Social Strategy for Effective Science Communication: Lessons for SATREPS Project and Beyond

SATREPS

Research Project on
Disaster Prevention/Mitigation Measures
against Floods and Storm Surges
in Bangladesh

Workbook on Social strategy for effective science communication: Lessons for SATREPS project and beyond

2018

AUTHORS

Md. Abul Kalam Azad

Dr. Rezaur Rahman

Dr. Rajib Shaw

Workbook on

Social strategy for effective science communication: Lessons for SATREPS project and beyond

Contents

Abbreviations and Acronyms 2

Executive Summary 4

1. Introduction 5

2. Objectives of the workbook 6

3. Methodology for producing the workbook 6

4. Target groups of the workbook 7

5. Concept and theory of social strategy and science communication 8

5.1 Social strategy 8

5.2 Risk Communication 9

5.3 Social Marketing Theory (SMT) 10

5.4 Science communication 12

5.5 Theoretical model of Science Communication 13

6. Why Social Strategy for Scientific communication for flood and storm surge risk? 15

7. Approaches and challenges of effective Social Strategy for Science Communication 17

7.1 General approach and challenges 18

7.2 Specific approaches to SATREPS project 26

8. Examples of effective science communication for flood and storm surge risk 37

9. Concluding Remarks and Way Forward 39

10. References 41

Abbreviations and Acronyms

BFSCD - Bangladesh Fire Service and Civil Defence

BMD - Bangladesh Metrological Department

BUET - Bangladesh University of Engineering and Technology

BWDB - Bangladesh Water Development Board

CBDM - Community-based Disaster Management

CPP - Cyclone Preparedness Programme

CRA - Community Risk Assessment

DDM - Department of Disaster Management

DECCMA - DEltas, vulnerability and Climate Change: Migration and Adaptation

DDMC - District Disaster Management Committee

DFID - Department for International Development

DMIC - Disaster Management Information Centre

DoE - Department of Environment

DRR – Disaster Risk Reduction

DU - University of Dhaka

FFWC – Flood Forecasting Warning Centre

GSB - Geological Survey of Bangladesh

IDMVS - Institute of Disaster Management and Vulnerability Studies

IRRAP - Inclusive Risk Reduction Action Plan

IWFM - Institute of Water and Flood Management

KII - Key Informant Interviews

LGED - Local Government Engineering Department

NGOs - Non-Government Organizations

MoDMR - Ministry of Disaster Management and Relief

MoWR – Ministry of Water Resources

PWDs - Person with Disabilities

PSTU – Patuakhali Science and Technology University

SPI - Science-Policy Interface

SMT – Social Marketing Theory

SMM - Self-marketing Model

SPM - Self-publication Model

UDMC - Upazila Disaster Management Committee

UDMC - Union Disaster Management committee

UK – United Kingdom

WDMC - Ward Disaster Management Committee

Executive Summary

Science communication in disaster studies has drawn an immense concern due to increasing uncertain climatic havocs. Evidence-based scientific innovations can support decision-planning process to assuage the unfavorable effects of these unanticipated risks. Therefore, social approach to science communication diffuses the notions of scientific innovations and links to policy implementation through engaging multi-stakeholders of disaster management. This paper coincides multi-stakeholder engagement in SATREPs project as a 'two-way iterative' procedure for co-designing and co-producing of knowledge, which empowers the scientists, the decision-makers and the end-users. It is exhibited that appropriate social strategy combining traditional notions influences to changing the behavior of disaster-affected people and helps them to adopt rationale actions against flood and storm surge. The unique social strategy of science communication also affirms that dissemination of early warning and flood forecasting information is done through community engagement, which has been identified as a key technique of science communication. To have a palpable impact on the community, the SATREPs project develops self-explanatory maps for risk communication and low-cost nature friendly infrastructure for protecting river erosion. However, self-publication model (SPM) brings a significant change in the mind-set of the decision planners and interdisciplinary experts. The policy makers are now thinking to implement the outputs of the SATREPs project to control risks of flood and storm surge in Bangladesh. Social strategy of SATREPs project has also instituted the outputs of the research through establishing university and NGOs network. The inclusive nature has produced a 'social space' in which the experts are producing knowledge from multidisciplinary standpoints and connecting with the community for ensuring sustainability of the scientific outputs. This workbook assures that social strategy for science communication is bridging a storing interface between science and policy implementation. To ensure sustainability for a long period a range of actions have been suggested, which will foster disaster risk reduction mechanisms.

1. Introduction

"If you can't explain it simply, you don't understand it well enough," -Albert Einstein

In the postmodern era, a systematic interaction between science and policy have drawn a great attention of scientists across the disciplines in the field of disaster risk reduction due to shifting its' paradigm from relief-based to risk reduction. Designing a science-based project pertinent to disaster risk reduction requires engagement of multiple stakeholders for advancing and co-innovation of knowledge. Indeed, effective interface between science and policy makes social relevance and correlates social needs of the community. Science-policy interface (SPI) has an imperative role in establishing a bridge between scientists and practitioners for co-design and co-production of knowledge for reaching the goals of science through decision-making (Heink et al. 2015). This nexus invites the scientists and implementing agencies to co-evaluate and to share their significant opinions about the appropriateness of science in disaster studies. The critical process also reduces the gaps between theory and practice and pave a way for inclusiveness of knowledge. Feasibility and relevance of the scientific research are also established in line of the community demands. This process of science communication, moreover, creates an interdisciplinary milieu for policy decisions and influences the perceptions of the policy makers about science and technology. The notion of this science communication in the context of disaster studies (Nisbet and Markowitz, 2015; Shaw et al., 2016) has conceptualized as a 'two-way' process which engage experts, practitioners, and community people, and other relevant stakeholders following an interdisciplinary approach. Because, proper science communication in disaster risk reduction can bring changes in perceptions and decisions, and develop an effective action plans of hazard maps, early warning, and evacuation. The rhetoric fact is that disaster science as an emerging field in science attracts scientists across different disciplines due to its' interdisciplinary nature. In essence, this interdisciplinary approach of disaster science has generated a new way of thinking and has conciliated the gaps between soft sciences and hard sciences in disaster risk reduction. The comprehensiveness of this discipline has also brought a breakthrough to unveil the answers of the critical problems of science research and technology in disaster risk reduction. The way of science communication, furthermore, inaugurates social platform consisting all stakeholders including practitioners, social scientists, and public. The perineal science communication will strengthen social resilience and self-reliance and ensures that science meets the local needs and circumstances. Failure to integrate the risk behavior and culture of the communities in research

project lead to unsuccessfulness of scientific research in disaster risk reduction. Need-based policy research can outreach the benefits to the disaster-prone community while demand-driven research can also create usefulness of scientific research and engenders new demands for risk reduction in the peripheral community. This research paper explores social processes of science communication in the context of SATREPS project and how science communication takes place as an effective tool for the hazard or risk maps, improved early warning system and policy decision in disaster risk reduction in Bangladesh. In addition, the paper has unfolded, how social strategies of the projects has institutionalized the knowledge through establishing an interdisciplinary university network.

2. Objectives of the workbook

The objective of the document is to chart a course for dissemination of scientific findings of different components of the SATREPS project for the uptake and benefit of the society. The document has been prepared in close collaboration with all component leaders of the project. The workbook has also targeted the following objectives to uptake the benefits of the project for the society.

i. To establish an interface with the scientists, key stakeholders, and the community people;

ii. To establish a comprehensive strategy so that scientists can establish a trusted relation with the public and policymakers;

iii. To enhance a proper science communication of the research results, especially for the hazard / risk maps and improved early warning system;

iv. To institutionalize knowledge resources developed under the project through involvement of resources organizations i.e. university network, NGO network;

v. To discuss the major techniques of dissemination of research findings of SATREPS project.

3. Methodology for producing the workbook

A systematic methodology is followed to promulgate the workbook among the academia and key professionals of this field. The way, indeed, explores an interplay between scientific innovations and community demands in policy reformations. This exploratory nature of the study focuses the techniques of social strategy of SATREPs project for effective science communication following the principles of unstructured research. The research paper starts with the background review of the SATREPs project, consultation with the component leaders and Japanese partners, conducting Key Informant Interviews (KII) with social scientists, decision makers, and key professionals. At least 10 key interviews were conducted with the

key stakeholders to grasp a clear view about the effectiveness of science communication. A business trip was also made by the project in Japan to understand the implications of the project in Japan. The research also reviews the relevant projects of the Institute of Water and Flood Management, BUET and other documents related to disaster risk reduction. In fact, the methodological procedure explores the thinking of practitioners and scientists regarding implementation of scientific innovations and policy decisions.

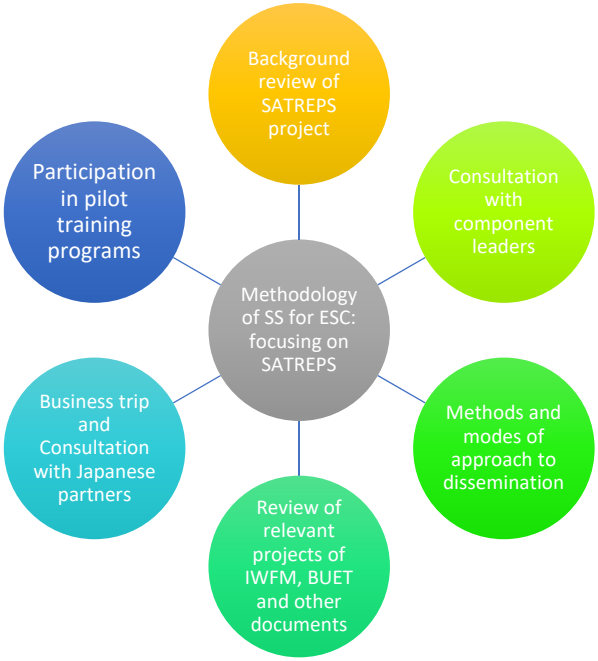


Figure-1: Methodology of the workbook

4. Target groups of the workbook

The workbook advocates for an “all-of-academia” and “all-of-policymakers” approach for social strategy to uptake its effectiveness, comprehensiveness, and explicitness. The multifaceted and reactiveness for social communication have been institutionalized to establish a two way inter-link between policymakers and academia. The different stakeholders are engaged in disaster risk reduction to multifarious characters of disaster risks. This workbook is aimed to withdraw the attention of inter-disciplinary stakeholders for co-production and co-design of the knowledge in the decision making areas of disaster risk reduction. To achieve the objectives of the workbook, the bodies such as SATREPS project members, university network members, policymakers, NGOs practitioners, technical connoisseurs of line disciplines, academia, young scholars, civil society representatives etc. will be assembled under this workbook for co-sharing, co-designing, and co-producing of knowledge in the aspects of disaster risk reduction.

5. Concept and theory of social strategy and science communication

5.1 Social strategy

The concept of social strategy has a pivotal role in building an interplay between science innovation and policy. The concept is esoteric due to having diverse meanings according to subject matter and uses. Social scientists use this term in relation to rational choices. A social agent will make several preferences based on conscious goals, which lead to produce a rational decision for social benefit (Heritage, 1991; Luce and Raiffa, 1957). The psychological meaning is also attached with this terminology. Heritage (1991:314) introduces the term "strategy$_{cog}$" which refers to "conscious reasoning and action". The cognitive science perspective is used in this research paper to understand how conscious behavior (Heritage, 1991) guides the end-decision making actions. This research paper infers a lucid view of social strategy for science communication to influence policy decision and understanding about scientific innovations for disaster risk reduction. Social strategy can bring a paramount significance in reshaping the decisions that are closely affiliated with flood risks and storm surge management. The terminology, indeed, accentuates an interface between science and policy (Heink, et al., 2015; Lubchenco, 1998; Spierenburg, 2012) in the context of cataclysms management. Thus, social strategy coincides science-policy interfaces (SPI) (Heink et al., 2015). Social strategy is defined as: social procedures which establishes an integrated milieu for connection amongst the interdisciplinary scientists (Heink et al., 2015), key actors and agencies, and the end-users in the policy development and implementation process, and which also broaches a common platform to share, and to co-evaluate, and to pave a way for co-production of knowledge (Van de Hove, 2007) towards achieving the targeted goals, and reinforces the concerned actors towards rational actions from cognitive thinking. In connection to this definition, social strategy is also explained as a communication strategy of the scientists with the other experts, local agencies, and the vulnerable populations, which enables them to exchange their views for co-development of knowledge and reduces the gaps and limitations of scientific efforts. Social strategy, moreover, rejuvenates social actions of the local people to assuage the perceived risks of disasters at the community level.

