raise the pipe and pump assembly so that the hand pump stays above flood level. The pump can be raised 1.5 to 3 feet.

The feasibility of a village water supply system that could be established out of the reach of high flood waters is an important concept that the field study will explore. Some new, low-cost technologies allow for field assembly, from precast blocks, of ground level or elevated storage tanks that could be used to store drinking water, among other things.

Water-supply systems that use power-driven pumping equipment are especially vulnerable during floods. If the system is submerged or otherwise put out of action, potability is compromised, and damage normally takes longer to repair than for hand-power equipment.

Sewerage

Another potential health problem during floods is the pollution of flood waters by human and animal waste. In areas where the community water supply source has been disrupted or submerged, inhabitants are forced to use flood water for drinking and washing. Flood water volume dilutes the various pollutants to some extent. However, especially in urbanized areas with relatively high population concentrations, the aesthetic and public health problems are substantial.

Currently, DPHE requires that a water-seal ring latrine be installed whenever a hand pump is installed in a household or groups of households. The hand pump now is required to be installed above the household plinth level. No such flood-proofing requirement apparently exists for the latrines.

During the interviews with private respondents and the DPHE, team members will seek to determine the extent of the problem and how the respondents, as well as DPHE, managed to cope with the problem. They also will solicit input from respondents, both individual and institutional, on how this problem might be addressed.

Solid Wastes

Floodwaters also carry away solid wastes that have been deposited or landfilled at various points in flood-affected areas. In municipal areas (Berger, 1991), solid wastes vulnerable to suspension in floodwaters include:

- partially decomposed, exposed organic matter and non-recyclable plastics from landfills;
- uncollected wastes deposited in drains, ditches, and sewers (comprising household and municipal refuse, animal hides and wastes, restaurant/hotel refuse, clothes and dyes, industrial sludge and refuse);
- wastes from public collection bins.

Toxic chemicals from disposal sites, as well as pathogens from the solid wastes in various forms of decay, pose serious health threats to those exposed to floodwaters near such waste sources. Resolution of these problems is closely tied to the existing and future state of solid waste collection practices in municipal and rural areas of Bangladesh. Any urban flood-proofing Pilot Project should include protection from the deleterious effects of solid wastes in floodwaters.

4.4.9 Power and Telecommunications

Electricity, telephone, and postal services are vital community services that are extremely vulnerable to disruption by floods. During the 1988 flood, numerous power lines, transformers, and telephone lines were severed or submerged and rendered inoperable, disrupting normal communications for many areas.

The risk-based flood levels above which switching and transformer facilities should be raised will be explored with these agencies. Major power stations located at river banks and in flood plains require the greatest degree of reliability, and may require independent, localized flood-control works such as embankments, dikes and river training works around their facilities. Phone exchanges and power substations may need to be raised above design flood levels, and control facilities be located in multi-storied buildings.

Interviews with the Rural Electrification Board (REB), the Bangladesh Power Development Board (BPDB), the Postal Department, and the Telephone and Telegraph Board (TTB) are planned to identify problems they encounter in maintaining services to their client populations. From the problems encountered, along with the field solutions they applied, should emerge key concepts for rendering their systems more resilient.

4.4.10 Public Health and Welfare

A related major problem is the access to health facilities during and immediately after floods. Disease, animal bites, and injuries must be treated, and needless deaths prevented. The flood proofing of health facilities and services, including family planning, are in the same category as flood proofing of refuge and livestock haven areas. The facilities must be raised to levels above appropriate design flood levels. These facilities also must be accessible by road during the floods, and their services must be maintained.

The problems experienced by these health facilities during the 1988 floods will be examined through the interview with officers from the Health Directorate, Ministry of Health. The experience of individual respondents with health clinics during this time will also be examined.

Solution of problems experienced in the health field may be related to the preparedness of the health establishment for floods. This may be true particularly in the supply and stockpiling of appropriate medical supplies at appropriate locations.

Community Pilot Projects involving flood-proofed facilities for health and welfare will include measures to keep the facilities operational during floods, including transportation and access to the facilities, flood-proofed buildings, access to client populations by health and welfare workers, and flood-proofed storage areas.

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Appendix B

TENTATIVE LIST OF NGOs

The following list of non-government organizations (NGOs) active in housing and flood relief was compiled by literature searches and telephone surveys with the NGOs concerned. ISPAN, throught the FAP 23 field study, will interview representatives of NGOs selected from the list below.

