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HKV

Mobile Services for Flood Early Warning in Bangladesh: Final Report

Funded by:

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Cordaid

Deltares

Title
Mobile Services for Early Warning in Bangladesh

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State
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LIST OF ABBREVIATIONS

A2i	Access to Information
BMD	Bangladesh Meteorological Department
BWDB	Bangladesh Water Development Board
CBS	Cell Broadcasting Service
CDMP	Comprehensive Disaster Management Program
CEGIS	Center for Environmental and Geographic Information Services
CFIS	Community Flood Information System
DC	Deputy Commissioner
DC	Digital Center
DDM	Department of Disaster Management
DDMC	District Disaster Management Committee
DG	Director General
DMC	Disaster Management Committee
DMIC	Disaster Management Information Center
DRR	Disaster Risk Reduction
DRRO	District Relief and Rehabilitation Officer
ECMWF	European Center Medium Range Weather Forecasting
EWS	Early Warning System
FEWS	Flood Early Warning System
FFWC	Flood Forecasting and Warning Center
FIC	Flood Information Center
IVR	Interactive Voice Response
IWM	Institute of Water Modelling
MMS	Manab Mukti Sangstha (Local NGO)
MoMDR	Ministry of Disaster Management and Relief
MoU	Memorandum of Understanding
MoWR	Ministry of Water Resources
NGO	Non-Governmental Organization
NILG	National Institute for Local Government
RIMES	Regional Multi Hazard Early Warning System
SMS	Short Messaging Service
SOD	Standing Orders on Disasters
UDMC	Union Disaster Management Information Center
UISC	Union Information Services Center
UNO	Upazila Nirbahi (executive) Officer
UNSIDR	United Nations International Strategy for Disaster Reduction
UNU	United Nations University
UP	Union Parishad
UzDMC	Upazila Disaster Management Committee

1 Executive Summary

Bangladesh is a very flood prone country: one-fifth up to one-third is being flooded during the monsoon period. Preparedness is key to saving lives and protecting livelihoods. Essential to enhancing preparedness is the establishment of a well-functioning people centred early warning system. In order to realise the maximum value of the system, each component (risk knowledge, monitoring and warning service, communication and dissemination and response capability) must function effectively. Communication and dissemination of the warning message is often downgraded as a less important component in comparison to developing the technical forecasting system itself (part of the monitoring and warning service component). This lesser attention has resulted in an information gap: many communities, especially the fragile ones in remote rural areas, do not receive early warning messages. The tremendously increased penetration of mobile services in Bangladesh offers great potential for improvements. This project exploited this opportunity to close the information gap. It started by evaluating the current early warning system and in particular the use of mobile services, secondly by choosing different means to potentially improve the communication and thirdly by testing and evaluating these improvements in a pilot in Sirajganj Bangladesh. Alongside this the project laid the basis for the development of business models and a vision for implementation to enhance sustainability of the project.

The two methods chosen were Voice Message Broadcast (VMB) for top down warning dissemination from national to district and local levels simultaneously and Short Message System (SMS) for bottom up water level data collection from the local to national level. Additionally, the available 5-day forecast warning message content was made more localised (union level). Furthermore, 20 volunteers were trained along with project staff and government officials, building their capacity to understand and react effectively to the warnings. Overall the project was led by Deltares, in partnership with HKV Consultants. These innovations were tested in the pilot with full governmental support from the Flood Forecasting and Warning Center (FFWC) and the Bangladesh Water Development Board (BWDB). The Regional Integrated Multi-Hazard Early Warning System (RIMES) locally based at the FFWC, acted as the linking pin between activities at the FFWC and implementation by the NGOs. Cordaid offered from the start of the project to supplement the RVO financing so that a thorough pilot and implementation at the community level could be done. Apart from being a supplemental donor, Cordaid acted also as an advisor on their community managed disaster risk reduction process and arranged for implementation at the community level by supervising a strong partnership of national and local NGOs: Concern Universal Bangladesh (CUB), Practical Action Bangladesh (PA) and Manab Mukti Sangstha (MMS).

The evaluation after the 2014 floods showed the successful impact of the project at the community and governmental levels. The national level forecast information was further localised and made accessible at the local level. Community people (estimated 5960 households) received, understood (80% had high understanding) and trusted (78% had very high trust) the information from the VMB, utilising it to prepare for the upcoming floods and reduce their losses. Overall it is estimated that the

Lal Chand Miah, Hand Loomer, Ghorjan, Chowhali, Sirajganj

Lal estimated his savings at 75,000 BDT (965 USD). He rearranged his machinery to avoid damage after receiving the voice message warning and validating it through the volunteers.

warnings through VMB reached 45% of the population both directly and indirectly in the pilot areas. The average savings per household (due to the early warning) were estimated at USD 472. These warnings allowed communities to prepare for the upcoming threat resulting in large savings to their livelihood.

This evaluation also revealed many ways to further improve the system in terms of the warning message content, communication, institutional dissemination pathway, end users response, and towards ensuing financial sustainability. For VMB these included, increasing the number of recipients of VMB and volunteers, increasing the frequency of messages, repeating important parts of the message and disseminating at specific times of the day. For warning content these included working towards delivering more location specific information with inundation depths, increased lead times and an outlook (action orientated) message. The potential of the existing Digital Centres (DC) and Disaster Management Information Centres (DMIC) at the Department of Disaster Management (DDM) should be utilised together with the local Bangladesh Water Development Boards (BWDB) offices, to move to a more decentralised process for warning generation, interpretation and dissemination. A warning communication strategy is required between the key institutions FFWC (BWDB), DDM and the NGOs for consistent and for warning dissemination. To enhance the effectiveness of communities' response, further awareness raising and knowledge, financial and resource support mechanisms are needed at the local level. These results will be utilised in the second piloting phase of the project in 2015 to further improve the warning communication at the local level. Recommendations at a higher policy and institutional level will be discussed with Bangladesh Delta Plan project.

The following recommendations are made to the financial sustainability of the project;

1) **Bridge the funding gap by cost sharing:** In order to cover the funding gap for a localised early warning system a division of total life cycle costs between to be covered by national and local actors is needed. Total capital investments are estimated in USD 2,5 million, and Operation and Maintenance costs USD 2 million per year. The cost sharing arrangement we propose is as follows: National government budgets (through FFWC/BWDB and DDM) should ideally cover all the necessary capital investments (USD 2,5 million) and the share of Operational and Maintenance costs that concerns the national level activities involved in detection, data collection and forecasting (USD230,000 per year). At union level contributions of the community users, local government, and/or NGO's should cover the Operation and Maintenance costs elements concerning (local) dissemination and response, as well as the local activities involved in data collection (USD 1,8 million per year for all 1502 flood prone Unions or around USD 1,200 per year per Union).

2) **Combine a national PPP with a Union Level social business model.** The Public-Private Partnership main goal is the removal of systemic barriers for effective response (e.g. weak linkages between agents in the productive value chains). The business model at the Union level aims at generating additional cash flows that cover at least partially, the operation and maintenance costs of the de-central elements of the improved EWS system. Together these two elements create the incentives at national and local level for an effective and sustainable Early Warning System.

3) **Develop a social business model for knowledge entrepreneurs – at Union Level:** that generate enough profit so as to cover the O&M expenses per year at the union level. It is recommended that this is linked to the existing local service providers already operating within communities.

4) **Operationalize a national Public Private Partnership for resilient agricultural value chains:** Public and private sector strengths and their synergy should be exploited to ensure the financial sustainability in the provision of EWS services and improve their effectiveness in reducing the losses of lives and livelihood. This can include using risk sharing arrangements between large agricultural companies and local actors, internal insurance schemes offered by companies to their contract growers, value-chain analysis, and portfolio management. A system that combines Early Warning functions (for a variety of weather related hazards) with frequent weather related data and satellite data for crop information services seem like a win-win situation for public and private parties. The combination of the public function of disaster warning with the private function of "customized" advise for different productive activities, is expected to set in motion a reinforcing loop that will ensure its longer term financial and institutional sustainability.

5) **Concentrate development cooperation efforts and enhance synergies between projects:** Concentrated development cooperation efforts such as climate financing, will allow for the necessary capital investments needed in the pre-start-up phase at the national and the union level. In order to tackle the combination of a variety of projects investing in early warning related activities; like this project and Satellite Data for Crops, exploiting the synergies of Dutch programs with the programs of other donors active in Bangladesh is recommended.

Recommendations 3 and 4 will be further investigated as part of the second phase the project and through collaboration with the Dutch Embassy in Dhaka and RVO through different projects and programs, such as the Satellite Data for Crops.

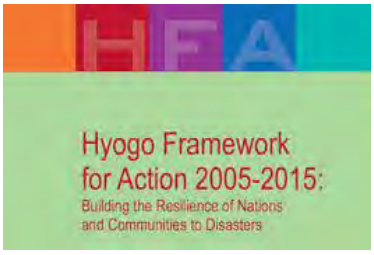
2 Project overview

2.1 Background

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. These features combined with high rainfall result in one-fifth to one-third of the country being flooded during monsoon (Fakhruddin, 2013). Such frequent flood events cause it to be one of the most disaster-prone countries in the world (UNU, 2012).

Why is early warning important to manage risks?

The importance of having effective and end user friendly early warning systems is widely accepted as one valuable preparedness measure 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 is expected to continue this attention: "Continuing to further strengthen early warning systems and tailoring them to users' needs, including social and cultural requirements" (Zero draft UNISDR, 2014). Furthermore, the ongoing negotiations between



the Intergovernmental Working Group on Targets and Indicators are considering proposals for an individual target on early warning e.g. multi-hazard early warning systems to cover 95% of population.

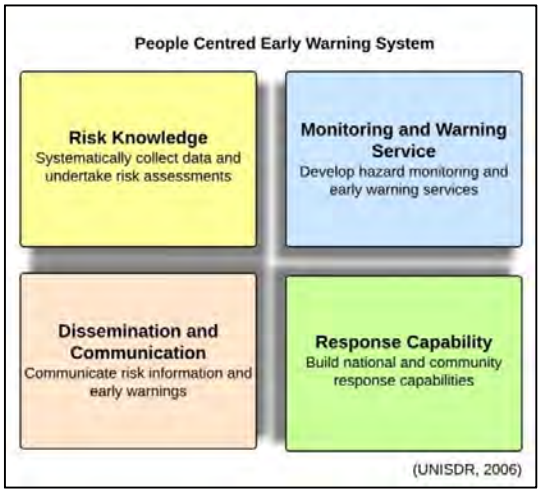


Figure 2.1 Four components of a people centred early warning system (UNISDR, 2006)

A people-centered early warning system comprises four key elements, see figure 2.1. These are 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 (UNISDR, 2006). Ultimately an early warning system will only be effective if all components are effective. The Communication and dissemination component has been recognised 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.

Flood Early Warning in Bangladesh

In 1972 the Flood Forecasting and Warning Centre (FFWC) was established under the Bangladesh Water Development Board (BWDB) to contribute to reducing the loss of life and economical damage caused by riverine floods. Over the past decades various studies and pilot programs have been carried out to understand the effectiveness of the current Flood Early Warning System and to suggest and test improvements. These projects were explained in the Combined Evaluation Report submitted in April 2014. Forecasts for the major and secondary rivers in the central region of the country are of acceptable quality, but messages are often not effectively conveyed.

There is a formal institutional disaster management structure (Disaster management committees at National, District Upazila and Union levels) set up under the Department of Disaster Management (DDM). This consists of Disaster Management Committees (DMCs) at each level being supported by Disaster Management Information Centers (DMICs) up to Upazila level, see figure 1.2. Unfortunately many studies show that this is only activated during flood response activities and not for early warning (exceptions for projects aiming to strengthen this).

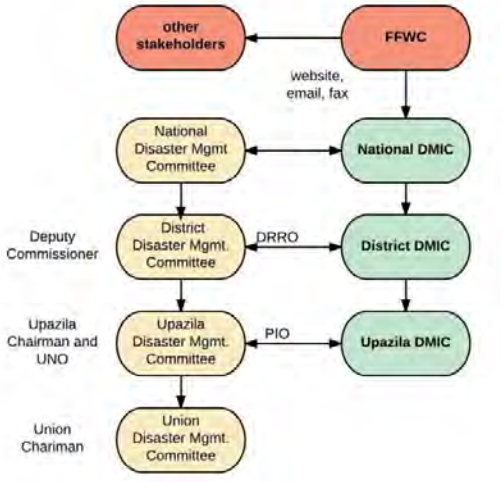


Figure 2.2 DDM dissemination structure (simplified) (DRRO – District Relief and Rehabilitation Officer and PIO – Project Implementation Officer)

The strong penetration of mobile services in Bangladesh, 75% of the population (BTRC, 2014), offers opportunities to enhance this communication and dissemination component. Mobile service techniques have been tested in Bangladesh for early warning – SMS by USAID (2008), Interactive Voice Response (IVR) by DDM, Cell Broadcasting by CDMP and DDM, Bulk SMS by DDM.

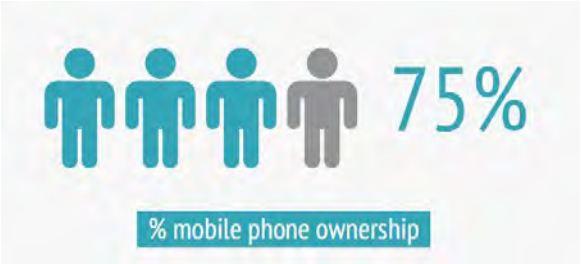


Figure 2.3 Mobile phone ownership in Bangladesh

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.

At present, the most urgent problems with regard to the effectiveness of the current flood early warning system in Bangladesh found from the a review of reports and interviews can be summarised as follows:

- Warnings do not always reach local stakeholders despite efforts to integrate the use of mobile services in numerous ways.
- The content of the warning is not always understood well by the recipient.
- Warnings could be made more effective by better targeting regions and different types of users.
- Insufficient attention to follow-up activities, integrating and up-scaling pilots in the national forecasting and warning system, and how to sustainably finance such activities

2.2 Objectives

Following the identification of the opportunities for improving the current flood warning system in Bangladesh, three objectives have been formulated for this project:

- Identifying, testing and evaluating potential improvements for flood warning;

    1. Dissemination and communication using mobile services
    2. Message content and understandability for the community level
    3. Message dissemination pathway (organisational)
    4. Response capabilities by end users

- Developing recommendations for each of the four areas a) communication, b) message content, c) dissemination pathway and d) end user response.

- Identification of alternative social business models for exploitation and maintenance of the of the improved Early Warning System in order to ensure its financial sustainability

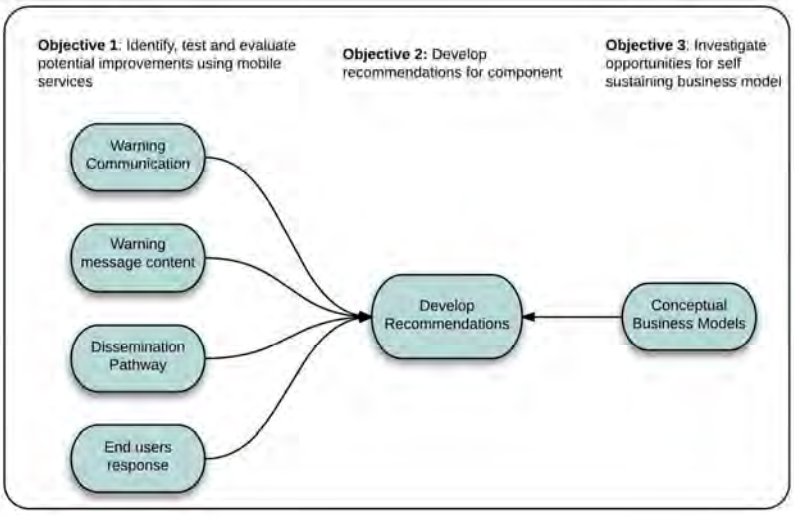


Figure 2.4 Objectives of the project

3 Methodological Approach

This section explains the overall approach taken, linking directly to the tasks outlined in the proposal and the deliverables. The section then goes on to explain the specific approach taken for the pilot activities and to briefly describe the pilot areas. The research methodology for evaluating the pilot is then discussed followed by the methodology for the business model approach C1.

3.1 Overall Approach

Three tasks were defined as part of the project and a number of sub tasks and deliverables were associated with these. The links to the project objectives outlined in 2.2 is also shown.

Task A: Improvements to the early warning system: link to objectives on message content (1a) and communication techniques (1b)

- A1: Evaluation of EWS
- A2: Improvements to EWS
- A3: User applications

Task B: Improvements to the organisation of the early warning system: links to objectives on warning dissemination pathway (1c) and end user response (1d)

- B1: Evaluation of current flood risk organisation
- B2: Capacity Building workshops
- B3: Recommendations

- B4: Pilot study

Task C: Business model for exploitation and maintenance of the EWS: links to the 3rd objective.

- C1: Analyse and evaluate alternative business models
- C2: Workshop and dissemination

The deliverables for the project were as follows;

- Inception Report (March 2014)
- Combined Evaluation Report (April 2014): Task A1 and B1
- Business Model Report (January 2015): Task C1
- Final Report (January 2015) including recommendations (Task B3) and final workshop report (Task C2)

The team was led by Deltares. RIMES and HKV provided technical support. The input of the national governmental partners was valued very strongly and this project and could not have been successful without them. In particular the Flood Forecasting and Warning Center (FFWC), the Bangladesh Water Development Board (BWDB) provided invaluable support and guidance. Cordaid offered from the start of the project to supplement the RVO financing so that a thorough pilot and implementation at the community level could be done. Apart from being a supplemental donor, Cordaid acted also as an advisor through their community managed disaster risk reduction expertise and arranged for implementation at the community level by supervising a strong partnership of national and local NGOs (Concern Universal Bangladesh (CUB), Practical Action Bangladesh (PA) and MMS).

3.2 Pilot Study

A pilot study was conducted as part of Task B, which ultimately linked all components of Task A, and B together to meet the project objectives 1 and 2. Task C did not link specifically to the pilot study but was used to gain a better understanding of potential business model approaches.

The pilot study focused on improving the four components of the EWS connected directly to the project objectives to;

1. Identify, test and evaluate potential improvements for flood warning;

    a. Message content and understandability for the community level
    b. Dissemination and communication using mobile services
    c. Message dissemination pathway (organisational)
    d. Response capabilities by end users

2. Develop recommendations

After an initial set up phase from March to June 2014, the pilot ran from June 2014 to September 2014

The pilot targeted two unions in the Sirajganj district, i.e. the Gorjan Union of the Chowhali Upazilla and the Rajapur Union of the Belkuchi Upazilla. Unions are the smallest rural administrative and local government units in Bangladesh with a governing Union Council (or Union Parishad). Bangladesh consists of 4550 unions, 488 Upazilas, 64 districts and seven divisions. The Sirajganj district is part of the Rajshahi Division, has nine Upazilas, 82 unions

and a population of 3,097,489 (BBS Census, 2011). The Gorjan Union has 18,748 inhabitants, 662 inhabitants per km^2 and 27,2 % literacy. The Rajapur Union has 48,331 inhabitants, 1933 inhabitants per km km^2 and 42,3% literacy. On average there are 5 people per household, thus 12,416 households were the total target area. Both unions are located in the remote Charlands. These areas are extremely vulnerable to floods as they are located in the middle of, or adjacent to, the Jamuna River, see figure 3.1. These areas experience a huge amount of damages from floods each year. Furthermore they have a lack of access to information due to their disconnection with the mainland.