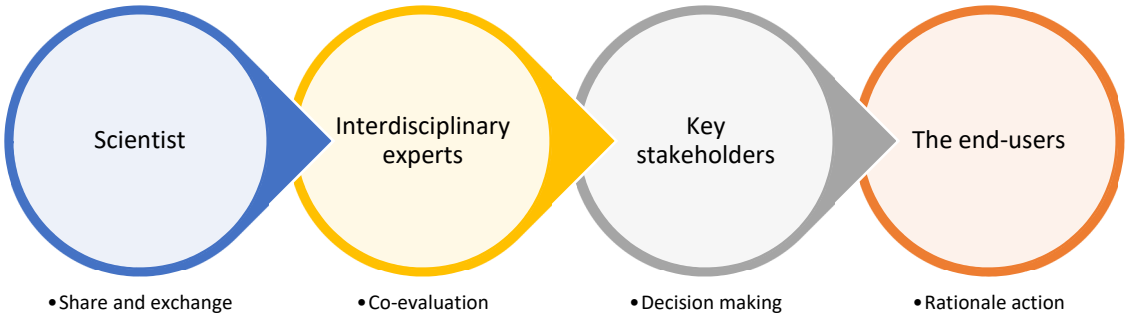


Figure-2: Linkage of different stakeholders through social

5.2 Risk Communication

The recent anecdotes on disaster science across the disciplines are concentrating on changing public behaviors and perceptions of disasters (Takeuchia and Shaw, 2011; Perry and Lindell, 2007) to enervate the negative implications of environmental stressors. The understanding on human behavior and clear perceptions on disasters are pivotal (Perry and Lindel, 2007) to the success of emergency responses. Reliable information to change human behavior must go in the line of proactive actions of the community people (Takeuchia and Shaw, 2011; Perry and Lindel, 2007). Takeuchia and Shaw (2011) has produced a sequential model on how communication system alters human action based on hazard information in Japan. This sequential model denotes four steps: (i) at first, the marginal community receives information pertinent to susceptibility of hazards, (ii) the second step is perceiving the risks of hazards, (iii) the third is to develop a proactive action plan, and finally the susceptible people adopt planned-based measures to mitigate the risks of hazards. Therefore, the science of communication must be acquainted with social and psychological cues (Perry and Lindell, 2007) and this process allows the key agents to account the pitfalls of public preparedness. Risk communication is also called public or disaster education (Coppola, 2007; Takeuchia and Shaw, 2011). According to disaster communication scholars Rajib Shaw, risk communication is "communication is undertaken to understand about risk information and it consists of understanding and making action plans" (Takeuchia and Shaw, 2011). Indeed, risk communication is a benchmark of any successful disaster preparedness and response mechanisms. The process allows the disaster managers to establish a network (Takeuchia and Shaw, 2011) thereby information relating to risks of life, hazards, and susceptibility are transferred to generate mass awareness for adopting the plan-based appropriate actions. Early

warning about flood and cyclones is one of the successful disaster communication in Bangladesh. The communication process is a "two-way interactive" (Kikkawa, 1999; Takeuchia and Shaw, 2011). The Bangladesh Metrological Department in cooperation with Ministry of Disaster Management and Relief (MoDMR) disseminate the imminent information about floods and cyclones and the denizen of the hazards-prone evacuate themselves and take action to lessen the losses of properties and lives. The effectiveness of a successful warning depends on how much the ordinary people are able to understand the information and respond to the anticipated hazards. However, risk communication in disaster education empowers the ordinary denizens and produce awareness about hazards and risks.

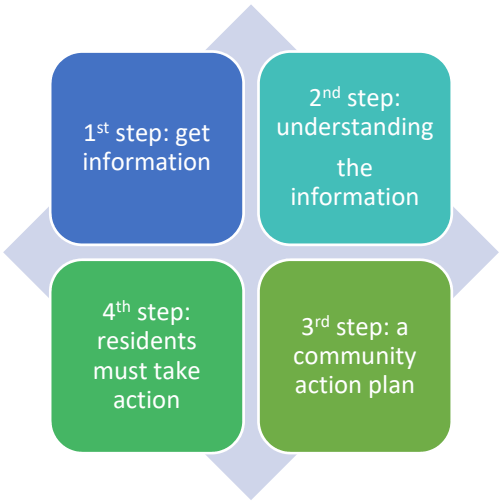


Figure-3: Steps of risk communication (Source: Takeuchia and Shaw, 2011)

5.3 Social Marketing Theory (SMT)

The inhabitants living in hazards-prone areas are made appropriate action plans based on their gathered experiences and information received from the government agencies. Risk communication influences risk reduction behavior to choice proactive options of risk reduction. The study uses social marketing approach to understand how the people energize their capability to preclude the antagonistic effects of natural disasters like floods and storm surges in Bangladesh. In disaster studies, the social marketing approach to disaster management has been applied to strengthen exigency response mechanisms (Wang and Ye, 2017; Steiger et al., 2015; Coppola, 2007). The concept was at first familiarized by Philip Kotler and Gerald Zeltman in 1971 (Coppola, 2007). The concept, indeed, is a combination of conventional views for altering social change and commercial approach to expedite the acceptable choices of social notions (Banu and Ozdemir, 2014; Coppola, 2007). The traditional and cultural approaches are attached with social marketing to change the social ideas of the people. The latent functions of

social marketing has been instituted in disaster education for stimulating disaster risk reduction behavior at the different phases of disaster management rather than conventional approach. This indicates a transformation in disaster communication and effective communication proceeds community resilience in susceptible areas. In Bangladesh social marketing has been assimilated with community-based disaster management (CBDM) approach for reshaping disaster behavior. CBDM is a community approach by which the community people participate in risk assessment process and prioritize the risks based on their own perception and experiences. Evidence also accentuates on integration between theoretical and pragmatic view for successful communication (Shaw et al., 2012). The assimilation process also instigates to develop a risk reduction action plan. Robinson (1998) presents seven steps of social marketing approach (Coppola, 2007) for elucidating new pragmatic principles in disaster preparedness delineated in table I:

Table I: Seven steps of social marketing approach in disaster education

Steps	Name	Views	Pertinent to disaster education in Bangladesh	Outcome
I	Knowledge (awareness)	The people must seek clear information about the imminent hazard and alternative options like evacuation maps for shelter options. Personal inclination paves a way to take reliable action.	The disaster-prone people require information on the predicted hazards. The Bangladesh Metrological Department forecasts hazards information to aware the people for taking proactive actions for risk reduction.	Risk perception
II	Desire (Change involves imagination)	The perceived imagination calls forth for a desirable future and rational welfare.	The marginal community seeks desirable future through taking adaptation options.	Seeking options
III	Skills (what to do)	The inhabitants select the best options and use easy examples for clear visualization.	The rustic people choose a suitable options from available choices at the community.	Prioritizing actions
IV	Optimism (belief)	Strong belief on best action that can bring success.	The disaster-prone people are taking risk reduction measures in Bangladesh. For example, when a risk is imminent, the people put sand bags on roads, or embankments.	Action implementation
V	Facilitation (outside support)	In implementing the action the marginal people face many constraints. To overcome these challenges they seek outside supports and establish a strong network with potential stakeholders.	The risk management process in Bangladesh requires outside support when it exceeds the capacity of the people. For examples, under the process of CBDM the community-based organizations implement the risk reduction actions with the cooperation of local government agencies.	Network establishment
VI	Stimulation (kick-start)	Social marketing approach stimulates the clients and confiscates drowsiness of mind. The process also inserts an urgency in mind to take an appropriate actions towards thereat belief.	Several processes like community risk maps, posters, community radio, and newspapers etc. are used to provide inspiration message for adopting proper measures.	Inspiration

VI	Feedback and Reinforcement	The approach accentuates on continual connection through maintaining regular basis communication. The feedback step also encourages people to make critical comments on the communication tools and opinions are addresses according to the need of the people.	Disaster education in Bangladesh is bolstering risk communication system through accepting feedback from the key stakeholders. In connection to feedbacks, new messages are reconstructed to bolster the peoples' mind and measures.	Endorsing community opinions

Source: Developed by authors (Coppola, 2007)

These steps can be used sequentially to buttress the knowledge of the risk-prone people as a learning process. For a robust resilience process disaster education model (O'Brien et al., 2010) can employ these principles of social marketing to strengthen the community responses to the negative implications of unwanted events. The emphasis of this model in disaster education is on confirming social-wellbeing of the destitute peoples though integrated communication.

5.4 Science communication

Over the couple of decades there has been a significant bridging between the science-based knowledge producers and the key users (Nisbet and Scheufele, 2009). The connoisseurs now seek reliable ways to popularize their scientific advancements by engaging the public including policymakers and interdisciplinary experts for co-sharing and co-production of knowledge (Cooke et al., 2017; Illingworth, 2017; Hu et al., 2018). Public involvement in research project is a key criteria of effective science communication which deepens the roles of the participants in co-evaluating and co-designing the scientific innovations. Effective science communication, however, divulges formal and informal engagement of the public and interdisciplinary connoisseurs in the science-based research project. Braha (2017) corroborates that public engagement in science brings a mutual interaction between scientists and others that allows an equilibrium milieu for learning and producing new area of knowledge. The societal dynamics of science communication is bringing a wide range of positive benefits from reshaping scientific innovations to taking science-based policy decisions for promoting sustainable values through science-based innovative actions. This research paper conceptualizes effective science communication as an educated approach to communication for disseminating and constructing the "science-related knowledge" (Cooke et al., 2016) and thereby the process puts a tangible effects on the end-users of knowledge. Additionally, the science communication proliferates knowledge and works as a key source of science-based policy decision.

Science communication, indeed, is a public communication and engaging public through different means for bourgeoning the quality of scientific innovations. Fischhoff (2013)

professes, scientists including social scientists, psychologists, and communication experts are using effective means of science communication considering cultural and socio-political factors.

5.5 Theoretical model of Science Communication

Science is deeply rooted across other disciples and perfectly pertinent to society. In relation to society, Bourdieu's Social theory (1987) has denoted 'science as a sub-field of society' (Luthje, 2017). The jurisprudence of science makes an interdependent bondage with other social determinants. The prominent scientist P. Bourdieu (1987) has integrated science into a 'social space' (Luthje, 2017) and thereby science has established itself as a scientific field of society. The balanced-integration also allows a prompt interaction with other agents of society. The theoretical standpoints symbolize scientists of a particular discipline as individual agents and the professional bodies, stakeholders, policy makers, practitioners, and laypeople have been identified as factions of agents (Bourdieu, 1987; Luthje, 2017). Evidence presumes, social field like science makes a coherent relation with each other that uptake the benefits of scientific innovation in society. Bourdieu (1987) shows an empirical relation between these agents and other social continuum through the equation: [(Habititus) + (Capital)] + Field = Practice (Luthje, 2017). This view argues that each social space empowers the agents with copious knowledge and capitals i. e. social and economic (Bourdieu, 1987; Luthje, 2017). In addition, robust institutional network also exists at this social space across the disciplines for effective science communication that emulates border across the community and the globe (Shaw et al., 2016). This borderless communication persists beyond the systematic methodological process (Bourne, 2015; Luthje, 2017) of science communication. This is an exceptional platform for the scientist to share their in-depth findings with other participants and allows to make critical comments. In accordance with Illingworth and Prokop (2017), the system also unlocks a direction for the future research grants. Correlational studies (Massimiano, 2008; Jucan and Jucan, 2014; Braha, 2017) have illustrated different innovative techniques of science communication between the scientific innovators and the layman, which can be discussed under the umbrella of the three model: the deficit, the contextual, and the participation model.

Science literatures postulate that the non-scientists and the layman have many equivocal perceptions about the prosperity of science. Wynne (1991) claims that paucity of understanding pertinent to the issue is especially responsible for this sceptic mind. The deficit model presumes that the scientists can remove these sceptics' ideas through exchanging their innovations with

the interdisciplinary experts, non-experts, and layman. This top-down sharing process can gain democratic support from audiences. The critical aspect of this top-down approach has been addressed in the article of Braha (2017). According to Braha (2017), this traditional approach simply familiarize the audiences about the science (Braha, 2017). On the other hand, the contextual model accounts the audience's attributes, interests, demands, and latent understanding and knowledge of the different stakeholders. Though the scientist share their views with the public to produce "reliable knowledge", this model allows the scientist to readjust their scientific innovation process (Miller, 2001) and to promulgate new means of communication. Miller (2001) substantiates that the change in nature also expedites the science-based consensus decision and reorients new areas of science. Another dominant approach in science communication is the participation model (Miller, 2001). The model is particularly reviving effective science communication through argumentation, questing and reasoning. The utmost goal of this argumentation and discussion is to formulate the research agenda (Hetland, 2016) and to set the main targets of science and technology. Thus, the participation approach opens an equitable learning process for all factions like contributory experts, policymakers, practitioners, and the public. This eloquent interaction enables the decision-makers and the laypeople how to utilize the scientific outputs effectively (Braha, 2017). A prominent study on community-based disaster risk reduction in Japan conducted by Shaw (2014) showed that after heavy participation in Hiroshima in 1999 the prefectural governments distributed hazard maps for early warning and evacuation, hazard locations, restriction on land uses. Shaw (2014) depicted that this innovative hazard maps were produced in consultation with the community leaders. An awareness assessment survey (Umakoshi, 2011; Shaw, 2014) uncovered that about half of the respondents (51%) out of 385 were cognizant with the evacuation route while 32% of the occupants were involved in the evacuation drills. The significant aspects of this science communication is that it is 'user-oriented' (Hetland, 2016) and the scientific socialization was able to produce a hazard-based risk reduction linkage with the susceptible community. However, the participation-based science communication boosts up the knowledge of the public about the contents of science and institutes a strong foundation between the scientists and the laypeople. Figure-4 has presented a continuum of effective science communication.

