Flood Warning System

A Cost- Benefit Analysis of the Northern Bangladesh

A Dissertation for the Degree of Master in Disaster Management

By

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DECLARATION

I hereby declare that this thesis is the staging of my original research work. Wherever contributions of others are involved, every effort is made to indicate this clearly with proper and due references and acknowledgement. This paper has not been submitted anywhere, either in a part or a whole, for a degree or an award, in this or any other University.

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ABSTRACT

Bangladesh is one of the most flood-prone countries in the world. As a developing country with poor economy, structural measures to control floods in the world's mighty rivers is a big challenge. Settings up a new devise of non-structural measures are needed minimising destructive effect of floods. Improvement of Early warning system through mobile could be an efficient approach to reduce the risk. Therefore, the study analyses the benefits and costs of early warning system (EWS) for flood hazard, and discusses issues associated with the design and implementation of early warning system to achieve the benefits expected to stem from the EWS. Both qualitative and quantitative methods (semi-structured surveys, field visits, and interviews) including participatory methods for data collection have been conducted in this study. A combination of a mathematical model and mobile data collection apps (Magpi) has been carried out for data collection and analysis. For survey sampling, 50 participants (including female respondent), out of 2000 households of V2R and CBDRR project in two *unions* in Sirajganj were taken. To compare the findings with an uncontrolled group, the same number of participants was taken for survey in Kurigram. In effort to investigate the extent and type of precautionary and protective measures taken by community people in response to flood, the study found that 98 % of the respondents took measures to protect educational materials while 96% tried to protect household belongings. Eighty percent of the participants shifted valuables to a safer place and 52% moved their livestock to the safety. With regard to the frequency of disseminating the flood warning message from V2R, a total of 76% (62% for Sirajganj and 90% for Kurigram) participants informed that they received warning message at least 7 days before the onset of flood. In both cases, miking and mobile based IVR have been found to be the best options to the respondents. The monetary benefit of flood early warning in the project and non-project areas under has been assessed taking into account different factors including different flood protection intervention. Through in-depth discussions with villagers, community leaders and local development workers and government officials, it was determined that the community based resilience and risk reduction projects provided significant economic, social, and environmental benefits that were unquantifiable. For example, benefits associated with increased social cohesion, education, empowerment, saved lives, and indirect impacts on economic capital were not considered in determining the Benefit and Cost ratio, but were considered in the qualitative analysis. The study explored minimum, maximum, average and gross monetary value of each sector in Sirajganj (controlled area) has benefited from early flood warning through the

mobile voice message system compared to Kurigram. The cost of family level damage and recovery are considered together to calculate the net benefit per family. Flood victim households were able to save additional BD TK 24,000 ($285) annually through the mobile phone based forecast service at Sirajganj compared to households that do not receive service at Kurigram. The study suggests establishment of a comprehensive early flood warning broadcasting equipped with IVR by the government is crucial to reach flood victim community. Setting up a functional pathway for ensuring consistency in message development and dissemination is also an issue of critical importance. Government and other actors need to connect local level stakeholders in FW System to ensure as many people as possible are warned, to lessen the damage"

TABLE OF CONTENTS

LIST OF TABLES

ACRONYM

BDRCS: Bangladesh Red Crescent Society
BMD : Bangladesh Meteorology Department
CBO : Community based Organization
CCA : Climate Change Adaptation
CDMP : Comprehensive Disaster Management Program
CSV : Comma-separated values
DRRO : District Relief & Rehabilitation Officer
DDM : Department of Disaster Management
D Form: Damage Form
DMB : Disaster Management Bureau
DMC : Disaster Management Committee
DRR : Disaster Risk Reduction
EDG : Esho Desh Gori
EFAS : European Flood Awareness System
EW : Early warning
EWS : Early warning system
FFWC : Flood Forecasting & Warning Center
FGD : Focus Group Discussion
FWV : Flood Warning Volunteer
IT : Information Technology
IVR : Interactive Voice Response
KII : Key Informant Interview
LRA : Local Resilience Agents
MMS : Manob Mukti Shongstha
NPDM : National Plan for Disaster Management
NGO : Nongovernment organization
PAB : Practical Action Bangladesh
PIO : Project Implementation Officer
SoD : Standing orders on Disaster
SMS : Short Message Service
SPSS : Statistical Package for the Social Sciences
RAMP : Rapid Mobile Phone based Survey
TV : Television
UNO : Upazila Nirbahi Officer

CHAPTER 1: INTRODUCTION

1.1 Statement of Problem

Bangladesh is considered to be a country perennially affected by recurring floods. The frequency of natural disasters has been increasing over the years, resulting in loss of life, damage to property and destruction of the environment (Living with Risk, 2000). Flood losses reduce the assets of households, communities and societies through the destruction of standing crops, dwellings, infrastructure, machinery and buildings, apart from the tragic loss of life. In some cases, the effect of extreme flooding is dramatic, not only at the individual household level, but also in the country as a whole (Integrated Flood Management Concept Paper, 2009). The Fourth Assessment Report (2007) of the Intergovernmental Panel on Climate Change (IPCC) predicts "heavy precipitation events, which are very likely to increase in frequency, will augment flood risk". These floods will affect life and livelihoods in human settlements in all areas, such as flood plains, coastal zones, river deltas and mountains. Flooding is also increasing in urban areas, causing severe problems for poor and vulnerable people.

Floods are annual phenomena with the most severe appearance during the months of July and August in every year. According to the Department of Disaster Management (DDM), regular river floods affect 20% of the country increasing up to 68% in extreme years. The floods of 1988, 1998, 2004 and 2017 were particularly catastrophic, resulting in large-scale destruction and loss of lives. Flood and riverbank erosion are two major environmental disasters that the country experiences recurrently and an estimated one million people are displaced every year due to riverbank erosion in the country (Elahi, 1989). This adversity is further worsened when the devastating flood and riverbank erosion together intensify the process of pauperization in rural areas in Bangladesh (Rahman et al, 2013). The number of people at risk has been growing each year and the majority is in developing countries like Bangladesh with high poverty levels making them more vulnerable to disasters (Living with Risk, 2000). Grunfest (1995) argues that due to high poverty levels, people have become more vulnerable because they live in hazardous areas including flood plains of river and over the embankment.

As a developing country with poor economy, structural measures to control floods in the world's mighty rivers is next to impossible. So, we have to devise non-structural measures to mitigate the impacts of floods. One such aspect is 'early warning'. The development of flood forecasting and warning systems is an essential element in regional and national flood preparedness strategies, and is a high priority in many countries including Bangladesh. Flood EWS are being considered as an alternative for dealing with flood problems, partly because these systems are less expensive compared to structural schemes. Early action is essential in order to mitigate potential damage (IFRC, 2009). Effective and timely dissemination of flood warning can minimize losses to a great extent. Bangladesh has developed the capacity to forecast floods for 72 hours ahead. However, the main challenge is the dissemination of the warning messages to the village level. The other challenge is making the warning messages produced and analysed in a way which is understandable by the population at risk of flooding. FFWC produces the warning messages and send those to Prime Minister's Office, all relevant Ministries, Ministry of Food and Disaster Management, Disaster Management Bureau, Deputy Commissioners offices, and mass media everyday though email, fax, telephone. Due to accessibility of the communication tools mentioned (phone, fax, website, e-mail), different level of organizations can access the warning messages. Timely action reduces loss of life and property damage. However, decision makers must also understand the expected consequences of taking action, in terms of the probability of false and missed alert, the cost savings due to mitigation actions and the cost of a false alert (Grasso 2007). Communicating the early warning and the uncertainty level of the information to users is critical (Grasso et al 2007), otherwise there is a high risk that warning information will be ignored or misused potentially resulting in significant societal and economic costs (Sarevitz et al 2000). Despite the high priority accorded to flood warnings in flood risk management by governments, there is a lack of good data on the benefits and costs of these systems (Rahman et al, 2013). Methods for estimating benefits to damage reduction measures such as flood alleviation are well established (Sally J. Priest et al., 2011), but there are contexts in which the estimation of benefits is more difficult. Estimating the benefits of flood warnings is one of the more problematic contexts.

1.2 Relevant studies of Early Warning System

Early warning is a key element of Disaster Risk Reduction. In recent decades there have been major advancements in medium range and seasonal forecasting. Babel et al. (2013) developed an experimental medium range (1-10 days) probabilistic flood forecasting model for Bangladesh. This progress provides a great opportunity to improve flood warnings and therefore reduce vulnerability to disasters.

The importance of having effective flood early warning systems is widely accepted as one component to manage disaster risk. The Hyogo Framework for Action (2010 – 2015) made early warning a Priority for Action and the post 2015 framework for Disaster Risk Reduction are expected to continue this focus "Continuing to further strengthen early warning systems and tailoring them to users' needs, including social and cultural requirements".

Basher (2006) conducted a study on early warning system and find that a people-centered early warning system comprises four key elements: knowledge of the risks; monitoring, analysis and forecasting of the hazards; communication or dissemination of alerts and warnings; and local capabilities to respond to the warnings received. Ultimately an early warning system will only be effective if all components are effective. Communication and dissemination component has been recognized as the component which lacks sufficient attention and results in a huge gap between the information produced by national level forecasting agencies and the information that is actually received and acted upon by the flood affected communities.

The FFWC is disseminating forecasts at national and district level through email, website and IVR services. This is an innovative approach using a voice recording of the most recent flood situation to the general public by dialing 10941 and pressing a certain number for flood information. This is a huge development attempting to get national level information to the potentially affected communities.

However, previous studies (Cumiskey et al., 2015) have shown that the awareness of this service is very low at the community level. Furthermore, DDM has been working towards having a national SMS dissemination system to disseminate SMS to all government officials and disaster management committees: pre-, during and post-flood for stronger coordination but it is not working sufficiently to date.

Flood early warning systems include a chain of activities: understanding and mapping flood vulnerability, monitoring rainfall and water levels, forecasting impending events, processing, and disseminating and communicating understandable warnings to decision makers and the population so that they can take appropriate and timely actions in response (UNISDR 2007).

Fakhruddin et al (2015) in their article "Community Response To Flood Early Warning System: A Case Study On Kajuri Union, Bangladesh" concluded that Flood warning systems need to be seen as providing (a) forecasting of floods, (b) warning bulletins to those at risk and (c) a communication mechanism for disseminating warning messages to those who need the information as a basis for their response. This 'Whole system' approach needs to be integrated to make the warning system successful.

Several factors should be considered while establishing a community based flood early warning system. These are hydrological characteristics, flooding frequency, community awareness, vulnerability, required lead time and the cost. First, the desired accuracy, achievable lead time, cost and sustainability of the system should be assessed. Then, a good rapport should be established with the communities and the technical and scientific expertise should be complemented with the indigenous knowledge of the communities. Therefore, communities and local government units should be adequately consulted before establishing the community based flood early warning system. The operational planning should include simulation exercises and mock drills for community preparedness as well as components for maintenance and system updating (Ahmed et al, 2007).

Dilip K, Anup G. (2013) in their article 'Community Based Approach to Flood Early Warning in West Rapti River Basin of Nepal' observed that the community based flood early warning system considered communities as an integral part and involved them in risk assessment, communication and dissemination and immediate response activities in a participatory way. Communities have been involved in the identification of the problems, activities and the design of the action plan. Participation of elderly people, women, children, young, people with disabilities and marginalized communities made the system truly inclusive. The system successfully established a linkage between the upstream stations with downstream communities.