Figure 3.1 Char islands Siragjanj

Ghorjan union of Chowhali Upazilla and Rajapur Union of Belkuchi Upazilla in Sirajganj district were selected as the pilot areas, see figure 3.1. This was due to the following reasons;

- High flood vulnerability.
- Good network at the local level through MMS and Practical Action.
- Good field accessibility due to MMS networks.
- Limited pilot activities in charlands.
- Rajapur union is common with that of another project on warning dissemination (BDPC, Ansar VDP) however, during 2014 this did not focus on community dissemination.
- Strong Digital Center (A2i program) in Rajapur.

The pilot was expected to run during the 2014 monsoon flood season.

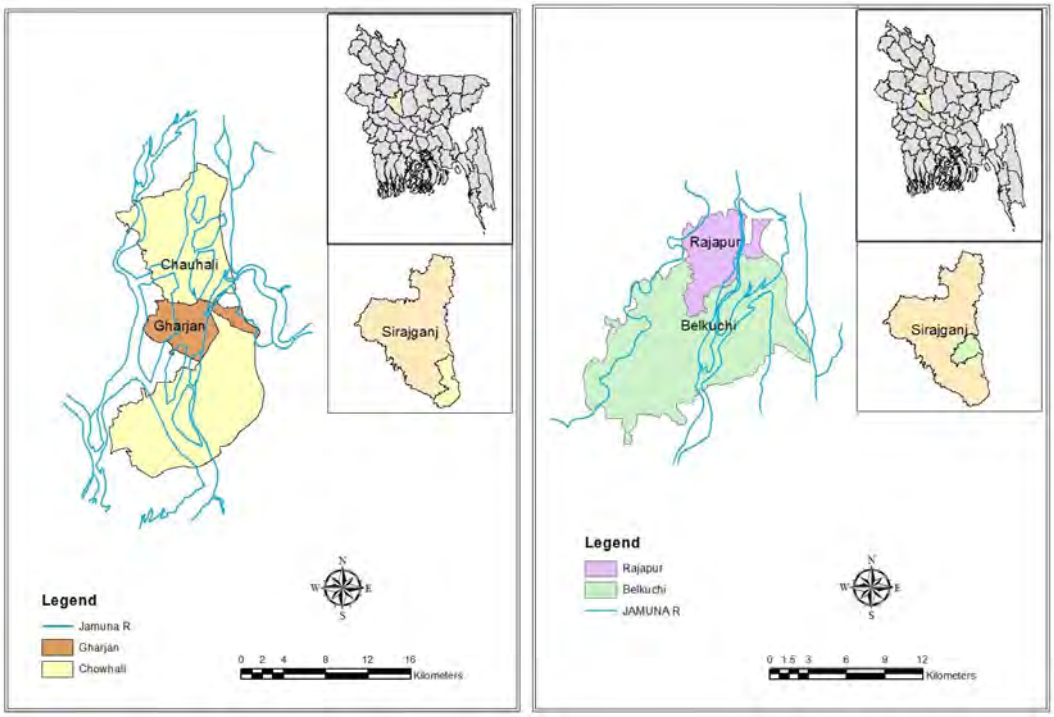


Figure 3.2 Pilot areas in Sirajganj: Gharjan, Chowhali (right) and Rajapur, Belkuchi (left).

3.3 Pilot evaluation methodology

In order to evaluate the impact of the interventions on the community a methodology for assessing this impact was established. The framework for assessing the social performance of mobile service technology for early warning dissemination (Cumiskey et. al. 2013) was applied. This involves assessing a number of characteristics related to the warning message, mobile services and the community. This was completed as part of the preliminarily project evaluation phase (baseline analysis) to define the best interventions. This framework was then applied during the pilot phase to evaluate the project interventions in terms of;

a. Characteristics of the warning in the 2014 floods in comparison to previous years
b. Characteristics of the mobile services as a communication technique
c. Characteristics of the community
d. Assess the end users response and benefits gained
e. Develop recommendations for further improvements to the system both at national and local levels

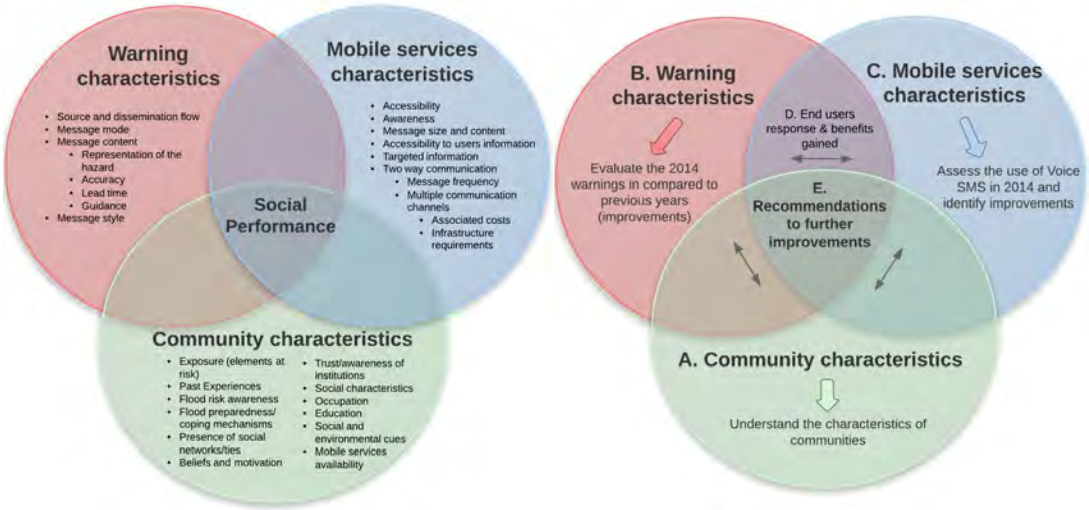


Figure 3.3 Framework of analysis based on (Cumiskey et al., 2013)

Four data collection tools were used to evaluate the pilot activities. These included;

- 91 semi structured interviews
- 10 Focus group discussions
- Key Informant Interviews
- One government officials workshop

Questionnaires and evaluation forms were used to collect the data. The questionnaire used for the semi-structured interviews can be found in Annex A and for the FGD in Annex B. The evaluation forms used in the governmental workshop can be found in Annex C. The summarised output from this workshop can be found in Annex D.

Figure 3.4 Data collection methods for the pilot evaluation

The respondents selected for the evaluation ranged from;

- Project volunteers
- Direct Voice Message Broadcast (project intervention) warning recipients
- Indirect recipients of the warning message (i.e. through volunteers)
- People who did not receive any warning message

Furthermore, respondents were selected sector wise in order to reach all the key sectors affected by floods. This included agriculture, fisheries, livestock, handloom, small business owners, boat owners, health sector workers, religious leaders, teachers, students, housewives, Ansar (local village police), and gauge readers. Approximately equal numbers of interviews were held in each project area, Rajapur and Ghorjen. Two to eight people per sector per project area were interviewed. A larger number were interviewed for the key sectors including agriculture, fishery and livestock.

See Annex E for further details on the characteristics of the respondents in the evaluation.

3.4 Methodology for the business model analysis

(Flood) Early Warning Systems are a responsibility of the government and are considered a public task. EWS have the economic characteristics of public goods that make them difficult to be privately funded and therefore depend heavily on public funding for their proper functioning. Especially in developing countries where taxation systems do not ensure enough public funding, this poses real challenges to the financial sustainability of its provision.

Economists define a public good as being non-rival and non-excludable. The non-rival part of this definition means that the consumption of that good by one person does not affect the consumption of the good by another. The non-excludable portion of this definition means that nobody can be prevented from consuming that good. Another way of understanding this concept is saying that adding an additional person to the public goods market has a marginal cost of $0. In other words, even those who do not explicitly (actually) pay for the good can

benefit from the good. Accordingly, a standard result of the theory of public goods is that, in general, pure public goods would be undersupplied by voluntary contributions[1].

In this project, the potential to generate revenue from the Early Warning System from private sources was analysed to reduce the expected funding gap and generate additional income in support of long-term financial sustainability. We explored the following avenues;

- Generate **additional positive cash flows** and incomes upstream (e.g. international subsidy programs, 3rd parties using the datasets) and downstream (e.g. applying user pays principle).
- **Reduce negative cash flows** by limiting operation and maintenance costs – e.g. engaging local parties in operation and management or data collection activities, and having part of the activities to process data and provide warnings carried out by private sector parties to increase efficiency.

In order to draft a number of alternative business models for the improved EWS, the following activities and analyses were undertaken:
- Review of previous studies and pilots on the use of mobiles for data dissemination in Bangladesh and their connection to EWS
- Review of international experiences on social business models related to climatic variability and/or disaster risk management
- Qualitative estimation of total life cycle costs – based on interviews
- Analysis of key stakeholders for the implementation of alternative business models – based on interviews

The findings of the research undertaken and resulting from these activities are presented in deliverable ***Business Model Report,*** corresponding to Task C.

Sources of information were 20 interviews, conducted in the first (May 2014) and the second mission (December 2014); as well as multiple work sessions with project partners in the Netherlands (Cordaid team for TamTam alert project and HKV) and Bangladesh (Concern Universal Bangladesh and MottMacDonald) and literature review. The findings presented in the Task C report have been presented to local community actors and national level actors, and they have been asked for validation. At the community level, during a field visit to Sirajganj, we presented all volunteers (for dissemination and gauge reading) that had received training on the value chain approach, the main findings and asked their feedback and suggestions. At the national level, this discussion took place after the presentation given in the closing workshop of the project, December 2nd.

The report for task C (***Business Model Report***) is divided in five main sections. After introduction, section 2 presents all the necessary background information and frame of reference from which the research conducted departs. Section 3 presents all the findings per activity realized: a) The challenge, as reformulated after research findings, b) Investments and O&M costs of an improved EWS, c) Stakeholder analysis and d) potential business models. In section 4 a vision for implementation of financial sustainable EWS services is drafted; based on the findings and inspired by successful experiences in other countries and sectors. Finally, section 5 presents a summary of the conclusions and recommendations.

[1] Bergstrom, T., et al. (1986). "On the Private Provision of Public Goods." Journal of Public Economics 29: 25-49.

3.5 Final National level workshop to validate results and recommendations

A final national level stakeholder workshop was held on the 3rd of December 2014 to share and disseminate project results. The goal of the workshop was to share and validate the results from the project evaluation at the field level, and build on the recommendations developed from these.

This consisted of two main parts. Firstly a formal opening by Mr. Amirul Hossain, Executive Engineer of the FFWC and Mr. Michael Slotema, Water Policy Advisor, The Netherlands Embassy of Bangladesh. A number of presentations followed this opening on the different components of the project, see figure 3.3. Furthermore, a short movie prepared especially for the workshop was shown.

Figure 3.5 Final project workshop 3rd December

The workshop broke out into five groups where specific topics were discussed and led by a facilitator. These topics were defined based on the need to gather input for the continuation of the project in 2015. The 5 topics are shown in figure 3.6 to the left.

The workshop report can be found in Annex F and the link to the movie can be found here.

Figure 3.6 Interactive group work sessions in the workshop

Figure 3.7 Group work sessions at the final workshop (3rd Dec 2014)

4 Implementation Approach

The project objectives outlined in Section 3.3 formed the basis for the implementation approach. Based on the results from the initial project evaluation (combined evaluation report) decisions were made on the innovative interventions for the pilot and an implementation plan.

This initial evaluation involved the following;

- Literature review
- Stakeholder consultations at national level
- End users needs assessment at local level
- Developing recommendations on potential improvements given the baseline conditions.

The project interventions were then tested during the 2014 monsoon flood season (end August/ beginning September) and evaluated in late September/ early October. There was a concern early in the project the no flood event would occur in 2014 but this was not the case.

The following sections explain the implementation approaches for a) warning communication component, b) warning message component, c) warning message dissemination pathway component and d) warning response capabilities.

4.1 Warning communication component

There are a number of different communication channels that can be used to disseminate warning messages using mobile services. The details of these are explained in the Combined Evaluation Report (April 2014), however a brief summary is provided below to substantiate the choice of the interventions for the pilot activities.

Interactive Voice Response (IVR) is being used by DDM with input from FFWC and Bangladesh Meteorological Department (BMD). This is a short code, 10941, that anyone on any mobile phone network can call and access the latest information on weather, flood and cyclone warnings. This is demand driven making it accessible to everyone however, it does come at a small cost (1BDT per minute). DDM are currently undergoing efforts to eliminate this cost and make it freely available to everyone.

Cell Broadcasting has been piloted in the past by DDM and showed huge potential because it can reach a large amount of people quickly, in a location specific area without the need to collect their phone numbers. However, there have been disadvantages associated with this including;

- Scroll message with limited characters and no alerting beep
- Infrastructure & handset adjustments required
- Possible time delay

SMS has also been used in the past and currently for warning dissemination. The key problem here is the high level of illiteracy in Bangladesh making it very difficult for people to understand the text based message. Technology is rapidly improving in Bangladesh yet still not all mobile phones enable Bangla script. For this reason, messages are sent in English

making it even more difficult for people to understand. Generally in Bangladesh, people prefer to talk and not text. For SMS the phone numbers must be collected. On the one hand this is positive because it increases awareness when collecting phone numbers but on the other hand, it is time consuming and difficult to keep updated and maintain. For DDMs use of SMS the main problem experienced is the difficulty in collecting and storing the government official's phone numbers. This is because individuals tend to have multiple SIM cards in Bangladesh and the government officials change every two to three years thus changing phone numbers.

Bulk SMS is currently being tested by DDM and combines features of Cell Broadcasting and SMS. It is possible to reach all the people within the reach of a specific cell phone tower but a regular SMS is disseminated rather than a cell broadcast.

Figure 4.1 Different option for mobile services dissemination

Based on this analysis **Voice Message Broadcast (VMB)** with Grameen Phone was chosen as the intervention to test for dissemination in the pilot. VMB is an automated Interactive Voice Response (IVR) system that dials-out to the targeted community and plays back relevant information through recorded voice clip(s) and enables the user to reach out to their target groups.

VBM has the following features;

- There is no character limitation like for Bulk SMS (80 for Bangla, 160 for English) – messages up to 10 minutes long can be recorded
- Automatic dialling facility allows pre-recorded message to be played out to the community as information without the need to enter phone numbers individually.
- Flexible dissemination-administrators can upload the numbers and set the dissemination time in the web interface.
- Messages can be sent to all phone operators and landlines and one increases awareness by collecting the mobile phone numbers.
- Illiterate members of the community can understand voice messages more easily than text.
- Automatic retry facility can be used with up to two retries for the administrator to choose for unanswered VMB.
- Easily manageable Do Not Disturb mode i.e. the end user can press * if they want to ignore the message.
- The VMB can be sent within a very short time (minutes).
- A large number of messages can be sent at one time (50,000).
- Cost is approx. 1 to 1.4 BDT per minute, which is not considerably higher than others.

- VMB can be both interactive (allowing a call back function and/or press certain keys for certain feedback i.e. dual tone multi frequency DTMF) and non-interactive. In this pilot the non-interactive function was used to simplify.

Figure 4.2 provides an overview of how VMB works and figure 4.3 shows the VMB interface.

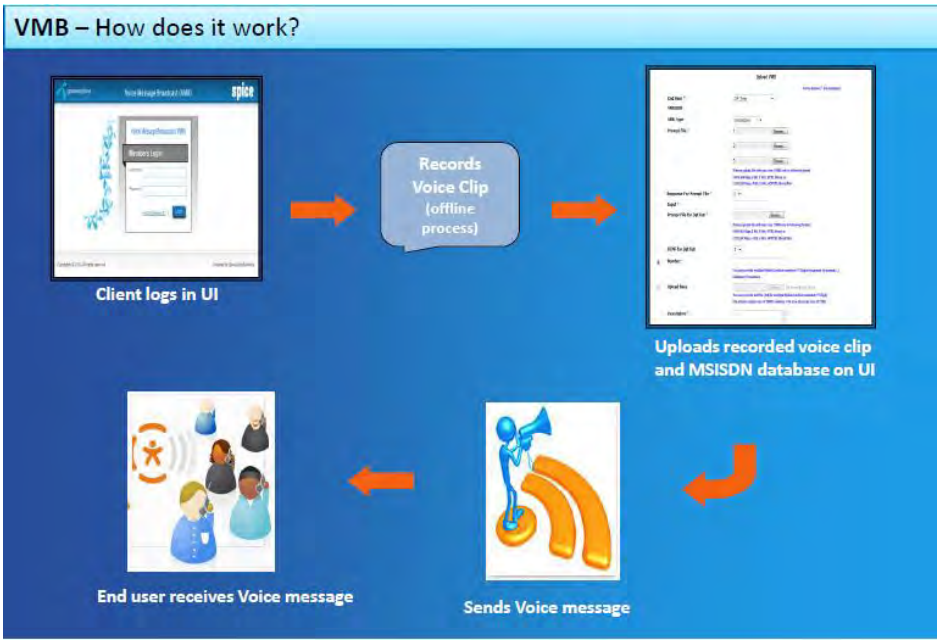


Figure 4.2 Overview of how the Voice Message Broadcast (VMB) works

Figure 4.3 Interface of the Voice Message Broadcast system

VBM was used for top down dissemination from national level to District, Upazila, Union and community levels. Along with this SMS was chosen for a bottom up approach to collect data from the community level for use at the national level. A “SMS2DASHBOARD” system was developed to assist in this process and is explained further in sections 4.2 and 5.2.

4.2 Warning message content

The FFWC produces daily flood forecasts during the flood season (May to October) at 54 locations in the main river system, all over Bangladesh. These locations are depicted in **Error! Reference source not found.**. The FFWC uses water level observations at some 84 water level measurements locations. The divisional offices of BWDB are responsible for providing flood and water level observation information to the flood information seekers, especially from the district administrative level.

The FFWC produces two kinds of forecasts;

- A 5-day deterministic daily forecast, based on a 7-day hindcast. For that, a model, called supermodel, is used (Mike-11). The simulated water levels are being assimilated with observed water levels (3 hour values, 5 times a day, 84 locations). The observed water levels are sent to FFWC every morning, by different means (SMS, mail and calling).

- A 10-day probabilistic forecast, which is in an experimental phase. This forecast is produced by RIMES at the FFWC office. For this, ECMWF (European Center for Medium Range Weather Forecasting) provides a 10-day precipitation forecast each day (1Gb data, every day). The rainfall run-off model, which also includes the Indian part of the catchment, is run by RIMES in Thailand. The simulated discharge at the boundaries (including uncertainty) is sent to FFWC and feeds a modified version of the supermodel. The 10-day forecast is also available on the FFWC website, but it is noted that it is still in experimental phase, so results should be handled with care.