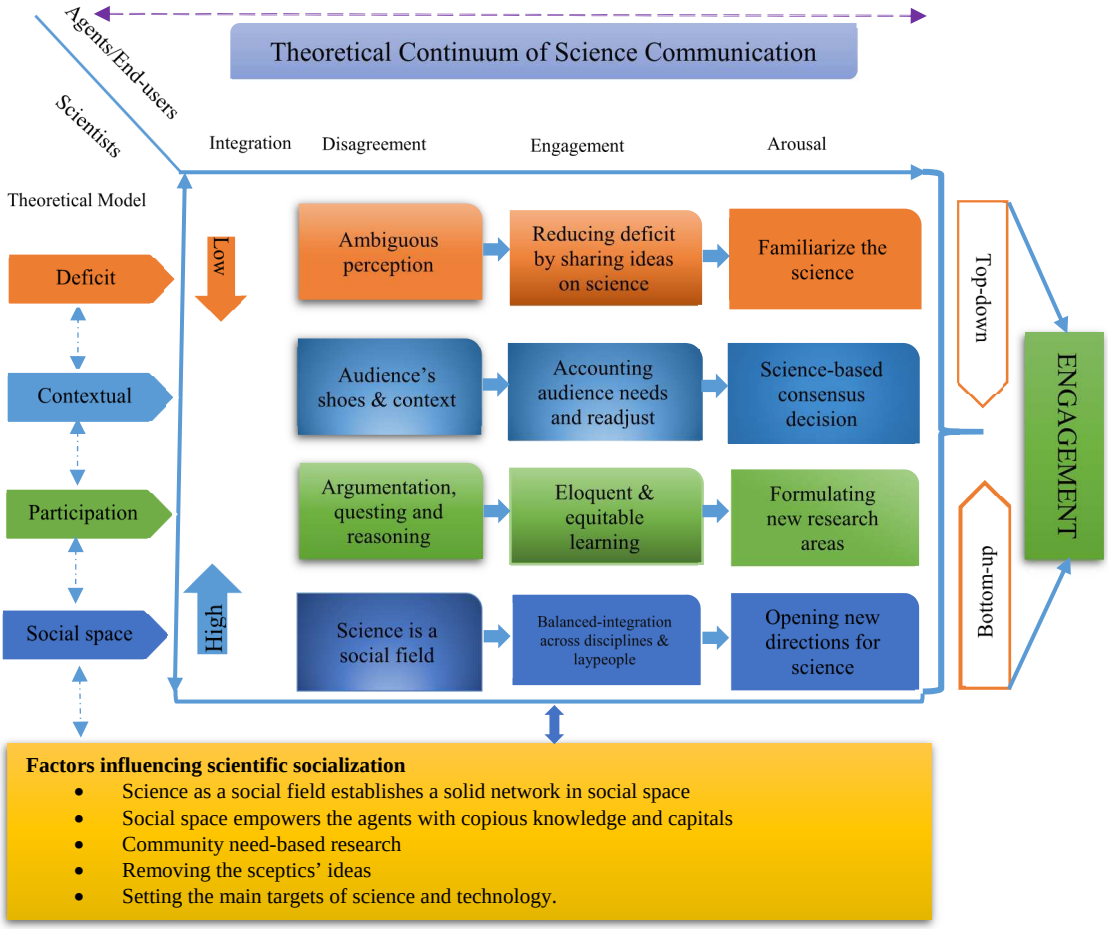


Figure-4: Theoretical continuum of effective science communication

6. Why Social Strategy for Scientific communication for flood and storm surge risk?

This paper uses the idea of social strategy as a way of communication and produces an interlinkage amongst interdisciplinary experts to provide the benefits of science at the peripheral level. Social strategy, here, is understood as an imperative tool to broach a unique platform for implementing the scientific knowledge through inclusive directions and policy decisions of relevant bodies. The techniques of social strategy would assemble all ideas of the proficient experts from the beginning of the scientific research, which build up an interdisciplinary foundation of the research. In addition, the techniques of science communication is intensively rooted in the community and has enlarged a community-based networks in precluding disaster risks (Hibino and Shaw, 2014). Shaw, et al. (2018) accentuates on need-based innovative scientific work on disaster risk reduction and focuses on diffusion of this 'science-based risk knowledge'. Hazard and risk related maps are one of the key ways of

dissemination of this risk knowledge. For example, in Bangladesh FFWC is using flood hazard maps to warn the people and is monitoring the flood situation consecutively through multi-satellite images. That's why, social techniques are required for establishing an effective science communication to disseminate risk-sensitive hazards information and maps promptly. On the other hand, science and technology, moreover, have been considered as the key triggers towards obtaining the Sustainable Development Goals in the Sendai Framework for Disaster Risk Reduction 2015 – 2030 (Shaw, et al., 2018; Shaw, et al., 2016). Social strategy as an inclusive approach in DRR is capable to build a 'science-policy' (Shaw, et al., 2016) nexus in the context of sustainable development agenda and is bringing the science-based decision into implementation. For this integrated science-based innovations and decisions (Shaw, et al., 2016), social strategy allows to engage all interdisciplinary experts, engineers, social scientists, policy planners, and the community people in making critical opinions and co-production of knowledge in disaster risk reduction. The strategies also put a wider impact in building trusted relationship between scientists and other individuals and influences the public to adopt rationale action based on the anticipated hazards. For instances, a comparative study between Japan and Bangladesh show that a hazard map in Japan is addressing possible deluged areas and denotes evacuation routes and short-term evacuation locations (Fujita et al., 2017). This study anecdotes (Fujita et al., 2017) that learning on hazard maps beginnings from elementary level. However, the people in Japan are able to understand the maps and apply their disaster risk reduction behavior before the imminent hazards like floods and typhoons (Fujita et al., 2017). While, in Bangladesh the floods and cyclones-prone people evacuate themselves based on their indigenous knowledges. Though there are few designated floods and cyclones shelters, the disaster-prone people are unable to use these appropriately due to dearth of evacuation route and hazard maps (Fujita et al., 2017). Regarding this situation, this study has utilized the concept of social strategy to institutionalize the knowledge on flood and storms surges produced from the SATREPs project through resources organizations like Bangladesh Metrological Department, Department of Disaster Management, Water Development Board, and other relevant organizations. Besides, social strategies could help the scientists in establishing a proper science communication through hazard and risk maps. As, the strategy have considered the key ideas of the stakeholders including local people and policy planners. Another imperative fact of social strategy is that it enables the laypeople and familiarize with the scientific findings of structural and non-structural interventions such as forecasting and early warning system. Integrating social strategy into warning system, furthermore, improves the quality of information due to addressing social cues of the society and guides the key agents

to disseminate accurate messages about storms surges and floods. For instances, the scientific innovations of component 2: improved storm surge warning and evacuation systems enables to provide additional information like height of storm surges, wind speed, types of physical structure to be damaged, and the polder of specific area along with the existing early warning system. This additional information would be helpful for evacuation and livelihood security because of addressing social and cultural issues. Social strategies also empowers the key agents, who are providing information about the anticipated hazards, about how to communicate with the local people through their own or common languages for the early warning and flood forecasting.

The coexistence of science, policy, and social strategy also helps the interdisciplinary experts how to design social development initiatives and to integrate socio-environmental cues in the project. Furthermore, postdisaster social development projects are also contextualized and designed from the holistic point of view. Social strategy is a key tool for assembling of all interdisciplinary experts from different disciplines like social scientists, economists, health experts, geographers, and environmentalists. Acknowledging the roles of social strategy also institutes the knowledge resources on floods and storm surges at the educational institutions. Additionally, an institutional linkage is maintained with the cross-cutting fields. Social strategy also entitles the scientists to introduce the community-met-science. However, despite having the demand-based scientific innovations science can also create new demand in the society through new ideas and technology.

7. Approaches and challenges of effective Social Strategy for Science Communication

Social transformation in a systematic pattern can build a resilient architecture against disasters. This transformation happens in different forms including structural and non-structural transformation on the basis of demands created by the unanticipated pressures. Shaw et al. (2016) claims that there is a need of balance combination of physical and social sciences in disaster studies to gain the palpable benefits of scientific interventions. The transformation calls a strong role for social strategy to mitigate the risks of floods and cyclones through effective science communication. As, effective dissemination of information about the outcomes of scientific innovations could strengthen preparedness, responses, and recovery mechanisms. The wider perspective of effective science communication (Cooke et al., 2017; Hu et al., 2018) have also a profound impact on disaster risk reduction due to sharing scientific knowledge with various audiences. This piece of work has taken an effort to articulate how the

disaster scientists and the key stakeholders circulate the knowledge pertinent to their scientific innovations and empirical study. In the first section, general approach to social strategy of effective science communication along with key limitations have been discussed in the context of flood and storms surge and the second portion have given an especial focus on component wise social strategy of SATREPs project for effective science communication.

7.1 General approach and challenges

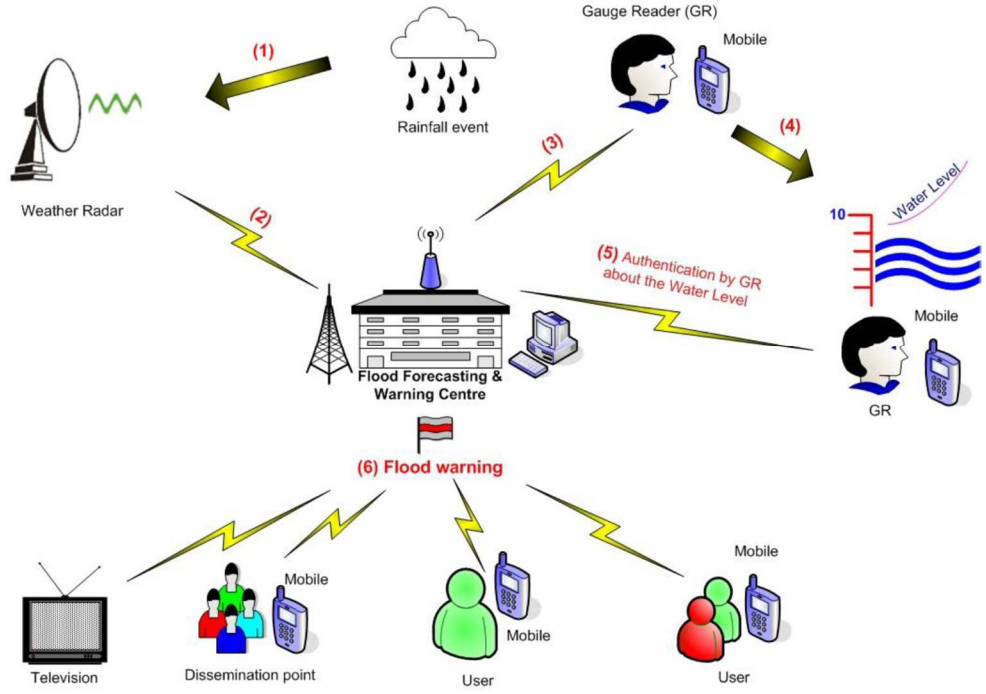
The scientists around the globe are using various techniques constantly to share disaster science-related knowledge with myriad number of audiences. The important aspect is that this sharing is not only between scientists to scientists, scientists to policymakers, and with interdisciplinary experts, this is also with the susceptible people who are frequently encountered with the disasters. But, what types of social strategies are the scientists using to disseminate their scientific and evidence-based research findings? It is evident that there are a variety of social strategies used by the disaster scientists in Bangladesh in the 21st century. This research paper outlines the key areas in which social strategy is helping the scientists to establish a science-based bond with the interdisciplinary experts, and the laypeople. However, their engagement is not always satisfactory and effective in disaster risk reduction. Disaster scientists, for instance, are not able to warn the people directly about floods and storm surges without proper channel. They are bridging with the public with the help of Bangladesh Metrological Department, Department of Disaster Management, Flood Forecasting Warning Centre, and other key agencies to aware about early warning and forecasting.

Science-based risk communication: flood and storms surge

The scientists and policymakers, who are working in the areas of flood and cyclones, are following a top-down (Illingworth and Prokop, 2017) risk communication approach to influencing evacuation behavior of the public. There are limited experimental and scientific research on early warning and forecasting because of its' sensitive nature. But, several research has been done on early warning and forecasting by the disaster specialists in Bangladesh through engaging the public and the policy planners. The bottom line approach of social strategy is that the opinions of the vulnerable populations on early warning and forecasting are evaluated to examine the evacuation behavior. In addition, the policy makers and other experts are also engaged through workshops or seminars. Warning is creating awareness about hazards have been considered as one of the key tool of risk communication (Perry and Lindell, 2007). Flood Forecasting and Warning centre (FFWC) of Bangladesh Water Development Board is playing significant role in creating awareness about flood hazards in Bangladesh by generating

different types of communication strategies such as publishing daily monsoon bulletin, river situation report, and special flood situation report. The centre is also forecasting the water level of water for 24, 48, and 72 hours. The centre is also providing flood alerts through mobile phone to the relevant person who would be able to deliver the verified alert to the responsible personnel of the district office for flood warning. The key challenge to flood forecasting is that due to dearth of reliable data accurate forecasting at the community level have not been possible. Forecasting about flash flood is also done at a narrow scale by FFWC. However, flood forecasting is a unique innovation of science in reducing flood risks in Bangladesh. One of the key informants affirms:

> "Flood forecasting and warning is a great development in Bangladesh. It has gained recognition globally. NOAA has expressed interests on how it has been innovated. Moreover, there are some community-based scientific innovations contributing to mitigating the risks of floods and cyclones."