BRAC
RDRS
Grameen Bank
CARE
ADAB
Red Crescent
Proshika Muk
Proshika Comilla
OXFAM
ASA
CARITAS
MIDAS
CCDB
GUP
G.K.
FIVDB
Mennonite Central Committee (MCC)
EDM

The findings of the interviews will be presented at the Workshop, and worked into the design of the various Pilot Projects.

Appendix C

LIST OF GOVERNMENT AGENCIES

Functional Area	Organization/Agency	Ministry
Rural Housing	- Housing and Building Research Institute, Mirpur.	Ministry of Works
	- PWD	
	- LGEB	Ministry of Local Govt. & Rural Dev. Cooperation.
	- "Operation Thikana" Land Ministry. Rural housing finance scheme.	Ministry of Finance
	- Bangladesh Bank	
	- Housing and settlement Directorate	Ministry of Works.
	- Bangladesh Telegraph & Telephone Board	Post & Tele Communication Ministry
	- House Building Finance Corporation/Commercial Bank. Physical planning, water supply & housing wing	Ministry of Finance
	- Planning Commission.	
	- BRDB -	Ministry of LGRDC
Agriculture	- BADC	Ministry of Agriculture.
	Food Department	Ministry of Food.
Livestock & Fisheries	Department of Fisheries	Fisheries Div.
	Department of Livestock.	Livestock Div.
		Ministry of Fisheries & Livestock.
Industry	BSCIC	Ministry of Industry

Functional Area	Organization/Agency	Ministry
Roads, Railways and waterways	Department of Road and Highways	Roads & Communication Division, Ministry of Communication.
	Railway Division Bangladesh Railway	- do -
	BIWTA	
Power	BPDB	
Postal	REB	
Telephone	Postal Deptt.	
	T&T Board	
Rural Water Supply	DPHE	Ministry of LGRDC
	Pourashava	
Rural Dev.	BRDB	"
Water Control Irrigation facilities	BWDB	Ministry of Irrigation, Water Dev. & Flood control.
	MPO	
Health	Health Directorate	Ministry of Health
Relief & Rehabilitation		Ministry of Relief & Rehabilitation
Education		Education Ministry.
Dist. Admn.	Cabinet Division.	
Upazila/Admn Parishad		Ministry of LGRD.
Pourashava		- do -
Rural/semi-urban trade/commerce Market		Pourashava
		Upazila Parishad Ministry LGRDC.

Appendix D

FLOOD-HAZARD INFORMATION

D.1 Introduction

In keeping with the overall goal of promoting local flood-proofing initiatives, information on flood hazards should be made available at scales appropriate to upazila-level planning, at least, and at more detailed scales for specialized users. This information must be made available to each Upazila Parishad as well as all upazila-level line ministry offices; it also should be made available to all NGOs, donor groups and monitoring agencies, and commercial and other lending and insurance institutions so that sound floodplain investment and engineering design decisions can be made.

Potential institutional and regulatory uses of the flood-hazard information include floodplain zoning, floodplain development criteria, flood insurance rate setting, and credit institution use for assessing hydrologic risks (exposure) of facilities to be supported by potential loans. ISPAN will explore these possibilities, with emphasis on the institutional setting and interaction of government and other agencies that stand to benefit from the availability of such information.

The following section discusses the risks inherent in habitation and use of the riverine floodplains. It is followed by sections that discuss some basic flood-hazard data and some methods by which such data could be displayed more usefully for end users. The final sections concern floodplain management practices such as hazard data dissemination, institutional constraints on floodplain development, and integrated hydrological planning of rural infrastructure, all of which build on the information provided by flood-hazard mapping.

D.2 Flood Risk

Any use of flood-prone areas for human activity entails a certain amount of risk of being affected by a flood. One location may be affected by some or all of the major flooding categories described in Chapter 2. Extreme events of any type of flooding are typically described by "return periods", or the inverse of the probability of exceedence in any given year. For example, a "50-year flood" describes an event that may be equalled or exceeded once, on the average, in a 50-year period. It has a 2% probability of occurring or being exceeded in any given year. Thus, this event may be expected to happen (or be exceeded) about twice in a century. It may happen on consecutive years, as the return period does not describe the actual timing of the occurrence of the event.

The longer one occupies a floodplain, the greater the chance that this 50-year event will happen during that time. Table 4 shows the chances of this event (and others) occurring over several years.