Figure 4.4 Flood Forecasting points of the FFWC

For the pilot implementation in Siragjanj the 5 day deterministic forecast was used as a basis for the warning message content for the VMB communication. This was used because it is easier to start with the deterministic forecast with the community having little or no knowledge of the probabilistic forecasting or even the forecasting system itself. The Bangla message starts with the name of the organisation and date. Further it describes the current situation, i.e. the water level compared to danger level. The message ends with the predicted change of the water level within 5 days, in centimetres. In this way, people can calculate themselves the situation within 5 days compared to danger level. The message contains different information for each union in one message. This was recognised as not being ideal but it was the simplest way to test the system in the area. Figure 4.5 shows the exact text of the message from August 15th 2014.

"Welcome to the FFWC of BWDB. Today Friday 15th August 2014. As per the observations of 6 AM this morning Jamuna river at Sirajgnaj is flowing 30 cm below Danger Level. According to the latest flood forecast water may rise 22 centimeters in Ghorjan union, Chowhali upazila & 29 centimeters in Rajapur union, Belkuchi upazila in next 5 days."

Figure 4.5 Text of warning message by VMB on August 15th 2014.

Message Frequency: It was decided that the frequency of the VMB would depend on the current flow situation and the trend for the coming few days. In a workshop this was discussed with project partners. It was concluded that no message would be sent when the water level is below danger level and has a falling trend. When the water level is rising and/or is already above danger level, 1 or 2 voice messages per day are being disseminated, see figure 4.6.

Figure 4.6 Frequency of the warning messages

Localised union level forecasts were produced at a distance from the regular FFWC point. This was possible due to the installation of 2 water level gauges at the community level in each union and the collection of observed water levels by gauge readers. These gauge readers were selected in the pilot communities and trained in reading the gauge and writing down their observations at 6am, 9am, 12pm, 3pm and 6pm each morning, see figure 4.7. Gauge readers write down the water levels in the official FFWC format logbook and communicate the reading once every day via SMS to the FFWC, see figure 4.7. We decided to limit the duration of the message to one minute, following the recommendations from the workshop on previous experiences with IVR. The SMSs were then sent to and stored at the FFWC.

Figure 4.7 Water level gauges and gauge readers

ST001 DDMMYY
09,1191 12,1192
15,1192 18,1193
06,1195

Figure 4.8 Content of the SMS the water level gauge readers send every day

Meanwhile a SMS and DASHBOARD system (SMS2DASHBOARD) was developed which can receive the SMSs and minimise the amount of work required to make a localised forecast for the 4 water level locations. It requires at least measured time series of 1-3 monsoons to compute a reliable and useful localised forecast. During this monsoon it was not possible to use the system as it was not complete in time. Data was collected at the 4 stations from August 1st 2014 (and ended at October 20th). The observed water levels were imported in the SMS2DASHBOARD system and subsequently the localised forecast was performed manually as a test case after the flood season. This was used to illustrate the system for the audience at the final workshop on December 2nd.

4.3 Warning dissemination pathway

The basic disaster management structure shown in figure 2.2 includes the newly implemented Disaster Management Information Centres (DMIC) from national to Upazila levels. More details of the roles and responsibilities of the different institutions can be found in the Standing Orders on Disasters (SOD, 2010). The DMIC network was further investigated in an attempt to utilise it as part of the project. During the stakeholder consultations at national and Upazila level it became evident that the DMICs are not actively playing the role that they were originally designed to do. Although the physical equipment (computer, modem and printer) is present, it is being used for regular activities and not specifically for managing disaster information. Therefore, for the purpose of this small pilot, it was decided not to rely on the DMIC for dissemination but to include them in the list of stakeholders to receive the VMB and corresponding email to keep them informed.

The Digital Centers (previously termed Union Information Service Center (UISC)) developed under the A2i program were also investigated as a potential sustainable pathway for warning dissemination to the local level given that they are active in all unions in Bangladesh. The Digital Center in Rajapur Union was assessed and deemed capable to play a role in warning dissemination. The Digital Center (DC) entrepreneur had some level of awareness of the FFWC and showed potential to be able to understand more complex forecast information and search for this on the FFWC website. For this reason it was thought the DC entrepreneur could record the voice message in an attempt to decentralise this activity from national level.

However, it was also clear that the entrepreneur is very busy with activities that can bring him income and he is less interested in doing voluntary, unpaid work. Therefore, we decided to keep the role of the DC in the pilot for the Voice SMS dissemination to a minimum. We emphasize however, that it might be possible to develop a viable social business case for the DC entrepreneur. Although in the pilot as held in 2014 the DC entrepreneur does not record the message, he receives it from RIMES/ FFWC and discusses it with UP chairman.

There was no DC at the other pilot area in Ghorjan Union but this was being set up in an established school by MMS. However, this activity was not ready before the onset of the floods and thus was not actively used for warning dissemination.

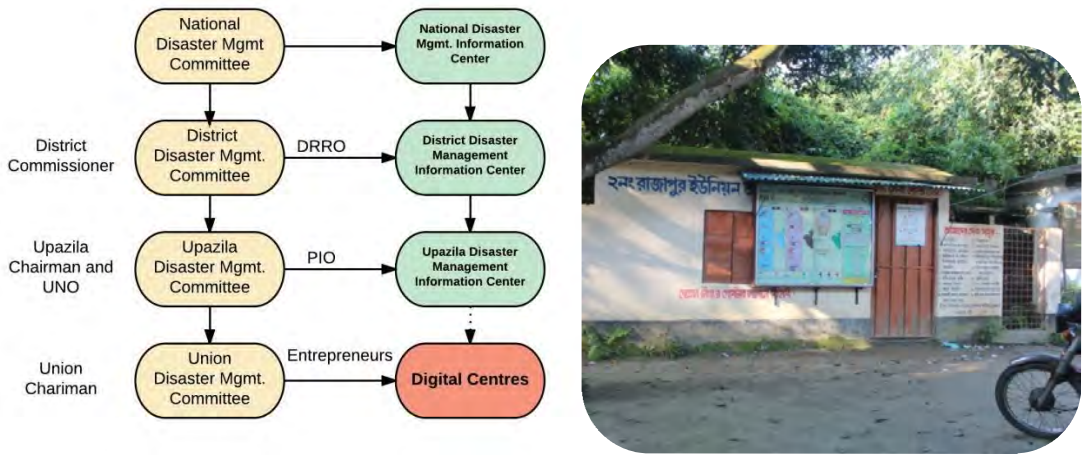


Figure 4.9 Potential link between the Disaster Management Information Centers (DMIC) of DDM and the Digital Centers (DC) of A2i Rajapur Union

Collectively it was agreed that for this pilot it was better to disseminate from national level (FFWC and RIMES) directly to the union level using VMB to 20 volunteers in each project areas and other direct recipients. This dissemination pathway is outlined in figure 4.10.

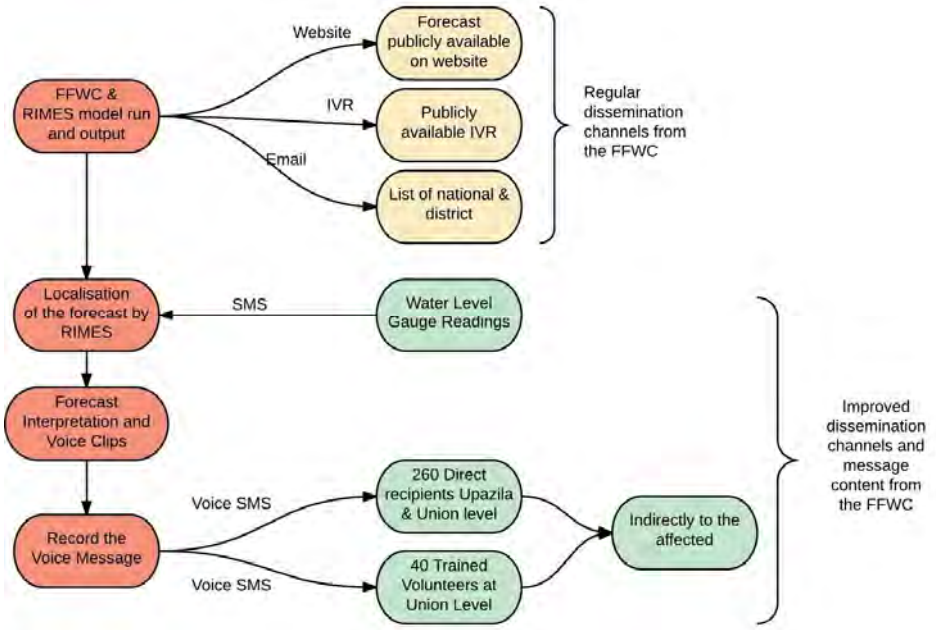


Figure 4.10 Project interventions (VMB and SMS) (in green) in addition to the regular FFWC dissemination pathway (in yellow)

The distribution of volunteers and direct VMB recipients among sectors is shown in figure 4.11. The following section explains how these people were trained in order to respond effectively to these messages.

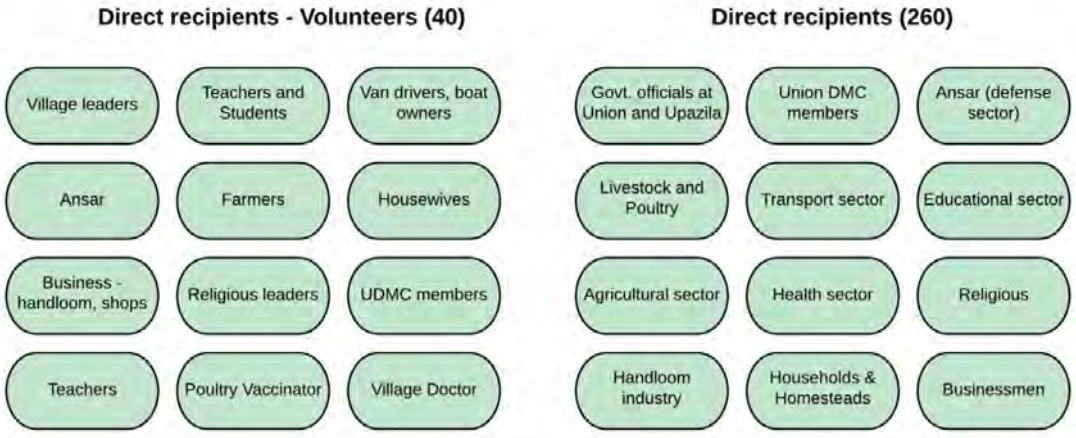


Figure 4.11 Overview of the sectors targeted for the volunteers (x40) and direct VMB recipients (x260)

4.4 Warning response capabilities

The next step in the project implementation was to train the local NGO staff and selected volunteers about the flood forecasting and warning process, see figure 4.12. RIMES and the FFWC conducted this training. The training specifically focused on warning message interpretation, see figure 4.13.

Figure 4.12 Technical training on forecast message interpretation by RIMES and FFWC to project staff and volunteers

Another set of training was provided to the volunteers focused specifically on how they should respond to the warning message. Concern Universals expert staff in the field of Community Managed DRR conducted this training. The training showed volunteers how to advise the different community members, to encourage groups to sit together and make decisions on how to respond, to disseminate the messages to the most vulnerable, assist the most vulnerable in evacuating, and moving items to higher grounds.

During these trainings the participants were informed about the I10941 IVR demand driven disaster information system and encouraged to use it, and share the information with the community. The following section describes the evaluation results of the pilot activities.

Figure 4.13 Disaster management training at the community level

5 Output and Evaluation Results

This section describes the output of the project, which is based on the evaluation results. The methodologies for this evaluation are as described in section 3.4 and particularly figure 3.3. This section first describes the results relating to the communities characteristics, then the warning characteristics, and lastly the mobile services characteristics.

5.1 Community Characteristics

The characteristics of the target audience must be understood in order to design effective warnings (Basher, 2006). It was very evident during the evaluation that these communities are severely at risk to floods and also erosion.

There are many **elements at risk** within these communities; their land being the most exposed one. Additionally, their many other physical and non-physical elements including crops, fish, cattle, handloom factories, employment, education, household goods, transportation, and health are at risk.

It was found that these communities are very accustomed to living with floods and do practice some traditional **flood preparedness/ coping mechanisms** such as raising the plinth level of houses. Some of the communities were involved in previous projects with NGOs and this greatly influenced their level of preparedness. Overall, the flood preparedness of the union was poor due to limited support from the government for preparedness activities and poor transportation facilities, especially during floods.

These communities have a lot of **experience** with flood events as minor floods and erosion happy nearly every year. However, they never formally received flood warnings before. For this reason, it was expected that it would take some time for them to become familiar with and trust such information.

The pilot areas have very strong informal **social networks and ties** but poor relationships with the local government in Ghorjen union (on the char island). In general these char islands lack support from the Union Parishad and feel disconnected. For example the Digital Center is located on the main land portion of the Union rather than on the char island. This is also understandable because the internet facilities are stronger there.

The illiteracy rate in these char island areas is very high especially in the more remote area of Ghorjen.

Figure 5.1 Impression of the Sirajganj char islands

Sharing the warning information

The results showed that a very high percentage (75%) of the people that received the warning message shared this with the community, see figure 5.2 (discussed further in section 5.2). The survey results also showed that 89% of respondents talked to someone about the information that they received in order to clarify it. This shows the importance of the connections within the community for further dissemination. This is particularly important for people who have access to a large network including Imams, teachers and rickshaw pullers.

Figure 5.2 Percentage of respondents that shared the warning information

Trust

A large proportion of the communities (78%) also expressed a high level of trust in the warning messages, see figure 5.3. The network of volunteers played a very important role in increasing the level of trust in the message. Communities were able to get confirmation from the local volunteers and check the accuracy of the messages. Communities were also able to use the installed water level gauges to validate the forecast.

Figure 5.3 Percentage of respondents that shared that expressed having very high trust in the warning message

Overall it is clear that these communities are at high risk of flooding and the potential damages are very high. They are accustomed to living and recovering from flood events, but the addition of an early warning message has huge potential to reduce the consequences of the floods. Given the strong social networks at the local level, high trust and tendency to share information, there is definitely the potential to effectively reach these communities if information is provided in a timely and accurate manner.

5.2 Warning Characteristics

During the 2014 monsoon season a localised forecast was prepared for each project area based on the national forecast for Siragjang point and data collected from the installed water level readings. Overall the 2014 floods in Bangladesh were less severe than the floods 2012 but more severe than 2013 both in terms of duration and intensity. As per a tentative calculation at the FFWC, 25% of the area was inundated making this the highest inundation level the last seven years. Figure 5.4 compares the hydrographs at Siragjang with previous flood events. Further technical details regarding the forecasting can be found in Annex G.

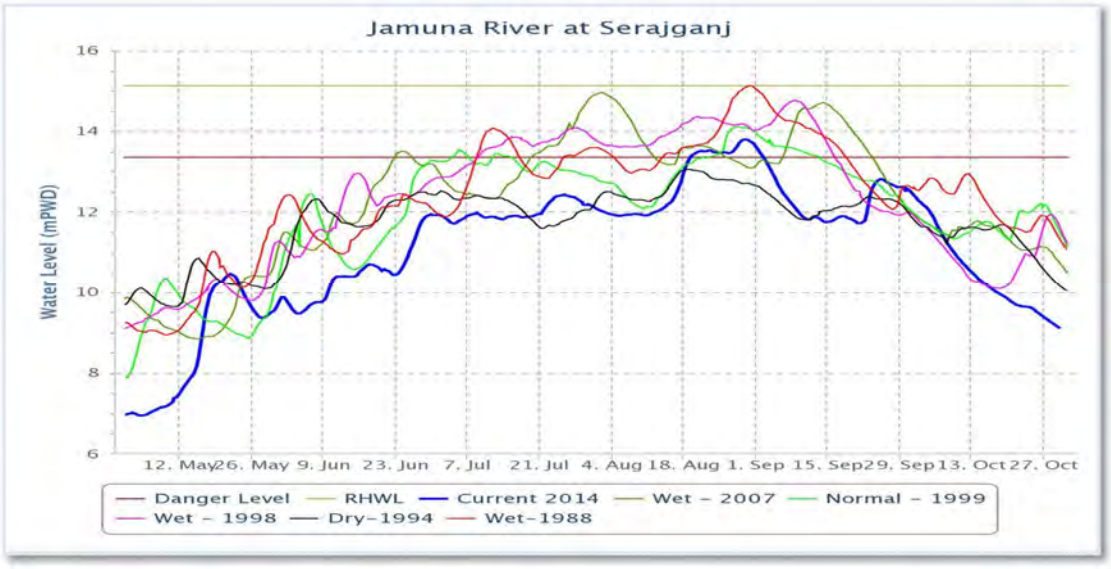


Figure 5.4 Comparison of hydrographs at Siragjanj for Flood 2014

The impact of the water level gauges on the community was assessed during the evaluation and the results were very positive. 82% of the respondents were aware of the installation of the gauges, 96% agreed that they were useful for the community and 61% actually used them during the flood, see figure 5.5. It was very evident that the community used the gauges to check the accuracy of the warning messages. The gauges acted as something visual in the community and sprung curiosity about project among the inhabitants.

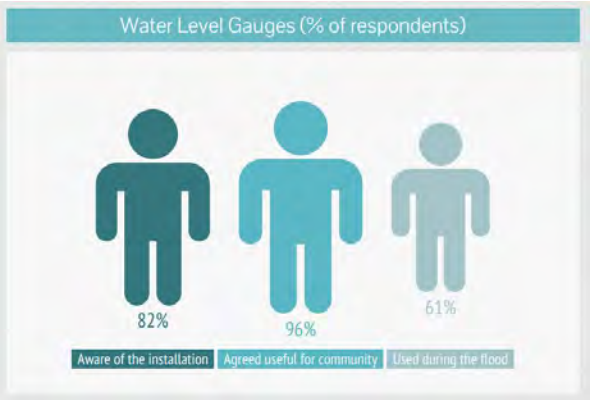


Figure 5.5 Impact of the water level gauges at the community level

Receiving the warning message

The respondents from the communities of Rajapur and Ghorjen were found to receive early warning messages predominately from the project interventions (87%) either by direct VMB and indirectly through the volunteers, see figure 5.6. Community people also sensed the danger of floods through their indigenous knowledge (14%). Some people were also found to use this indigenous knowledge to clarify or confirm the warnings from the project interventions. Only very few people were found to receive warning from the official DDM structure and some from the media. However, these were mainly received after the floods arrived.

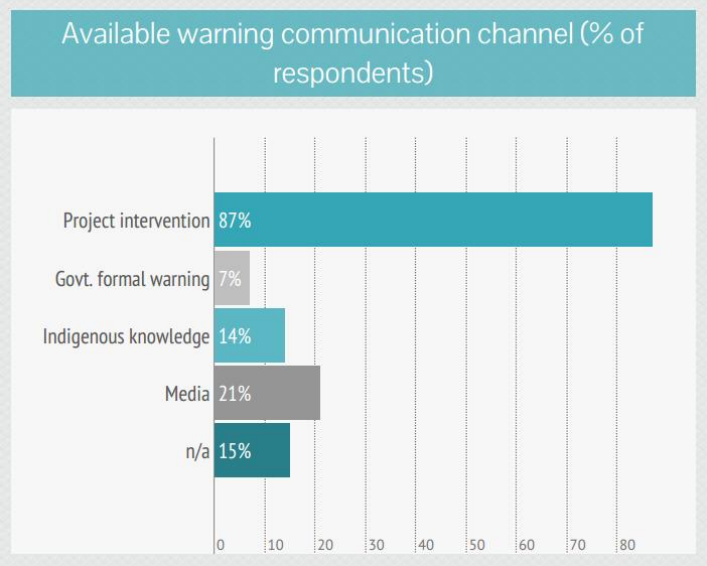


Figure 5.6 Available warning communication channels (% of respondents)

The number people that the early warning reached were estimated using the following equation and parameters in Table 5.1.

$$Number\ (\#) of\ people\ reached = (1A \times 2B) + (1B \times 2B) + (1C \times 2C)$$

The parameters 1A and 1B were defined at the start of the project (figure 4.11) and 1C was assumed given that each person who received the message directly shared it with at least 3 people (to be conservative).