Source: (MoWR, 2006)

Storm surges are frequently striking in Bangladesh due to geo-morphological location. Early warning is an effective tool of risk communication in Bangladesh. Mollick et al. (2009) showed that around 70 major catastrophic cyclones attacked in the coastal zone. However, longitudinal studies (Dhar and Ansary, 2008; Nasreen, et al., 2016) considered early warning as one of the significant tool of communication with the cyclone prone people. The Disaster Management Information Centre (DMIC) is collecting information on storm surges from key stakeholders

including Bangladesh Metrological Department, Flood Forecasting Warning Centre, Institute of Water Modeling, Bangladesh Bureau of Statistics, and Centre for Environment and Geographic Information System. This disaster information dissemination centre warns the people in collaboration with the Bangladesh Metrological Department following a top-down approach. In fact, the Bangladesh Metrological Department under the Ministry of Disaster Management and Relief (MoDRM) is fully responsible to produce warning messages for a particular hazard like cyclone (Dhar and Ansary, 2008). This risk communication system have been connected with the lower tier of the administrative unit and with the household level. There are 11 numbers of signals used by BMD to warn the cyclone-prone people. The key pitfalls to these signals is that these are maritime port-based signals and have been more equivocal to the vulnerable people. Another top-down approach to public engagement is Cyclone Preparedness Programme (CPP), which was established in 1972 with the help of local volunteers of the coastal community. BMD disseminates message to the local CPP units and the selected personnel of the disaster management committee such as chairman and member of District Disaster Management Committee, Chairman and Member Secretary of Upazila Disaster Management Committee, and Chairman and Member of Union Disaster Management committee through high frequency radio. The local volunteers announce cyclone warning message among the villagers through megaphone, sirens, or mobile communication. To overcome the ambiguousness of signals CPP has introduced a flagging process for early warning (Dhar and Ansary, 2008). Three flags have been used to exemplify the signal process (figure-5), of which flag-1 is substituting signals number 1 to 3, flag-2 is indicating signal numbers 4 to 7, and flag-3 is substituting signal numbers 8 to 11. They also provide additional supports including first aid, operating relief and rehabilitation activities, and performing rescue and evacuation functions. Message dissemination related to floods and storm surges is also performed through interactive voice response system (IVR). The people can get weather forecasting and other information relating to cyclone and flood from 10941 or 1090 (Figure-6). The critical aspect is that in Bangladesh the rural people have no enough ability to afford a mobile phone. In contrast, the peripheral people are not more accustomed with the usages of mobile phone.

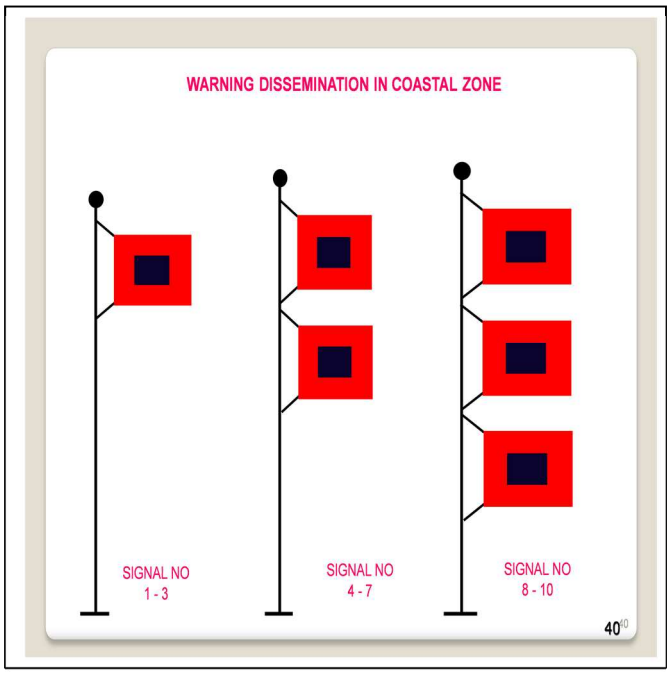


Figure-5: CPP warning process (Dhar and Ansary, 2008

Figure-6: Interactive Voice Response System (IVR)

Hazard map-based science communication: floods and storm surge

Hazard maps have been identified as a key tool of effective communication in Bangladesh. Different types of maps with several layouts are produced for communication with the experts. For examples, Flood Forecasting Warning Centre (FFWC) is producing different maps based on riverine floods. For examples, district inundation maps, upazila inundation maps, and flood forecast maps are produced to indicate the danger level of water and which areas are more prone to flood. The online portal of FFWC also shows several maps like river-based map, division-based map, and district-based map. These maps are indicating different level of water like normal level, warning level, flood level, and sever flood level. Though these maps are easily understandable to the disaster experts, there are some key constraints encountered by the flood-prone people. These includes (i) there are a limited access of the community to these maps due to paucity of internet and computer facilities in the flood-prone areas of Bangladesh, (ii) the vulnerable people are not more aware of these flood hazard maps, (iii) interpreting language of the maps are mostly in English not in local language, and (iv) these hazard maps are not available at the community and at the institutional level. In recent, there has been a change in producing these maps. In contrast, storms surge maps are also produced by the scientists in Bangladesh to estimate the cyclone track based on the port. Like flood hazard maps, these maps are only understandable to the disaster experts. On the other hand, the

interdisciplinary scientists and the cyclone-prone people are not more capable to perceive the scenario of cyclones from the maps due to lack of knowledge. However, community-based risks maps has gained its' significance in the community and in the academia as a key tool of science communication in disaster studies in Bangladesh. These evidence-based multi-hazard maps are particularly produced and designed in consultation with the susceptible peoples. To mitigate risks of the community, the rustic people also propose several risk reduction actions and measures. This is an excellent way of engagement of the community in designing multi-hazard and risks maps.

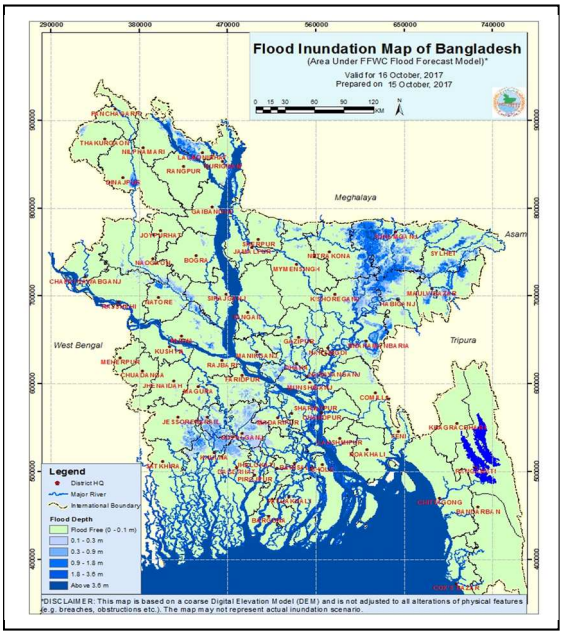


Figure-7: Flood inundation map (FFWC)

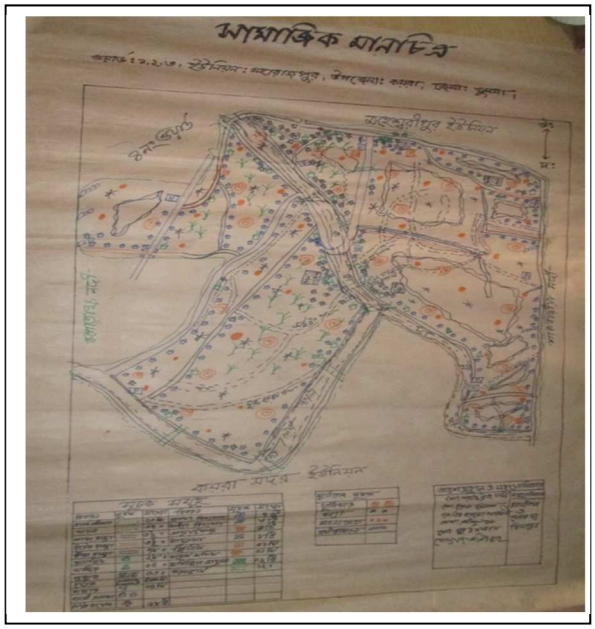


Figure-8: Social Map produced through CRA

Multifaceted social strategies for public engagement

Concurrent development in risk communication system is also playing a crucial role in lessening disaster risks in Bangladesh, for example, via developed short message service (SMS) for flood and cyclone, and the development of community radio. Appropriate early warning system can influence to adopt protective actions and to making appropriate decision for public safety (Perry and Lindell, 2007). The Ministry of Disaster Management and Relief with the support of Disaster Management Information Centre broadcasts information related to imminent hazards via television and radio. But, this process happens only when a hazard is detected in the disaster-prone areas. There is no regular-basis disaster communication process

with the vulnerable people in Bangladesh. Therefore, the application of social marketing approach to sensitize disaster risk reduction behavior is gradually increasing. Disaster risk reduction behavior is also modified and motivated through evacuation drills or simulation programs and mass awareness programs. Bangladesh Fire Service and Civil Defence (BFSCD) under the Ministry of Home Affairs is organizing evacuation drills on fire and earthquake with the public to create awareness. On the other hand, NGOs is also arranging cyclone simulation programs with the inhabitants to change their disaster risk behavior. In addition, international day for disaster risk reduction and national disaster preparedness day are observed by the government agencies, academic institutions, and national level NGOs with direct involvement of public. Different kinds of programs including procession on hazards, rally, and dialogues are organized with the interdisciplinary experts, scientists, and the laypeople. Interdisciplinary expert opinions and dialogues are also telecasted on televisions to produce mass awareness about disasters in Bangladesh. Special bulletins on the daily newspapers, leaflets, and posters are published in observing these special days. To sensitize social notion and the behavior of the inhabitants, different thematic issues are also addressed to ensure the public safety. For example, the thematic titled '*Disaster preparedness round the clock brings sustainable development*' was used to observed the National Day for Disaster Preparedness in 2017. In fact, these events are more urban-based, the people living in disastrous situation have rare access to these program. Thus, these public engagement events have not been fully successful in an effective science communication process.

Interdisciplinary communication: scientists to interdisciplinary scientists, and policy makers

With the increasing demand of disaster studies in Bangladesh, the scientists are also following other effective approaches to social strategy for involvement of the interdisciplinary scientists and the laymen. In conducting empirical research, science communication is extremely pertinent to influence the policy planners. For example, ESPA-Delta was a successful research project of IWFM, BUET. Though an effective communication was not made at initial stage, the scientists of the project conducted 2 to 3 workshops with the policy planners and shared the contribution of the project to ecosystem services. Another research publication also attracted the attention of the policymakers and this research paper emphasized on how ecosystem services had increased in term of food, agriculture, and fisheries among the coastal people. Indeed, this project initiated especially an effective science communication between the scientists and the policy planners of Planning Commission of Bangladesh. Fischhoff (2011)

claims that such communication is ineffective and troublesome to the disaster scientists because of lack of understanding on the issue. One of the key informant cites:

> "The policymakers and laypeople are learning while they face a problem. We are addressing sustainable development. But, what is the cost of it? And what is the tradeoff behind it? Due to paucity of political commitment and timeframe the policy planners cannot work. Thus, the scientists need to understand the language of policymakers about what they want from a science-based research project. But, science-policy interaction is gradually improving in Bangladesh because of institutionalizing holistic approach."

Dissemination on the research projects also takes place at the beginning or at the end on research findings (Keen, Todres, 2007). A very few number of scientists of disaster studies disseminate their research works with well articulation. Perhaps the scientists and engineers working on structural options for disaster risk reduction are not more inclined to publish their research-based scientific innovations in Bangladesh. It happens because of different mind-set of the scientists and policy makers like academic positions, and perceived values and status (Hu et al., 2018). However, social strategy is more influential and draws the concerns of scientists and policymakers by addressing their perceived needs of social engagement in research. For instances, self-publishing model of social strategy was undertaken with the Ministry of Disaster Management and Relief (MoDMR) under DECCMA project of IWFM to enhance the playmakers' concerns. The interaction between scientists and policy planners is now occurring on regular basis in Bangladesh, which leads to producing a better decision in disaster risk reduction. Illingworth (2017) argues that this 'two-way dialogue' fills the gaps and knowledge and boosts up a professional ties and network. During this session, it is very significance for the scientists to represent their research findings to the non-experts or policy makers with easy language rather than scientific.

The broad spectrum of effective science communication in DRR is that it demands a harmonious approach (Shaw, et al., 2016) among the scientists and policy makers. This process is now accommodating interdisciplinary researchers in conducting research in disaster studies. It draws various attentions from several experts from a holistic point of view. A good example of interdisciplinary science communication is 'REACH: Improving Water Security for the Poor'. REACH is an interdisciplinary research project funded by DFID, UK and led by the University of Oxford. The research is conducted in Bangladesh, Kenya, and Ethiopia through engaging multidisciplinary experts like climate scientists, flood experts, water experts, social

scientists, economists, and environmentalists. In addition, interdisciplinary science-based communication creates chances for the students to build their career in scientific research. The academic institutions in Bangladesh are offering interdisciplinary educational curriculum on disaster management and recruiting the young scholars to proliferate interdisciplinary research on disaster studies in Bangladesh. Moreover, hiring interdisciplinary experts on disaster issues is also observed as an effective social strategy to continue the disaster education at tertiary level. This interdisciplinary collaboration brings an effective science-policy interaction and enables the scientists to address critical aspects of integration between science and social science (Shaw, et al., 2016; Illingworth and Prokop, 2017). The key challenge to social strategy is that the scientists are not engaging the public or the interdisciplinary experts from the beginning of the research project in disaster studies. But, the situation is gradually improving because of changing the nature of the research work in disaster studies. The scientists are now approaching to the demand-revenue research project and share their views with the interdisciplinary experts, public, and the policy planners. The contribution of each group is considered significantly in designing to the research project, thereby it creates belongingness to the research work. Thus, interdisciplinary public engagement have been a key tool of social strategy to restructuring a community need-based scientific innovations.