Assume, for example, than an agribusiness owner decides to construct and operate a rice mill for a minimum of 25 years. According to Table 4, there is a 40%

Table 4 Probability that a flood of a given magnitude will be equalled or exceeded in the indicated time interval (no. of years)

No. of Years	10-year Flood	25-year Flood	50-year Flood	100-year Flood	500-year Flood
1	10 %	4 %	2 %	1 %	0.2 %
10	65 %	34 %	18 %	10 %	2 %
20	88 %	56 %	33 %	18 %	5 %
25	93 %	64 %	40 %	22 %	5 %
30	96 %	71 %	45 %	26 %	6 %
50	99+ %	87 %	64 %	39 %	10 %
100	99.99+%	98 %	87 %	63 %	18 %

Source: FEMA 1956c

chance that the 50-year flood will occur at some time during that 25-year project life. As another example, if a resident desires to construct a pucca house in a flood-prone area, and wishes to occupy that house for at least 50 years, then there is an 87% chance that the site will be hit by a 25-year flood, a 64% chance that a 50-year flood will occur, and a 39% chance that a 100-year flood will occur during that 50-year occupancy period. The house owner may then decide to raise his plinth above the 50-year flood level, and take his chances about inundation and inconvenience of access due to greater floods, rather than incur the greater expense of protecting his property further.

The significance of this information is that rational decisions on personal, private sector, and public sector investment on vulnerable floodplains can be made, provided that information on the hazard inherent in each event and location is also available to the decision maker.

D.3 Flood Elevations

A basic item of hydrologic information useful for flood proofing many engineering structures and personal dwellings is the design-flood elevation. The elevations of water levels for a range floods are required for decisions on protecting public and private infrastructure, properties, and equipment above the expected water levels of floods of different severity.

This information, for example, will enable rural engineers to determine how high to construct the surface of an upazila road to ensure that the road will not be submerged during the flood selected as the design event. Property owners and businessmen could use this information to determine how high to construct the house plinth or the sill level of a cottage industry factory, depending on the level of flood protection desired. This information also is required to retro-

fit existing vulnerable permanent and semi-permanent structures located in the floodplains.

Table 5 shows a typical set of flood elevation-frequency information for Savar, taken from the BWDB stream gauge located there. Public evacuation areas such as local school buildings or road embankments, utilities such as electrical substations and telecommunications, and other facilities essential to community survival and post-flood recovery may be protected from inundation by floods of greater severity such as the 50 or the 100-year event. On the other hand, businessmen whose capital equipment has a design life of, say, 20 years and whose factory has a design life of about 40 years may opt for protection levels associated with the 40- or 50-year event. The period of business loan repayment, availability and cost of insurance, or penalties for delays in order fulfillment may be important to some such decisions.

Table 5 Stage-Frequency Estimates Savar BWDB Gauge (Stn. 69)

Historical Floods	
Year	Gauge Height (m)
1974	7.80
1987	8.30
1988	9.68
Stage (water level) Frequency	
Return Period (Years)	Gauge Height (m)
2	7.17
5	7.76
10	8.14
20	8.52
30	8.73
50	9.00
100	9.36

Source: JICA, Interim Report, Greater Dhaka Protection Project (FAP 8A)

Public-works infrastructure, personal dwellings and office buildings probably should be designed to avoid submergence by the type of flood that produces the highest water levels (the Monsoon floods in many areas), but other uses should be designed against what may be more appropriate levels. For example, a business investor may wish to design the planned project facility for avoidance of Monsoon flood levels, if indeed the Monsoon floods produce the high water levels in that upazila.

Farmers also may benefit, for example, by selection of the type of crop to be cultivated, or by calculation of flood risks associated with that crop, where the appropriate flood-hazard information is the probability of the depth and duration of flooding during that crop growing season. If the crop is a dry-season crop, the governing flood hazard is the flood depth and duration (of various return periods) during the dry season rather than the flood hazard for the Monsoon season. Hence the provision of seasonal flood-hazard information is required to supplement the extreme flood-hazard information.

To be useful, this information must be available at the Upazila level or lower. Local public works officials and upazila officers could directly use this information in planning and designing local works such as roads, evacuation centers, hat mounds, and, as a public service, for advising local private-property owners planning improvements or new construction. Villagers and other private individuals planning housing and other works could use water level data for floods of various return periods to plan the ground floor elevations of new construction.

D.4 Hazard Mapping

D.4.1 Uses.