Parker and penning-rowsell 1972; parker et. Al. 1984, in their article ‘the indirect effects of floods and benefits of flood alleviation: evaluating the chesil sea defence scheme’ concluded that the benefits of flood early warning systems come from the savings in flood damages. Floods are random events that cause damages and hence flood damages are also random or probabilistic events: the probability of any specific amount of flood damage depends on the probability of the flood event necessary to cause those damages. Determining flood damages combines a risk assessment in terms of the probability of future flood events to be averted, and a vulnerability assessment in terms of the damage that would be caused by those floods and, therefore, the economic savings to be gained by their reduction. Flood damages can be either direct or indirect. Direct damages are physical and are usually `visible' losses arising out of direct contact with water (e.g. water damage to household structures, personal possessions etc.). Indirect damages are the consequences of direct damages such the interruption and disruption of economic and social activities (e.g., production losses due to flood damage of machinery). From an economic perspective, flood damages belong to two further categories: tangible and intangible. The tangible impacts are those to which a monetary value can be assigned in order to estimate them. Intangible impacts are identified as those that cannot directly be evaluated in terms of money.

In this context, there is no initiative taken to assess the direct and indirect a. costs and b. benefits of investing in a Flood Early Warning System in Bangladesh. This study looks into the investments done to manage disasters by different government agencies as well as NGOs, used for their best practices. Furthermore, the outcome of these investments in terms of benefits availed would also need to be reflected in the study.

1.3 Importance of the Study

With growing prevalence rate of flood across the globe, an effective flood early warning system is now widely accepted as a component for management of disaster risk as it has been proven effective in reducing disaster risk and saving lives. “There has been a paradigm shift from single-hazard to multi-hazard early warning and also from providing hazard information to providing risk and impact information. However, there are gaps in effective implementation of people-centered, multi-hazard warning systems. In addition, knowledge concerning disaster risk and impact

information is often not at all, or insufficiently, integrated into multi-hazard early warning systems. The Standing Order on Disaster (SOD) of the Government of Bangladesh has mandated compliance of flood warning by all the concerned ministries, departments and Disaster Management Committees (DMCs). `The potential monetary benefits of early flood warnings are estimated based on the forecasts of the continental scale European Flood Awareness System (EFAS) using existing flood damage cost information and calculations of potential avoided flood damages. The benefits are of the order of 400 Euro for every 1 Euro invested. A sensitivity analysis is performed in order to test the uncertainty in the method and develop an envelope of potential monetary benefits of EFAS warnings.

The basic benefit of a local flood warning program is an increased lead time for watches and warnings at locations subject to flood risk. The information of warning can be used to predict whether a flood is about to occur, when it will arrive, and how severe it will be. Organizations and individuals are given notice by the system so they can protect themselves and their property. The basic parts of a flood warning program include: The FWS, including equipment, people, and procedures for recognizing an impending flood and disseminating warnings; a prepared plan of action to be taken before and during the flood; and arrangements for updating and maintenance of equipment and plans Local flood warning programs can be extremely effective.

Those institutional practices now in use have been credited with saving scores of lives and preventing damage of resources. Timely collection of more detailed information on local rainfall and stream levels allows more accurate and reliable predictions of floods. Advance knowledge about an impending flood can be used to: warn low-lying areas to evacuate; information for the local farmers about timely harvesting of crops and thus ensuring protection of crops from inundation; protection of livestock; schedule closure of schools and transportation of students.

A people-centred early warning system comprises four key elements: knowledge of the risks; monitoring, analysis and forecasting of the hazards; communication or dissemination of alerts and warnings; and local capabilities to respond to the warnings received (Basher, 2006). Ultimately an early warning system will only be effective if all the stated components are effective.

1.4 Aims of the Study

The overall aim of this study is to analyse the cost-benefit of investing in a Flood Early Warning System in Northern Bangladesh and recommend a best practice to the govt. that may contribute in improving the national system. Following are specific objective of the study:

a. To assess the direct and indirect costs and benefits of investing in a Flood Warning System.
b. To know the people's perception on flood vulnerability and existing warning system on flood by government and non-government organization
c. To develop some interventions that may be of great use in early warning of flood.

1.5 Conceptual Definition

1.5.1 Cost-benefit analysis

Bhemani Alnoor (2004) defines the cost-benefit analysis as it is the exercise of evaluating a planned action by determining what net value it will have for the company. Basically, a cost-benefit analysis finds, quantifies, and adds all the positive factors. These are the benefits. Then it identifies, quantifies, and subtracts all the negatives, the costs. The difference between the two indicates whether the planned action is advisable. The real key to doing a successful cost-benefit analysis is making sure to include all the costs and all the benefits and properly quantify them.

Zahirul Hoque (2005) mentioned in his book '*Handbook of Cost and Management Accounting*' that cost-benefit analysis can be explained as a procedure for estimating all costs involved and possible profits to be derived from a business opportunity or proposal. It takes into account both quantitative and qualitative factors for analysis of the value for money for a particular project or investment opportunity. Benefits to costs ratio and other indicators are used to conduct such analyses. The objective is to ascertain the soundness of any investment opportunity and provide a basis for making comparisons with other such proposals. All positives and negatives of the project are first quantified in monetary terms and then adjusted for their time-value to obtain correct estimates for conduct of cost-benefit analysis. Most economists also account for opportunity costs of the investment in the project to get the costs involved.

1.5.2 Early warning system

According to the United Nations Office for Disaster Risk Reduction (2017), Early Warning System is an integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication and preparedness activities systems and processes that enables individuals, communities, governments, businesses and others to take timely action to reduce disaster risks in advance of hazardous events. Effective “end-to-end” and “people-centred” early warning systems may include four interrelated key elements: (1) disaster risk knowledge based on the systematic collection of data and disaster risk assessments; (2) detection, monitoring, analysis and forecasting of the hazards and possible consequences; (3) dissemination and communication, by an official source, of authoritative, timely, accurate and actionable warnings and associated information on likelihood and impact; and (4) preparedness at all levels to respond to the warnings received. These four interrelated components need to be coordinated within and across sectors and multiple levels for the system to work effectively and to include a feedback mechanism for continuous improvement. Failure in one component or a lack of coordination across them could lead to the failure of the whole system.

CHAPTER 2: DATA SOURCE AND METHODOLOGY

The methodology of the study has been designed based on the scope of work, objectives, criteria and deliverables of the Study. The study has been carried out in districts Kurigram and Sirajganj. The study has included both qualitative and quantitative approaches with a variety of primary sources including participatory methods using the mix-matrix and adopted the data collection procedure. The data sources have been investigated through questionnaire survey, Key Informant Interviews (KIIs), Focus Group Discussions (FGDs), and meeting with stakeholders and project staff and covered all dimensions of the project. The quality of the data with respect to accuracy, reliability and validity has been confirmed by triangulation of similar information and improved the validity of collected data by using different tools from different sources. The list of tools and data collected is presented in the table below.

Table-1: Status of Performed Tools and Collected Data

Tools/Methods	Source of Information	Targets	Remarks
Questionnaire survey	Individual survey	100	Project beneficiary in Sirajganj. In Kurigram the number of Individuals was replicated as Sirajganj
KII	Relevant stakeholders	10	UP Chairman/Member, School teacher, CDMC Leader, VDC Leader, UNO, PIO
FGDs	Relevant stakeholders	04	• Farmer -3 • Day laborer- 3 Producer/Entrepreneur woman-2 • Small Enterprise-2
Meetings	Project Staff	01	BDRCS and PAB
Significant Evidence Result (case studies)		As available	Local people

2.1 Pre Field Activities

The pre field activities were focused on formation and orientation, desk review and clarification of project concept and understanding. At the first step of the assignment, the Chief Consultant has formed the study and oriented the members about the technical aspects of the study and so forth. Alongside of the orientation, the desk review has been conducted on project documents like existing flood warning systems, document on V2R+ project, relevant studies and reports. Discussion with project staff has taken place and the study got the clarity on the proposed study. During the discussion meetings, the study presented the draft study plan, tools and checklists and finalized those by incorporating the feedback from project members and thereafter goes for field work and data collection.

2.1.1 Data Collection Apps Development

After finalization of the paper form of survey questionnaire, the data collection software has been developed by the IT officer. The final version of data collection apps has been installed into the tablets for data collection. All the data for questionnaire survey has been collected into the tabs by the developed apps during interviews.

2.1.2 Survey Questionnaire

The semi-structured survey questionnaire has been developed considering that the survey has captured both qualitative and quantitative aspects of the project interventions covering the set outcome and indicators. The questionnaire has been developed by the guided by the objectives of the study. The survey questionnaire has been field tested and finalized and data collection was conducted randomly at the project sites.

2.1.3 Discussion Meetings

Discussion meetings were held with the project field staff and shared the field activities plan for field organization, also to gather the implementing mechanism of projects at both in Dhaka and project location. During discussion meetings, the tools for data collection, plan for field test have been shared and finalized the data collection tools. The project field staff has been sensitized for identification and sharing of most significant changes among the beneficiaries through case studies. The list of stakeholders for FGDs and KIIs have been prepared and finalized at the same

time. After review and finalization of checklists for KII, FGDs, the types of FGD participants, the field observation sites have been selected for commencing the study.

2.2 Field Activities

The study has considered both the wards under the project and conducted data collection by survey, FGDs, PRA and KII including field observations for mid-term evaluation of the project. Based on set plan and tools, data collection has been completed following the objective and deliverables of the study.

2.2.1 Questionnaire Based Survey

The random questionnaire based survey has been conducted at both the wards to measure the changes as impact of the project interventions. A total number of 100 respondents have been interviewed and captured the most significant changes as set in the project goal and objectives. Three categories of respondents have been interviewed under the survey are: in Sirajganj, only the project beneficiary and in Kurigram random basis.

2.2.2 Survey Population Selection

The survey has been conducted following "**Stratified Random Sampling"** method for identifying survey respondents. The survey has been conducted using a semi-structured simple questionnaire administered by a group of experienced data enumerators. In Sirajganj, out of 2000 total households at 2 unions, the study has conducted survey with 50 (2.5%) sampled including female producers. The same figure was replicated in Kurigram which is not project area of V2R project. The targeted respondents for the questionnaire survey was mainly farmers, livestock rarer, fisherman, daily labour, shop keeper and women headed households who are involved with farming.

2.2.3 Training of Supervisor and Enumerator

All enumerators selected for the assignment has been given a one day orientation on various aspects of the survey, such as questionnaire content, interview techniques, field procedures, data collection and maintaining data quality.

2.2.4 Data Collection

Experienced, skilled and trained data enumerators have collected the data. A written instruction on data collection has been provided to all enumerators. Data has been observed and monitored regularly through the server; those were processed and

checked for completeness and consistency of the information returned on a daily basis. As a part of the voluntary participation of the respondents, the respondents were first made aware of the purpose of the survey. Alongside, they were also ensured that all information collected have been confidential and used at aggregated level for this project purpose only.

2.2.5 Quality Control

In every step of the survey, quality has been ensured by the following steps:

- A day long orientation was provided to the enumerators and they have understood the data collection methods, quality parameters, and overall guideline for field data collection.
- Utmost effort was given to select skilled and experienced enumerators.
- Cross checking of questions within the questionnaire and random supervision during data collection has been followed.
- Survey has sat in each afternoon, rechecked the field information and made conclusion on confusions.

2.2.6 Key Informants Interviews

The Key Informants Interviews (KII) has been conducted among the selected relevant stakeholders of duty bearers. The interviews have captured the qualitative progress including sustainability of the undertaken project activities. The project staff has assisted to some extent in organizing the meetings with the key stakeholders and conducted the KIIs. The KIIs have been conducted following a pre developed checklist. The KII checklist has contained the aspects of outcome and indicators and captured the information during the interviews. The checklist was finalized in keeping the similarities of undertaken activities of the project with the stakeholders and in consultation with project management. A total number of 10 KIIs have been conducted with the selected key stakeholders. The number of KIIs and the respondents has been finalized in consultation with BDRCS and Practical Action Bangladesh.