The parameters 2A, 2B and 2C were calculated from the survey results. This was done by calculating the average number of people that the survey respondents shared the warning with. These were broken down into, direct voice SMS from volunteers, direct voice SMS through non-volunteers, or indirect Voice SMS recipients. It is interesting to note that people that received the warnings directly and were volunteers shared them with a much higher amount of people (175) than those that received them directly and were not volunteers (30). Understandably, the number again decreases for those that receive the warnings indirectly (15).

Using this method the total number of people reached was found to be 29,800 people, representing approximately 5960 households. This equates to 45% of the total population of the two unions.

Table 5.1 Parameters for estimating the total number of people reached with the warning message

	A. Voice SMS Directly (volunteers)	B. Voice SMS Directly (non-volunteers)	C. Indirectly Voice SMS
1. # people that received the warning	40	260	1000
2. # people that shared the message per person	175	30	15

Understanding

The respondents were found to understand the main components of the message, these being the hazard, intensity and duration. The water level gauges helped people to understand this. A large amount of the communities (80%) were found to have a high understanding (75 % of the message), see figure 5.7. This level of understanding grew after the end users received the message for the 2nd or 3rd time. Furthermore, 80% of the respondents perceived the seriousness of the message to be high. These positive results increase the chances that end users actually respond to the warning information.

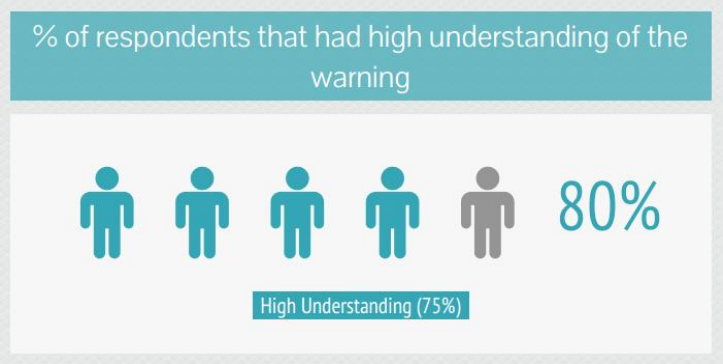


Figure 5.7 % of respondents with a high understanding of the warning

Additionally, the results showed that 64% of the respondents perceived the message to be 100% accurate and only 10% perceived the accuracy to be below 75%, see figure 5.8.

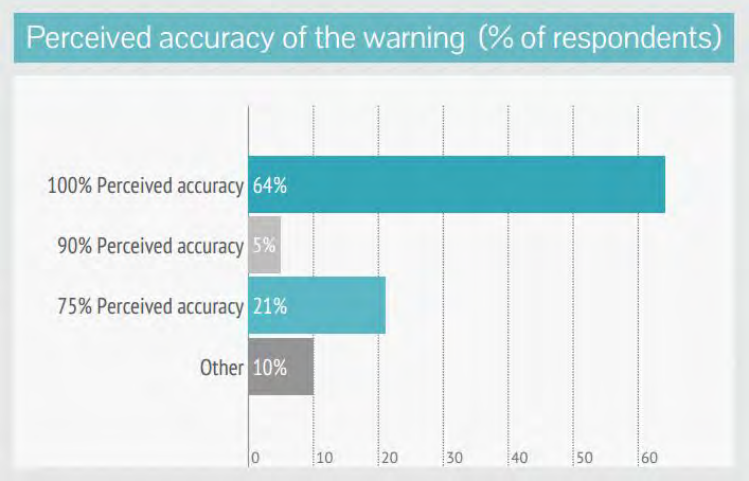


Figure 5.8 Perceived accuracy of the warning (% of the respondents)

The respondents were not found to have problems in receiving the warning message from the FFWC, even though this is not a familiar source for them. It is likely that this result is influenced by the

5.3 Mobile Services Characteristics

Overall the use of VMB as a means of warning dissemination from national to local level was found to be very positive.

The VMB was prepared by RIMES at the FFWC upon reviewing the severity of the flood forecast. The interface from Grameen Phone as described in Section 4.1 was easy to use and reliable. The VMBs were sent to the 300 recipients before and during the onset of the floods, at varying frequencies.

The evaluation at the field level showed that the VMB effectively reached the intended recipients. Some minor network problems were identified in Ghorjan union on the charlands. The VMB allowed the messages to reach the end users within minutes.

The end users were not **familiar** with receiving VBM so it took them some time to get used to listening to them. The incoming message did not indicate it was from a particular source (i.e. FFWC) until it was opened. This is a technical constraint from Grameen Phone. It was decided that showing a full number was better than a short code because short codes are often used for advertisements which people tend to ignore.

Another problem identified was that the message could not be **stored** in the end users phone. Due to the limited experience of the end users in receiving warning information, it took some time for the information within the message to sink in, or was easily forgotten due to the more technical terminology. Therefore, being able to listen to it again would be very helpful.

The **message length** was another issue that was discussed in the evaluation. During the course of the floods, RIMES experimented with the length of the message and gathered feedback from the field. The initial message length was then reduced as a result. However, results from the evaluation showed that the end users preferred to receive a longer message

and/ or have specific important pieces of the message repeated. The reason for this being that it would help them to absorb the information more easily.

Interesting information was found on the warning **message frequency**. Figure 4.6 showed the frequency at which the warnings were disseminated. The evaluation revealed that the frequency was not enough and the end users wanted to receive the messages more often. The community also recommended that messages were sent at specific times of the day (morning, lunch and one hour before dark) so they know when to expect the message and have enough time before sunset to respond.

Aside from the constraints experienced regarding the disseminated VMB, the results clearly showed that the communities and government officials greatly valued VMB as a warning dissemination tool. Figure 5.9 shows that 62% of the respondents found VMB and the most useful means of warning communication and 26% found the volunteers the most useful source. This combination of these two communication means was seen as the most useful.

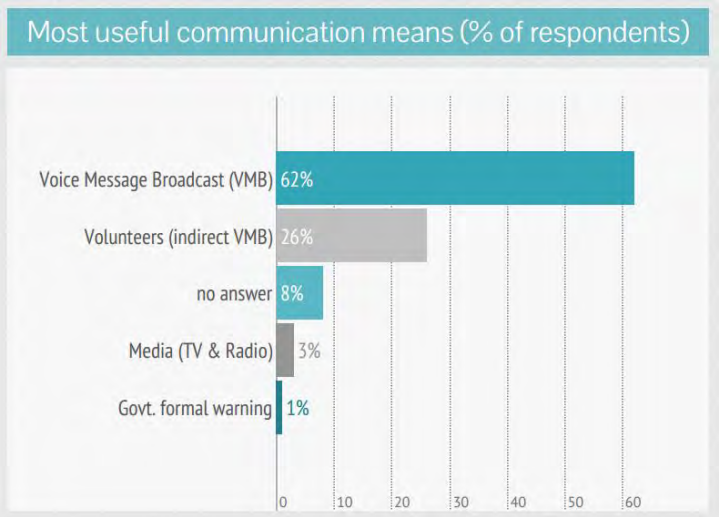


Figure 5.9 Most useful communication means (% of respondents)

The 10941 IVR system was also evaluated because it was introduced to the communities during the training sessions. The results showed that 54% of the respondents were aware about the IVR service and unfortunately only 15% of respondents actually used it during the floods. As the service is demand driven and comes at a small cost to the end user, huge efforts need to be made to increase awareness about the service so that they remember the short code and value the information being provided by it.

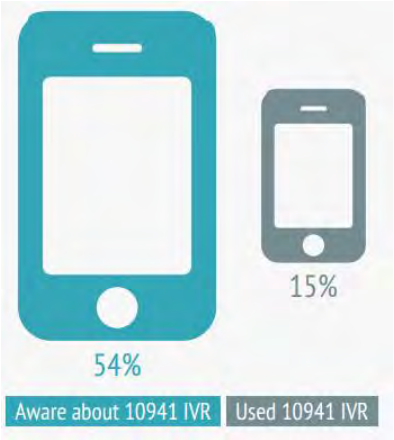


Figure 5.10 Evaluation of the IVR service from DDM

5.4 Dashboard Development

The SMS2DASHBOARD solution is a powerful solution to obtain good localized flood forecasts, because it is a mean-and-lean internet application, it can easily be extended to any other location in Bangladesh and last but not least needs a minimum of information to produce the localized flood forecast. In this project we designed and built the SMS2DASHBOARD, installed water level gauges at four locations and started observing the water levels and produced localized flood forecasts for four locations.

The features of the dashboard are:

- Automatically collecting of observed water levels by SMS
- Automatically displaying of observed water levels
- Automatically producing localized flood forecasts, based on the FFWC forecast in the main river system

The URL of the dashboard is http://bangladesh.dashboardwatersafety.com/ figure 5.11 shows the main window of the dashboard.

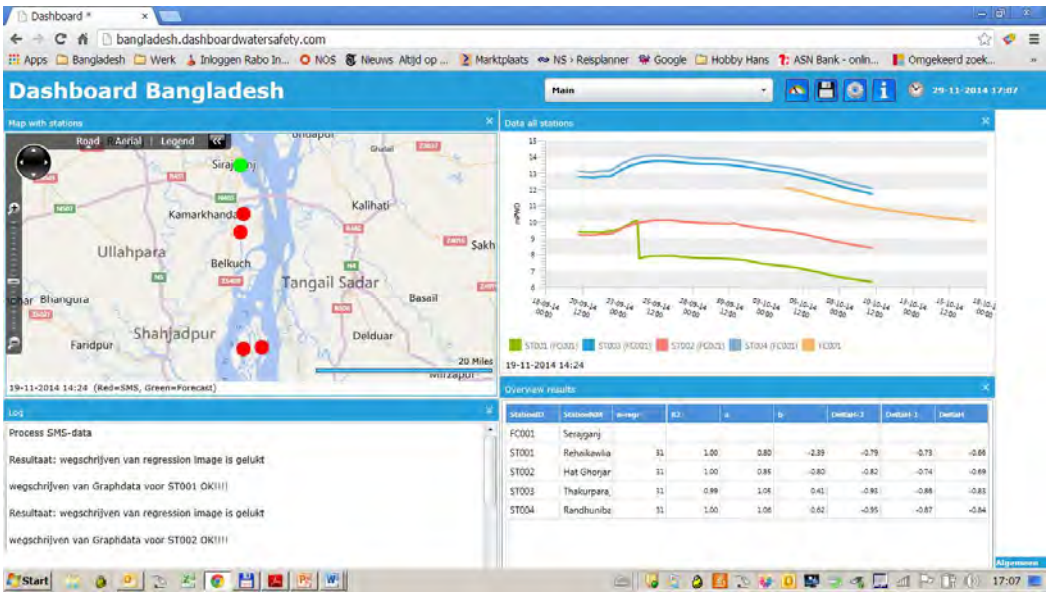


Figure 5.11 Main window of the dashboard water safety Bangladesh

The Geographical window (figure 5.11 left, above) shows the locations of the 4 water level gauges (red dots). It also shows the location of the FFWC forecast station Sirajganj The dashboard uses the daily forecast of this location to produce daily forecast at the other four locations.

The time series window (figure 5.11 right, above) shows the observed water levels at four locations and the water level (observed and predicted) of the FFWC location Siragjanj. This window supports the user in quick and easy validation of the data.

The Logging Window (figure 5.11 left, under) shows all kinds of logging information.

Finally the Statistical Window (figure 5.11 left, under) shows a summary of the computed statistics. Every day and for each location the observed water levels at that location and the observed water levels at the FFWC location are added to a database. Then the parameters of the linear regression function will be derived. Subsequently, this linear regression function is used for computing a flood forecast at the local level.

For each location, this statistical computation and the resulting forecast is visualised in extra window within the dashboard, see figure 5.12 for one of the four locations.

Figure 5.12 Statistical window of the dashboard water safety Bangladesh

For a good localised forecast of water levels, it is important to use a sound statistical relationship. Therefore time series of observed water levels need to be collected over several monsoons, i.e. also within the domain of extreme flooding events. We advise at the moment only experts to use this dashboard and draw conclusions, since there are not extended time series available at the moment.

Knowledge transfer

The DASHBOARD comes with a technical manual. This manual is included in annex H.

Furthermore, training was carried out at the FFWC office on the 1st of December 2014. This training was attended by four flood forecasting specialists of the FFWC.

6 Outcomes – benefits and response

It is clear from the evaluation that the end users were able to really use this warning information to take protective actions, to reduce losses to their livelihoods. See figure 6.1 for a brief overview of the actions. Annex I goes into more detail and shows the list of actions that end users took more generally and sector wise.

The survey results showed that 63% of respondents decided what actions to take in a group rather than on an individual basis. Additionally, it was found that respondents utilised the social network in the community to take more effective actions in response to the warnings. This included getting help from the gauge readers, UP chairman, agricultural officers, NGO staff and DC operators and family in order to more effectively carry out their response actions. Support was provided through manual labour and by offering advice on the best actions to take. In order to respond financial resources are often required. It was found that 56% of respondents received said support from relatives and only 2% got support from the local government. Furthermore, 29% of respondents indicated that they were able to bear the costs from household savings.

However, on the other hand, the poor transportation facilitates (including a lack of boats and poor road quality), lack of manpower, lack of safe storage places, and limited access to financial support, constrained the end users ability to effectively respond to the warnings. Furthermore, it was clear that there was only limited livelihood advisory information was at the local level including information on agricultural, livestock (cattle rearing), fish culture and health, which would be useful in combination with a warning message.

Another barrier is the ”watch and wait” principle where it was found that people often did not take action until they could physically see the flood water in their neighbourhood. This is somewhat expected due to their lack of experience with flood warnings and that this is their usual way of managing the floods.

The volunteers who directly received the warnings were found to take the most response actions both for themselves and the community. This can be explained from their increased response capacity through training programs.

It was found that 72% of the respondents found the VMB warning message helped to improve their response, some indicating “*it was much better than last year*”.

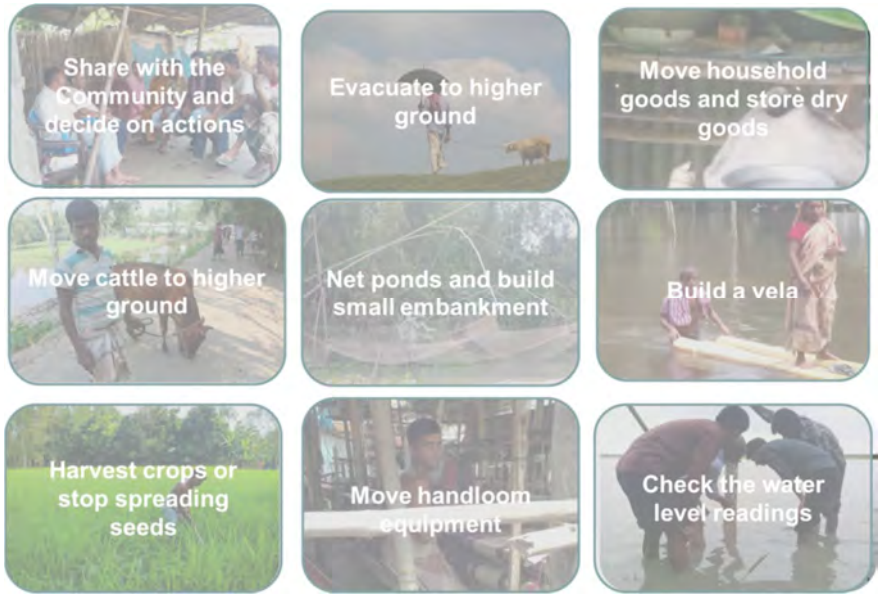


Figure 6.1 Response actions to the early warning message

Overall the community people managed to save a large amount of damages by taking these protective actions after receiving the early warning. Figure 6.2 shows that the average savings per household was the highest in the fisheries (768 USD), agriculture (640 USD) and livestock (678 USD) sectors. Annex J gives a more detailed breakdown of the savings per sector.

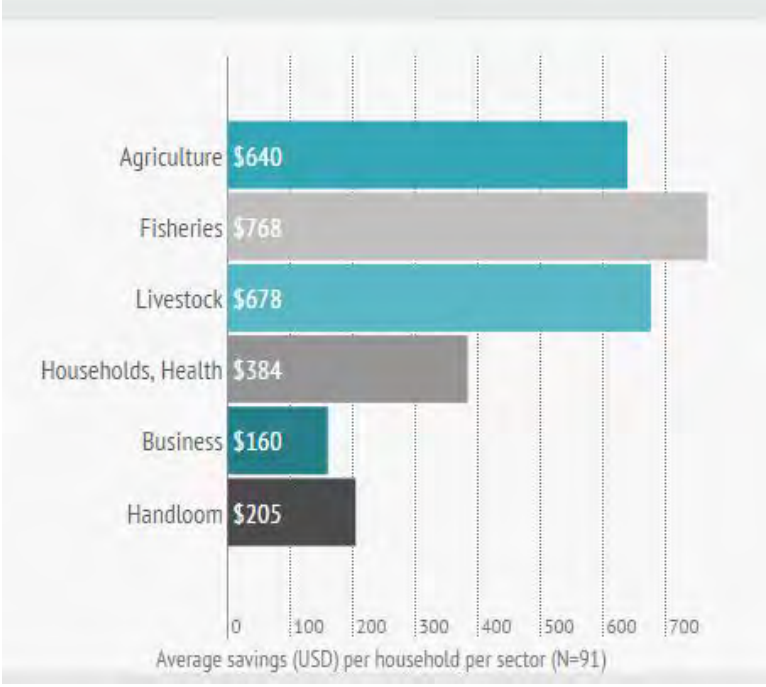


Figure 6.2 Average savings (USD) sector wise per respondents household (1BDT = 0.128USD)

The average savings per household was found to be USD 472 due to taking action in response to the warning. The total estimated number of people reached was 29,800 (5960 households). Due to a number of constraints relating to the warning message, mobile services and the community, the number of people that actually take action in response to the message is only a portion of those which receives it.

From the survey, 78% of respondents were found to respond to the warning information. However, to be conservative and take into account uncertainties, it is hereby assumed that only 25% take action (i.e. 1450 households). It is acknowledged that this could vary significantly and requires further socioeconomic analysis to estimate this accurately. This leads to an approximate estimate of the total savings in the two unions of 703,280 USD.

Furthermore, the impact of the project on the community people is evident in their testimonials provided during the evaluation in October 2014 (see below).