The presentation of extreme flood-hazard data could be done in terms of tabulated values of the water-surface elevation of floods in different parts of the upazila. However, a more effective method would be to combine the elevation values with local topographical maps to produce flood-hazard maps.

Flood-hazard maps show the spatial extent of the flooding event and other related information. There are several types of information that can be shown on flood-hazard maps. They include:

- floodplain boundaries for flood events of various return periods for each flood type
- flood flow velocities (where appropriate)
- maximum flood depths within the flood prone areas
- flood durations for different parts of the map coverage
- estimated damages to be incurred by floods of given magnitude.

The information from these maps and the accompanying documentation serves and the basis for appropriate siting and design decisions for private- and public-sector flood proofing.

Flood-hazard maps could be derived from geomorphological, land use, soils, and other data. This method uses the different landforms and their hydrological characteristics to infer the hazard due to flooding. It is an approximate method of flood plain delineation, and provides little or no information on the actual flooding depths or durations. This method can be applied to any area with the appropriate data, and is often the sole indication of flood hazard in areas with little or no measured hydrological data (JICA, 1980).

Flood hazard can be expressed in maps showing historical flood extents and levels. These provide a measure of flood hazard in the absence of statistical (risk defining) flood-level information. In an area where there are no flood-level data, local memories and physical evidence of historical flood levels can form a basis for flood-hazard mapping until model simulation results become available. This information, while specific for the particular historical flood

being depicted, provides accurate and useful general information when translated to various design and management actions (Ministry of Construction, 1982).

Finally, flood-hazard information can be estimated using appropriate hydrologic engineering methods. These typically involve combining available hydrological data with rainfall/runoff computations and computational streamflow hydraulics. The water surface elevations computed thus are then transferred to available topographical mapping to create the hazard map. Use of these engineering methods generates the most flexible and useful type of flood-hazard information for general planning and design of properties that must be protected from inundation (FEMA, 1985; Ministry of Construction, 1982). Floodplain extents, depths, and, depending on the method used, flood durations can be computed for flood events of any return period.

Table 6 Flood-hazard Mapping Methods

	Geomorphological	Historical	Hydrological
Purpose	Estimates approx. extent of flooding by using avail. soils, geologic, vegetation, and other data	Delineates actual extent of historical floods based on avail. records and recollections	Predicts extent and other flood parameters for any return period by using hydrologic engineering methods
Data Requirements	Topographic maps to suitable scale Aerial photos Historical flood levels Soil survey and geological maps Vegetation and agronomic maps Well water level hydrographs	Topographic maps to suitable scale Aerial photos Historical flood levels Stream gauge records Newspaper records and interviews with local populace	Topo maps to suitable scale Aerial photos Historical flood levels Stream gauge records Hydrologic and hydraulic models Historical data
Utility as a Management Tool	Approximate flood hazard estimates, less accurate as predictive tool	Accurate for historical event and model calibration use; less accurate for predictive purposes	Most useful as predictive tool. Used for deriving flood levels for any desired return period

Table 6 summarizes these various mapping methods.

These mapping methods can be applied to produce various *types* of flood-hazard maps. The flood boundary map described above are used to plan and design structures and facilities which must avoid being flooded.

Flood-hazard maps could be produced for various seasonal inundation events, provided that such data could be available. These maps could be useful for planning for events which do not depend on the level of the extreme flooding in the area. For example, planning for an agricultural crop whose growing season does not overlap with the main-river Monsoon flood season may not require flood boundary maps that depict the extent and severity of flooding of the Monsoon floods. Instead, a map delineating the extent and duration of inundation possibilities during the crop growing season would be more appropriate.

Table 7 Some Possible Flood-hazard Maps

	Flood Boundary Map	Seasonal Flooding Map	Flood Damage Map
Purpose	Depicts maximum extent, depth, and/or velocity of floods	Depicts depth and duration of seasonal floods (mainly for agriculture use)	Depicts areal extent and amounts of flood damage potential (monetary)
Data Requirements	See Table 6	Detailed inundation data for each growing season (local interviews) Extensive local data collection Local soils and agricultural data	Local stage-damage surveys at required field data resolution Existing and future land use planning maps Flood boundary map data
Utility as a Management Tool	Basis for many regulatory and design actions Determine specific design parameters for proposed facility Determine flood hazard as a function of location at each upazila	Basis for regulatory and design actions Determine flood hazard for seasonal operations (e.g. agriculture)	General planning tool for flood mitigation, floodplain management, and land use planners

Finally, flood-damage maps that show the spatial distribution of expected flood damages (in monetary terms) could be useful for flood-mitigation works planners to help prioritize projects and areas to be protected. These also serve as useful supplements to local land-use and land-valuation maps, providing planners with yet another tool for floodplain management. The uses to which flood-hazard maps could be put to use are limited only be the ingenuity of the user. Table 7 summarizes the information on the above three mapping possibilities.