Multifaceted social ways: science communication in disaster studies

The transmission of knowledge on disaster science has also been done by multifaceted ways. The findings of the commissioned research appear after the end of the research project in the mode of journal article, book chapter, final report, and oral presentation at the conference (Keen and Todres, 2007). The peer-reviewed research articles are now being published by the connoisseurs of disaster studies to synthesize the demands of disaster studies in wider society. The findings of A brief policy document reflecting major outputs and recommendations is also produced to synthesize the knowledge of non-specialized persons after the end of the project. The broad aim is to establish disaster studies as an independent discipline in the existing paradigms of science by removing all discrepancies. To achieve this goal, various training programs are offered for the multidisciplinary professionals and experts. For instance, the Institute of Disaster Management and Vulnerability Studies (IDMVS), University of Dhaka (DU) is now conducting various multidisciplinary training program on disaster management. The grass root public engagement on disasters has become a new tool in disaster communication. The government of Bangladesh has promulgated disaster education from primary level to tertiary level. For effective science communication, initiatives have also been

taken for engagement of the students with the community. The academic intuitions such as IDMVS, DU; Department of Geography and Environment, DU; Department of Disaster Science and Management, DU and Faculty of Disaster Management, PSTU are involving the bachelor level students through real-life programs like internship. Internship program develops a proper science-based students-community engagement and invigorates pragmatic knowledge of the students. This community engagement program would able to reduce misconception about disaster studies in community and build trust on disaster communication. Dearth of technical and funding facilities founders the learning process of the students. Apart from this, a real-life bridge between the students and community has also been institutionalized by conducting independent research on disaster related issues. Science-based linkage is also established by conducting seminar, workshops, symposiums, round table discussions, and writing editorial on disaster issues among different stakeholders like scientists-to-scientists, scientists-to-policymakers, scientists-to-laypeople. Inviting the interdisciplinary scientists, experts, policymakers, young scholars, and media personnel at international conference, bi-annual conference, and at group meetings is also promoting the negotiation between science and policy in disaster risk reduction. The 2nd 2018 International Conference on Disability and Disaster Risk Management appealed to the scientists and policy makers to formulate science-based disaster risk policy for the community. Several interactive documentaries, videos, and folk programs have been introduced by NGOs and governmental agencies create mass awareness among the public and the disaster-prone people. Introducing different ways of science communication foments the predilection of policy makers, practitioners, and inhabitants towards disaster risk reduction.

7.2 Specific approaches to SATREPS project

The dominant view of the SATREPS Project is to recognize the key notions of the community, the knowledge of the specialized and non-specialized experts. The scientists of the project adopt several proactive social strategies from the designing of research works. The goal of this proactive science communication is to have a palpable impact of the scientific works on disaster risk reduction in Bangladesh and to influence the decision-making process through producing transparent and credible outputs of the research. The scientific socialization of the SATREPs project, indeed, started with a joint coordination meeting at the beginning of the project between the Bangladeshi researchers and the Japanese counterparts. The joint coordination meeting typically focused on understanding of risk behavior and culture of communities for effective translation of knowledge into resilient development. As, failure to perceive the

community needs and risks decimates sound mitigation measures against flood and storm surges. There also have been ad-hoc science communication at different levels among the scientists for co-design and co-solution of the problems of the research. Co-production of the knowledge is also a key preamble of this research project. This co-production happens at several layers through engaging interdisciplinary experts, researchers, and laypeople in the research works. A methodological process for science community is inbuilt in the research plan from designing phase. This portion of the study emphasizes principally component-wise social techniques adopted in this project for effective mode of science communication, with an especial attention on effective communication process between the researchers (component leaders), interdisciplinary erudite experts, policy makers, and the denizens.

Component I: Flood Disaster Risk Assessment and Mitigation

Across all components, there is a unified science communication for co-production of knowledge on flood and storm surge mitigation. This strengthens the capacity of research at all levels to integrate the community needs in protecting risks of flood and storms surges. In this connection, the prime target of the component I are to (i) map sectoral risks of riverine and flash flood and to produce hazard maps, (ii) revisit the danger level of flood forecasting and warning system, (iii) assess extensive flood damage to identify which sectors like facilities, infrastructure are more vulnerable to flood hazard and to what extent they might be affected, and what responses can be taken quickly. The principles of science communication are truly applied to restructuring soft risk reduction options of flood through involving the flood-prone inhabitants and key stakeholders. At the beginning, the scientists transfer the key ideas to various factions (Hetland, 2014) like public and senior officials of the government to create a solid notion of the research. A novel approach to science communication is self-publishing model adopted under this component. The researchers talked to the flood affected people of Gaibandha and Goawainghat, and to the concerned authorities of flood forecasting in Bangladesh. Interaction at local level with the lower level administrative units like union parishad and Upazalia parishad also proliferate the capacity of the researcher to generate new knowledge. Several communication meetings was held with Bangladesh Water Development Board (BWDB), Department of Disaster Management (DDM), Flood forecasting Warning Centre (FFWC), Geological Survey of Bangladesh (GSB), Local Government Engineering Department (LGED), and Planning Commission of Bangladesh. The study depicts that there are a long-term working relation with Bangladesh Water Development Board and the government officials of BWDB, who have completed graduation from BUET, are working as

vehicle in transferring and implementing science-based knowledge in flood risk management. For effective translation of knowledge several small meetings are organized by the component leader with the Director General of BWDM and other relevant stakeholders. Interaction between the scientists of the component and the government officials have also been possible due to organizing inception workshops. These strategies bring into focus the interests of BWDM how the research can redefine danger level. The flood-prone inhabitants and influential personnel are also involved in the research project to elicit a new pathway of research through accepting their critical opinions on flood risk mapping. The researchers also interacted and consulted with the community people for exploration of new dimensions of damages and losses to the property and lives. The sharing and feedbacks from different stakeholders at the beginning of research employ the scientists to rethink or to modify their proposed research questions, thereby they would be able to invigorate "reliable knowledge" (Miller, 2001) and establish linkage with the community. For examples, flood risk map have been introduced with key features and redefined the danger level by assessing flood damages in the context of local setting and flood mapping is made more tangible to the concerned authorizes and the community. The existing danger level was defined in the context of aman crop damage and homestead. While, flood damages are also associated with other sectors like industry, market places, growth centers etc. Mathematical simulation was used for flood damage mapping and flood levels at different return period was determined. Flood mapping indicates at what level of water which sectors will be damaged. Figure-9 indicates flood analysis for a 100 years return period. The map delimits different sectors including velocity of water with high flow, roads, hospitals, and embankments along with flooding depths. Areas with more than 0.4 m/s flow velocity are indicated as high flow-velocity areas and what type of evacuation are needed (Salehin et al., 2017). Though flood hazard and risk map are highly technical, these self-explanatory maps would be able to guide the decision makers to take proper evacuation actions and flood protection measures. In addition, the manifested characteristics of maps would enable the policy planners in taking profound decision. The component leader confesses:

> "We have planned to validate the maps through workshop at the community level and to create awareness among the inhabitants so that they can understand their risks in a participatory way."

Integrated disaster research generates new outputs of scientific investigation and explore possibilities for sustainability of disaster risk reduction process (Shaw et al., 2016). An integrated collaborative nature was adopted with Bangladesh Institute of Development Studies

(BIDS) for assessing the impacts of flood. Assessing flood damage from comprehensive way have only been possible due to this collaborative nature of the component. For ensuring sustainable of flood damage assessment process in decision making process a teaching and training module has also been prepared for the government, non-government officials, and students to provide holistic training on flood damages and danger level. A participatory pilot training has also provided among different level of government and non-government officials for smooth implication of the outputs of the component I. However, the key limitation to science communication is that maps should not only focus on flood damage. Other damages germane with flood could be damaged for better preparedness measures. Though an approach has been applied through effective science communication, it will take long time for integration into decision-making process of flood risk management.

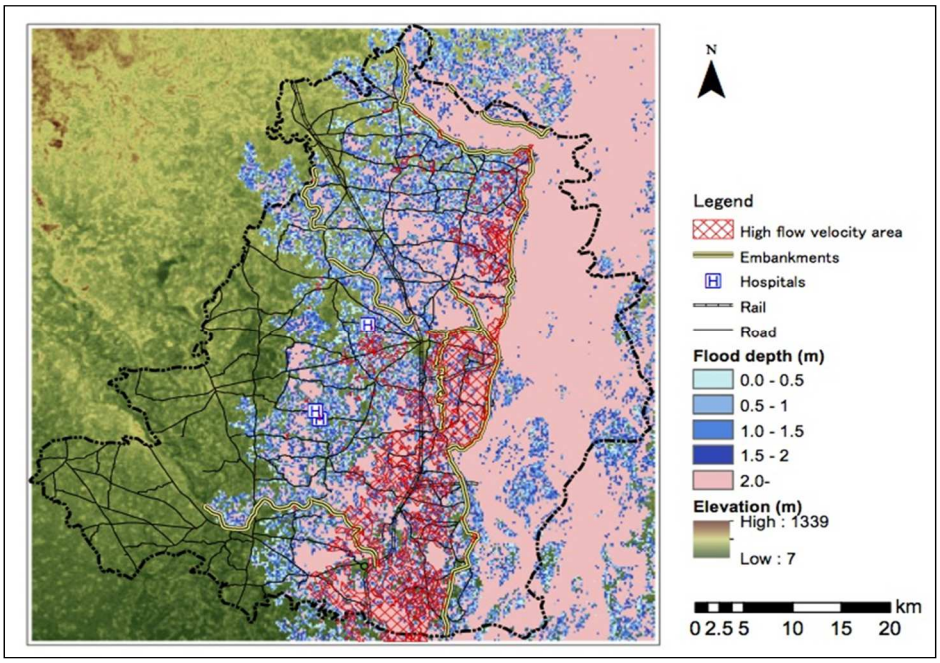


Figure 9: Hazard mapping in Gaibandha District (Salehin et al., 2017)

Component II: Improved Strom Surge Warning and Evacuation Systems

Effective mode of science communication in storm surge warning aids the inhabitants to evacuate from a trapped situation. Hibino and Shaw (2014) provide a constructive view of risk communication for community warning. In accordance with them, an informative communication system brings changes in risk knowledge and makes them more reactive in lessening the unwanted susceptibility and shocks. In a similar vein, the component II presumes that cyclone warning is a soft risk reduction step that can pacify human life loses and damage

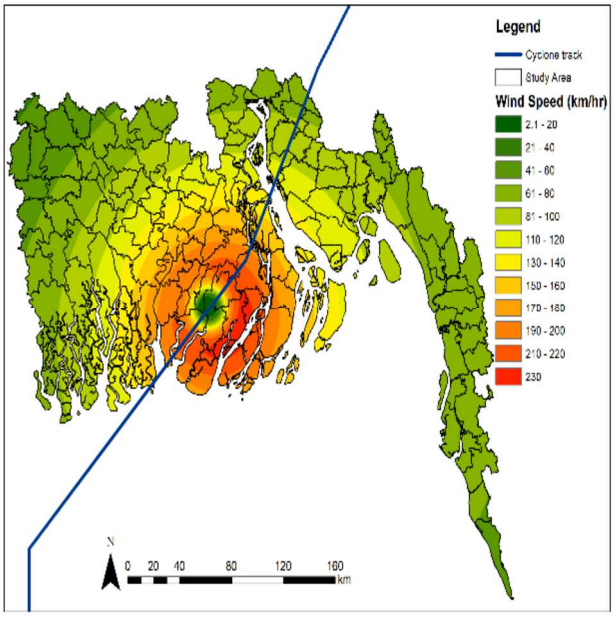
to property. The present warning is basically port oriented and it's too much qualitative. Quantitative information is not presented while disseminating early warning information. Even, meanings of warnings 5, 6 & 7 and meanings of warning 8, 9 & 10 are similar. In addition, community language has not been addressed in the warning process. Thus, the cyclone-prone people become bemused and delayed their evacuation actions. One of the scientists admits:

> "The component II is working on cyclone warning and evacuation. Bangladesh Metrological Department is now providing port centric warning message from 1 to 10. But, this warning had not been developed considering amount of loss, property, and language of the common people."

In order to improve apocryphal condition of cyclone warning system the component II has taken initiatives to review the existing warning system. This innovative research argues that there have possibility to improve the current warning system without modification of the signal number. But, additional information like wind speed, height of surge, household status, polder status can be included in the current cyclone warning system on location basis (Haque et al., 2018). However, a self-publication model was followed initially for effective science communication with Bangladesh Metrological Department. The self-publication meeting with BMD informs that the research is capable to formulate modelling at root level like village and mouza to disseminate disaster warning. Classification of houses such as pucca, semi-pucca, kutcha, and jhupri is made following technical definition of Bangladesh Bureau of Statistics (BBS). Translation of cyclone warning from scientific language to local language is more understandable for the community people. It is presumed that this warning system would able to detect which types of infrastructure will be damaged at what height and extent of storm surges. However, Due to sensitiveness, BMD is not prepared to implement this system along with the existing cyclone warning. Early warning is highly susceptible and directly linked to human lives. Thus, BDM would like to implement this warning process slowly after getting evidence-based result of the study.

Linkage of research findings with the community is also imperative for validation and for the community betterment. Community engagement is also done directly to assess the reliability and validity of the outputs of the improved early warning system. In this context, a field meeting with the community was done in Batiagacha upazila of Khulna and Sharonkhola upazila of Bagerhat district. The community engagement meeting cites that the present warning system would be more effective for them in reducing disaster risks. However, to reduce

confusion about early warning system posters and leaflets could be distributed among the local people to aware about present early warning system. Science communication of this component has also been completed by providing training on the improved early warning system. The component leader shared the working process of the cyclone warning system with the government and non-government agencies. Like other components, the young researchers have also been recruited in conducting innovative research. Based on research findings, three (3) conference papers has also been submitted to inform others about the current status of the research. For example, a research paper titled '***Effectiveness of Adaptive Measures against Storm Surge Hazard based on Field Experience from a Real Time Cyclone in Bangladesh Coast***' have been presented on 2nd UIU International Conference on Sustainable Development, 2018. Another paper on 'Impacts ***of Storm Surge on Coastal Infrastructure in the Coastal Region of Bangladesh***' have been submitted to the 12th International Symposium on Ecohydraulics in Japan. Cyclone hazard maps, furthermore, have been prepared based on historical cyclone track (1960 – 2009) for bettering understanding the future cyclone events (figure – 10). However, these social strategies for science communication have been effective for disseminating the outputs of the result with an attention on communication process between the researchers (component leaders), interdisciplinary erudite experts, and the denizens or the laypeople.