Abu Sayeed, Fisherman
Union: Rajapur, Upazila: Belkuchi, District: Sirajganj
Abu saved his fish hatchery worth BDT 150,000 - 200,000 BDT (1,900 – 2,500USD) from a flood. He received flood early warning from the volunteers and he netted his pond to avoid the fish being washed away with the floodwater. His preparatory action resulted in huge benefit for his fish culture.

Rajib Siddiqui, Farmer
Union: Ghorjan, Upazila: Chowhali, District: Sirajganj
Rajib saved at least 1200 kgs of rice paddy from damage by heavy rain. When he was planning to boil the paddy, observing the weather situation, he called 10941 and came to know about heavy rainfall forecast. So, he stored the grain instead of boiling it and managed to save his grains because the forecast was accurate.

Samad Miah,
Farmer
Union: Ghorjan, Upazila: Chowhali, District: Sirajganj
Saved his whole onion field. Received the weather forecast of heavy rainfall from volunteer and restrained from planting onion. After the heavy rain was over next week he prepared his land and cultivated onion which helped him to avoid substantial loss and obtain good onion production.

7 Recommendations

The following recommendations are made based on the outcomes of this project. Recommendations are targeted at the institutions, donors or others who are interested in further development of the flood early warning and in particular, the communication system in Bangladesh. It is indicated where the recommendations are linked to the planned extension of the project in 2015 which will be supported by Cordaid. The recommendations are linked to the objectives as outlined in Section 2.2, a) warning communication, b) warning message, c) warning dissemination pathway, d) end users response and e) self-sustaining business model. These recommendations were developed by combining the results of the pilot evaluation, additional bi lateral meetings and the final workshop group discussion sessions.

7.1 Warning communication

The following recommendations are made to improve the warning communication at the local level focusing particularly on the use of mobile services.

1.1 Increase the number of recipients of the VMB and volunteers: Although the project did manage to reach a considerable amount of people, it could have reached many more. Therefore it is recommended that the VMB is disseminated directly to more than 150 people per union (as was the case for this project). Although this does come with the constraints of collecting, storing and updates mobile phone numbers, it could process could be handled at the local level by the Digital Centers.

1.2 Investigate the technical constraints for VMB: the VMB cannot currently be stored on the end users devise, the possibilities for doing this should be discussed with telecom providers. Additionally, the message arrives as a regular phone number with no specified source. This should also be investigated.

1.3 Frequency and length of the message: Increase the frequency of the dissemination during the flood, increase the length and repeat certain parts of the message, and disseminate a specific times of the day.

1.4 Multiple communication means: Communities should not rely on one means of communication. Other project are investigating the use of Bulk SMS and this could be used in a complimentary way with VMS to reach the more educated members of the community while VMB can focus on the less educated members or both. Furthermore, traditional communication means including mosque miking and public meetings are very important for the last mile communication.

1.5 Utilize the media: The power of the local media should also be utilized both in the pre-monsoon phase for awareness raising e.g. TV advertisements and for warning dissemination. The possibility of using community radio can also be further assessed.

1.6 Bangla email: The official system still relies on fax which is very unreliable and slow. The penetration of smart phones among government officials is growing and efforts should be made to collect email addresses and send Bangla versions of the forecast by email. This was done in the pilot but to a very limited extent.

Recommendations 1.1 to 1.6 will be implemented in the next phase of the project.

1.7 Investigate way to make the dissemination automatic: In order to limit the need for human intervention in the dissemination system more automatic means should be installed. This could include automatic warning generation and dissemination of emails.

1.8 Two way communication: The project did not allow for the end user to call back after receiving the voice message to get further information or ask a specific question. This option should be further investigated to allow for a feedback loop.

Recommendations 1.7 and 1.8 will be investigated the next phase.

1.9 Develop a warning dissemination strategy between NGOs, DDM and FFWC (BWDB): There are a lot of efforts ongoing for warning dissemination in Bangladesh and most are project based. Together DDM and FFWC need to gather the outputs of each project and develop a strategy of their ambitions for the short, medium and long term on how to utilize the lessons learned. This could also indicate more clearly the various roles and responsibilities. This would set the path for innovation based on their combined rather than singular objectives.

Recommendation 1.9 will not be addressed in the follow up project but will be further discussed with the Bangladesh Delta Plan.

7.2 Warning content

The following recommendations are made to improve the warning message content and understanding for the local level.

2.1 Location specific inundation forecasts: Union level water level forecast information was provided as part of the pilot. This was possible because the unions were located at the main river and additional water level gauges were installed and this method can be further investigated. This project disseminated water level forecasts not potential inundation depths. This information could be represented in inundation maps and used to help local managers in the response efforts e.g. choose shelter areas. A constraint to achieving this is the capacity at the national level FFWC. Further investigations are required into how to decentralize the localization of the forecast process.

Recommendation 2.1 will be tested in the next phase by establishing the Flood information center (FIC) at the local BWDB Siragjanj office. However, this recommendation must be taken seriously at the national strategic level and will be discussed with the Bangladesh Delta Plan.

2.2 Increasing the lead time: A 5 day forecast was disseminated as part of the project but there was a 10 day probabilistic forecast available. Although this is less accurate it would give the end users much more time to prepare for the floods and reduce potential impacts but extra care must be taken when communicating this information to decision makers. Projects are currently in place supporting the extension of the lead time.

2.3 Action orientated warnings (outlook based): In order for a warning to have maximum impact it should tell the end users what to do with the information. The FFWC is constrained and not mandated or knowledgeable enough to indicate in the message what preparedness actions should be taken. To move towards an action orientated forecast the FFWC needs to

work closely with DDM to integrate potential response actions in the disseminated messages. DDM is already doing this in some cases but is not mainstreamed e.g. “hold a UDMC meeting” “discuss the situation”, “take shelter”. Furthermore, the warning could have different levels of severity and actions associated with these levels similar to what RIMES is working on for a flash flood outlook.

Recommendation 2.3 will be investigated in the next phase but strong coordination and support is required from DDM which is difficult due to their limited capacities. Policy level implications will be shared with the Bangladesh Delta Plan.

2.4 Using the SMS2DASHBOARD system to improve localized forecasts:

- Represent nonlinear relations: Expand the DASHBOARD with functionality to derive several linear regression functions for each location, in order to better represent the non-linear physics of the system, for example flooding because of embankments.
- Extend the time series: The DASHBOARD needs time series to produce a statistical relation between two locations. The minimum length of the time series needed depend on what flood dynamics are already enclosed in the time series. At this moment (2014), the time series are very short and therefore we advise only an expert to interpret the localized flood forecast. Furthermore we advise to continue measuring water levels, resulting in larger time series by which a sound statistical correlation can be computed. It is also needed to analyze the time series to investigate possible discontinuities.
- Automate water level readings: The possibility of using automatic water level gauges should be investigated. However, the limitations in terms of locating them at durable points must be carefully investigated.
- Automated SMS data collection: The FFWC is working on developing a system to collect data using SMS and storing it in a database so any further efforts in this regard should link to their developments. The dashboard could be considered as a tool for regional or community level data collection.
- Simplify for non-expert end users: The DASHBOARD can easily made more accessible for other user groups besides experts, by putting some effort in translating the graphs into understandable graphical information.

Recommendation 2.4 will be further investigated by HKV.

7.3 Warning dissemination pathway

The following recommendations are made to improve the effectiveness of the warning dissemination pathway from national to local level;

3.1 Utilise the Digital Centers: This will ensure the connection to non-disaster related information and a simple communication tool throughout the year. The role of the DC should be officially linked to warning dissemination and updated in the SOD. They have huge capacity to browse the internet and capacity to understand the more technical information and share with the community. This capacity of the DC operator should to be increased so that one is able to record and disseminate voice messages upon demand. Such a VMB dissemination service can be offered to the union chairman or agricultural officer for example wants to send a message to 200 farmers, he can pay the DC operator with a small fee.

Recommendation 3.1.will be tested in the next phase of the project.

3.2 Utilise the existing DDM and DMIC networks: The official DDM system is in place at all levels in Bangladesh and the DMICs are expected to act as a great resource in the coming years so these must be integrated with projects on warning dissemination and response. These should assist in decentralising the dissemination process although currently these centres lack the capacity to do so.

Recommendation 3.2 is a strategic policy level recommendation that will be shared with the Bangladesh Delta Plan.

3.3 Local BWBD offices: These offices are currently only involved in data collection and are not trained in forecasting. If their capacity is built they could play a role in decentralising the forecasting process making it more localised.

Recommendation 3.3, the next phase of the project will attempt to do this by implementing a Flood Information Centre at this local BWDB office. This is linked to recommendation 2.1.

3.4 Utilise any other existing local social networks and projects: These communities have a huge network that vary from area to area. All of these must be activated and made aware of the importance of warning information and dissemination. Further integration with NGO projects at the community level must also be accomplished e.g. Bangladesh Disaster Preparedness Centre, CMPD and Ansar VDP project, DIPECHO project.

Recommendation 3.4 will be done in the upcoming phase by linking to the DIPECHO program.

3.5 Disseminate to the private sector: The private sector companies have huge networks at the local level in Bangladesh and could be greatly utilized for assisting in warning dissemination.

Recommendation 3.5 will be tested in the next phase of the project.

3.6 Strengthen the human capacity at FFWC and DDM: These organisations struggle to manage in the monsoon season and it is not surprising that they cannot perform effectively in their warning dissemination activities. Additional staff is required to specifically manage the dissemination activities in both organisations. As these are governmental organisations, it is

very difficult to influence this issue of capacity on a project basis; this requires commitment from the government.

Recommendation 3.6 will be discussed with the Bangladesh Delta Plan.

7.4 End users warning response

The following recommendations are made to improve the end users response capabilities at the local level;

4.1 Increasing awareness at the community level: Although communities are familiar with living with floods they are not familiar with receiving and using warning information especially not through VMB. Considerable attention must be placed on this component for any project to have the desired impact at the community level. This must be done for national level (non-project based) information sources too especially the FFWCs website and the IVR service from DDM.

The next phase aims to work closely with DDM and FFWC to address Recommendation 4.1.

4.2 Provide additional support services: In the face of floods these communities lack sufficient financial help, medical services, security protection and shelters. Additionally the community infrastructure requires improvement including embankments and roads. These elements are much more difficult to tackle as part of a project as they are related to the inherent characteristics of the community. However, the provision of improved response materials at the NGO office will be provided next year.

Recommendation 4.2 is targeted at NGOs and will be addressed in phase 2.

4.3 Provide additional information to help interpret warnings: The warning messages do not need to include all the information about the options for responding, however, there should be a place at the local level where further information can be found. For example information on the availability of seeds, market price for cattle and crops, availability of vaccinations and location of safe storage areas. The next phase aims to provide a means to connect to all available information sources rather than developing new ones.

4.4 Link to non-disaster information: A system is required that can communicate all types of risk and livelihood information to the community level in a timely manner e.g. elections, dangers, weather etc. this will keep the system running through the year and make it easier to activate in a disaster.

Elements of recommendation 4.3 and 4.4 will be integrated in the next phase.

4.5 Utilise fun gaming techniques: It is important that the communities are reminded about the availability of warning messages before the monsoon period. A fun way to do this is by playing early warning games. These have been developed by the Red Cross Climate Cente.

These games will be used in the next phase as part of the capacity building exercises.

7.5 Public-Private Partnerships and Social Business Models for financial sustainability

The following recommendations are made to the financial sustainability of the project;

5.1 Bridge the funding gap by cost sharing
In order to cover the funding gap for a localised early warning system a division of total life cycle costs between to be covered by national and local actors is needed. Total capital investments are estimated in USD 2,5 million, and Operation and Maintenance costs USD 2 million per year. The cost sharing arrangement we propose is as follows: National government budgets (through FFWC/BWDB and DDM) should ideally cover all the necessary capital investments (USD 2,5 million) and the share of Operational and Maintenance costs that concerns the national level activities involved in detection, data collection and forecasting (USD230,000 per year). At union level contributions of the community users, local government, and/or NGO's should cover the Operation and Maintenance costs elements concerning (local) dissemination and response, as well as the local activities involved in data collection (USD 1,8 million per year for all 1502 flood prone Unions or around USD 1,200 per year per Union).

5.2 Combine a national PPP with a Union Level social business model
The Public-Private Partnership main goal is the removal of systemic barriers for effective response (e.g. weak linkages between agents in the productive value chains). The business model at the Union level aims at generating additional cash flows that cover at least partially, the operation and maintenance costs of the de-central elements of the improved EWS system. Together these two elements create the incentives at national and local level for an effective and sustainable Early Warning System.

5.3 Develop a social business model for knowledge entrepreneurs – at Union Level:
This would generate enough profit so as to cover the O&M expenses per year at the union level. It is recommended that this is linked to the existing local service providers already operating within communities.

5.4 Operationalize a national Public Private Partnership for resilient agricultural value chains
Public and private sector strengths and their synergy should be exploited to ensure the financial sustainability in the provision of EWS services and improve their effectiveness in reducing the losses of lives and livelihood. This can include using risk sharing arrangements between large agricultural companies and local actors, internal insurance schemes offered by companies to their contract growers, value-chain analysis, and portfolio management. A system that combines Early Warning functions (for a variety of weather related hazards) with frequent weather related data and satellite data for crop information services seem like a win-win situation for public and private parties. The combination of the public function of disaster warning with the private function of "customized" advise for different productive activities, is expected to set in motion a reinforcing loop that will ensure its longer term financial and institutional sustainability.

5.5 Concentrate development cooperation efforts and enhance synergies between projects
Concentrated development cooperation efforts such as climate financing, will allow for the necessary capital investments needed in the pre-start-up phase at the national and the union level. In order to tackle the combination of a variety of projects investing in early warning

related activities; like this project and Satellite Data for Crops, exploiting the synergies of Dutch programs with the programs of other donors active in Bangladesh is recommended.

Recommendations 3 and 4 will be further investigated as part of the second phase the project and through collaboration with the Dutch Embassy in Dhaka and RVO through different projects and programs, such as the Satellite Data for Crops.

8 Project extension phase II with Cordaid

As indicated in the recommendations, a number of these will be addressed in the upcoming phase II of the project, supported by Cordaid. The next phase wants to move away from focusing only on early warning to taking a risk-based approach. The first component of the people centred early warning system is risk knowledge (figure 2.1). In 2014 the project focused predominately on the communication and dissemination component but also on monitoring and warning, and response capabilities. In 2015, the project will look deeper into the risk knowledge component which can form the underlying information (including exposure and vulnerability data) that is very useful to compliment and interpret forecast information for the local level.

Four objectives have been formulated to achieve these goals which are centred around a framework for a "People Centred Interactive Risk and Livelihood Information Gateway" consisting of four components; risk and livelihood knowledge hub; real-time monitoring and warning service; communication and dissemination system and enhanced response capabilities, see figure 8.1.

1. **Build capacity** at different levels (national, regional and local)
2. Increase the **availability of information** to communities and private sector
3. **Increase accessibility** to information for communities and private sector
4. Ensure **action orientated use** of information

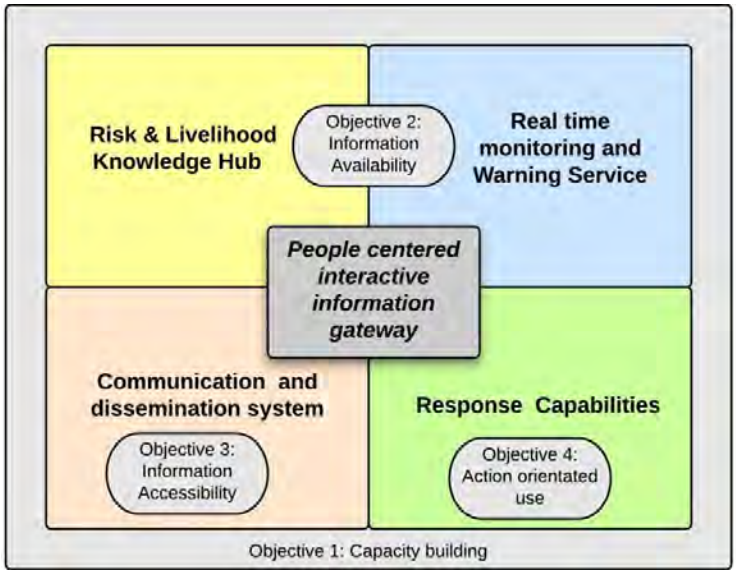


Figure 8.1 Overall framework for phase II to create a people centred interactive information gateway.

What is the information gateway?
It plans to be an online interactive web portal including a communication module using mobile services that will be made available at the Digital Centre at the Union Parishad and Flood Information Centre of BWDB, at district level. By utilising the Digital Center entrepreneur and Flood Information Center operators it is working towards decentralising tasks on early warning preparation and dissemination. To compliment this digital information, a human knowledge network will be developed of trained volunteers. It will contain a gateway to the most important data sources and services (such as hotlines or online platforms) on hazards, risk and the mitigation thereof via an easy to understand intuitive interface. This can create an informal way to increase interaction between the union and its people and their accessibility to risk and livelihood based information.

Table 8.1 Activites for Phase II of the project in 2015 linked to the interactive information gateway

Risk and Livelihood Knowledge Hub	Real time monitoring and warning service
• Knowledge hub at the Digital Center through a geo-portal with links to other available information sources e.g. online Q&A database, call centers. • Collect local data on exposure and vulnerability using OSM and connect to the open sharing platform GeoNode. • Supplemented with personal knowledge hubs. • Community Risk Assessment (CRA) data digitally and interactively available at union level. • Other hazard information including weather information and public advisory bulletins.	• The Flood Information Center (FIC), BWDB will store all WL data and rainfall (real time and historic) in a database at FIC. • BWDB local staff at the FIC will prepare the localised forecast based on the most recent water level gauge recordings for access by the Digital Centers. • Real time inundation mapping. • FIC links its information to the Digital Centers. • Data collection by gauge readers on water levels and disaster impacts e.g. inundation depths, damages.
Communication and dissemination system	**Response capabilities**
• Install a voice message broadcast system at the Digital Centre for multi-use e.g. disasters, violence, livelihoods, health. • Groups of lists of important mobile phone numbers and emails (incl. private sector) • Websites, Media, brochures & advertisements for cable TV • Flood Information Boards at DC and FICs	• Capacity Building for local resilience - DRR training activities for, gauge readers, volunteers and community, mock drills. • Investigate potential of serious gaming – climate games. • Further develop local knowledgeable people to share risk information and mitigation options. • Continue developing awareness raising activities at the local level supported by national level initiatives. • Provide emergency response support.
Financial Sustainability	
• Engaging the private sector in early warning communication and response - focus on local businesses e.g. for milk and seed companies. • Investigate having charges at the local level for example the most to date 3hourly water level readings from BWBD and having the Digital Center entrepreneur charge for disseminating the Voice Messages to the community e.g. Union Chairman, seed companies, milk companies, producer groups – local businesses. • Develop a system that is useful all year round and not only for early warning during the monsoon. • Potential up scaling of these operations at DC and FIC upstream in the Jamuna.	

This phase will run from January 2015 to December 2015. The project will continue working with Concern Universal to lead the community level implementation, Deltares for international technical support and RIMES for local support to the FFWC. TNO will also be part of the project because of their involvement with the TamTam project in 2014 and offer both technical and innovation management support.