2.2.7 Focus Group Discussions

The Focus Group Discussions (FGDs) have been onducted with the targeted community and relevant stakeholders which captured the progress in regards to damage due to status of existing flood warning, its fruitfulness, potential flood warning system, flood, recovery cost, etc. The access to basic educational facilities and resilient services has been mapped out through FGDs with the relevant stakeholders following a pre-prepared checklist considering the project activities with the community and stakeholders. A total number of 04 FGDs have been conducted with the community members. The numbers of FGDs and FGD checklist have been finalized in consultation with the project management. The participants of FGD were as follows:

- Farmer -3
- Day laborer- 3
- Small Enterprise-2
- Producer/Entrepreneur woman-2

2.2.8 Significant Evidence (Case Study)

The study has captured the most significant changes as case study during the data collection at field level. The project field team has helped the study during identification of most significant changes. The identification was also conducted during the questionnaire survey and FGD with sampled individual. The information of most significant changes has been captured following a pre-prepared checklist.

2.2.9 Data Processing, Entry and Analysis

Survey data processing has been done using the RAMP-Magpi software. In this process, the filled in questionnaire data has been stored into the server. The daily basis data checking has been continued during the period of data collection. The collected data has been imported into the CSV files for analysis and regenerating the output tables. Data analysis was carried out using the SPSS software which produced frequency tables, cross tabulation and standard statistical calculations to produce required project effectiveness, assessment indicators. The results are then used in developing this report.

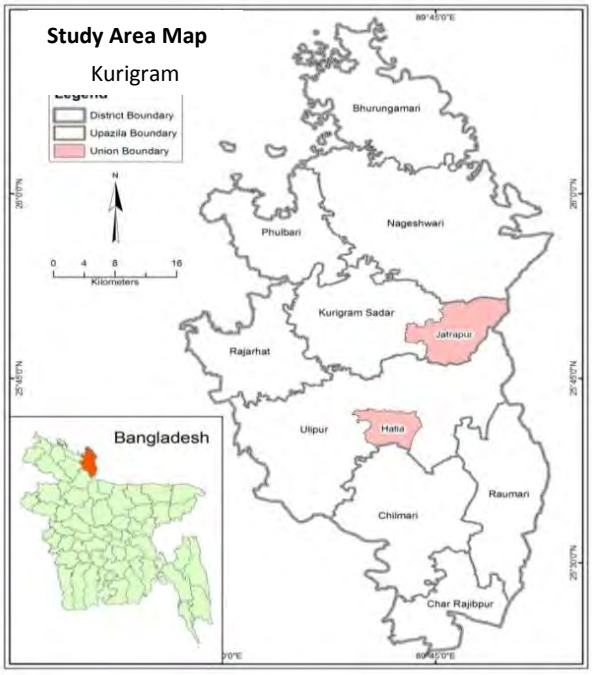
2.2.10 Limitation of data collection

Sample size of quantitative assessment could not be suitable due to time constraint. In Sirajganj, out of 2000 total beneficiaries at 2 unions, the study has conducted survey with 50 (2.5%) sampled including female producers. The same figure was replicated in Kurigram which is not project area of V2R project. It has been mentioned earlier that the accurate cost-benefit analysis largely depends of the quality of both primary and secondary data. In this study, primary data have been collected from the field through questionnaire survey, FGD and KII information. The quality of field data is well in accepted level. However, the limitations remain with the quality and availability of secondary data. For cost-benefit analysis, it requires damage data (included in D form), govt. relief data (included in D form), NGOs relief data, Relatives relief data, Govt. recovery data, NGOs recovery data, Govt. flood forecast costing data, and PAB flood forecast (mobile based) data. Among all these secondary data set, Govt. data in D-form is not only inadequate but also non-reliable and inconsistence. It bears no sense to include in the mathematical expression. Other data are not available at all. However, despite all limitations, data on annual spent for V2R cost (TK 1000000) by PAB, and family level data on damage cost, recovery cost and saving value are good enough to run the modified formula for cost-benefit analysis.

2.3 Profiling the Study Area

2.3.1 Kurigram District

Kurigram is located in the northern region of Bangladesh, bordering with Cooch Behar and Assam of India in nortl Lalmonirhat along with Rangpur of B Several rivers pass through the land, major rivers while Dudhkumar, Phulk Differing from the middle and southe temperatures are correspondingly high temperatures are around 32-33 °C and monsoon, with the average amounts be

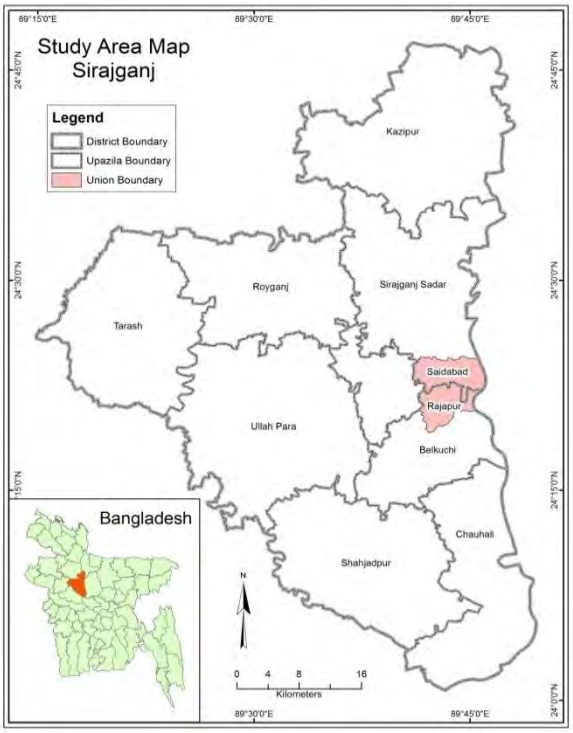


Climate: Excluding monsoon (June throughout the year. The distr flows to the south without much obstru temperatures being 30-35 °C. Monso Kurigram is one of the five districts prone to cold waves, with average temperatures reaching but not falling below 2 °C. From March the weather starts to warm up with the onset of spring, followed by autumn in May, which is the traditional major rice harvesting season.

2.3.2 Sirajganj District

Regarded as the gateway to North Bengal, Sirajganj is located in northern Bangladesh, bordered by Bogra in north, Natore in north and west and Pabna in west and south. With an area of 2497.92 sq. km, this district's main rivers are Jamuna, Baral, Ichamati, Karatoya and Phuljuri. Sirajganj is an area of perennial floods due to its location being on the banks of the treacherous Jamuna in addition to its low topography. Flood durations are increasing, as every flood that affects Bangladesh also affects Sirajganj. Some of the parts of this district are more vulnerable to floods than others due to their locations. The marginal population living in the perennial flood zones of Jamuna is mostly malnourished, unwell and uneducated. Floods engulf their crops, assets, fisheries and livestock while also being a cause of concentration of landownership due to distress sale by the poor people after a flood has struck the area.

Climate: Maximum and minimum annual average temperatures are 34.6 °C and 11.9 °C respectively, while the annual rainfall is 1610 mm (64.4 in.). The tropical monsoon climate of South Asia combined the district's low topography make Sirajganj one of the most flood prone areas of the country. High rainfall in India along with melting of snow in the Himalayas overload Jamuna with excess water that it cannot discharge properly, resulting in floods in the adjacent Upazilas of the district.



2.3.3 Justification of the study area

Flood has been affecting Kurigram and Sirajganj district almost every year and has impact on peoples live and livelihoods. BDRCS and Practical Action Bangladesh have been implementing community based flood early warning activities with a view to building capacity of local people as well as local government to disseminate the warning message timely, accurate as scale. To align with the objective of the study, the study has selected the Sirajganj district as project implementation area, and Kurigram as project control area where there is no community base warning system implementing by government or any NGO/INGOs.

Table-2: Respondent Characteristics

Education Level	Education Statistics in %			Occupation	Occupation %			Income Range	Income Statistics in %		
	Sirajganj	Kurigram	Study Area		Sirajganj	Kurigram	Study Area		Sirajganj	Kurigram	Study Area
Illiterate	50	74	62	Day labor	22	46	34	<2000	10	0	5
Primary	30	16	23	Farmer	34	32	33	2000-4000	20	24	22
Secondary	18	10	14	Fisherman	0	4	2	4000-6000	52	54	53
Tertiary	2	0	1	Livestock rarer	2	0	1	6000+	18	22	20
Technical	0	0	0	Shop keeper	30	18	24	**Total**	**100**	**100**	**100**
				Other	12	0	6				
Total	**100**	**100**	**100**	**Total**	**100**	**100**	**100**				

CHAPTER 3: FLOOD WARNING SYSTEM IN BANGLADESH

Recurring disasters have appeared as one of the cardinal challenges impeding the pace of development of Bangladesh. Frequent flooding, cyclone, prolonged water-logging, and drought have scourged dire environmental, social and economic consequences on the country over the last few decades. The country has adopted both structural and non-structural approaches for disaster risk reduction. It has already been proven that the most cost-effective forms of DRR investment tend to be non-structural approaches i.e. land use planning, early warning systems. The poor socio-economic condition and resource constraints are the daunting challenges for Bangladesh to reduce vulnerability to floods through structural measures.

3.1 Flood Warning Perspectives

Early warning system is the set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities, and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss**.** A flood early warning system is an integrated system of tools and plans that guide detection of and coordinates response to flood emergencies. A properly designed and implemented system can save lives and reduce property damage by increasing the time to prepare and respond to the threat of flood and time available to take protective measures prior to the occurrence of flood.

Bangladesh is a flat deltaic country located at the lower part of the basins of three large alluvial rivers, the Ganges, the Brahmaputra and the Meghna. It includes 57 trans-national rivers and a total river basins area of 1.7 million km^2. The numerous tributaries of these rivers and extensive floodplains are the main physiographic feature of the country. Low sea level and crisscrossing of numerous rivers have turned flooding into an annual phenomenon for the country. Floodplains constitute about four-fifths of the country's total landmass – a simple figure that prompts us to draw the inference about how much portion of our total population is vulnerable to flood hazard. This warrants the need for a flood early warning dissemination system across the vulnerable districts. Moreover, rapid population growth is creating an extra pressure on the land required for agriculture, settlements, and construction of roads and highways etc. (Khalequzzaman, 1994). Due to unplanned urbanization, the towns

and cities are most vulnerable to floods in particular during the prolong rainfall event (Rahman, 2011). Therefore, it is essential to predict flood in wet season. During the 1998 flood season, the Flood Forecasting and Warning Centre (FFWC) of BWDB prepared daily bulletin and incorporated information of rainfall, rise/ fall of river water, flood forecasting for 24 and 48 hour in advance and warning message.

3.2 Flood Warning by Flood Forecasting and Warning Centre

Government of Bangladesh set up the Flood Forecasting and Warning Center under the Water Development Board in 1972. Ever since, the FFWC has been providing flood forecasts on a 72 hours, weekly, fortnightly and monthly basis. As part of the process, the FFWC generates and disseminates daily statistical bulletin of river situation, a descriptive flood bulletin, forecast for 24, 48 & 72 hours. It also develops Thana Status Map of flood situation, Satellite Imageries, special flood report along with different graphical and statistical presentations during the monsoon season. During the monsoon, FFWC generates warning messages and share it with the Prime Minister's Office, all relevant Ministries, Disaster Management Bureau, Deputy Commissioner's offices, and also the mass media on a daily basis. The early warning messages are then passed to the Upazila Nirbahi Officer's office (PIO) through the Deputy Commissioner's office (DRRO) and later to the Union Parishad. The Union Disaster Management Committee is responsible for dissemination of the flood warning among the community people at risk.