Signal		Wind Speed (km/hr)
Cautionary Signal No.	2	20 - 40
Warning Signal No.	4	41 - 61
Damage Signal No.	6	62 - 87
Great Signal No.	8	88 - 117
Great Signal No.	9	118 - 170
Great Danger Signal No.	10	More than 171

Figure-10: Cyclone track map and proposed improved early warning system (Haque, 2018)

Component III: River Bank Erosion and Embankment Failure

To manifest the application of science and technology in reducing river bank erosion and levee failure the SATREPs project under component III aims to (i) review the existing research documents and collect relevant data from the field; (ii) to produce geographic information-based maps by investigating failure mechanisms of embankment, (iii) develop nature and low-cost friendly protection measures for sustainable development. The subject matter of this scientific study requires an extensive involvement of concerned authorities including government, non-government, and public that can boost up the capacity of the researchers to implement the results in flood risk management. Thus, effective science communication of this component have been started from the projects' inception. Due to working for a long period the scientists would able to share their research ideas and establish a linkage with Bangladesh Water Development Board, Local Government Engineering Development, and Planning Commission. The sharing meeting discussed about how we can communicate with the local people. For research-based scientific communication with the inhabitants and the key stakeholders the research project has produced several articulated maps on flood. Fujita et al (2017) claims that hazard map needs to articulate a balance combination of evacuation and early warning due to destructive speed of flood and erosion. The maps, developed under component III, would be able to predict the impact on housing and possible disasters will strike in the future at the community. This self-explanatory maps have highlight different legends and pictorial so that the local people and decision planners can make quick decision for flood risks. It has been planned to validate these maps at the community after completion of final process to institute science communication with the community.

Another science communication strategy is performed by the researchers in a collaborative way. The component III have promulgated a low-cost infrastructure for protecting river erosion in collaboration with Bangladesh Water Development Board and Kyoto University, Japan. An in-depth-interview with the component leader reveals:

> "This is nature friendly infrastructure made of bamboo and wood. It will not work against river forces like velocity, sediment etc. Conversely the low-cost infrastructure will manage river erosion by using river forces. One (1) km nature friendly infrastructure cost only BDT 20000. It is very much beneficial for nature to protect our biodiversity."

To institutionalize this indigenous river protection measures a broad community engagement is established while constructing this low-cost infrastructure in cooperation with BWDB. For

examples, BWDB contextualized this idea among the community people and engaged them at the phase of implementation. A short documentary has also prepared by BWDP to create awareness among the local people. As a result, a strong ownership have been established from its' inception at the community. Apart from it, a monitoring plan has also proposed to ensure its' sustainability and BWDB showed interest to provide necessary financial support for monitoring and sustainability.

Like other components, interdisciplinary communication means are also followed to achieve the subject matter of the study. The research teams comprise of social scientists, gender specialists, engineers, environmentalists, and disaster specialists co-production and co-evaluation of the developed knowledge. In fact, the research has been conducted by involving interdisciplinary young scholars for long term knowledge development. This interdisciplinary approach, moreover, is inbuilt in this research due to conducting research on various issues supported by JICA for 20 years. Though collaborative research suffers to establish a way of communication, it is every effective in generating good output of the research. External public involvement in research also unlock funding opportunities for the researchers (Shaw et al., 2016; Illingworth, 2017), and it is very important to the funders how research is producing evidence based results through effective science communication (Spicer, 2017). This collaborative research project has created a funding opportunity for future research. BWDB has offered a great opportunity to carry out an extensive research on river erosion with sufficient fund. Thus, it is evident that there are ample chances to replicate tools and techniques in other flood prone areas of Bangladesh. The process, furthermore, will ensure the sustainability of this innovative science in protecting river erosion and embankment failure.

Organizational communication for sharing knowledge is also playing significant role in building network. A self-marketing approach is actually applied by the scientists in producing a broad spectrum of idea about SATREPs project. Because of having a long-term relation with the relevant stakeholders it has been possible to organize training program and workshop for exchanging the ideas. This organization relation also helps to co-design and co-evaluation of the projects. In addition, the lead scientist of the component plays a pivotal in institutionalizing science communication with several wings of Planning Commission and other relevant institutions. In the words of lead scientist of the component:

> "When I worked in the project of Delta Plan of Bangladesh Government. I wrote a letter to the Minister, Ministry of Planning about the involvement of a study into Delta Plan. I thought, I don't get any response from the minister. But, the minister forwarded the

> letter to Planning Commission. It was established a link with the decision-planners and implementers and created a long-term institutional network."

Self-initiatives social strategy for science communication has accelerated prompt responses from several international and national organizations. Thus, science communication between the scientists and the policy planners is possible due to innovative thinking of the researchers. In addition, personal connection between the scientists and the policy makers also enhances the working capability. Though, there are some institutional barriers in science communication, regular communication like meetings, seminars, and symposiums can make a stronger bondage between scientists and policy planners.

Component IV: Flood Assisted Spreading of Deposited Toxic Substances

This part has primarily put an emphasis on science communication from malign environmental toxic aspects. The primary aim of the component IV is to examine the quality of water and to focus the pollutants which are negatively affecting health of urban poor community by flood in Dhaka city. An especial concern is also given to understand the behavior under different environmental scenarios. For scientists, this research is an excellent opportunity to engage various stakeholders including Department of Environment (DoE), the community. An effective science communication begins when the scientists design the methodological framework. Self-marketing model (SMM) is adopted for building awareness about flood assisted spreading of deposited toxic substances. This self-publishing meeting with DoE is, indeed, contextualize and familiarize the research problems. This initiative inspires the scientists to transmit the knowledge among other pertinent groups including community leaders, interdisciplinary researchers, and vulnerable people. In line of research techniques, a social mapping is conducted through close interaction with the community people on Tongi Khal and Balu River for delineating possible sources of contamination during flooding in Dhaka city. This way of communication is actually raising awareness among the people living in anthropogenic polluted areas. Scientists-practitioners interface has also been instituted by disseminating maps and the findings on a training program. At the pilot training, the team leader of the component discusses about critical outputs of the study and invites opinions from the participants including academia, government officials, and practitioners. A very inclusive approach to science communication is also involvement of young researchers under the component objectives. These fellows are able to make face-to-face communication with the scientists and make valuable contributions in completing the research works successfully. To reach at the wider academic milieu peer-reviewed research publications have been produced

for effective communication. Apart from this, a workshop have been set for influencing the community, NGOs, and GOs about possible preventive measures for pollution and anthropogenic factors. As, it is evident that mainstreaming the findings into policy planning can only be successful through generating and disseminating evidence-based scientific outputs.

Component V: Disaster Management Strategy for Resilient Society

Science-policy interface in disaster risk reduction has burgeoned as key agenda in the post-2015 global accords (Shaw et al. 2016) and holistic standpoint is also required for proper interplay between policy and practice (Shaw et al. 2016, Weichselgartner and Pigeon, 2016). SATREPs project presents effectively an insight of mainstreaming policy into practice in disaster risk reduction in Bangladesh. The assembled social strategies of the project are working as vehicles to transfer innovative knowledge from scientific stage to practice. Indeed, the component-V makes a bridge with various key factions of disaster management to mainstream scientific knowledge into policy implementation. This mainstreaming starts with establishing a university network. At least 14 recognized public and private universities are now jointly working to mainstream disaster education at tertiary level. Shaw et al. (2012) examined that a university network is a platform of sharing knowledge and of producing knowledge pertinent to disaster management. The university network developed under SATREPs project organized four (4) network workshops for sharing knowledge on disaster risk reduction and made critical evaluation of disaster education in Bangladesh. The critical role of university network paves a way to produce course curricula on flash flood and urban flooding for undergraduate and graduate students. This university network as a social tool of communication is particularly influencing the interdisciplinary scientists to engage in scientific research. For instances, five field-based research projects on interdisciplinary issues of disaster management have been carried out under this university network. Field-based storytelling case study reports have been prepared from these projects to extend the knowledge on disaster risk reduction at tertiary level. Besides, peer-reviewed articles and scientific papers for sources are also prepared for dissemination of scientific knowledge at academic arena. It is evident that these approaches to social strategies are pivotal for effective science communication and for sustaining disaster education at tertiary level.

In the continuum of disaster management a gap between theory and practice is always persistent. To minimize this gaps the scientific initiatives of SATREPs produces a social space for both practitioners and scientists. Like university-based social space, a NGO network is also

developed for bridging between theoretical and pragmatic works. Bourdieu (1987) claims that science as a social field correlates theoretical view to practice and enables the agents like scientists, policy planners, and practitioners with ample ideas and knowledge (Bourdieu, 1987; Luthje, 2017). Several workshops for NGOs practitioners and government officials are organized to reach out the benefits of the project at the community level. These workshops actually empowers the practitioners with sufficient knowledge and techniques on how to deal with flood risks in Bangladesh. Furthermore, eight (8) training modules have been introduced for buttressing their knowledge in connection to flood and cyclone risk management. A pilot training on these respective modules was also performed to validate and to address the critical aspects of scientific communication. Other communication materials such as booklet and leaflet are also used to articulate scientific knowledge of SATREPs project. However, a broader spectrum of science communication denotes an extensive focus on need-based science-policy integration to conciliate uncertain risks induced by climatic pressures.

7.3 Challenges towards science communication of SATREPs

This workbook elucidates several complexities involving in science communication in Bangladesh. Disaster studies as an emerging discipline is still at the stage of development and is encountered many theoretical and pragmatic crises to establish itself as a scientific discipline. Especially, the controversies and debates between theory and practice have been illuminated by the scientists from several standpoints of views. An attempt have been adopted in this research paper to illustrate the key drawbacks of science communication in Bangladesh in the context of SATREPs project. It is evident that effective science communication takes a long time to uptake the outputs at field level. As a result, a great challenge to the SATREPs project is about its' sustainability. After project period it is very importance to continue the activities for effective implementation of scientific outputs. In addition, funding is a key challenge for sustaining the scientific innovations of the project at community and at institutional level.

Though SATREPs project has taken a good initiative in illuminating prevention and mitigation functionalities against flood and storm surge, an especial focus is needed to address the state of art and gaps. For example, the existing process of flood damage focuses only direct loss. But, there is an urgency to address other dimensions and sector wise expected losses. On the other hand, the research has produced some specific hazard maps for flood and storm surge. It is very imperative for the researchers to validate these maps with the community to unfold the critical issues of maps. Simplification of scientific language is also required for these hazard

maps. The research findings of improved early warning and evacuation system, furthermore, has not been possible to implement at field level due to sensitiveness of early warning and forecasting. As, BMD is not ready to apply the outputs of the research. Early warning is so susceptible and directly linked to human lives. Thus, without evidence-based research and practical it is very hard to achieve public trust on early warning. Moreover, technological support is also needed to apply early warning system. Limited knowledge of the community on warning system is also a barrier to create mass awareness about early warning. In addition, fatalistic attitude discards belief of the people on early warning.

Like early warning, the research has taken initiatives to revisit the danger levels. These redeveloped initiatives has not been implemented at field level. Though the scientists has taken self-publication model (SPM) to share their ideas with Bangladesh Water Development Board and Bangladesh Metrological Department, it is important to motivate the agencies by giving priority on the project results. Another key limitation is that the implementing agencies in Bangladesh are not communicating with the scientists. Because, there is no solid relationship between the scientists and the implementing agencies. Thus, institutional system is important to address values for application of science and technology into decision-making. A low-cost nature friendly is also installed in Sirajganj hard point for protection river erosion under the project. For developing ownership with the community a long-term monitoring plan is required. But, there is uncertainty due to lack of sufficient fund after the project period.

8. Examples of effective science communication for flood and storm surge risk

A wide dissemination of hazard related information is needed in context of scientific innovations for disaster risk reduction. Weichselgartner and Pigon (2017) claims that there is inadequate advancement in interplay “science-policy-practice” that is foundering the usage of risk knowledge against unexpected natural pressures. Evidence (Miamaki and Shaw, 2014; Fujita and Shaw, 2014; Shaw, 2014) anecdotes that Japan has made successful progress in disaster risk reduction through specific social approaches to science communication. For examples, a successful science-based risk communication was made by the Kyoto University after a school disaster education program after a number of catastrophic typhoons in 2004. The university introduced the program in collaboration of Saijo City education board. The broad aim of this program was to build a bondage between school and community through observing situation of affected people (Shaw, 2014). A “mountain watching” program was actually introduced for the participants including children, inhabitants living in mountain areas, teachers,

local government authorities, and forest officials. Indeed, the participants paid an extensive attention to perceive the devastating damage crated by typhoon. During this period another relevant program like “town watching” was also introduced for the living in plain land of Saijo city. Initially, “town watching” program was applied in 5 elementary schools whereas “mountain watching” program was for three junior high schools (Shaw, 2014). A school-community linkage was established through engaging the students with the community. The students talked to the affected people for gathering extensive knowledge and integrated this knowledge into education system. After the project period the education board of Saijo city continued this disaster education program and institutionalized in the education process (Shaw, 2014).