For further information on the next phase contact Marlou Geurts, Cordaid marlou.geurts@cordaid.nl (overall program coordinator), Wahida Bashar Ahmed, CUB wahida.bashar@concern-universal.org (coordinator in Bangladesh), Lydia Cumiskey, Deltares lydia.cumiskey@deltares and Marc van den Homberg, TNO, marc.vandenhomberg@tno.nl.

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2. Annexes

A. Field level evaluation – Semi structured interview questionnaire

B. Field level evaluation – Focus Group discussion checklist

C. Governmental Workshop – Evaluation form

D. Governmental Workshop Summarised Results

E. Further details on the respondents in the pilot evaluation

F. Final workshop report

G. Facts and figures 2014 flood

H. Manual SMS2DASHBOARD

I. List of Protective Actions

J. Savings and protective actions taken per sector

A. Field level evaluation – Semi structured interview questionnaire

Questionnaire No.

Field Visit Sirajgang 2014 – Evaluation "Mobile Services for Flood Early Warning" Project
Questionnaire Survey September/ October 2014

Name of the respondent: _____ M ( )/ F ( )
Age or range: _____
Receipt of Voice SMS (circle the correct one): Direct Indirect Not received Mix
Upazila: _____Union: _____ Ward _____ Date: _____
Mobile ☐☐☐☐☐☐☐☐☐☐☐ Organization (*if any*): _____
GPS coordinates _____ Occupation _____
Education Level _____ Monthly Income _____
Land Ownership (area) _____

Part A: Community characteristics

1. Please identify what kind of **damage** you experienced during the 2014 floods? (circle)

   1 - Household
   2 - Livelihood
   3 - Crop/Catch/Production
   4 - Unemployment
   5 - Education
   6 - Health
   7 - other _____

2. Please identify how much (BDT) these damages cost you? _____
3. What was the maximum water depth (cm) during the floods in 2014 (cm)? _____
4. Date of inundation started? _____
5. Date inundation peak? _____
6. What was the duration of the floods in 2014 (days)? _____
7. Are you aware of the following institutions (circle those that apply)?

   FFWC, (=1)
   BWDB (=2)
   UISC (=3)
   BMD (=4)

Part B: Early Warning Characteristics

1. Did you **receive** a warning message from each of the four sources? (circle those that apply)
   1 = Project intervention
   2 = Government formal warning
   3. Indigenous knowledge (informal warning)
   4. Media

2. Through what **communication medium** did you receive information from these sources for the listed sources in B1? Please refer to last question e.g. 1a, 1b (add line connecting them)

1 = Project intervention 2 = Government formal warning 3. Indigenous knowledge (informal warning) 4. Media	a = voice SMS b = mosque miking c = TV and radio d = volunteers e = community people by talking f = community people by phone

3. Which information source and communication mode is most useful? (based on previous answer)

   _____

4. What is your perceived level of accuracy of the early warning information you received from the most useful source? (circle)

   1=100% 2=75% 3=50% 4=25% 5=0%

5. In what order did you receive information from the sources/ channels mentioned in question B.2? Add 1 for the first, 2 for second etc. for those that apply.

Project Intervention (voice SMS)	Government formal warning	Indigenous knowledge	Media

6. What is the time lag between you and the source according to the fastest source identified in B.5?

   _____ (in hours)

7. What information did you gather from the most useful source?
   1=Timing 2=Intensity 3=Duration 4=how to respond

8. Did you receive any advice for flood response activity? Yes or No (circle)
9. From who? _____

10. Are you aware of the installation of the **water level gauges**? Yes or No

11. Do you think they are important for your community? Yes or No

12. Did you use them during the flood? Yes or No

13. How much time (**lead time**) did you have to take action before the floods were expected to arrive? _____(hours)

14. How frequently did you receive the warnings from each source?

    1 = Project intervention _____
    2 = Government formal warning _____
    3. Indigenous knowledge (informal warning) _____
    4. Media _____

15. What is your preferred frequency of information to enable you to take actions?
    _____

Part C: Mobile Services Characteristics – Voice SMS

1. How familiar are you with Voice SMS?

   1=high 2=medium 3 = low

2. Was the message length ok? How could it be improved?
   _____

3. How did the mobile phone infrastructure preform during the floods? Did you experience any problems?

   _____

4. Would you be willing to pay for receiving such a message in the future? Or how do you think such messages could be financed?

   _____

Part D: Response and Benefits of early warning

1. How much did you understand the information in the message from the most useful source identified in B1?

   1=100% 2=75% 3=50% 4=25% 5=0%

2. How did you perceive the seriousness of the floods upon receipt of the information?

   Not serious = 1 potentially serious = 2 3=serious 4= very serious

3. How useful did you think the information was when you first received it from the most useful source?

   Not useful = 1 potentially useful= 2 3=useful 4= very useful

4. What is your level of trust from the information from the most useful source?

   1=100% (very high) 2=75% (high) 3=50% (medium) 4=25% (low) 5=0% (no trust)

5. Did you talk to someone about the information from the different sources received to check it? Yes or No

6. How many people did you share the information with once you received it from the given source?

   _____

7. On what frequency do you share early warning information with others? *(Please use ✓ in one box only*).

Never	If anyone shows interest then only	In case of own household's need only	Depending on the perceived severity of the hazard	In case of panic situation only	Share all the time as and when information is Received

8. What actions did you take in response to the early warning information?
   (see further list of actions – Annex 1 per sector)

☐ Do noting
☐ Move to safer locations
☐ Organize/arrange household and livelihoods assets/crops
☐ Wait for external assistance
☐ Discus and validate information from the community (haat/bazaar etc.)
☐ Discus and validate information from the family and friends
☐ Discuss things within the household
☐ Check information with the UP representatives

Others (please specify per sector)_____

9. Who decides to take these actions? Is it an individual or group decision i.e. who takes on the risk? What other stakeholders are involved? Public/Private

_____

10. Did you use combinations of information sources in order to make a decision? Yes or No
    If yes, which ones?

    _____

11. Please indicate in what situation your household/ individual reacts to the early warning? *(Please use ✓ in one box only)*

When someone dies in the community	When people observe some damage in property	When hazard arrives in the area	In case of panic situation only/officials put enforcement	When the information is widely spread in community	Whenever early warning is heard

12. What did you save because of taking these actions (based on the voice SMS)?

    1 = Household
    2= Livelihood
    3= Crop/Catch/Production

4=Unemployment
5= Education
6 = Health
7= other _____

13. How much (in BDT) of your combined assets did you save because of taking these actions (based on the voice SMS)?

    _____

14. Did the Voice SMS help improve your response? Yes/No

15. Did you consider the costs and benefits of taking these actions? Yes or No

    If yes, please explain _____

    _____

16. Were you able to bear the cost of response activities from household savings? Yes or no

17. Do you have access to financial support from the following sources?

    (a) Relatives (b) government (c) NGO

18. What factors in your situation/ social environment helped you to take these actions?
    1 = social network, 2 = family, 3 = volunteers, 4 = gauge readers, 5 = UISC, 6 = UP chairman
    _____

19. What factors in your situation/ social environment constrained you to take these response actions?
    _____

Part E: Further improvements

1. What can be done (suggestions) to improve further or strengthen the EW system in your community?
   1)……..
   2)……..
   3)……..

2. What do you suggest for sustainability (and initiatives can be taken) of the EW system at community level?
   1)……..
   2)……..
   3)……..

3. What other information needs/ gaps are present at the community level?
   1)……..
   2)……..
   3)……..

4. How do you think the information gaps can be improved?
   _____

5. Explain the concept of a UISC or CISC - what do they think - is this a good option for information sharing?
   1)……..
   2)……..
   3)……..

6. What do you think about having Flood information boards in your community?

   1)……..
   2)……..
   3)……..

7. Awareness raising activities – how can we improve these? Do you know about 10941?
   _____

B. Field level evaluation – Focus Group discussion checklist

Questionnaire No.

Field Visit Siragjong 2014 – Evaluation "Mobile Services for Flood Early Warning" Project
Focus Group Discussion (FGD), September/ October 2014
Note: Fill in participant list

Type of FGD: _____ M ( )/ F ( )
Age or range: _____
Receipt of Voice SMS (circle the correct one): Direct Indirect Not received Mix
Upazila: _____Union: _____ Ward _____ Date: _____
Mobile ☐☐☐☐☐☐☐☐☐☐☐ Organization (*if any*): _____
GPS coordinates _____ Occupation _____
Education Level _____ Monthly Income _____
Land Ownership (area) _____

1. What kind of **damage** you experienced during the 2014 floods and cost? (circle)

   _____

2. What was the maximum water depth (cm) during the floods in 2014 (cm)? _____

   Date of inundation started? _____

   Date inundation peak? _____

   Duration of the floods in 2014 (days)? _____

3. Are you aware of the following institutions (circle those that apply)? (add number)

   FFWC, (=1) BWDB (=2) UISC (=3) BMD (=4)

4. What sources did you receive warning messages from (add number)?
   1 = Project intervention 2 = Government formal warning 3. Indigenous knowledge
   4. Media

5. Through what **communication medium** did you receive information from these sources?
   _____

6. Most useful source _____ medium (communication mode) _____

7. **Water level gauges**
   _____

8. **Voice SMS** - actual and preferred
   a. Frequency _____

b. Message content (lead time, duration, intensity)
_____
c. Message length/size _____
d. Understanding _____
e. Seriousness _____
f. Trust _____
g. Accuracy _____
h. Willing to pay (BDT) _____

9. Response

i. Sharing
_____
j. Actions
   i. _____
   ii. _____
   iii. _____
k. When do you take these actions
_____
l. Decisions to take actions (individual or group – who pays)
_____

10. Benefits (Tangible or intangible)
   i. _____
   ii. _____
   iii. _____

11. Facilitators for response activities
   i. _____
   ii. _____
   iii. _____

12. Constraints for response activities
   ii. _____
   iii. _____
   iv. _____

13. Suggestions for further improvement, sustainability, filling gaps
   i. _____
   ii. _____
   iii. _____

14. Comments on UISC, CISC, Flood Information Board
   i. _____
   ii. _____
   iii. _____

C. Governmental Workshop – Evaluation form

WORKSHOP QUESTIONAIRE FILL IN SHEET
"Mobile Services for Flood Early Warning" Project
15th October

Name: _____ M ( )/ F ( )
Upazila: _____ Union: _____ Ward _____
Mobile | | | | | | | | | | | |
Organization (*if any*): _____ Occupation _____

Part A: Regular dissemination system (without project intervention)

1. Do you receive flood warning information (e.g. during the 2014 floods)? [ ] yes [ ] No
   Source of the information: _____
   Communication medium: _____

2. Do you disseminate the flood warning info to others? [ ] yes [ ] No

3. If yes, mention name of organizations receiving food early warning from you:

Name of receiver	Type of organization/ affiliation/ role	Media of communication

4. Do you use early warnings in your organizational activities? [ ] yes [ ] No

5. If yes, mention activities where flood early warning is used:

   i. _____
   ii. _____
   iii. _____

6. Do you have any legal and institutional set up for receiving / disseminating early warning?
   [ ] yes [ ] No If yes, give following information.

   (a) Legal obligations: _____
   (b) Annual budget for flood early warning activities related to early warning: _____

7. Constraints for receiving flood warning information

Constraints for receiving	Constraints for disseminating

8. Suggestions for further improvement, sustainability, filling gaps
   iv. _____
   v. _____
   vi. _____

Part B: Voice Message Broadcast (Project intervention)

Todays situation (sent on the 15th of October))

Welcome to the Flood Forecasting & Warning Center of Bangladesh Water Development Board. Today is Wednesday, 15th October 2014; As per today's observation at 6 AM, Jamuna river at Sirajganj is flowing 3m below danger level. According to today's flood forecast water will continue to decrease in Jamuna river at Rajapur union of Belkuchi & Ghorjan union of Chowhali for next five days. This message is disseminated as a demo to get you introduced with the voice message service. Thanks.

Example of a SERIOUS situation (sent on the 15th of August)

"Welcome to the FFWC of BWDB. Today Friday 15th August 2014. As per the observations of 6 AM this morning Jamuna river at Sirajgnaj is flowing 30 cm below Danger Level. According to the latest flood forecast water may rise 22 centimeters in Ghorjan union, Chowhali upazila & 29 centimeters in Rajapur union, Belkuchi upazila in next 5 days."

9. Did you receive the Voice Message Broadcast (during the mock)? [ ] yes [ ] No
10. What did the message tell you (in your own words)?

    _____

11. Did you understand the information (circle)? 1= Yes 2= Most of it 3= not at all
12. How accurate do you think the information is? 1 = Very accurate 2 = Accurate 3 = Not accurate

13. Would you trust this type of information? [ ] yes [ ] No; Why? _____

14. How frequently would you like to get this information?

Before the flood	During the flood	After the flood

15. What would you do with this information if it represented a serious situation (see the second example)
    iv. _____
    v. _____
    vi. _____
    vii. _____

16. How would you confirm the information? Would you need to call the number back to confirm?

    _____

17. Who would you share the information with and through what communication medium?

Name of receiver	Type of organization/ affiliation/ role	Medium for communication

18. What were the positive and negative features about the message and the Voice SMS?

Positive	**Negative**	**Improvements**

19. How do you think this intervention would help the distribution of information among government officials?

    _____

20. How do you think such communication could be financed?

    _____

    Would government organisation be willing to pay? [ ] yes [ ] No; How much? _____

    Should the community pay themselves for the message? [ ] yes [ ] No; How much? _____

21. Do you think the Union Information Service Center and Char Information Center can play a larger role in warning dissemination? Explain your reasoning.

    _____

    _____
    _

THANK YOU

D. Governmental Workshop Sirajganj Summarised Results

Recommendations Date: 15th October 2014

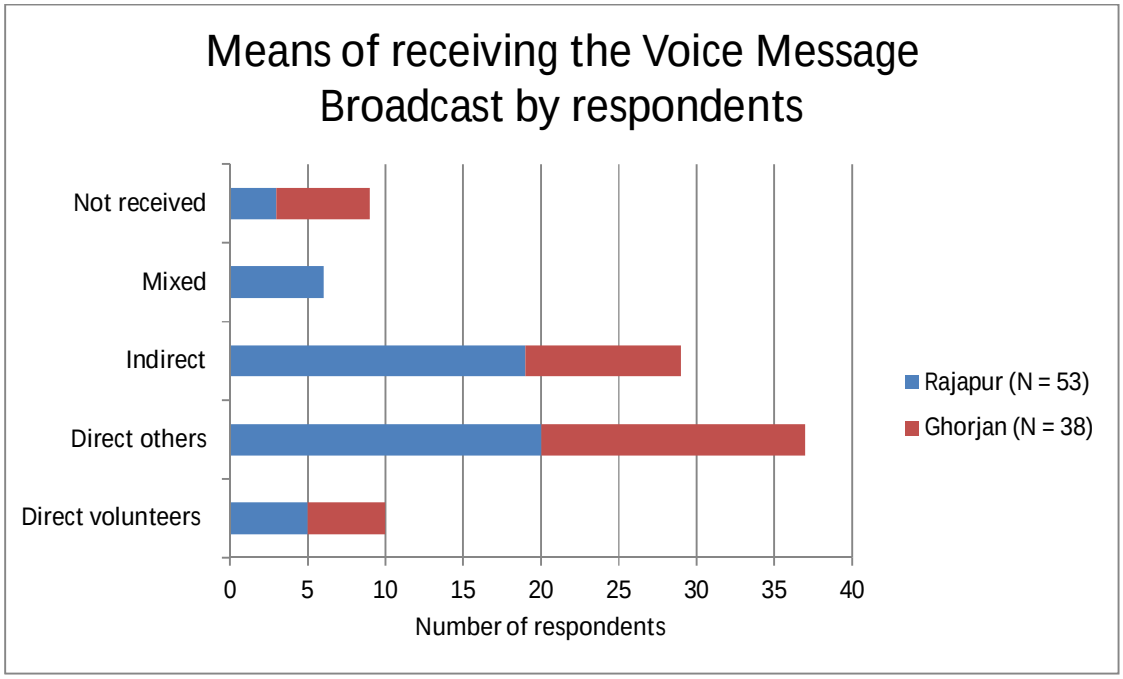
- **Flood Pillars:** Danger level should be displayed in open space (market, school, club, hospital, and mosque) with symbol like red, yellow or green colour-red for danger, yellow for water increasing and green for normal situation. If the water flowing above the 1ft high then red colour would be 1 ft for easy understanding to the community because they can't measure the cm or inch, ft. Need to identify permanent feature so that comparison of inundation can be easier
- **Message content should be village location specific (inundation area):** Should mention the zone-that, that village or union will be inundated within 5 days if water cross above X cm of the danger level.
- **Separate VMB messages per union:** Upazila or union wise separate VMB can be delivered i.e. Belkuchi of Rajapur union or Chowhali of Ghorjan union not combined as it was this year.
- **Increase the recipients for the Voice Message Broadcast (VMB) of government officials at District, Upazila and Union level:** Include the relevant stakeholders like department of agriculture, livestock, education, fishery, forestry, health, public health others for mass covering.
- **Increase the recipients for the Voice Message Broadcast (VMB) of key community people:** Involve mosque Imam and mike, school teachers for dissemination warning message, and ward committee, union committee should be involved. Union chairman recommends that the school teachers take the lead in dissemination.
- **Message frequency:** Warning message should be given 2-5 times in a day. Increase frequency of sending, so that if one person misses one call they can receive it a 2nd time.
- **Repeat the message:** If on the 1st time the receiver not able to understand the content, 2nd time he/she will listen more carefully and able to understand clearly
- **Message dissemination time:** Voice SMS should disseminate in particular time so that people can memorize (should deliver before/after Muslim prayer time) in a day should be disseminated
- **UISC key point for dissemination:** UISC should be considered as center point for dissemination voice SMS to the mass community
- **Investigate the use of smart phone:** Recommendation from Deputy Commissioner,
- **Awareness raising**: Should organize series of pre monsoon awareness raising session for DDMCs, UzDMCs, UDMCs and UISCs.
- **Local communication means**: Further use of the loud speakers and mosque miking, disseminate cluster wise (para moholla), and conduct a pre-monsoon meeting with the community.