D.4.2 Data Needs

Each of these maps require successively greater amounts of information before they can be compiled. A good estimate of the flood level associated with each design event must be known. Hydraulic analysis of flood flows must be performed to derive flood-flow velocities. Reliable mapping with topographic data and key cultural features is needed. Soils data and local geomorphological patterns should be available. Historical information on flood recession (duration) must be available for reliable flood-duration maps. Observation well data may provide estimates of rain-induced inundation levels in the lower parts of agricultural areas. Soil-association maps and more detailed soil data help extrapolate the hydrologic data. Flood damage or vulnerability maps require detailed field surveys to inventory and assess property and crops vulnerable to damage, and such work should include development of stage-damage curves for urbanized areas. In addition to different information needs for compiling maps containing this information, the scale of the maps must be appropriate to the level of the target user audience.

D.4.3 Use of GIS

Generation of such maps is greatly simplified if use can be made of a Geographic Information System (GIS). Topography can be entered as a "layer" in each map coverage. Infrastructure, particularly facilities relevant to flood preparedness such as evacuation centers; roads, health, water supply and sanitary facilities; and power-supply installations can be other "layers". Flood levels for various return periods could be yet another "layer", perhaps by season and/or type of flooding. Cropping patterns and crop value by season could comprise further "layers" of data. If the various types of flood-hazard maps listed above do not meet a specific user's needs, a GIS system could construct a customized map to fit that user's information need, provided that the information is available in, or can be added to, the GIS database for the locale. Hydrologic data, supplied by various parties, could be made part of the general GIS database for each map coverage.

Under ISPAN's GIS Study (FAP-19), team members will be examining various possibilities for developing GIS map coverage for Bangladesh in support of the FAP. Basic agronomic data could be contributed by field work, by FAP-12 (Agriculture Study), FAP-14 (Flood Response), and by other supporting studies as well as the regional studies. Local infrastructure could be obtained from Local Government Engineering Bureau, Public Health Engineering Bureau, and from the Upazila Parishads, as well as a host of central government engineering agencies that maintain a variety of trunk infrastructure facilities.

Identification of appropriate types flood-hazard mapping for various end users, and the creation of sample maps using available GIS methods and hydrological sample data from FAP-25 (River Modelling), may be one appropriate tasks for Phase I of this study. In Phase II, these maps could be produced and disseminated as one of the Pilot Projects, using TORs developed during Phase I.

APPENDIX E

FLOOD ROOFING STUDY (FAP-23)

Institutional

Name of interviewer.....

Date.....

1. Introduction

1.1 Name and Designation of the interviewee.....

1.2 Name of the Organization/Agency.....

1.3 Location of the Organization/Agency:

Upazila.....Town.....Zila.....

1.4 Primary focus/Objectives of the Organization/Agency:

1.5 Major responsibilities./functions of the Organization/Agency:

90

2. Flood Responses

2.1 How does flood normally affect your organization's operations/programs and activities? (seek information particularly against each function mentioned in 1.5)

2.2 What were the affects of 1988 flood on your Organization/Agency (Office facilities related)?

I T E M	Type and nature of damages/ losses (Specify against each item)	Extent of damages/loss(Specify against each item)		
		Total damage (Beyond repair Define)	Partial damage/ Repairable)	No damage
-Office premise -Buildings -Machineries/ Equipment -Important Office documents,paper -records etc. -Utility facilities such as - Gas -Electricity -Water Supply -Telephone Services. - Stock of raw materials - Stock of goods produced - Furniture - Access roads/ culverts. - Others(Specify) - - -				

Zamanfap.23

2(a)

2.3 Did you receive warning measure about 1988 flood?

☐ Yes ☐ No

If yes. Specify the source.

2.4 After receiving the warning did you taken any preparedness measure?

☐ Yes ☐ No

If yes. Specify measures.