The present flood forecasting and warning system by FFWC is underpinned on four elements: Real-timing rainfall and water level data collection, Meteorological forecasting, Flood forecasting, and Flood warning dissemination. Through regular forecast and early warning, the FFWC helps people and organizations to necessary preparation to reduce damage and protect lives, livelihoods and assets. The Flood Forecasting and Warning Centre, under the Directorate of Processing and Flood Forecasting Circle, Hydrology, BWDB, carries out monitoring of 86 water level stations and 56 rainfall stations throughout the country.

The major limitations of present early warning system are - lead-time, dissemination down to union level, full understanding of the EW messages, information availability with its interpretations for the likely damages, EW specific to geographical conditions. Despite constant and pervasive flooding, FFWC does not have an effective

system for providing useful flood warning messages and dissemination procedure at the community level. The present system of government-issued flood warnings is presented in both a context and a format that are poorly understood by the floodplain inhabitants and also mode of dissemination took long time to reach the affected community. A user friendly flood warning messages and timely dissemination mode can effectively reduce the loss and sufferings of poor flood affected people. The construction of effective flood warning message is a complex task. Message need to be short, informative and prompt a response from recipients.

3.3 Flood Warning by DDM through IVR

Interactive Voice Response (IVR) is another technology using the mobile for promoting awareness on disaster related information. General public can access the pre-recorded weather advisory and disaster early warning by dialing a specific code from their mobile set on 24/7 basis. In this regard, an agreement was signed between Teletalk Bangladesh Ltd., erstwhile DMB and CDMP (Comprehensive Disaster Management Program) on 29 December 2010. The Teletalk has procured equipment for routing this service to other 5 telecom operators to expand the coverage to the whole nations.

The key objective of the mobile device-based people-centered multi-hazard early warning systems is to provide the communities at-risk sufficient lead time information and thus empower them to take the timely and appropriate actions to reduce the potential injury, loss of life and damages to property and the environment. This system is being operated as pilot basis in 2 unions at Jadurchar union of Rowmari Upazila, Kurigram and Kulkandi union of Jamalpur district. Accessible from any mobile operators by dialing 10941, the IVR-based early warning messages disseminate five hazard-related information i.e. weather forecast, rainfall, cyclone, flood and landslide. But all flood prone Upazilas are not covered under this system yet.

3.4 Voice SMS-based EW and agricultural advisory services by PAB

The current V2R project of Practical action Bangladesh focuses on flood early warning system (EWS) using ICT, local interpretation of weather forecasts, an associated agricultural advisory service, threshold-based livelihoods and small scale infrastructural innovations. Practical Action’s experience has shown that poor farmers

have limited access to the existing EWS and that they lack the knowledge and also capacity to take actions to protect their lives and livelihoods. Low literacy rates further limit the use of information in flood-prone areas. Various studies have found that while flood forecasting contains messages now of an acceptable quality, these, however, are not always relevant to specific user needs. For example providing additional information on how to protect crops in response to floods and weather forecasts transmitted.

Practical Action Bangladesh, under the V2R Project, has been disseminating voice SMS-based flood early warning messages among 70,000 small and medium scale farmers involved in crop cultivation, fishing and livestock rearing in Sirajganj and Bogra districts. For dissemination of the voice messages among the farmers, mostly women farmers, Practical Action Bangladesh has developed mobile phone-based specialized app and installed it in the cell phones of the project beneficiaries.

Engaging concerned metrological experts, PAB Bangladesh facilitates the content development process of flood early warning. For dissemination of the messages, PAB involved call centres, Union Digital Centres, entrepreneurs, rural extension workers, and government staff at district, Upazila and union levels. In addition to the voice SMS, it has also developed a pool of trained volunteers, popularly known as Local Resilience Agents (LRAs), to reach the warning messages at household level. 6-9 Flood Warning Volunteer (FWV) volunteers, deployed in each union under this project, are also paid small remuneration for other jobs (under same project). They take necessary initiatives to disseminate the flood warning to the community. They have hand mikes. And, sometime they mobilize the authority of Mosque to disseminate the flood warning for ensuring the greater coverage of the warning.

3.5 Community based flood early warning dissemination by BDRCS

The CBDRR project of Bangladesh Red Crescent Society focuses on community based flood early warning system with linking the community initiative with national warning system, dissemination of flood early warning message after transforming into local dialect. In this regard, local volunteer groups and students are formed to disseminate early warning message to be understandable for the local people and to response during adverse situations. Most importantly volunteers are trained on how to extract the forecast based information from the FFWC website and its interpretation.

CHAPTER 4: FLOODS AND FLOODING: THE PERSPECTIVES

As a disaster prone country, facing different types of natural disaster is nothing new to the people of Bangladesh. However, the types, nature and characteristics of those disasters are of area specific. In this section, attempt will be made making an elaborative situation of the study districts in the context of flood frequency, vulnerability and responses to early earning.

4.1 Perceiving Floods in the Study Area

4.1.1 Flood Frequency in the Study Area

Flood is a regular annual event in Bangladesh during the monsoon, although its nature and characteristics is site specific. The occurrences of unusual flood, as have been seen in all the study sites, have increased significantly in recent years. Table-3 shows that, in Kurigram, 100% respondents, and in Sirajganj, 80% respondents have witnessed unusual flood-events for 5 times during the last 5 years. Flood frequency in Kurigram is higher than that of Sirajganj. This flood is mostly riverine in nature due to which the water level rises up fast, overflows the embankments, and inundates the flood-plain and chars. It is also the major cause of river-bank erosion.

Table -3. Flood Frequency during the last 5 years

Districts	Flood Frequency					
	1 time	2 times	3 times	4 times	5 times	Total
Sirajganj	0	0	3%	14%	80%	50
Kurigram	0	0	0	0	100%	50
Study Area	0	0	3%	7%	90%	100

4.1.2 Causes of Flood

Flood is a hydro-meteorological hazard which, in Bangladesh, is primarily caused by monsoon rainfalls in the catchment area. However, along with the natural causes, man-made causes are also responsible for severe flood occurrences, as have been seen in this study (Table - 4). Majority of the respondents are in the opinion that increase of rainfall (70%) and breaching of embankment (74%) are the main causes of flood in Sirajganj and Kurigram respectively. Other important causes are siltation of river beds (68%) and untimely rainfall (66%).

Table-4: People's perception on causes of flood in the study area

Districts	Causes of Flood	Percentage of respondent
Sirajganj	Increase of rainfall	70
	Untimely rainfall	66
	Breaching of embankment	6
	Siltation of river	68
Kurigram	Increase of rainfall	54
	Untimely rainfall	52
	Breaching of embankment	74
	Siltation of river	64
Study Area	Increase of rainfall	62
	Untimely rainfall	59
	Breaching of embankment	40
	Siltation of river	66

4.1.3 Changing Trends of flood occurrence

The frequency of floods have increased in a major part of the study area and 100% of the respondents have identified flood as the most frequent natural hazard in their area. Table-5 also shows the changing trends of the flood event in both the districts. 58% respondents are in the opinion that flood-events have significantly increased and 42% are in the opinion that it has considerably increased during the recent years. The respective figures are 32% and 68% for Sirajganj and 16% and 84% for Kurigram. None of the respondents has reported that flood-trends remain unchanged or has decreased.

Table-5: People's perception on changing trends of flood in the study area

Districts	Changing Trends of Flood	Percentage
Sirajganj	Significantly increase	32
	Considerably increased	68
	Remained unchanged	0
	Decreased	0
Kurigram	Significantly increase	16
	Considerably increased	84
	Remained unchanged	0
	Decreased	0
Study Area	Significantly increase	58
	Considerably increased	42
	Remained unchanged	0
	Decreased	0

4.2 Flood Vulnerability Assessment

Vulnerability assessment is the process to classify and identify the inabilities of people to resist and respond to a hazard when it is occurred. The exposure of local communities to annual flood is not only site specific but it also depends on the capacity of the community. In this section, discussion will be made on some vulnerable sectors once the area is hit by an unusual flood.

Due to unusual flood, the immediate and immense impact is on the livelihood at community level. Table-6 shows the overall social and economic situation of the people of the study area. Vast majority of the people are illiterate, under-employed and possess very poor monthly income. More than 80% families are very poor and their livelihood become vulnerable when they are affected by flood. People become jobless and as a result, without any income, farmers, labors and fishermen live in hardship. The flood also severely affects education system causing massive damage to the schools. It takes quite a long time to restore regular classes renovating the school buildings.

Agriculture is the most vulnerable sector in both Kurigram and Sirajganj districts. Most of the people are farmers and their livelihood largely depends on agricultural production. When an unusual flood hits these districts, it destroys the entire agricultural land and the standing crops/seed beds. For example, it has been noticed in Sirajganj district that, due to river erosion, huge amount of valuable agricultural lands have been washed away and the victim families were left vulnerable. It has also been noticed this year that due to flood, both in Sirajganj and Kurigram, standing crops in fertile agricultural lands have been destroyed. The study found that agriculture is the highest vulnerable sector followed by livestock farming. According to local people, pond fishing is also highly vulnerable. However, fishing in river is not as highly vulnerable as pond fishing.

The vast majority of the people of the study areas are economically poor and their position in the community is comparatively sub-standard. Due to lack of awareness and economic hardship, the overall health and WASH condition of the people are very bad and fragile. Table-5shows 36-46% respondents have identified that WASH is severely affected due to flood. Although some NGOs have taken initiative in the study areas, the progress is not satisfactory.

Table-6: Sector wise Effects Due to Flood

District	Union (Upazila)	Sectors Effected	Level of Effects				Remarks
			Slightly (%)	Moderately (%)	Badly (%)	Severely (%)	
Sirajganj	Rajapur Union (Belkuchi) &Soydabad Union (Sadar)	Livelihood	14	38	30	18	
		Agriculture	22	4	42	32	
		WASH	8	16	40	36	
		Livestock raring	32	16	12	4	Not applicable 36%
		Poultry bird raring	26	26	6	2	Not applicable 40%
		Day labor	4	16	8	16	Not applicable 56%
		Shop keeping	6	16	6	4	Not applicable 68%
		Health	66	24	8	2	
		Schooling	8	0	26	66	
Kurigram	Hatia Union (Ulipur) &Jatrapur Union (Sadar)	Livelihood	0	4	22	74	
		Agriculture	44	2	16	38	
		WASH	0	16	38	46	
		Livestock raring	6	14	14	12	Not applicable 54%
		Poultry bird raring	10	6	10	48	Not applicable 26%
		Day labor	0	2	12	48	Not applicable 38%
		Shop keeping	2	0	6	10	Not applicable 82 %
		Health	6	28	32	34	
		Schooling	4	0	8	88	

The overall health facilities are also very fragile in the study areas. Due to their remote location and poor communication, doctors are unwilling to stay in their assigned hospitals or community clinics. Because of such socio-cultural settings, the health sector is highly vulnerable during the advent of any hazard. Compared to Sirajganj, both the WASH (46%) and health (34%) sectors are more vulnerable in Kurigram. In general Kurigram district is more vulnerable to flood hazard. Besides the questionnaire survey, a good insight of the social vulnerability, particularly gender issues, have been identified through in-depth FGDs, KII and stakeholders sharing.