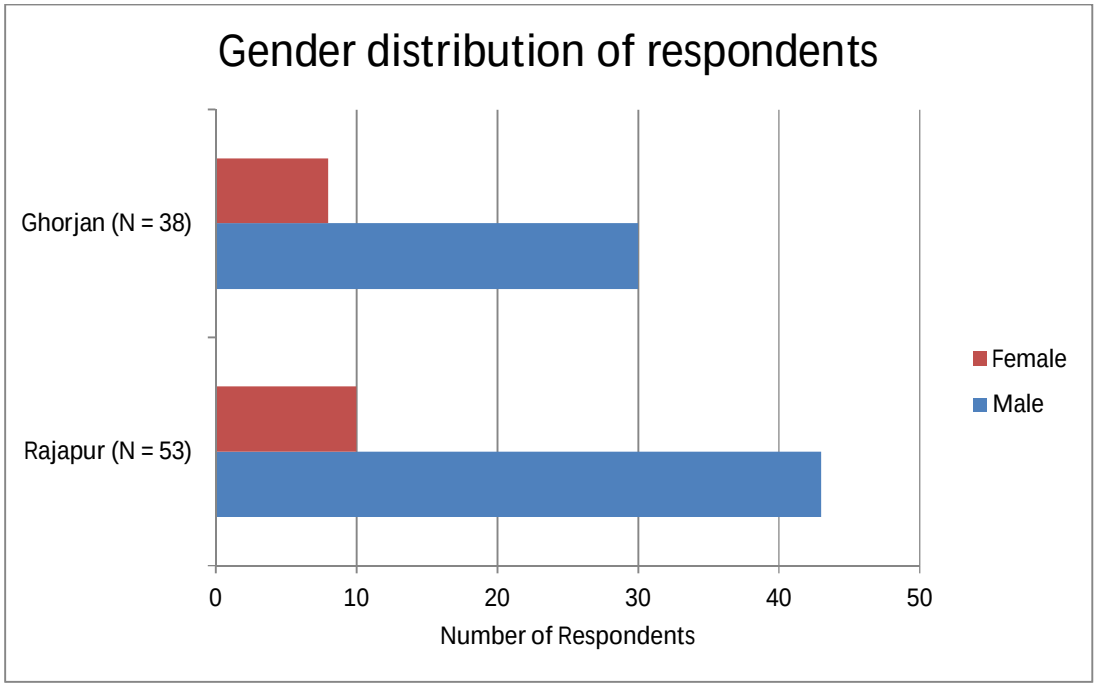
Benefits and importance of the flood warning in 2014 (project interventions)
"We saved properties, crop and cattle" (Secretary Gorjan Union)
"When the warning was announced at community-village level, shifted the children, women, pregnant elderly people" (Secretary Gorjan Union).
"Mobile voice based flood early warning dissemination is essential for better disaster management" (DC Sirajganj).
"I believe this system would be very useful for our clients" (Upazila Agriculture Officer).
"Excellent programme" (DTO, DAE)

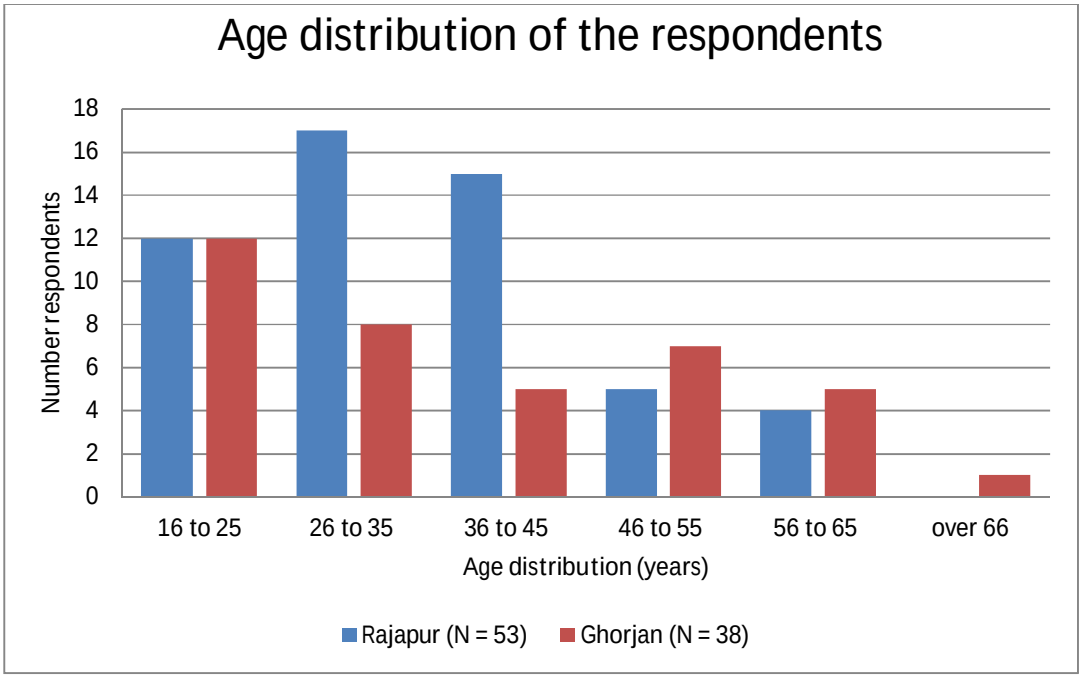
Questionnaire Results

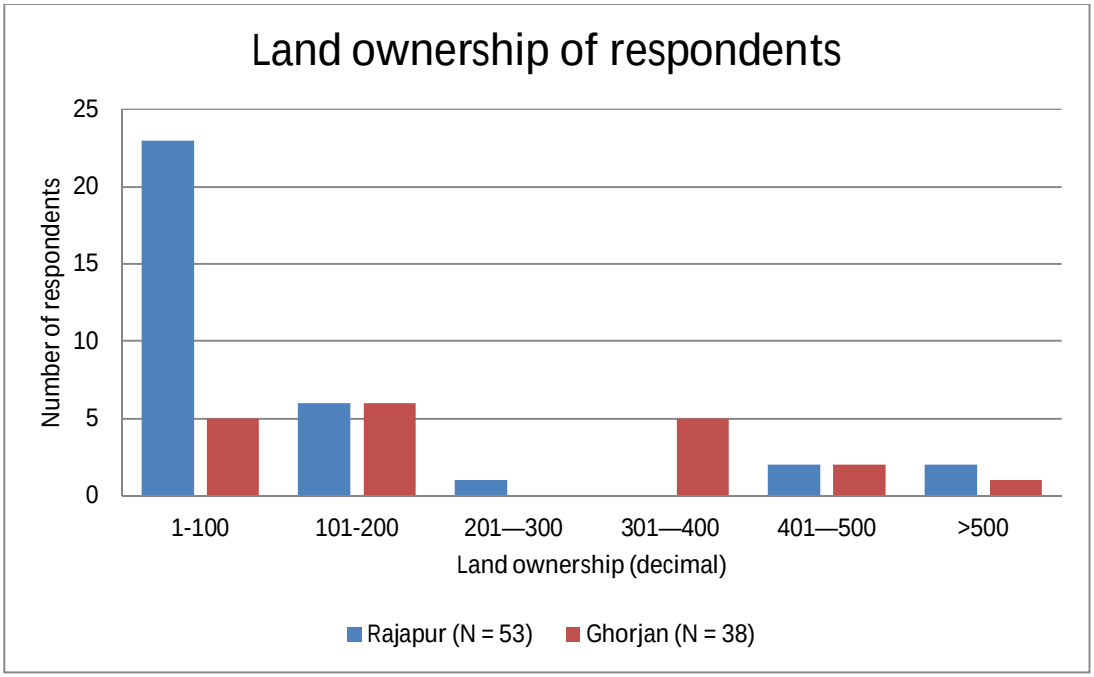
Organisation/ Designation	Existing early warning system	Project intervention – voice message broadcast
Civil Surgeon Office, Medical Officer	• He receives flood warning information from BWDB/FFWC through radio, TV and newspaper	• Understood, trusted the message • Useful for saving life and health and help coordination among government officials. • Action: Further disseminate • Recommendation: Increase number of recipients
Union Parishad Secretary	• He received warning through the project	• Action: Disseminate to UP members, village police, aware the community people using mosque mike • Benefits: Farmers, students & schools • Recommendation: improve quality and quantity of the message, utilise UISC
Project Implementation Officer	• Received through project intervention	• Action: Disseminate to UzDMC members and held a meeting and confirm with the FFWC. • Recommendations: Increase the number of messages and make it longer. Provide area wise message. Utilise UISC.
Upazila Education Officer	• Not received	• Usefulness: for all schools, head teachers and assistant teachers and students.
Upazila Agricultural Officer	• Received information through BWDB/FFWC by mobile phone and disseminated it through farmers Integrated Crop Management and Integrated Firm management component (ICM/IFMC) club through mobile phone	• Understandable, trustworthy • Recommendations: More specific and less scientific. • Increase frequency: every 2 hours during and every day after the floods. Centimetres are not so understandable.
Dept. of Agriculture, District Training Officer	• Received through BWDB/FFWC by phone • Activities: rice transplantation, seedbed preparation and vegetable cultivation • Constraints: Lack of a communication channel and institution for warning dissemination	• Understandable, trustworthy • Recommendations: Fix the time, increase length, make specific to an area, and increase the number of elite people and leaders that receive the message. • Willing to pay • Use the UISC
DAE, Deputy Director	• Not received	• Action: disseminate to DAE officials by mobile/telephone and in person • Recommendations: Published at mosques and hat bazars, according to the seriousness of the situation the number of messages can change (1 – 6 times per day) • Compare the upcoming situation to the previous situation
DLS, Upazila Livestock officer	• Received from FFWC/BWDB on printed and electronic media but did not use it for any activities or disseminate it further.	• Understood and trusted • Recommendations: Increase number of receivers
BWBD	• Received from FFWC internet and email but not further disseminated.	• Recommendations: use loud speaker, local leaders, religious leaders, teacher ,union members, Ansar VDP, gram police to further disseminate the message
Deputy Commissioner	• Not received • Activities would be to attend pre-disaster preparation meeting and work with district admins on relief programme	• Actions: send the information to their flood control room at district level
Directorate of Livestock services	• Received from BWDB/FFWC through media and TV but did not use it	• Understood, high accuracy and trust • Action: mass disseminate to the people, and local government dept. • Recommendation: expand the number of people, utilise the UISC

E. Further details on the respondents in the pilot evaluation






Age distribution of the respondents
Number respondents
18
16
14
12
10
8
6
4
2
0
16 to 25
26 to 35
36 to 45
46 to 55
56 to 65
over 66
Age distribution (years)
Rajapur (N = 53)
Ghorjan (N = 38)


Land ownership of respondents
Number of respondents
25
20
15
10
5
0
1-100
101-200
201—300
301—400
401—500
>500
Land ownership (decimal)
Rajapur (N = 53)
Ghorjan (N = 38)

F. Final workshop report

See attached document

G. Facts and figures 2014 flood event

Floods of 2014 were mainly characterised by flooding in the Brahmaputra basin. The peak flooding was recorded on 28th August 2014 when 19 stations all over the country were flowing over the danger level with all the stations along the Brahmaputra-Jamuna and Padma were flowing respective danger levels. Maximum flooding was at Sariakandi of Bogra district where peak water level was 99 cm above danger level on 29th August. Embankment breaching in that area worsen the situation. The duration of flood was more or less 12 days on an average over different river stations in the Brahmaputra basin. In the Ganges basin the flooding was maximum at Goalondo point where the Ganges was flowing 27 cm above danger level on 31st August 2014. Overall flooding in the Ganges basin was less prolonged and the duration varied from 8-10 days at different river stations. Flooding in 2014 was less severe than flood 2012 but more severe than flood 2013 both in terms of duration and intensity. However, area inundated (25% tentative calculation by FFWC) was highest in last seven years after flood 2007. The flooding was less severe than 2012 and the water receded rapidly as because there was no peak synchronization (Figure 1 between Jamuna and Ganges rather when Jamuna at Bahadurabad station reached the peak, Ganges was already following a receding trend. For example the hydrograph of 2014 flood at Bahadurabad and Sirajganj are shown in Figure 2 and Figure 3. Duration was short in the north (along the Brahmaputra-Jamuna River) and short to moderate in the part of north east. Duration of flooding in the central part (along the Padma river) was moderate. Duration of flooding in the south west, in the part of Satkhira and Khulna districts was prolong, due to slow drainage or very low carrying capacity of rivers. Overall, the monsoon 2014 was a above normal flood year but not severe.

The main and major characteristics of 2014 flood are the sharp rise in water level at different stages of monsoon. Out of the 13 important Water Level (WL) monitoring stations in the Brahmaputra basin, at 8 stations river WL was crossed their respective Danger Levels (DL), these are Kurigram on Dharla for 4 days, Dalia on Teesta for 13 days and Bahadurabad on Jamuna river for 19 days and Serajgonj on Jamuna for 16 days, Aricha on Jamuna for 15 days, Sariakandi on Jamuna for 15 days and Gaibandha on Ghagot river for 14 days from mid of August to the 1st week of September. As a result, low-lying areas of Kurigram, Lalminiorhat, Gaibandha, Bogra, Rangpur, Serajgonj, Tangail, Jamalpur and Narayangonj districts were flooded for short period. Height of flooding in the Brahmaputra river from Noonkhawa to Bahadurabad and Jamuneswari at Badargonj at the end of June was not like the major flooding pattern. The flood characteristics of 2014 flood are summarized in **Table 1**. The 10-day medium range forecast is able to track the peaks of well ahead and the information is disseminated through FFWC to different stakeholders **Figure 4** shows the detection of flood water level on August 19 by CFAB model 7 days ahead.

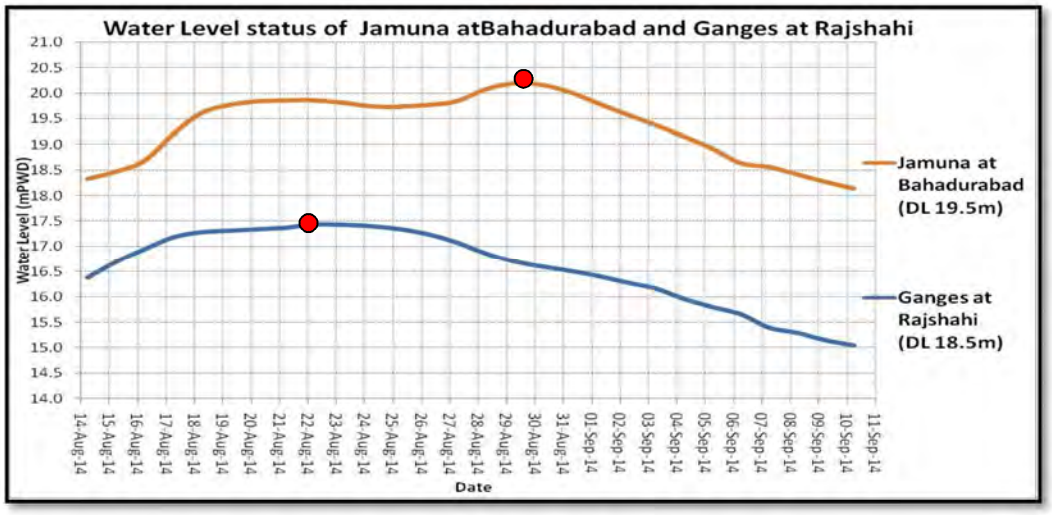


Figure 1 No peak synchronization in Flood 2014

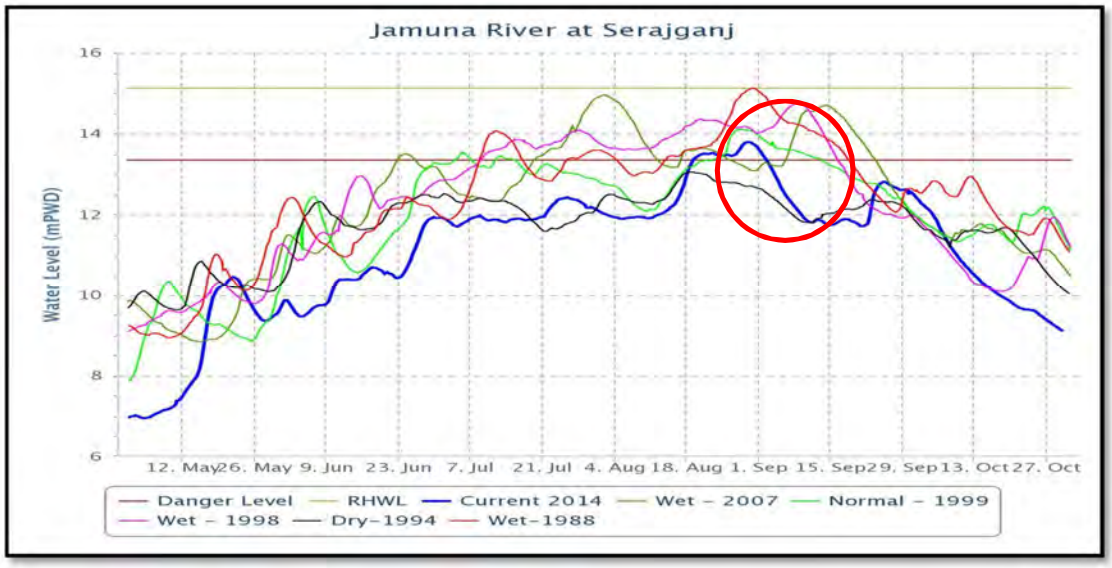


Figure 2 Comparison of hydrographs at Siragjanj for Flood 2014

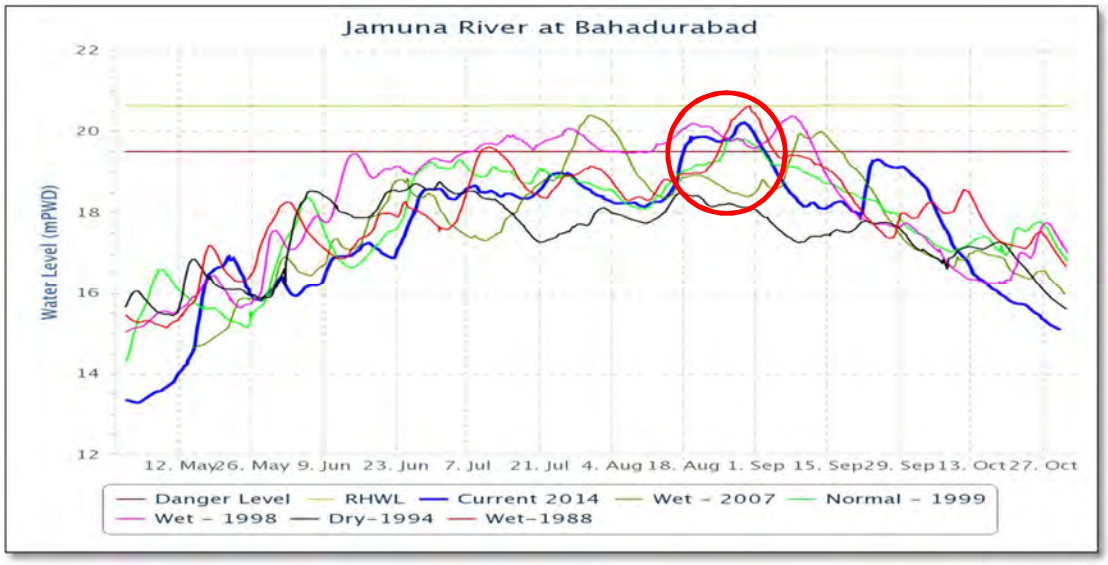


Figure 3 Comparison of hydrographs at Bahadurabad for flood 2014

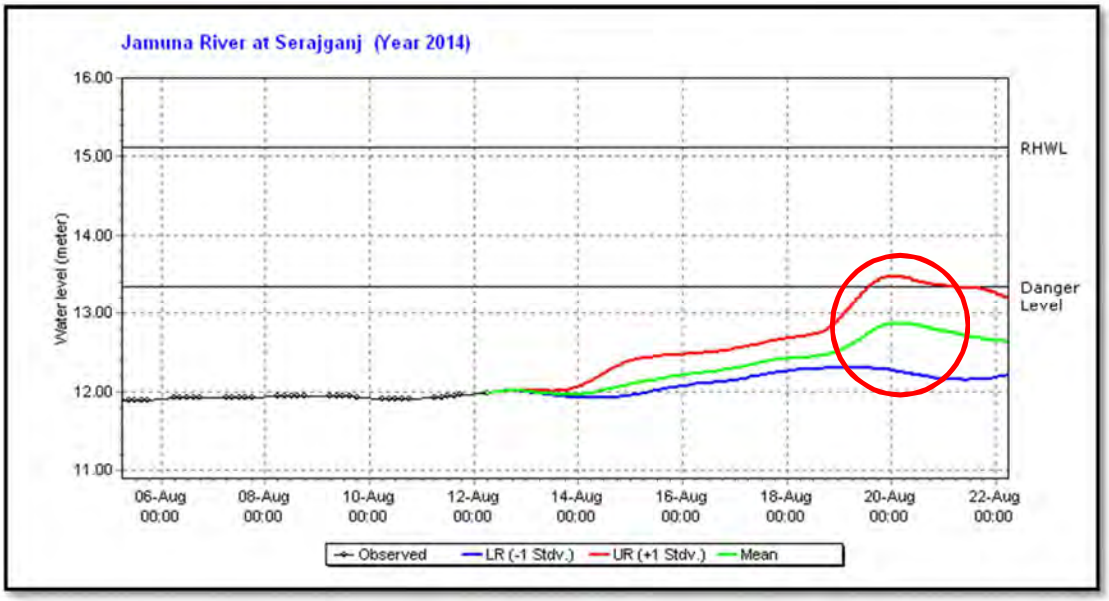
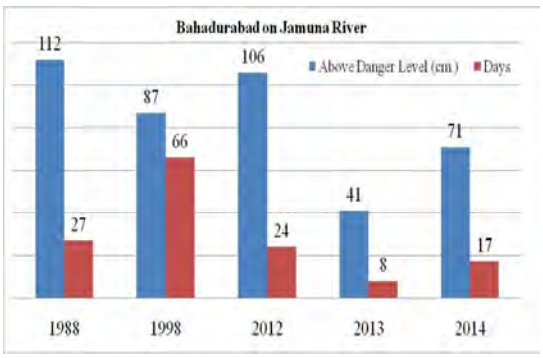