3. Flood Mitigation and Relief Measures

3.1 What measures did your Organization/Agency take immediately after the 1988 flood?(Serial numbering from A to B).

Mitigation Measures	Relief Measures
A. Target activities oriented (Ref. No. 1.5)	
1.	
2.	
3.	
4.	
5.	
B. Office facilities Oriented(Ref.No.22).	
6.	
7.	
8.	
9.	
10.	

3.2 How effective were these measures? (Maintain the serial number as above).

Mitigation Measures.	Degree of Effectiveness
1.	☐ Highly ☐ Moderately ☐ Nil
2.	☐ Highly ☐ Moderately ☐ Nil
3.	☐ Highly ☐ Moderately ☐ Nil
4.	☐ Highly ☐ Moderately ☐ Nil
5.	☐ Highly ☐ Moderately ☐ Nil

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3.3 What measures did other Organization/Agency take during 1988 flood which also helped to reduce your Organization's damages, sufferings/problems?

a. Target activities oriented

Name of the Agency/ Organization	Measures	Degree of Effectiveness
1.		☐ Highly ☐ Moderately ☐ Nil ☐ Create difficulty
2.		☐ Highly ☐ Moderately ☐ Nil ☐ Create difficulty
3.		☐ Highly ☐ Moderately ☐ Nil ☐ Create difficulty
4.		☐ Highly ☐ Moderately ☐ Nil ☐ Create difficulty

b. Office facilities oriented

Name of the Agency/ Organization	Measures	Degree of Effectiveness
1.		☐ Highly ☐ Moderately ☐ Nil ☐ Create difficulty
2.		☐ Highly ☐ Moderately ☐ Nil ☐ Create difficulty
3.		☐ Highly ☐ Moderately ☐ Nil ☐ Create difficulty

3.4 What flood proofing/flood preparedness measures does your organization propose or intend to take to reduce suffering and damages which may result from future floods?

a) Measures on target activities?

b) Measures for office facilities?

3.5 Is your Organization required by existing agency's laws/regulations/policies to take any flood proofing/ flood preparedness activities?

☐ Yes ☐ No

If yes. Describe the relevant provisions of the law/policy. How adequate/in adequate the law/policy? What changes are necessary?

3.6 What kind of flood hazard information your organization/agency would need/require for flood proofing measures?

- Extent of flooding map

- Water levels of various floods expected in Upazila.

3.7 What measures do you think your Organization/Agency should be responsible to undertake for flood proofing and for reducing flood damage and suffering? (Refer 1.5)

a. Target activities oriented;

b. Office facilities oriented

3.8 What mitigation measures do you think other organization/Agencies should be responsible to undertake for flood proofing and for reducing flood damage and suffering?

Union Parishad

Upazila Parishad

Paurashava

District Administration:

Central Government Agencies:
(Line Ministries)

Autonomous Bodies:

NGO's/Private Organizations:

Elected Public Representatives:
(Member Parliament)

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APPENDIX F

Flood Proofing Study (FAP-23)

Questionnaire

Individual (Professional group)

1. Introduction

A. Name :

B. Father's name :

C. Age : D. Education:

E. Marital status :

F. Number of children : Son :
Daughter :
Relative : G. Total family members:

H. Occupation :

- Trade/commerce/businessman/ Teacher/Lawyer/Imam/ Shopkeeper

- Location of the Trade/ commercial enterprise/
- Location of the shop: office area Residential area Market area (Trade/commercial area)

- Average daily income/sale:

- Type of shop: Stationery/Medicine/Domestic Food items/Construction materials

- Type of trade/commercial enterprise : Wood furniture/clothing/ jwellery

- No. of Staff(if any):

- Monthly income from the main occupation:

- Monthly income from other sources of work. If any.

- Gross annual income from all sources: Tk.

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1. Was there any distress sale?

☐ Yes If yes. Name the items.
☐ No

2. Housing Facilities

2.1 A. Type: ☐ Kacha ☐ Pucca ☐ Semi-Pucca

B. No. of room:

Size (approx):

C. No. of stories:

D. Height of
- Floor:
- Roof :

E. Roof materials:
☐ Thatched/Straws/Bamboos
☐ Corongated tin
☐ Concrete
☐ Others (sperity)

F. Wall materials:
☐ Corrugated tin
☐ Mud
☐ Bamboo
☐ Others (Specify)

G. Floor material:
☐ Pucca
☐ Mud
☐ Wood
☐ Other (Specify)

H. Covered storage area:

I. Toilet facilities : Type-☐ Sanitary
☐ Traditional/Indigenous

- Toilet problems particularly for woman during 1988 flood.