CHAPTER 5: PEOPLE-CENTERED FLOOD WARNING SYSTEM

In a separate section, the existing Early Warning System (EWS) operating in Bangladesh by the FFWC has been illustrated. However, under V_2R program, is also providing mobile based IVR (Introducing Voice Recording) message to their registered members. PA, previously through a baseline survey, has enlisted about 15,000 such members in 15 unions of two districts (Sirajganj and Bogra); average 1000 members in each union. However, about 2000 members are now under the coverage of SMS through mobile phone voices under V2R project. To examine the efficiency of V2R/CBDRR support, we have carried out this survey at Sirajganj (as controlled site under V2R/CBDRR) and Kurigram (as open site without V2R), and in each case, we have interviewed 50 respondents, and have conducted FGD and KIIs.

5.1 Community Response to Early Warning System

The study has also attempted to figure out the level of responses at community level, once they have been informed by SMS through mobile phone voices. Not necessarily, all respondents in the past responded equally when they heard the voice. There are some volunteers of CBOs of PA who stimulated the members to take necessary action as suggested in the SMS through mobile phone voices. The quantitative data of early warning system is shown in the Table-7. It is found that despite mobile based V2R at Sirajganj, in both districts TV (56 and 88%) and miking (26 and 12%) from the mosque are playing vital roles in community level early warning. However, in case of V2R, the timely dissemination of the warning (64%) and easily understandable voice

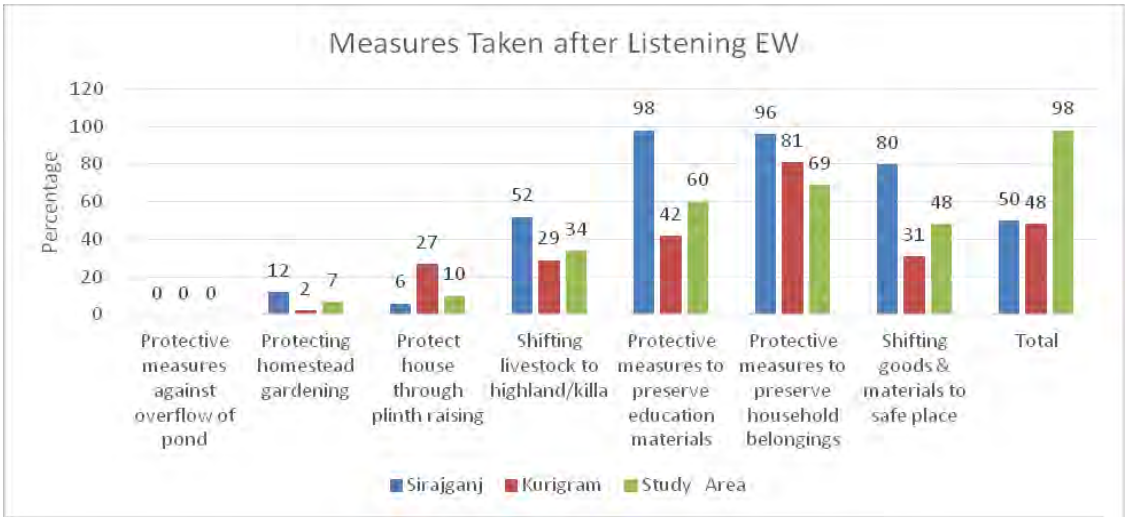
Table-7: Early Warning System and Its Effectiveness

Expected modality				Current modality				Effectiveness of mobile phone			
	Sirajganj	Kurigram	Study Area		Sirajganj	Kurigram	Study Area		Sirajganj	Kurigram	Study Area
Radio	0	0	0	Radio	0%	0%	0%	Fruitful	31% (14)	0	31% (14)
TV	56%	88%	72%	TV	4% (2)	40% (20)	22%	Understandable message	56% (25)	0	56% (25)
Mobile phone	88%	0%	58%	Mobile phone	90% (45)	0%	47%	Timely Delivered	64% (29)	0	64% (29)
Miking	26%	12%	18%	Miking	86% (43)	52% (26)	69%	Covers entire area	4% (2)	0	4% (2)
Up Leaflets	0	0	0	UP Leaflets	0	2%	1%	Total	45	0	45
NGO Leaflet	12%	0	6%		0	2%	1%				
Total	50	50	100	NGO Leaflets	50	50	100				

(56%) are the two major causes of effective response of the community due to IVR warning.

Moreover, CBO volunteers also use megaphone and mikes to disseminate the news among the communities. Although, the FGD and KII suggest that mobile operation and understanding the real meaning of SMS through mobile phone voices is not clear to many of the local people due to their poor education level and lack of training. However, despite all limitations, the graph-1 shows that people take protective measures to preserve their education materials (98%), preserve their household belongings (96%), shift goods and materials to a safer place (80%) and move their livestock to a safer place (52%).

Graph-1: Measures Taken after Early Warning System



5.2 Desired Early Warning System

People in Kurigram are getting flood early warning from Government source, and people in Sirajganj are getting the warning both from Government and PA operated V2R source under V2R project. In both districts, people are not fully satisfied with the warning system. They desire EW much earlier. Table-8 shows that most people (76%) are in the opinion of receiving the warning at least 7 days early. This figure is 62% for Sirajganj and 90% for Kurigram. In both cases, Miking and mobile based V2R seem to be the best options to the respondents.

Table-8: Expected Medium and Time-lag of Early Warning System

Medium of Early Warning	Respondents (%)			Expected Time lag of EW	Respondents (%)		
	Sirajganj	Kurigram	Study Area		Sirajganj	Kurigram	Study Area
Radio-TV	2%	12%	7%	3 days before	0	0	0
Mobile phone	58%	4%	31%	5 days before	16%	4%	10%
UP Miking	40%	78%	59%	7 days before	62%	90%	76%
UP Leaflets	0	2	1%	2 weeks before	22%	6%	14%
NGO Leaflets	0	4	2%				
Total (N)	50	50	100		50	50	100

CHAPTER 6: DEDUCING THE COST-BENEFITS

Quantifying the cost effectiveness of early warning systems is acknowledged to be difficult and is therefore not often undertaken. One problem is that factors other than the destruction of property and the number of deaths are seldom included in analysis, and it is often not possible to determine reliably avoided loss (Glantz 2004). Cost benefit analysis requires data on family level and community level damages, which includes damage cost of physical structures, economic and livelihood damage, social and physiological damage, and also the environmental damage. It is very difficult either to collect all types of data either from the field or from secondary sources. Secondary information, particularly on loss, damages, relief, recovery, and flood forecasting is also inadequate, improper, and incorrect.

However, in this assessment four major questions have been considered with high importance to measure the net return from the mobile based IVR program of PA operated V2R project. These are:

- Q-1: How much is the net cost of damages of properties at family level due to flood
- Q-2: How much is the net cost of recovery at family level
- Q-3:How much is the value of resources being saved due to flood warning at family level; and
- Q-4: How much could have been saved if an effective warning system was developed.

6.1 Mathematical Expression of Cost, recovery cost and saving

Table 10 shows the statistical expression of sector-wise damage cost, recovery cost and saving between coverage areas in Sirajganj and open system in Kurigram. The field data clearly shows that, in the context of minimum, maximum, average and gross monetary value of each sectors, the control are is getting the benefit of mobile voice record based IVR flood warning system. Besides, the general description, it has also been attempted to make a mathematical expression of cost-benefit of the V2R project to see how feasible the project is for the sustainability of fold response at grass-root levels. Such an expression requires calculations of:

• Damage Cost at Family Level;

• Relief Cost at Family Level:;

• Recovery Cost at Family Level;

• Govt. Warning Cost at Family Level; and

• IVR Warning Cost at Family Level:

The formulas for each of these cases are as follows:

Assessment of Damage Cost at Family Level:

$D_c = \sum(dp+de+dl+ds+dev)$ ----------i.

Where,

D_c =Damage cost
dp= physical damage
de= economic damage
dl =livelihood damage
ds=social and physiological damage
dev=environmental damage

Assessment of Relief Cost at Family Level:

$R_c = \sum (rg+rn+rng)$ ----------ii

Where,

R_c =Relief cost
rg= Govt. relief cost
rn= Neighborhood relief cost
rng=NGOs relief cost

Assessment of Recovery Cost at Family Level:

$R_{cv} = \sum(r_cf+r_cn+r_cg+r_cng)$ ----------iii

Where,

R_{cv} =Recovery cost
r_cf= Family recovery cost
r_cn= Neighborhood recovery cost
r_cg =Govt. recovery cost
$r_c$ng=NGOs recovery cost

Assessment of Govt. Warning Cost at Family Level:

$F_{wcg} = \sum(Icg+Pcg+Ocg)$ ----------iv

Where,

F_{wcg} =Govt. flood warning Cost

Icg= Govt. institutional cost

Pcg= Govt. project cost

Ocg=Govt.operational cost

Assessment of IVR Warning Cost at Family Level:

$F_{wcm} = \sum(Icm+Pcm+Ocm)$ ----------iv

where,

F_{wcm} =Mobile Operated Flood Warning cost
Icm= Initial cost for mobile operation
Pcm=Project cost for mobile warning
Ocm=Operational cost for mobile warning

6.2 Cost-benefit Analysis at Family Level

It is obvious that the IVR system is only become feasible if the damage cost under mobile coverage (controlled system) become lower than that of without mobile coverage (open system). Calculation of such net damage cost between controlled and uncontrolled systems is a challenging task.

However, it is thus necessary to calculate the respective costs by using the following formula:

$C_{twm} = \sum(D_c + R_c + R_{cv} + F_{wcg})$----------v

$C_{tm} = \sum(D_c + R_c + R_{cv} + F_{wcg} + F_{wcm})$----------vi

Where,

C_{twm} = Total cost without Mobile warning

C_{tm} =Total Cost with Mobile warning

Using the formula (v) and (vi) it is now straight forward to calculate the net benefit of the mobile based early warning system. The formula fot it is

$B_n = C_{twm} - C_{tm}$ ----------vii

Where,

B_n=Net Benefit

The larger the B_n value the more is the monetary return and profit of the mobile based flood warning system (under V2 R). To apply the above formulas (i-vii) for cost-benefit analysis, the actual and reliable values of ds, dev, Rg, rn, rng, $R_{cv,}$ F_{wcg} are not available or even possible to make available due to poor quality of data collection and preservation by concerned organizations. However, data primarily from field

survey, on $F_{wcm,}$ C_{twm} and C_{tm} are available to apply for cost benefit analysis. However another very important data available from the field on Family recovery cost without mobile (R_{fcwm}) and with mobile (R_{fcm}) services are also available.

Based on these $F_{wcm,}$ $C_{twm,}$ C_{tm}, R_{fcwm} and R_{fcm} values, two different modified formula have been used separately to calculate the cost benefit.

From the field survey, one set of data was collected on the issues of total damage cost (Table 10). Another set of data was collected on the issues of total saving due to early warning (Table 11). Extractions from these two sets of data show two different categories of profit scenarios. It is thus necessary to examine both the scenarios in the context of cost-benefit analysis of Voice Message through Mobile Phone.

The formula to apply for damage-cost approach (based on table 10 and Graph 2)is as:

$$B_n = \{(C_{twm} + R_{fcwm}) - (C_{tm} + R_{fcm})\} \times N - (F_{wcm}) \quad \text{----------viii}$$

Where,

B_n=Net Benefit
C_{twm} = Total Cost without mobile warning
C_{tm} =Total Cost with mobile warning
R_{fcwm}=Family recovery cost without mobile
R_{fcm}=Family recovery cost with mobile
F_{wcm} =Mobile Operated Flood Warning cost
N= Number of mobile service receivers

Similarly, the formula to apply for property -saving approach (based on table 10 and Graph 2) is as:

$$B_n = \{(S_m - R_{fcm}) - (S_{wm} - R_{fcwm})\} \times N - (F_{wcm}) \quad \text{----------ix}$$

Where,

B_n=Net Benefit
S_{wm} = Saving vale of damage without mobile warning
S_m =Saving value of damage with mobile warning
R_{fcwm}=Family recovery cost without mobile
R_{fcm}=Family recovery cost with mobile
F_{wcm} =Mobile Operated Flood Warning cost

N= Number of mobile service receivers

From the table below it is seen that when the cost of family level damage and recovery are considered together, then the net benefit per family within mobile forecast system (at Sirajganj) gets extra annual savings of TK **23,921** compare to a family outside the service (at Kurigram). However, the annual saving per family is much lower; **TK 5,485**, when the value of savings due to mobile based early warning and recovery cost are considered together. Both the figures show that the IVR system is beneficial to the community level to save their lives, properties and livelihood significantly.