Another good example of risk-based science communication is about the development of Inclusive Risk Reduction Action Plan (IRRAP) in Durgapur upazila of Netrokona district in Bangladesh. This administrative unit is quite susceptible to flash floods, generated from surrounded river Someshwari. In 2014 flash flood caused a great deal of damage to infrastructures such as roads, embankments, and standing crops (Nasreen et al., 2014). In reducing the devastating effects the DIPECHO VII developed an Inclusive Risk Reduction Action Plan (IRRAP) in two unions of Durgapur upazila through multi-stakeholders consultations. The process targeted chairman and members of union parishad, teachers, farmers, guardians of school going children, businessmen, and special groups such as women, person with disabilities (PWD), and children (Nasreen et al., 2014). At first, a meeting was held with the Union Disaster Management Committee (UDMC) and Ward Disaster Management Committee (WDMC) to ensure participation of all groups. A participatory approach was followed to include all views of all stakeholders, including ideas of vulnerable groups. At the beginning, the entire process provided a short training workshop with the participants on how to analyze community hazards and risk following community risk assessment (CRA) techniques. The training also emphasized on preparedness mechanisms and first aid. However, during CRA process the local inhabitants identified their potential risks, vulnerabilities, and potentialities. The community also developed a hazard map and indicated areas prone to flash flood, roads, embankments, houses, and crop fields through group consensus and consultation. Finally the group consultation process developed a Risk Reduction Action Plan (RRAP) and identified major key actions based on priority of risks (Nasreen et al., 2014). After recommencement of a joint CRA, the UDMC and WDMC took initiative to repair roads, tube-well, embankments and tried to revive the livelihood of vulnerable groups. The participants

also developed four schools and a transition school with the help of DIPICHO VII, which were also used as flood shelters during emergency situation. The participants of CRA worked effectively with the members UDMC and WDMC to mitigate vulnerabilities. The key challenge of this process was that conservative mind-sets of local people destabilized the participation of women. However, social learning of RRAP was that the rustic people were more enthusiastic and devoted to lessen their risks by applying their own developed community-based risk reduction action plan (Nasreen et al., 2014).

9. Concluding Remarks and Way Forward

This research paper has synthesized an entire process of social strategy for depicting a lucid view of science communication in disaster risk reduction. Considering interdisciplinary nature of disaster management mechanisms the SATREPs project adopted an integrated social technique for effective science communication that contributes to produce better policy-making decision and to changing evacuation behavior of vulnerable populations. This inclusive nature of the projects has developed a social space, in which the interdisciplinary scientists are working jointly for co-production and co-evaluation of knowledge and reducing the gaps of research. The modest endeavor of science communication has also linked the policy planners, decision makers, practitioners, and the inhabitants living in disaster-prone areas. In this aspect, social strategy, which assembles a wide range of communication activities, has established "two-way interactive' Kikkawa, 1999; Takeuchia and Shaw, 2011) channel to institute proactive action against natural disasters at different strata of society. It is evident that engagement of multi-stakeholders in research project generates real-life based scientific knowledge and is very imperative for unfolding negative effects of climatic events and its' preventive mechanisms. Our extensive findings of the study illuminates social approaches to science communication, which are bridging between the interdisciplinary experts and the policy planers. Institutional network is revealed as a key instrument of equilibrium whereas community engagement has also helped to produce demand-based renovation in the research works. Though participation-based science communication has burgeoned knowledge at institutional and community level, application of the research outputs to field level requires long time. On the other hand, dearth of disaster knowledge of the community and expertise of the policy makers are destabilizing novel efforts of SATREPs project. By doing in-depth analysis on several social strategies for science communication we have proposed some constructive recommendations for more extension application of the research outputs to practical level.

- Academic engagement for more demand-revenue scientific innovation is required to document disaster management practices into academic knowledge. In addition, there is a need of balance between demand-revenue research and community-need based research.
- A wide extensive dissemination of results is also required to educate different level of stakeholders. Self-publication approach could be applied to other relevant stakeholders working in the areas of disaster management.
- Engagement of academicians and students are important from schooling and university in community activities and services for disaster risk reduction. These such types of activities can bring a change in risk behavior and can create awareness about disasters. It is suggested by the study that one (1) compulsory community engagement course can be introduced for the undergraduate students.
- For smooth application and sustainability of the research results, field school on different disaster prone areas can be established in collaboration with the NGOs.
- The SATREPs project has established an academic network. This network can work as a change agent for storing data on different disasters. Thus, a data hub can be introduced in different areas so that the researchers can collect data on a particular area of disaster management.
- For more implication of research outputs, an effective science communication can be done through inter exchanging the faculty members and students. Even, knowledge sharing program can be organized at different universities.
- The community people have confusions on early warning and forecasting system. To overcome the confusions a pilot simulation or drill can be organized to overcome the confusion of BMD and local people.
- Social campaign is needed to create awareness about early warning. A good initiative could be taken to distribute posters with signal numbers and information on damage probability at every union office and at the community level. The people will watch this and getting accustomed with the information. Thus, when BDM will warn the people about any disaster, they will understand that will instigate to take prompt evacuation action before disaster occurs.
- Early warning dissemination apps can be developed and distributed among the community people and youth or volunteers that will enhance the activities of Cyclone Preparedness program.

- It is evident that without political interest it is not possible to implement research findings at the field level. Thus, research findings should be brought to political leaders and community people through common language. For examples, hazard maps, flood damage maps can be shared with them and feedback can be incorporated.
- Maps should be more self-explanatory with sufficient features so that common audiences including inhabitants, policy planners, and other experts are able to anticipate risks and make risk-based decisions.
- Collaborative monitoring plan comprising academia, policy makers, and practitioners is needed to address proper investment and demand of the community and to focus the gaps.
- Finally, it is revealed from the study that there is a question of sustainability of the research innovations. Though some innovations have been implemented at field level, a collaboration is required to continue the project. In this context, alternative funding sources can be explored for sustaining the scientific innovations.

The overall evaluation on application of social strategy reveals that science communication is playing a pivotal role in redeveloping new ideas on disaster risk reduction. Several critical reviewers (Shaw et al., 2016; Bourne, 2015; Luthje, 2017)) has emphasized on importance of science communication in disaster risk reduction. Evidence-based scientific socialization will foster demand-revenue knowledge and will help in policy planning through developing a network.

10. References

Banu, K. D. and Sami S. O. (2014). Social marketing concept and application of social marketing on organizations. *International Journal of Advances in Management and Economics*, 4:1- 7.

Bourne, L. (2016). Targeted communication: the key to effective stakeholder engagement. *Social and Behavioral Sciences*, 226: 431 – 438.

Braha, J. (2017). Science communication at scientific societies. *Seminars in Cell & Developmental Biology*, 70:85-89.

Cooke, S.J., Gallagher A.J., Sopinka, N.M., Nguyen, V.M., Skubel, R.A., Hammerschlag, N., Boon, S., Young, N., & Danylchuk, A.J. (2017). Considerations for effective science communication. *FACETS 2*: 233–248. doi:10.1139/facets-2016-0055.

Coppola, D. P. (2007). *Introduction to International Disaster Management*. Elsevier: Amsterdam.

Dhar, A. S., & Ansary, M. A. (2008). *Disaster Early Warning System for Cox's Bazar*. Comprehensive Disaster Management Programme (CDMP), Ministry of Food and Disaster Management: Dhaka.

Fischhoff, B. (2011). Applying the science of communication to the communication of science, *Climate Change*, 108:701 – 705.

Fishhoff, B. (2013). The science of science communication. *Proceedings of the National Academy of Science*, 110(3): 14033-14039. Doi: doi:10.1073/pnas.1213273110.

Fujita, K., & Shaw, R. (2014). Community Practices of Transmitting Daily and Disaster Information in Reihoku Area. R. Shaw (ed.), *Community Practices for Disaster Risk Reduction in Japan*, Disaster Risk Reduction, DOI 10.1007/978-4-431-54246-9_10, © Springer Japan 2014

Fujita, K., Shaw, R., & Nakagawa, H. (2017). Social Background of River Erosion Areas in Bramaptra and Ganges Rivers: Implication for Japanese Hazard Mapping Technology in Bangladesh. *DPRI Annuals*, No. 60 B.

Haque, A. et al. (2018). Training module on Development of Improved Storm Surge Warning and Evacuation Systems for Bangladesh Cost. Paper was presented at a pilot training held on 14 February. 2018 at Institute of Water Flood Management, BUET.

Heink, U., Katja, E. M., Jax, K. H. et al. (2015). Conceptualizing credibility, relevance and legitimacy for evaluating the effectiveness of science-policy interfaces: Challenges and opportunities. Social and Public Policy, Vol. 42. Issue: 5: 676-689. https://doi.org/10.1093/scipol/scu082.

Heritage, J. (1991). Intention, Meaning and Strategy: Observations on Constraints on Interaction Analysis. *Research and Language and Social Interaction*, Vol. 24, 1990/1991: 311-332.

Hetland, P. (2011a). Science 2.0: Bridging Science and the Public. *Nordic Journal of Digital Literacy*, 6(special issue), 326 – 339.

Hetland, P. (2014). Models in Science Communication Policy: Formatting Public Engagement and Expertise. *Nordic Journal of Science and Technology Studies*, 2(2), 5 – 17.

Hetland, P. (2017). Rethinking the Social Contract between Science and Society: Steps to an Ecology of Science Communication. Doctoral Thesis, Department of Education, Faculty of Educational Sciences, Oslo: University of Oslo.

Hibino, J., & Shaw, R. (2014). Role of Community Radio in Disaster Management: Reflections from Japan. In: R. Shaw (ed.), *Community Practices for Disaster Risk Reduction in Japan*. Springer: Tokyo.

Hu, S., Li. Z., Zhang, J., & Zhu, J. (2018). Engaging scientists in science communication: The effect of social proof and meaning. *Journal of Cleaner Production*, 170: 1044 – 1051.

Illingworth, S. (2017). Delivering effective science communication: advice from a professional science communicator. *Seminars in Cell & Development Biology*, Vol. 70: 10 – 16. http://dx.doi.org/10.1016/j.semcdb.2017.04.002.

Illingworth, S. and Prokop, A. (2017). Science communication in the field of fundamental biomedical research. *Seminars in Cell & Development Biology*, 70:1 – 9.

Jucan, M. S. and Jucan, C. N. (2014). The Power of Science Communication. *Social and Behavioral Sciences*, 149: 461 – 466.

Keen, S. and Todres, L. (2007). Strategies for Disseminating Qualitative Research Findings: Three Exemplars, *Qualitative Social Research*, 8(3):1 – 10.

Lubchenco J. (1998). Entering the century of the environment: A new social contract for science. *Science*, 279: 491 – 7.

Luce, R. D. and Raiffa, H. (1957). *Games and decisions*. New York: Wiley.

Luthje, C. (2017). Field-specific mediatization: Testing the combination of social theory and mediatization theory using the example of scientific communication. *Mediatization Studies*, 1(1): 45-67.

Mallick, B., Witte, S. M., Sarkar, R., Mahboob, A. S., and Vogt, J. (2009). Local Adaptation Strategies of a Coastal Community during Cyclone Sidr and Their Vulnerability Analysis for Sustainable Disaster Mitigation Planning in Bangladesh. *Journal of Bangladesh Institute of Planners*, 2: 158 – 168.

Massimiano, B. (2008). Of Deficits, Deviations, and Dialogues: Theories of Public Communication of Science, In: Massimiano Bucchi and Brain Trench (ed), *Handbook of Public Communication of Science and Technology*. New York: Routledge.

Miller, S. (2001). Public understanding of science at the crossroads. *Public Understanding of Science*, 10: 115-120. DOI: 10.1088/0963-6625/10/1/308.

Mimaki, J., & Shaw, R. (2014) Community Development and Disaster Preparedness in a Depopulated Society: Case of Tosashimizu City, Kochi Prefecture. In: R. Shaw (ed.), *Community Practices for Disaster Risk Reduction in Japan*, Disaster Risk Reduction, DOI 10.1007/978-4-431-54246-9_8, © Springer Japan.

MoWR (Ministry of Water Resources). (2006). Consolidation and Strengthening of Flood Forecasting and Warning Services. *Final Report*, Vol. 5-Project Extension Report.

Nasreen, M., Hossain, K. M., Azad, A. K., & Hassan, K. (2014). *Best Practices of Strengthening Resilience and Safety in Schools and Communities in Bangladesh*. Research Report. DeSHARI Consortium Bangladesh: Dhaka.

Nasreen, M., Hossain, K. M., and Azad, A. K. (2016). Climate Change and Livelihood in Bangladesh: Experiences of People Living in the Coastal Regions. In: C. Effendi, V. Rajendran, M. H. Kawsar (ed.), *Climate Change and Vulnerability: Cases from CIRDAP Member Countries*. CIRDAP. Dhaka.

Nisbet, M. C., & Scheufele, D. A. (2009). What's next for science communication? Promising directions and lingering distractions. *American Journal of Botany*, 96(10):1767-1778.

Nisbet, M.C. & Markowitz, E. (2015) Public Engagement Research and Major Approaches. Literature review and annotated bibliography prepared support of the AAAS Leshner Leadership Institute. Washington, DC: American Association for the Advancement of Science. Available at: http://goo.gl/gRCg8M.

O'Brien, G., O'Keefe, P., Gadema, Z., & Swords, J. (2010). Approaching disaster management through social learning. *Disaster Prevention and Management: An International Journal*, 19 (4): 498-508.

Perry, R. W. and Lindell, M. K. (2007). *Emergency Planning*. John Wiley & Sons, Inc.: Danvers.

Shaw, R., Takeuchi, Y., Krishnamurthy, R., Pereira, J. J., & Mallick, F. (2012). Universities and Community-Based Disaster Risk Reduction. *Community, Environment, and Disaster Risk Management*, 10: 55 – 66.

Shaw, R. (2014). Typhoon, Flood and Landslide Related Disasters in Japan: Role of Communities. In: R. Shaw (ed.), *Community Practices for Disaster Risk Reduction in Japan.* Springer: Tokyo, 33 – 47.