2.2 House floor: Does it remain dry in normal inundation?
☐ Yes ☐ No

2.3 What was the condition of dwelling house during 1988?

- ☐ Roof under water
- ☐ only roof was above water
- ☐ water on the floor
- ☐ water in the house premise

2.4 Did you abandon the house during the flood?
☐ Yes ☐ No

If yes. Where did you go?

- ☐ Relief camps
- ☐ High community ground
- ☐ School/Club
- ☐ Relative's house
- ☐ Others (specify)

2.5 Nature and extent of damages (if any) to dwelling house during 1988 flood.

3. Utility/service facilities.

3.1 Electricity supply

A. Is there electricity in the town?
☐ Yes ☐ No
Agency: ☐ REB ☐ PDB

B. Condition of electricity supply during flood of 1988.

- ☐ Total suspension of supply: How many days.
- ☐ Frequent failure of supply: Duration of non-supply each day.
- ☐ Occasional failure of supply:

C. What should be done to ensure an uninterrupted supply of electricity during flood?

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3.2 Drinking Water Supply

A. From where do you normally get drinking water?

- ☐ Pond
- ☐ River
- ☐ Tube well
- ☐ Ring well
- ☐ DTW
- ☐ Pourashava/DPHE water supply
- ☐ Others (specify)

B. What was drinking water situation during 1988 flood?

- ☐ Very poor
- ☐ Poor
- ☐ Reasonable

C. Was your normal supply of drinking water unavailable during the 1988 flood?

☐ Yes ☐ No

If yes. For how long?

- How about during normal flood?

D. What do you think should be done to ensure reliable and regular supply of drinking water for yourself and others during large floods?

E. What can you do to ensure a reliable water supply during the floods?

3.3 Fuel supply

A. What was the condition of fuel supply during flood of 1988?

Item	Sufficient	Insufficient	Hardly any
- Kerosine :			
- Fuel wood :			
- Leaves/twigs:			

B. Was there increase in fuel price during 1988 flood?

Pre flood prices :

Prices during flood :

Present price :

C. Why do you think the fuel prices increased/decreased?

D. What do you think should be done?

3.4 Health condition

A. Did anyone in the family get sick/ill during 1988 flood?

☐ Yes ☐ No

If yes. What type of sickness/illness?

Name of disease:
Affected person:
Type and number
Adult-
Children-

Infant
No of death (if any):
Cause for death :

B. What did you do for treatment?

- ☐ Visit Govt. health complex
- ☐ Use private doctor
- ☐ Visit private clinic
- ☐ Other's (specify)

C. Was the Government or private health facility in operation during the flood?

☐ Yes ☐ No

If yes. Could you travel to the clinic?

D. What do you think should be done?

4. Transport facilities

4.1 Is the town connected by a road with the district headquarter?

☐ Yes ☐ No

If yes. Describe its condition during 1988 flood.

- ☐ Completely submerged
- ☐ Partially submerged
- ☐ Useable

4.2 most commonly used mode of travel within upazila town and to Dist. headquarter.

Mode of transport for people	Monsoon time	Flood time (1988)
Bus		
Boat		
Rickshaw		
Launch		
Train		
Others (specify)		

4.3 What do you think can be done to improve the situation particularly during flood time?

Transforation of people:
(within upazila/outside upazila)

Transportation of goods:
(within upazila/outside upazila)

5. Credit Facilities

5.1 A. Did you borrow any money?
☐ Yes ☐ No.

If yes. In normal time/distress time
Amount: Tk

B. What did you do with the money?

C. Purpose of the credit

D. Credit sources:

- ☐ Individual/private persons
- ☐ Traditional lender
- ☐ Relatives
- ☐ Bank
- ☐ Neighbors/Friends
- ☐ Others (specify)

E. Interest rate (if any)

F. Did you borrow any money during flood of 1988?

☐ Yes ☐ No

If yes. Total amount borrowed: Tk

Purpose of the borrowing:

Items on which the money was actually spent:

Mention the borrowing sources:

Rate of interest (if any):

G. Did you pay back the credit?

☐ Yes ☐ No

Time of borrowing/Time of pay back.

H. Do you feel any need to borrow money?

☐ Yes ☐ No

If yes. For what purpose?