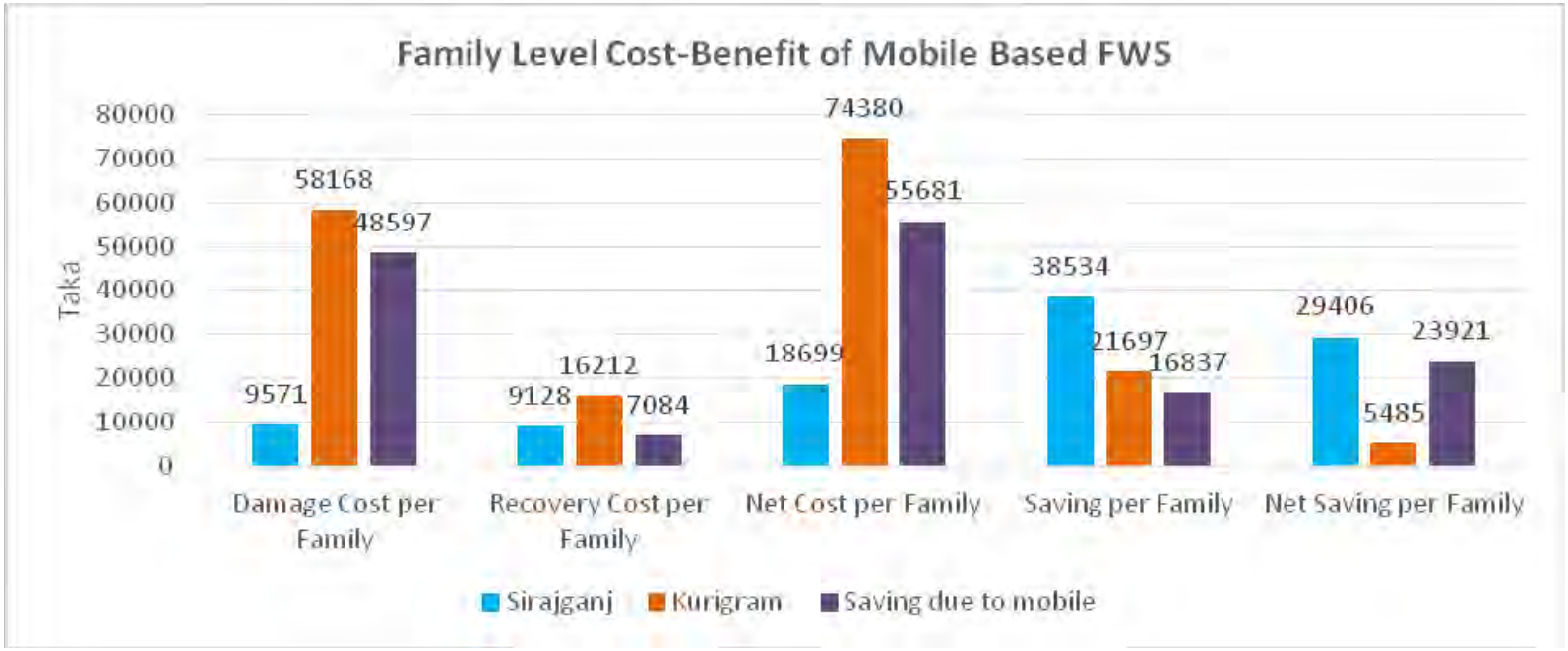
Table 9: Family Level Cost-Benefit of Mobile Based Flood Warning System

Districts	Calculation Based on Damage Approach (Tk.)						Calculation Based on Saving Approach (Tk.)			
	[a] Damage Cost		[b] Recovery Cost		[(a+b)] Net Cost		[c] Saving		[(c-b)] Net Saving	
Sirajganj	4,78,550	9,571	4,56,400	9,128	9,34,950	18,699	19,26,700	38,534	14,70,300	29,406
Kurigram	29,08,406	58,168	8,10,600	16,212	37,19,006	74,380	10,84,850	21,697	2,74,250	5,485
Diff	24,29,856	***48,597***	3,54,200	7,084	27,84,056	**55,681**	8,41,850	***16,837***	11,96,050	**23,921**

Table-10: Shows the Sector wise Damage, Recovery and Savings at Sirajganj and Kurigram Districts

District	Sector	Sector Wise Damage (Tk.)				Sector Wise Recovery (Tk.)				Sector Wise Savings (Tk.)			
		Maximum	Minimum	Average	Total	Maximum	Minimum	Average	Total	Maximum	Minimum	Average	Total
	Agriculture	35,000	3,000	**17,375**	**139,000**	8,000	500	3,562	92,600	50,000	0	5,885	153,000
	House	30,000	2,000	9,571	**134,000**	12,000	1,500	2,934	146,700	20,000	1,000	4,574	215,000
	Pond Fishing	12,000	0	12,000	12,000	12,000	0	7,000	7,000	9,000	0	9,000	9,000
	Paultry	5,000	600	1,814	12,700	4,500	500	2,667	64,000	5,000	400	1,329	37,200
	Livestock	25,000	1,200	11,700	70,200	25,000	1,200	3,100	24,800	140,000	2,500	37,089	1,038,500
Sirajganj	Plant Trees	5,000	0	1,386	9,700	500	0	500	500	5,000	300	2,294	39,000
	HH Belongings	15,000	100	2,500	32,500	2,500	500	300	15,000	20,000	100	4,426	221,300
	Daily Wages	5,000	200	1,750	14,000	0	0	0	0	5,000	1,000	3,259	94,500
	Retailers	20,000	500	5,420	27,100	20,000	500	1,156	20,800	5,000	500	2,239	40,300
	Transport	3,000	100	980	4,900	0	0	0	0	5,000	100	1,215	31,600
	Business	0	0	0	0	3,000	0	3,000	3,000	2,000	0	2,000	2,000
	Health	10,000	0	1,871	22,450	9,000	200	1,871	82,000	7,000	100	906	45,300
	Total	**Damage at Sirajgonj**			**478,550**	**Recovery at Sirajganj**			**456,400**	**Savings at Sirajgonj**			**1,926,700**
	Agriculture	120,000	5,000	35,842	681,000	9,000	500	4,545	100,000	50,000	3,000	7,045	155,000
	House	500,000	3,000	24,822	1,117,003	13,000	1,500	4,500	225,000	20,000	500	2,834	141,700
	Pond Fishing	6,000	0	3,000	6,000	4,000	0	2,667	8,000	1,000	0	333	1,000
	Poultry	7,000	100	2,169	84,600	7,000	500	3,207	93,000	2,500	300	842	27,801
	Livestock	24,000	0	5,695	113,900	7,000	1,500	2,600	52,000	150,000	2,000	17,860	446,500
	Plant Trees	40,000	500	8,132	227,700	3,500	500	1,800	3,600	7,000	0	781	12,500
Kurigram	HH Belongings	10,000	0	3,770	165,900	9,000	400	2,539	111,700	40,000	500	4,356	195,999
	Daily Wages	10,000	700	5,063	177,200	0	0	0	0	3,000	200	457	12,800
	Retailers	30,000	2,000	11,111	100,000	8,500	2,000	3,888	31,100	30,000	500	4,625	37,000
	Transport	15,000	500	2,964	133,400	0	0	0	0	5,000	200	879	33,400
	Business	500	500	0	5,000	4,500	0	4,500	4,500	3,000	0	3,000	3,000
	Health	8,002	100	2,418	96,703	12,000	400	3,634	181,700	3,000	0	363	18,150
	Total	**Damage at Kurigram**			**2,908,406**	**Recovery at Kurigram**			**810,600**	**Savings at Kurigram**			**1,084,850**

Graph 2: Family Level Cost-Benefit of Mobile Phone Based FWS



6.3 Desired Benefit at Family Level

Another aspect of this cost benefit analysis is to assess the value of the saving at family level if an effective V2R flood early warning system was developed (question-4). This is an important assessment and the findings are shown in table-12. The table shows that if an ideal and effective V2R system was developed, it was possible to save additional Tk. 15,138 for Sirajganj and Tk. 36,946 for Kurigram at each family level. The saving would have been higher at Kurigram, because the district now remains outside the V2R system.

Table-11: Expected Benefit at Community Level Due to Perfect EWS

Districts	Sectors	Desire Benefit			
		Maximum	Minimum	Average	Total
Sirajganj	Agriculture	40000	1000	9442	135,041
	House	25000	1000	7514	125,398
	Pond fishing	10000	10000	10000	39,147
	Paultry	4500	200	1311	10,016
	Livestock	140000	1000	41250	211,360
	Plant trees	5000	200	2676	54,086
	HH belongigs	15000	100	3362	57,761
	Daily wages	6000	100	2240	19,515
	retailers	6000	200	2900	45,557
	transport	10000	100	1954	18,971
	business	3000	3000	0	16,149
	Health	7000	100	1086	14,445
	Education material	5000	100	803	9,472
				Total	**756,918**
Kurigram	Agriculture	60000	0	24454.55	538000
	House	80000	1000	10770	538500
	Pond fishing	4000	2000	3000	9000
	Paultry	2800	200	887.8788	29300
	Livestock	24000	20	4960.8	124020
	Plant trees	40000	200	5870	176100
	HH belongings	35000	500	3691.111	166100
	Daily wages	8000	500	2553.571	71500
	retailers	28000	1000	7312.5	58500
	transport	5000	200	1605.263	61000
	business	5000	5000	0	5000
	Health	5000	150	1009.302	43400
	Education material	2500	200	768.5714	26900
				Total	**1847320**

6.4 Cost-Benefit of V2 R Project

The data in Table-10 shows the sector wise statistics of damage cost, recovery cost, savings and expected saving both at Sirajganj and Kurigram districts. The mobile based voice SMS program is now in operation to 2,000 unit members in Sirajganj districts. It is thus necessary to calculate the gross-return from the ongoing project of Practical Action in both these districts.