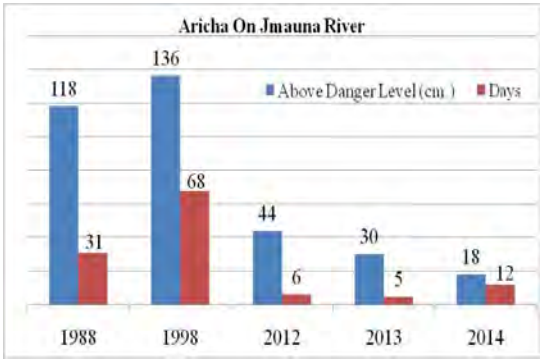
Figure 4 Forecast of water level crossing DL for Serajganj at 19 August 2013 (7 days ahead)

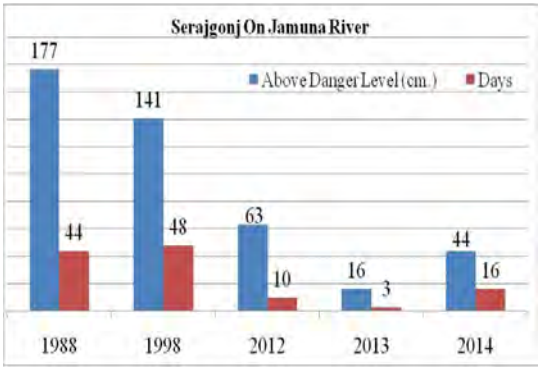
Table 1 Facts and Figures of Flood 2014

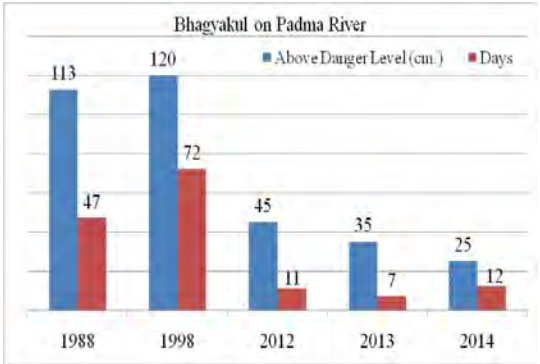
Sl.	River Name	Station	Danger level (mPWD)	Peak Water level (2014) (mPWD)	Peak Date (2013)	Total days above Danger level in 2014	Total days above Danger level in 2013	Historical peak (m PWD) and dates (dd.mm.yy)
1	Dharla	Kurigram	26.50	26.93	11/07/2014	4	3	27.66 (14.07.96)
2	Brahmaputra	Chilmari	24.00	24.47	10/09/2014	12	-	25.07 (23.08.62)
3	Jamuna	Bahadurabad	19.50	20.21	11/09/2014	19	8	20.62 (30.08.88)
		Aricha	13.35	13.58	11/09/2014	15	5	15.12 (30.08.88)
		Serajganj	9. 40	13.79	11/09/2014	15	3	10.76 (02.09.88)
4	Meghna	Bhairab Bazar	6.25	6.05	11/09/2014	-	-	07.78 (24.07.04)
5	Padma	Hardinge B.	14.25	13.31	07/09/2014	-	-	15.19 (10.09.98)

Figure 5 Comparison of flood 2014 in different station with respect to intensity and duration









H. Manual SMS2DASHBOARD

Manual SMS2DASHBOARD

Date: 24-11-2014

Location of the dashboard

http://bangladesh.dashboardwatersafety.com/

SMS receiver

SIMcard

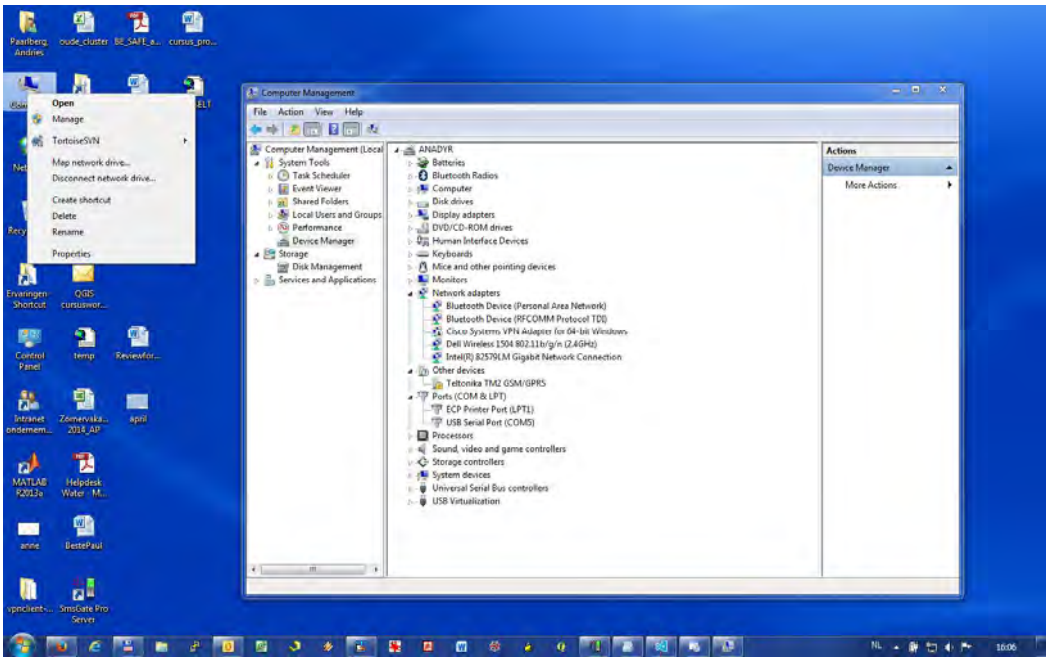
- Use a mini-sim, see http://nl.wikipedia.org/wiki/Simkaart
- The SIM-card must not have a pin-code (factory setting is usually something like). When is has, remove this by using your mobile phone.
- The device works with the already installed card, number: +31645466106

Prerequisites for SMS host/server

1. The laptop/PC/server requires MUSITEL drivers for the SMS receiver: connect SMS receiver and use CD to install drivers.
2. Under “My Computer/Manage/Device Manager” one can find the COM-port, see figure below, in this case COM5.
3. Install SMS Gate Pro (Server), (using administrator privileges!)
4. Set the COM-port under “Communication Settings” and test the communication with the SMS receiver.
5. You can change some settings under “Message Settings”, e.g. how long messages are kept in the stored folder (which is usually “c:\Musitel\SmsGate Pro v2.03\SmsServer\TXT\SMSIN\”)
6. Install the SMS Gate Pro Server under “Status”

7. Note that this software runs for a 30 days evaluation period. After that registration is required (via the ? screen in SMS Gate Pro)

Now the laptop/PC/server will automatically receive SMS-es which are send to the SMS in the MUSITEL device.



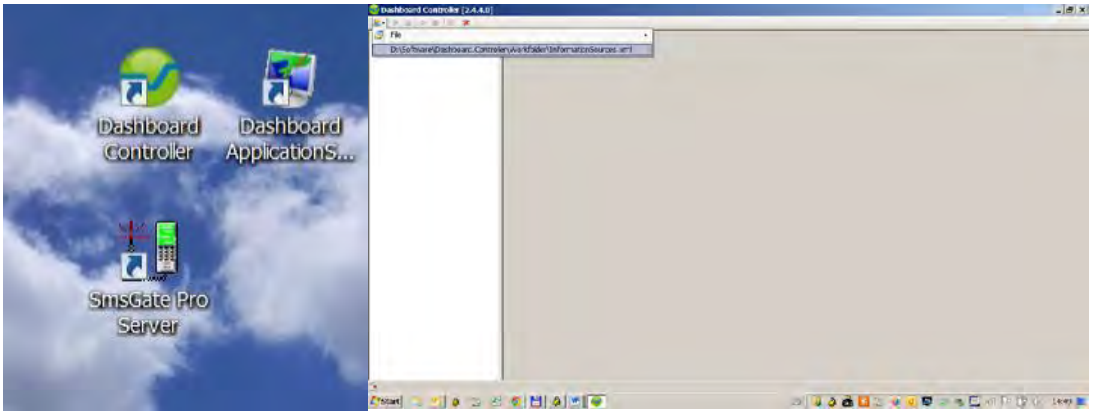
Dashboard controller

To send the information in SMS-es to the Dashboard, a Dashboard controller is required:

1. Use a set-up available at HKV.
2. Configure a XML-file for the settings, see d:\Software\Dashboard.Controller\...**InformationSources.xml**
3. Important settings in XML are:
    a. RefreshInterval in minutes: time interval with which SMS-es are processed
    b. SMSInMap: path where SMS-es are stored by SMS Gate Pro Server
    c. Minimum/Maximum: min/max for graph with combined station-info

Procedure to set your laptop/PC/server for sending SMS-es to Dashboard

1. Attach the SMS receiver to the PC, Laptop or server
2. Open the Dashboard Controller
    a. Open the Dashboard Controller
    b. Left button, open d:\Software\Dashboard.Controller\Workfolder\InformationSources.xml
    c. SMS, SMS inbox
    d. Click second left button START
3. Now the server/laptop/PC will read the SMS-es and send the information to the dashboard.
4. Start http://bangladesh.dashboardwatersafety.com/



Format of SMSes

"ST001 280514,09 1850,12 1851,15 1852,18 1853,21 1900,00 1700,03 1800,06 1850"

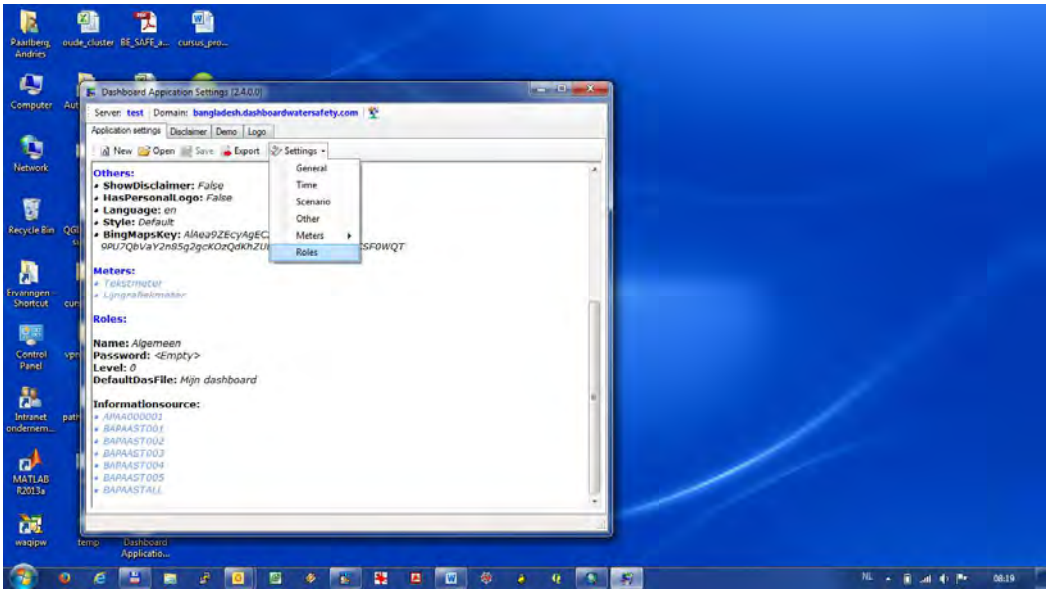
- The date is the date of the day the SMS is sent, so it corresponds to the reading at 00, 03 and 06 hr.
- Important: stick to this EXACT format, so e.g. no space after the comma.
- Notation of the water level in cm w.r.t. reference level. The dashboard converts it to meters.

Storage of incoming SMSes

"c:\Musitel\SmsGate Pro v2.03\SmsServer\TXT\SMSIN*.txt

Using the Dashboard

1. Adding a graph of a new station,
    a. Use p:\Pr\2732.10\Werkmap Andries\00_Dashboard_install\Dashboard Applicationsettings\
    Then a new “role” must be added to the server.
    b. Use p:\Pr\2732.10\Werkmap Andries\02_Dashboard_configonly\domainlist.txt for domain.
    c. Add Key, see figure below.
2. Add a new station by adding a meter in the dashboard
3. To change the upper/lower scale of the combined graph, use the settings in the XML. This might require deleting and adding the graph again.


Dashboard Application Settings (2.4.0.0)
Server: test | Domain: bangladesh.dashboardwatersafety.com
Application settings | Disclaimer | Demo | Logo
New | Open | Save | Export | Settings
General
Time
Scenario
Other
Meters
Roles
Others:
ShowDisclaimer: False
HasPersonalLogo: False
Language: en
Style: Default
Meters:
Roles:
Name: Algemeen
Password: <Empty>
Level: 0
DefaultDasFile: Mijn dashboard
Informationsource:
AMA000001
BAPAAST001
BAPAAST002
BAPAAST003
BAPAAST004
BAPAAST005
BAPAASTALL

I. List of Protective Actions

Sector	Protective actions taken with 5 days lead time
General Actions	• Evacuate and move to safer locations • Do nothing and wait • Talk to your neighbours, friends, relatives or Union Chairman • Hold a meeting with your community • Share the early warning with the community • Help others to take protective action • Monitor the water level gauges
Household	• Lifting up of furniture and household assets up to anticipated level of flood water • Rapid shifting of valuable assets to nearby safer places (e.g. embankment, school /madrasa). • Preparing of portable mud oven for cooking • Stocking of cereal, dry food and carbolic acid • stocking of fire box and fuel
Agriculture	• Harvesting of matured crops as much as possible • Harvest ripening crops • Delaying of seed bed preparation • Abstaining from planting crops • Stocking of seeds for emergency period
Fisheries	• Netting the cultured pond with Banna/net to prevent escaping of fish • harvesting and selling of fish in the market despite of low price • Heightening the pond dike • Make temporary Hapa for preserving small fish
Livestock	• Construction of higher platform temporarily • Raising of farm house plinth • Shifting of cattle to nearby safer places (e.g. embankment) • Security Problem – Cattle stolen
Health and Life	• Rapid collection of emergency medicine and oral saline • Temporary sealing of tube well
Business	• Rapid shifting of goods to nearby safer places (e.g. embankment /another market place) • lifting up the goods-shelf up to anticipated flood level
Transport	• Construction of “vela” made off banana trunk • Construction of bamboo made bridge from one house to another and connect high land
Education	• Arrange a boat to transport school children • Shift the location of the school • Discuss the issue with the students
Handloom	• Stop weaving and rapid shifting of appliances to the higher places - removed the rim in the handloom factory • Set up temporary dike to prevent flooding

J. Savings and protective actions taken per sector

Sector	Main assets elements at risk from floods	Protective actions taken with 5 days lead time	Approx. % of assets saved	Approx. Savings (BDT)
Agriculture	Standing Crops -Jute, Kalai (pulse) Aman and Padddy Seeds Land and trees Households	Harvesting of matured crops as much as possible	50%	*Range per HH:* 5,000 – 100,000 *Average per person:* 50,000
		Harvest ripening crops		
		Delaying of seed bed preparation		
		Abstaining from planting crops		
		Stocking of seeds for emergency period		
Fisheries	Catch production Households	Netting the cultured pond with Banna/net to prevent escaping of fish	50%	*Range per HH:* 6,000 – 70,000 *Average per HH:* 60,000
		harvesting and selling of fish in the market despite of low price		
		Heightening the pond dyke		
		Make temporary Hapa for preserving small fish		
Livestock	Cattle, goats, Land Crops Households	Construction of higher platform temporarily	50%	*Range per HH:* 30,000 – 100,000 *Average per HH:* 52,500
		Raising of farm house plinth		
		Shifting of cattle to nearby safer places (e.g. embankment)		
		Security Problem – Cattle stolen		
Health and Life	Households Livelihoods Health	Rapid collection of emergency medicine and oral saline	n/a	*Range per HH:* 7,000 – 50,000 *Average per HH:* 30,000
		Temporary sealing of tube well		
Business	Household	Rapid shifting of goods	n/a	*Range per HH:*

	Unemployment Stock/goods/ production	to nearby safer places (e.g. embankment /another market place)		10,000 – 50,000 *Average per HH:* 12,500
		lifting up the goods-shelf up to anticipated flood level		
Transport	Households Unemployment	Construction of "vela" made off banana trunk	n/a	*Range per HH:* 10,000 – 20,000 *Average per HH:* 15,000
		Construction of bamboo made bridge from one house to another and connect high land		
		Shift the location of the school		
		Discuss the issue with the students		
Handloom	Household Unemployment Equipment Production	Stop weaving and rapid shifting of appliances to the higher places - removed the rim in the handloom factory and	50 – 75%	*Range per HH:* 5,000 – 75,000 *Average per HH:* *16,000*
		set up temporary dike to prevent flooding		