6. Market Facilities

6.1 A. What was the condition of hats and bazars during 1988 flood?

	Miles	No damages	Partially abandoned	Totally abandoned
Nearest hat :				
Nearest bazar:				

B. Where do you normally go for buying your required goods?

Neighborhood shops:	Distance in miles from house	Flood items	Non-flood items
Nearest hat:			
Nearest bazar:			
Others (specify):			

6.2 What should be done so that you have access to hats, bazars, shops during times of flood?

6.3 What can you do about it?

What should the government do?

Self Efforts:

Government efforts:

7. Damages suffered by you during flood of 1988.

- ☐ House/dwelling — Type: / Value:
- ☐ Storage facilities — Type: / Value:
- ☐ Property (Furniture, rotensils clothing) : — Quantity : / Value :
- ☐ Food items (Rice/Wheat): — Quantity : / Value :
- ☐ Loss of poultry — Number : / Value :
- ☐ Loss of live stock — Number : / Value :
- ☐ Others (specify)

7.1 Did you do anything to avoid/reduce damage to items mentioned above?

☐ Yes ☐ No.

If yes. What measures taken.

Did they work?

What will you do for the next flood?

7.2 What can the Government do to help you?

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--- reinforcing walls and corner posts

D--- Building a platform (macha)

E--- Reinforcing roof

F--- Others (if any) specify.

Flood Preparedness

A--- Harvesting standing crops

B--- Storing belongings

C--- Storing fodder

D--- Storing food

E--- Storing water

F--- Preparing boat

G--- Moving stored grain

H--- Moving valuable things

I--- Moving chula to boat

J--- Moving house..... where to

K--- Moving livestock (Cattle)..... where to

L--- Advanced warning system

M--- Community grain storage facility

N--- Credit for pucca building construction

O--- Credit to buy water tight metal storage drums

P--- Water tight metal storage drums

Q--- Others (specify)

10. Agency/organization's Role in Flood Proofing/Preparedness.

10.1 What flood proofing/preparation measures are generally undertaken by the following organizations/agencies.

Neighborhood group : Measures

Name of the group:

Degree of useful of these measures

☐ Very Helpful

☐ Moderately helpful

' Neutral

☐ M. Harmful

☐ V. Harmful

10.2

Union Parisad Measures

Degree of usefulness of these measures.

☐ V. Helpful ☐ M. Helpful ☐ Neutral ☐ M. Harmful ☐ V. Harmful

10.3 Upazila Parishad/Upazila Admn.

Agency/Department Measures

Degree of usefulness of these measures.

☐ V. Helpful ☐ M. Helpful ☐ Neutral ☐ M. Harmful ☐ V. Harmful

10.4 Pourashava Measures

Degree of usefulness of these measures

☐ V. Helpful ☐ M. Helpful ☐ Neutral ☐ M. Harmful ☐ V. Harmful

10.5 NGO or any other organization

Name of orgn./NGO Measures

Degree of usefulness

☐ V. Helpful ☐ M. Helpful ☐ Neutral ☐ M. Harmful ☐ V. Harmful

11. Flood Response:

11.1 What flood response measures were undertaken by the following during the 1988 flood.

Neighborhood group — Measures

Name of the group.

☐ V. Helpful ☐ M. Helpful ☐ Neutral ☐ M. Harmful ☐ V. Harmful

11.2 Union Parishad — Measures

- Normal Flood response measures
- Measures undertaken in 1988 during flood

Degree of usefulness

☐ V. Helpful ☐ M. Helpful ☐ Neutral ☐ M. Harmful ☐ V. Harmful

11.3 Upazila parishad/Admn. — Measures

- Normal Flood response measure
- Measures undertaken during 1988 flood.

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Degree of usefulness

☐ V. Helpful ☐ M. Helpful ☐ Neutral ☐ M. Harmful ☐ V. Harmful

11.4 Pourashava

Measures

- Normal flood response measures

Measures undertaken during 1988.

Degree of usefulness

☐ V. Helpful ☐ M. Helpful ☐ Neutral ☐ M. Harmful ☐ V. Harmful

11.5 NGO or other private organization.

Name of NGO :

Name of private orgn:

Measures.

Normal flood response measures by each NGO/orgn.

Measures taken during 1988 flood.

12. Respondents Recommendations/suggestion

What flood proofing/preparation measures do you consider should be

undertaken and by whom?

Local level:

A. Local community group (Neighborhood)

B. Union Parisad. Suggested measures

C. Upazila Parishad/Admn Suggested measures

D. Pourashava

E. NGO/other orgn. Suggested measures