Calculation on the Basis of Damage-Cost Approach: (Q-1)

$B_n = \{(C_{twm} + R_{fcwm}) - (C_{tm} + R_{fcm})\} \times N - (F_{wcm}) =$

$= \{(58,168+16,212) - (9,571+9,128)\} \times 12000 - (1000000)$

$= \{(74380-18699)\} \times 2000 - (100000)$

$=55681 \times 2000 - 1000000$

$= 111362000 - 1000000$

$= 110,362,000$----------R-1

Calculation on the Basis of Property Saving Approach: (Q-3)

$B_n = \{(S_m - R_{fcm}) - (S_{wm} - R_{fcwm})\} \times N - (F_{wcm}) =$

$= \{(38,534- 9,128) - (21,697-16,212)\} \times 2000 - (1000000)$

$= \{(29406-5485)\} \times 2000 - (100000)$

$=23921 \times 2000 - 1000000$

$= 47842000 -1000000$

$= 4, 6842, 000$----------R-2

Calculation on the Basis of Property Saving Approach: (Q-4)

$B_n = \{(E_{bwm} - E_{wm})\} \times N - (F_{wcm}) =$

$= \{(36946-15138) \times N\} - (F_{wcm})$

$=(21808 \times 2000) - 10,00000$

$= 43,616,000-10,00000$

$= 42,616,000$----------R-3

Where,

E_{bwm}= Expected benefit without mobile

E_m= Expected benefit with mobile

Table 12: Cost Benefit Comparison between Sirajganj (V2R) and Kurigram (Open)

Cost-Benefit	Sirajganj (Tk.)	Kurigram (Tk.)	Sirajganj compare to Kurigram (Tk.)
Damage cost	9571	58168	(-) 48597
Recovery cost	9128	16212	(-) 7084
Net saving	29,406	5,485	(+) 23,921
Desired Benefit	(29,406+15138) = 44,544	(5,485 + 36946) = 42,431	

Application of formula (viii) of damage-cost approach shows that the IVR project is highly feasible (profitable), with annual gross-return of TK. 110,362,000 (R-1). On the other hand, the application of formula (ix) of property-saving-property approach shows that the IVR project is also highly feasible, with annual gross-return of TK. 4,6842,000 (R-2). Moreover, with the expectation of an effective IVR system the calculated value is TK. 42,616,000 (R-3)

However, the information derived from FGDs and KIIs sources suggest that the later two values (R-1 and R-2) are more acceptable, although the former one shows 2.33 times higher.

Despite all uncertainties and data gaps, it can be suggested that the mobile operated voice record early warning service in the flood prone areas on Bangladesh is highly profitable in the context of monetary return.

Case Story

Laily Akter, a 35 year-old woman lives at Char Soydabad in Sirajganj. She is a community volunteer of Manob Mukti Shongstha (MMS). She regularly receives flood warning through mobile phone from V2R project office located in MMS. Just before the devastating flood of 2o17, she got the flood warning message in her mobile phone. As a volunteer, she came forward to announce the message using her hand microphone. Because of her warning dissemination, several families were able to save their livestock and poultry birds. Laily said, I have also saved my own property worth 20,00o taka from flood after I had received the warning. A mobile phone based flood warning system and community volunteerism is contributing in building resilient community to flood disaster.

CHAPTER 7: SUMMARY AND CONCLUSIONS

Disaster risk, including flood, is inherently characterized by uncertainty. This makes it difficult to know, for certain, whether a flood risk management intervention will ultimately prove worthwhile. Benefit-cost analysis provides one means of measuring the efficacy of the flood early warning system to manage risk in a cost-effective way. Therefore, the general aim of this study was to analyse the cost benefit of investing in a Flood Early Warning System. In order to achieve this, the study comprehensively assess the direct and indirect costs and benefits of investing in a Flood Early Warning System and develop some interventions that may be of great use in early warning of flood. However, the summary of the study has been given below.

- The study suggests that the mobile operated voice record early warning service (V2 R) in the flood prone areas on Bangladesh is highly profitable.
- The net benefit per family within mobile phone based forecast system (at Sirajganj) gets extra annual savings of TK **23,921** compared to a family outside the service (at Kurigram).
- Based on damage-cost, property-saving-property and desired benefit approach, the study shows that the annual gross-return of TK. 66, 71, 72000, TK. 28, 60, 52000 and TK. 26, 06,96,000 respectively. This indicates that damage cost approach is higher feasible than the other approaches.
- Application of formula (viii) of damage-cost approach shows that the IVR project is highly feasible (profitable), with annual gross-return of TK. 66, 71, 72000 (R-1). On the other hand, the application of formula (ix) of property-saving-property approach shows that the IVR project is also highly feasible, with annual gross-return of TK. 28, 60, 52000 (R-2). Moreover, with the expectation of an effective IVR system the calculated value is TK. 26, 06,96,000 (R-3)
- Although five years ago, the government has introduced the IVR system for cyclone risk zone around the country, flood risk zone were not considered in this system. Moreover, the mobile penetration rates among the poor households are low. However, a little effort has been taken by the FFWC but the programme has not included in all the unions and districts. Upazila Nirbahi Officer (UNO) could take the responsible not only for

monitoring the web site of FFWC and daily weather message of BMD but also provide the warning to the Union level daily basis by using IVR to develop as a part of aim of the study. Moreover, DDM can allocate the Upazila among the INGOs according to their outreach area at the grassroots. Also, PAB needs to take into cognizance that a people-centered approach to early warning, with the active participation of local communities, enables a multi-dimensional response to problems and needs. In this participatory process, local communities, civic groups and traditional structures can contribute to the reduction of vulnerability and to the strengthening of local capacities.

- Around 95% participants of the survey population emphasized the fruitfulness of disseminating the flood warning massage through Miking. Taking those findings into consideration, the study recommends instantaneous dissemination of flood warning massage through loud speaker (Mike) by Union Parishad and NGOs. A clear message articulated in simple form with useful information is critical to enable proper responses that helps safeguard lives and livelihoods. It needs to use multiple communication channels to ensure as many people as possible are warned, to avoid failure of any one channel, and to reinforce the warning message.

Considering the findings of the study and the pace at which the results are being found, the following recommendations have been put forward:

1. **Establish Flood Early Warning Dissemination at Grassroots by the Government:** Flood warning dissemination needs to be established across the country by the government. Now UNO/PIO receives the warning from DDM over mobile phone. The trickle down process of warning information is not at all thoroughly documented. The government has introduced the IVR system five years ago where selected (chairman, secretary and elected member of a union) around the country. Also mobile penetration rate among the poor is low. IVR service was introduced only for the especially in cyclone zone of Bangladesh. In flood prone area, government could not extend the program in all the unions and districts. The same service need to be launched for flood warning dissemination covering the unions and districts vulnerable to flood. So the concerned. As far as the point of dissemination is concerned, a specific person should be located in office of the Upazila Nirbahi Officer (UNO). The incumbent should be responsible only

for monitoring the web site of FFWC and daily weather message of BMD. Besides, he will be responsible to collect the flood warning using the IVR and send the warning to the Union level daily basis with the permission of UNO/PIO. Flood that hit Kurigram in August, 2017 was flash flood in nature. In case of such situation, flood warning dissemination is possible. In August 2017, FFWC's warning was properly uploaded in its website. If Government can establish warning center at Upazila level, the dissemination could possible.

2. **Enhancing Technical Capacity of Non-state Actors in FW System:** Need to strengthen the service of concerned department to ensure EW message is delivered on daily basis. There needs to be a functional pathway for ensuring consistency in message development and dissemination. At grass root level, volunteer should be deployed at ward level for yielding wider distribution of the message through multiple outlets and receiving feedbacks from a whole range of users. For quick dissemination of warning message, the messengers need to be well-equipped (I.e. bi-cycle and hand-mike). The entire process of message delivery needs to be thoroughly documented at central level and implementation level.

3. **Involvement of Local Level Stakeholders in FW System:** Establishing a comprehensive early warning system across the country may take time. The study revealed that flood-affected people saved significant amount of resources in the areas. In this context, Government can replicate its model and scale it up at larger scale reaching the areas where other NGOs are working. They will be responsible for their own area. DDM can allocate the Upazila among the INGOs according to their outreach area at the grassroots. Also, Government needs to take into cognizance that a people-centered approach to early warning, with the active participation of local communities, enables a multi-dimensional response to problems and needs. In this participatory process, local communities, civic groups and traditional structures can contribute to the reduction of vulnerability and to the strengthening of local capacities.

4. **Introducing Appropriate Communication Tools for Effective FW:** Around 95% participants of the survey population emphasized the fruitfulness of disseminating the flood warning massage through Miking. The same finding has been observed from the

FGD. Taking those findings into consideration, the study recommends instantaneous dissemination of flood warning massage through loud speaker (Mike) by Union Parishad and NGOs. A clear message articulated in simple form with useful information is critical to enable proper responses that helps safeguard lives and livelihoods. It needs to use multiple communication channels to ensure as many people as possible are warned, to avoid failure of any one channel, and to reinforce the warning message.

The benefits and costs of early warning system (EWS) for flood hazard have been analyzed in this study using mathematical expression. Studies also explored the benefit of IVR process as well as generated a new devise of non-structural measures to minimising destructive effect of floods. However, there are lots of limitations to put into practice the technique in local level. Therefore, more comprehensive strategy or tools are needed to develop by researching and connecting GO, INGOs and local NGOs together.

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ANNEX

List of Key Informant Interview

District	Upazila	Union	Name of Key Informant
Kurigram	Kurigram Sadar	Jatrapur	UP Chairman
			Agriculture Officer
			PIO
			UNO
	Ulipur	Hatia	UNO
			PIO
			Agriculture Officer
			UP Chairman
Sirajgonj	Belkuchi	Rajapur	UNO
			PIO
			Agriculture Officer
			UP Chairman
	Sirajgonj Sadar	Soydabad	DRRO
			UNO
National level			DD-DDM
			DD-BMD

FGD Findings

District	Upazila	Union	Participants' Info	FGD		Remarks
				Flood & Its Nature and Degree of effect on Different Sectors	**Role of Flood Warning to Reduce the Damage Caused by Flood**	
Kurigram	Kurigram Sadar	Jatrapur	Name of Village: Uttar Garuhara No. of Participants: Total: 12 Male: 10 Female: 2 Occupation category: F-3 F&L- 3 L-2 SE-2 IW-2 Date: 4.12.2017	1. Identified frequency of normal floods in the area during the last 5 years: 5 times 2. Effect of flood on livelihood: Severe 3. Effect of flood on agriculture: Severe 4. Effect of flood on WASH condition: Severe 5. Effect of flood on livestock rearing: Severe 6. Effect of flood on Poultry birds rearing: Severe 7. Effect of flood on day laborers and their works : Severe 8. Effect of flood on shop keeping: only one had a slight effect, others were Severe 9. Effect of flood on health conditions: Bad 10. Effect of flood on schooling: Severe 11. Major causes of flood in your area: Onrush of upstream water	- They are not familiar with Flood Warning System - In their opinion, mike announcement will be the most effective flood warning system for them because it will cover the entire area. - Since existing flood centers get submerged in water, they are of the opinion that a sort of highland/killa would be very helpful. They would send their livestock to the highland. - They expect flood warning at least 7 days before flood occurs.	People reported that the recent flood is more severe than the flood of1988. Never before has such large amounts of flood water entered into the land. Additionally, the amount of loss and damages that took place were higher than ever before.

				12. Changing trend of flood disasters during the last 10 years: Significant Increase		
	Ulipur	Hatia	Name of Village: Hatiya Bhabesh No. of Participants: 12 Male: 10 Female: 2 Occupation category: F-3 F&L- 3 L-2 SE-2 IW-2 Date of GFD held: 5.12.2017	1. Identified frequency of normal floods in the area during the last 5 years: 5 times 2. Effect of flood on livelihood: Severe 3. Effect of flood on agriculture: Severe 4. Effect of flood on WASH condition: Severe 5. Effect of flood on livestock rearing: Moderate 6. Effect of flood on poultry birds rearing: Severe 7. Effect of flood on day laborers and their works: Severe 8. Effect of flood on shop keeping Severe 9. Effect of flood on health conditions: Moderate 10. Effect of flood on schooling: Severe 11. Major causes of flood in the area: Overflow of river water 12. Changing trend of flood disasters during the last 10 years: Significant increase	- They are not familiar with any Flood Warning System. - They recommended Mike announcement and mobile voice message in Bangla as effective mediums of flood warning system for them. People prefer mike announcement to any other method of announcements, because these are easy to hear and understand. Additionally, mikes can cover larger areas. Most of the people can't read SMS and have no access to newspaper and/or TV. - In this area, many people were able to save their livestock by shifting them to the embankment. - They expect flood warning at least 7 days before flood occurs.	

Sirajgonj	Belkuchi	Rajapur	Name of Village: Thakur para No. of Participants: Total: 12 Male: 10 Female: 2 Occupation F-3 F&L-1 L-1 SE-5 IW-2 Date: 7.12.2017	1. Identified frequency of normal flood in the area during the last 5 years: 5 times 2. Effect of flood on livelihood: Severe 3. Effect of flood on agriculture: Severe 4. Effect of flood on WASH condition: Severe 5. Effect of flood on livestock rearing: Slight, 6. Effect of flood on Poultry birds rearing: Moderate 7. Effect of flood on day laborers and their works: Severe 8. Effect of flood on shop keeping Severe 9. Effect of flood on health condition: Severe 10. Effect of flood on schooling: Severe	- Most of them are familiar with mobile based flood warning system (IVR). - People believe that mike announcement is suitable and effective for ordinary people because it covers all types of people and the message is easily understandable. - Both mobile based warning and mike announcement are effective because these mediums jointly cover the entire area. - After listening to the flood warning, people took several measures including protection against overflow of	Most of the participants are involved in V2R project and therefore are aware of the mobile based warning system. - A volunteer reported that mobile IVR based flood warning system run by Concern Universal was better than the service of Action. Their

				11. Major causes of flood in the area: increased rainfall 12. Changing trend of flood disasters during the last 10 years: Significant increase	pond-water, shifting their livestock to highland, preserving their household belongings, using net around the pond to protect fish etc. - They expect flood warning at least 7 days before flood occurs.	prediction was more accurate.
	Sirajgonj Sadar	Soydabad	Name of Village: Char Soydabad No. of Participants: Total: 9 Male: 7 Female: 2 Occupation F-2 F&L-2 L-1 SE-2 IW-2 Date: 9.12.2017	1. Identified frequency of normal flood in the area during the last 5 years: 5 times 2. Effect of flood on livelihood: Severe 3. Effect of flood on agriculture: Severe 4. Effect of flood on WASH condition: Severe 5. Effect of flood on livestock rearing : Moderate 6. Effect of flood on Poultry birds rearing: Severe 7. Effect of flood on working as daily labor: Severe 8. Effect of flood on shop keeping Severe 9. Effect of flood on health condition: Slight 10. Effect of flood on schooling: Severe 11 Major causes of flood in the area: breaching of	- Most of the people get flood warnings by mike announcements in mosques. General people hardly know about mobile based warning system. - Majority of them are not comfortable with mobile based warning. - Mike announcement is effective for them, because it can cover all types of people. - After listening to the flood warning People took several measures including protection against overflow of the pond, shifting the livestock and poultry birds to highland, preservation of the household belongings. - Some practiced sack	Most of the FGD participants were not involved in V2R project and hence were not familiar with mobile IVR. - They reported that flood of 2017 was the second-most severe flood so far. The most severe flood they experienced was the flood of 1988.

				embankment 12. Changing trend of flood disasters during the last 10 years: significantly increased	farming (cultivation of vegetable in a sack). They put the sacks on higher places to protect the vegetables. - They expect flood warning 5-7 days before flood occurs.	
Summary of findings	In the study areas of Kurigram district, the community people have no access to flood warning systems and are not aware of any mobile based flood warning system. In addition, there is no warning dissemination system. Communication channel regarding flood warning is weak and no flood warning related activities of NGO, CBO and volunteers are found here. Flood situation was severe, resulting in high amounts of losses and damage. The community people were unable to do anything to mitigate their losses. On the other hand, loss and damages were comparatively low in the study areas of Sirajganj. There are volunteer s and CBOs who disseminate flood warning systems at the community level. Here, some people are aware of mobile based flood warning systems. Furthermore, some of the local people receive flood warning through their mobile phones. Mosques also play a part in broadcasting warnings. The CBOs and non-government organizations are highly capable, and local governments receive and broadcast flood warnings among their people. Some international NGOs worked here on strengthening flood warning system and building capacity of local NGOs, CBOs and volunteers. CBOs and volunteers work as first responder during flood in their areas. After listening to the flood warning, people took several measures including protection against overflow of the pond, shifting the livestock and poultry birds to highland, preservation of the household belongings etc. The areas studied in both districts have very few or no flood shelters. Most of the shelters are uninhabitable. These shelters have very low capacities and often get submerged under flood water. Some school buildings are used as shelters during floods, while many people took shelters on the embankments. Livestock suffer the most. “Killa” system is not available and most of the flood shelters have no place for livestock. Having no other options, people shifted their livestock into the embankment. Mike announcement will be the most effective flood warning system for them as it will cover the entire area and the message is understandable to the general mass. The community people expect flood warnings to be available at least seven days before flood occurs.					

Quantitative tool: Cost Benefit Analysis Survey

92 Questions

==========

1. Geographical Location and Respondent's Information

2.District
Choose one response

- Sirajganj

- Kurigram

3.Upazila
Choose one response

- Belkuchi

- Sirajganj sadar

- Ulipur

- kurigram sadar

4.Union
Choose one response

- Rajapur

- Saidabad

- Hatia

- Jatrapur

5.Village
Choose one response

- 1

- 2

- 3

- 4

6.Respondent's name

7.Gender
Choose one response

- Male

- Female

8.Contact no (If any)

9.Age
Choose one response

- less than 18

- 19-30

- 31-60

- morethan 60

10.Education
Choose one response

- Illiterate

- Primary

- Secondary

- Tertiary

- Technical

11.Occupation
Choose one response

- Farmer

- Fisherman

- Livestock rarer

- Shop keeper

- Day labor

- other

12.Monthly Income (Average)
Choose one response

- <2000

- 2000-4000

- 4000-6000

- 6000+

13. Flood& Its Nature of Effect in Different Scale

14.Identify the frequency of normal flood in your area during the last 05 years
Choose one response

- 1

- 2

- 3

- 4

- 5

15.Effect of flood on livelihood
Choose one response

- Slightly

- moderately

- badly

- severely

16.Effect of flood on agriculture
Choose one response

- slightly

- moderately

- badly

- severely

17.Effect of flood on WASH condition
Choose one response

- slightly

- moderately

- badly

- severely

18.Effect of flood on livestock rearing
Choose one response

- slightly

- moderately

- severely

- badly

19.Effect of flood on Poultry birds rearing
Choose one response

- slightly

- moderately

- badly

- severely

20.Effect of flood on working as daily labor
Choose one response

- slightly

- moderately

- badly

- severely

21.Effect of flood on shop keeping
Choose one response

- slightly

- moderately

- badly

- severely

22.Effect of flood on health condition
Choose one response

- slightly

- moderately

- badly

- severely

23.Effect of flood on schooling
Choose one response

- slightly

- moderately

- badly

- severely

24.What are the major causes of flood in your area?
Choose all that apply

- Increase of rainfall

- Untimely rainfall

- Breaching of embankment

- siltation of river bed

25.Changing trend of flood disaster during the last 10 years
Choose one response

- significantly increased

- considerably increased

- noticeably increase

- remained unchanged

- decreased

26. Role of Flood Warning to Reduce the Damage Caused by Flood. Please answer the questions below

27.Do you know that there is flood warning system to reduce the damage caused by flood?
Choose one response

- Yes

- No If this response, jump to 61

28.What kind of flood early warning systems are you familiar with?
Choose all that apply

- Radio-Television

- Through mobile Phone

- Miking by Union Parishad

- Leaflet by NGO

- Leaflet by Union Parishad

- None of these

29.What kind of flood early warning is effective according to your opinion?
Choose one response

- Radio-Television

- Through mobile Phone

- Miking by Union Parishad

- Leaflet by NGO

- Leaflet by Union Parishad

- none of these

30.Why do you think that it is effective?
Choose one response

- Understandable message

- Timely delivered

- Fruitful

- Cover the entire area

31.Did you take any measure after receiveng the flood early warning?
Choose one response

- Yes

- No If this response, jump to 46

32.What kind of measure/s have you taken after listening to the flood warning?
Choose one response

- Protective measures against overflow of the pond

- Protect the homestead gardening

- Protect the house through plinth raising

- Shifting the livestock to highland/killa

- Protective measures to preserve the education materials

- Protective measures to preserve the household belongings

33. How much money did you save due to taken measures after listening to the flood warning? Please answer the questions below.

34.How much did you save in agriculture

35.How much did you save in house damage?

36.How much did you save in pond fishing

37.How much did you save in Losses of poultry birds?

38.How much did you save in Losses of livestock

39.How much did you save in Losses of plants/Trees ?

40.How much did you save in household belongings

41.How much did you save in daily wage?

42.How much did you save in lossess of ordinary retailers?

43.How much did you save in lossess of the transportation for shifting the family members and household belongings?

44.How much did you save in lossess of other business ?

45.How much did you save in health of the family members?

46. Effect of inappropriate and improper flood warning. Pls answer the questions below

47.Do you think that flood warning was not appropriate and improper?
Choose one response

- Yes

- No If this response, jump to 61

48.How much money was your loss due to improper flood warning in Agriculture?

49.How much did you loss in house damage?

50.How much did you loss in pond fishing

51.How much did you loss in Losses of poultry birds?

52.How much did you loss in Losses of livestock

53.How much did you loss in Losses of plants/Trees ?

54.How much did you loss in household belongings

55.How much did you loss in daily wage?

56.How much did you lossin lossess of ordinary retailers?

57.How much did you loss of the transportation for shifting the family members and household belongings?

58.How much did you loss in other business ?

59.How much did you lossin health of the family members?

60.What kind of social losses you have experienced due to improper flood warning?
Choose all that apply

- Death

- Traumatized

- Additional stress for emergency shelter and food

- Living in unhygienic place

- Hampering schooling

- Vulnerable community-PWD, elderly, children, women

- Money lending

- Sanitation problem (especially of the women)

61. Effect of not having flood warning. Please answer the questions below.

62.How much money was your loss due to not having flood warning in Agriculture?

63.How much did you loss in house damage?

64.How much did you loss in pond fishing

65.How much did you loss in Losses of poultry birds?

66.How much did you loss in livestock

67.How much did you loss in Losses of plants/Trees ?

68.How much did you loss in household belongings

69.How much did you loss in daily wage?

70.How much did you lossin lossess of ordinary retailers?

71.How much did you loss of the transportation for shifting the family members and household belongings?

72.How much did you loss in other business ?

73.How much did you lossin health of the family members?

74.What kind of social losses you have experienced due to not having flood warning?
Choose all that apply

- Death

- Traumatized

- Additional stress for emergency shelter and food

- Living in unhygienic place

- Hampering schooling

- Vulnerable community-PWD, elderly, children, women

- Money lending

- Sanitation problem (especially of the women)

75.What would your expected medium for flood warning be?
Choose one response

- Radio-Television

- Through mobile Phone (IVR)

- Miking by Union Parishad

- Leaflet by NGO

- Leaflet by Union Parishad

- none of these

76.When do you expect flood warning?
Choose one response

- 3 days before

- 5 days before

- 7 days before

- 2 weeks before

77. If the proper flood warning is available at least 7 days before or more how much money you will be able to save at family level? please answer below questions.

78.How much will you save in agriculture?

79.How much will you save in house damage?

80.How much will you save in pond fishing

81.How much will you save in poultry?

84.How much will you save in household belongings

85.How much will you save in daily wage?

86.How much will you save in ordinary retailers?

87.How much will you save in the transportation for shifting the family members and household belongings?

88.How much will you save other business ?

89.How much will you save in health of the family members?

90.How much will you save in Education materials?

91.Survey Date

92. Give thanks to the respondent. Go to take next interview.