Shaw, R., Izumi, T., & Shi, P. (2016) Perspectives of Science and Technology in Disaster Risk Reduction of Asia. *International Journal of Disaster Risk Science*, 7:329-342

Shaw, R., Yang, S., Chan, E., and Shi, P. (2018). *Science and Technology into Action: Disaster Risk Reduction Perspectives from Asia*. Beijing, China: ASTAAG Secretariat.

Spierenburg, M. (2012). Getting the message across biodiversity science and policy interface: A review. *GAIA*, 21:125-34.

Steiger, E., Albuqerque, J.P., & Zipf, A. (2015). An advanced systematic literature review on spatiotemporal analyses of Twitter data. *Transactions in GIS*, 19(6): 809-834. Accessed on 01 June, 2018.

Spicer, S. (2017). The nuts and bolts of evaluating science communication activities. *Seminars in Cell & Development Biology*, 70: 17 – 25.

Takeuchia, Y. and Shaw, R. (2011) Possible Risk Communication Framework in Typhoon Affected Areas of Taiwan. *Asian Journal of Environment and Disaster Management.* 3(2): 63–175.

Wang, Z. and Ye, X. (2017). Social media analytics for natural disaster management. *International Journal of Geographical Information Science,* DOI: 10.1080/13658816.2017.1367003.

Weichselgartner, J. and Pigeon, P. (2017). The Role of Knowledge in Disaster Risk Reduction. *International Journal of Disaster Risk Science*, 6: 107 – 116.

Van den Hove S. (2007). A rationale for science-policy interfaces. *Futures*, 39:807-26.

Social strategy for effective science communication: Lessons for SATREPS project and beyond

"If you can't explain it simply, you don't understand it well enough,"
-Albert Einstein

Content of the presentation

1. Introduction
2. Concept and theory of social strategy and science communication
3. Why Social Strategy for Scientific communication for flood and storm surge risk
4. Approaches and challenges of effective Social Strategy for Science Communication
   - General approach and challenges
   - Specific approach for SATREPS project
5. Examples of effective science communication for flood and storm surge risk
6. Way Forward
7. References

Introduction

- In the postmodern era, a systematic interaction between science and policy have drawn a great attention of scientists across the disciplines in the field of disaster risk reduction due to shifting the paradigm from relief-based to risk reduction
- Effective interface between science and policy makes social relevance and correlates social needs of the community
- Science-policy interface (SPI) has established a correlation with other scientists and actors for producing joint construction of knowledge and for effective decision making
- Effective science communication is needed to enhance the activities and the feasibility of the research in relation to the community demands
- Research and science communication should target to reach the different audiences through credibility, relevance, and legitimacy
- **A growing number of researchers** across fields are investigating the factors that influence **public perceptions of science and technology** and the **implications for effective communication**

Contd..

- Much of the research has conceptualized **communication as a tow-way iterative dialogue** involving experts, the public and the stakeholders
- Because, effective science communication can change **perceptions, decisions, and action plans in the context of situation** like hazard map, early warning, and evacuation
- The rhetoric, that emerging fields such as **disaster studies, climate change science attract researchers from different disciplines**, and as a result, this **interdisciplinary collaboration will generate new ways of thinking and reduce the gaps between hard and soft sciences towards achieving the goals of SDGs**
- Effective science communication will bring breakthroughs solving existing scientific and technological problems for disaster risk reduction and will make a **social platform consisting of all stakeholders**
- The involvement of local people promotes self-reliance and ensures that emergency management plans meet local needs and circumstances
- This paper illuminates the **social context within which science communication and outreach takes places**

Objectives of the paper

- The objective of the document is to chart a course for **dissemination of scientific findings of different components** of the SATREPS project for the uptake and benefits of the society
- To establish **an interface** with the scientists, key stakeholders, and the community people
- To establish **a comprehensive strategy** so that scientists can establish a trusted relation with the public and policymakers
- To enhance **a proper science communication** of the research results, especially for the hazard / risk maps and improved early warning system
- To institutionalize knowledge resources developed under the project through involvement of resources organizations i.e. university network, NGO network
- To discuss the **major techniques of dissemination of research findings** of SATREPS project

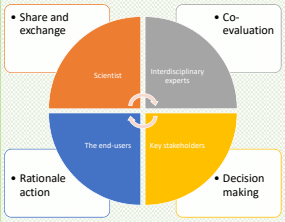
Methodology for producing the workbook

Module target groups

Concept and theory of social strategy and science communication

Key concept: Social strategy

- Strategy is derived from Greek word - strategia, meaning 'generalship'
- Social strategy which establishes a close connection amongst the interdisciplinary experts, key actors, and the end-users in the policy development and implementation process, which broaches a common platform to share, and to co-evaluate, and to pave a way for co-production of knowledge towards achieving the targeted decision, and reinforces the actors towards a rationale action.



Risk communication

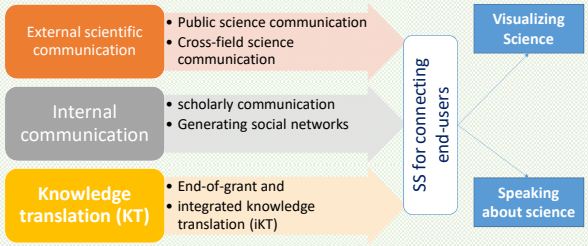
- Understanding the risk information
- Risk communication is the process of sharing information about hazards, vulnerabilities, and protective actions
- The senders and receivers
- Action plan

Source: (Takeuchi**a** and Shaw, 2011)

Science communication

- Science communication is a reliable ways to popularize their scientific advancements by engaging the public including policymakers and interdisciplinary experts for co-sharing and co-production of knowledge (Cooke et al., 2017; Illingworth, 2017)
- Effective science communication, however, divulges formal and informal engagement of the public and interdisciplinary connoisseurs in the science-based research project
- Science communication, indeed, is a public communication and engaging public through different means for bourgeoning the quality of scientific innovations

Key concepts: Science communication



Key concepts: Scientific communication

- Scientific communication is categorized into **two sub-fields**:
  - External scientific communication and
  - internal communication
- External scientific communication: **two types - public science communication and cross-field science communication**
- **External scientific communication**: seeks to convey scientific findings, recruit new scientific talents, inspire trust and credibility, and secure the provision of sufficient financial and structural resources of sciences
- It is also the **negotiation of socially legitimate forms of science and the manner** in which society deals with scientific knowledge

Contd..

- **Public Science communication**: can be divided into
  - the communication of science to the public and
  - the communication of science with the public
  - This science communication includes journalism, science PR as well as events, shows or exhibitions that are addressed to as wide an audience as possible
- **Cross-field science communication**, in contrast, relates to the communication of agents in the scientific field with agents from other social fields such as politics, economy, and media
- On the one hand, communication with the political fields has to do with the existential conditions of science (e.g. financing, social status)
- **Scientists are important as expert advisers for the decision-making of politicians**

Contd..

- **Informal scholarly communication** includes all other areas of scholarly communication
- Although it does not follow fixed written rules, it is no less strictly regulated than formal scholarly communication
- The practices of informal scholarly communication correspond to field logic and are habituated and made invisible
- Informal scholarly communication is a product and, at the same time, generates social networks, most of which are relatively closed

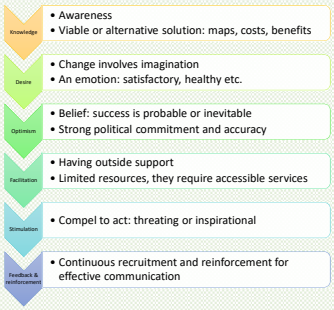
Knowledge translation (KT)

- Knowledge translation (KT): Two type
  - End-of-grant and
  - integrated knowledge translation (iKT)
  - End-of-grant activities is often built into funding proposals
  - As the name suggests, such activities are typically conducted at the end of the knowledge creation process
  - They are focused on **translating knowledge into effective communication tools and disseminating those to a particular audience**. These include peer-reviewed papers, guidelines, conference presentations, press releases, radio spots, community dramas, and so on

Theoretical standpoints: Social strategy and science communication

Social Marketing Theory (SMT): 7 steps

- Philip Kotler and Gerald Zaltman (1972)
- Social marketing is defined as "the design, implementation, and control of programs aimed at increasing the acceptability of a social idea or practice in on or ore groups of target adopters"



Bourdieu's cultural and social theory: Science as a social field

- Science is deeply rooted across other disciples and perfectly pertinent to society
- Bourdieu's Social theory (1987) has denoted 'science as a sub-field of society'
- The theoretical standpoints symbolize scientists of a particular discipline as individual agents and the professional bodies, stakeholders, policy makers, practitioners, and laypeople have been identified as factions of agents (Bourdieu, 1987)
- Evidence presumes, social field like science makes a coherent relation with each other that uptake the benefits of scientific innovation in society.
- **Society is constituted by its internal rules** and on the other hand, by being rooted in society at large and **its relationship to other sub-areas of society such as politics, economy or media**
- **Bourdieu did not devise a self-contained overarching theory of culture and society**
- Interdependence of his flexible theory components, which in each case must be **empirically applied and adapted to the respective research object**
- Bourdieu (1987) shows an empirical relation between these agents and other social continuum through the equation:

[(Habititus) + (Capital)] + Field = Practice

Models of Science Communication: three ways

The deficit model	The Contextual Model	The Participation Model
• Public skepticism due to lack of relevant knowledge • Sharing and addressing the deficit • Knowledge transfer: one way and top-down	• Sharing the information with the public • Scientists also put themselves in their audience's shoes • Scientists are aware of the needs, attitudes, and existing knowledge of their different audiences and adjust their content and communication approach	• In this model, scientists, the public, and policymakers participate equally in **discussions and debates about issues in science and technology** • Discussions and debates in a variety of formats, such as consensus conferences and public forums • Encouraging members of the public to learn about a scientific topic and its implications for society

Theoretical Continuum of Science Communication

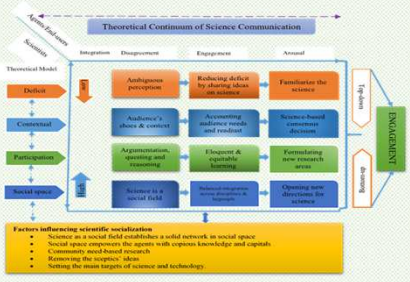
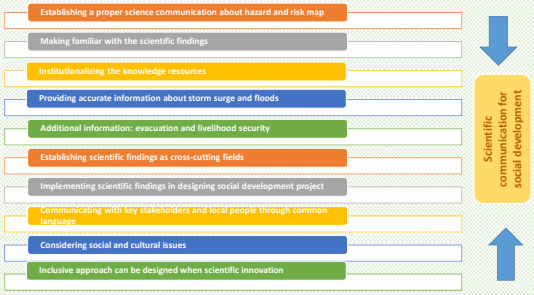


Figure-4: Theoretical continuum of effective science communication

Why social strategy for scientific communication for flood and storm surge risk?



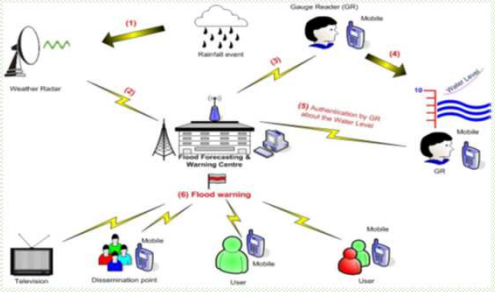
Approaches of Social Strategy to Scientific Communication: general approach

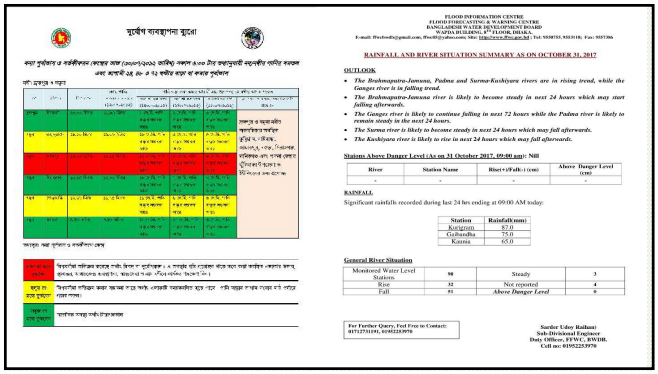
- The scientists and policymakers, who are working in the areas of flood and cyclones, are following a top-down risk communication approach to influencing evacuation behavior of the public
- Warning is creating awareness about hazards have been considered as one of the key tool of risk communication

Flood forecasting

- Flood Forecasting and Warning centre (FFWC) of Bangladesh Water Development Board is playing significant role in creating awareness about flood hazards in Bangladesh by generating different types of communication strategies such as -
  - publishing daily monsoon bulletin, river situation report, and special flood situation report.
- The centre is also forecasting the water level of water for 24, 48, and 72 hours
- The centre is also providing flood alerts through mobile phone to the relevant person who would be able to deliver the verified alert to the responsible personnel of the district office for flood warning

Information collection and dissemination process of FFWC





FLOOD INFORMATION CENTRE
FLOOD FORECASTING & WARNING CENTRE
BANGLADESH WATER DEVELOPMENT BOARD
WAPDA BUILDING, 6TH FLOOR, DHAKA.

RAINFALL AND RIVER SITUATION SUMMARY AS ON OCTOBER 31, 2017

OUTLOOK

- *The Brahmaputra-Jamuna, Padma and Surma-Kushiyara rivers are in rising trend, while the Ganges river is in falling trend.*
- *The Brahmaputra-Jamuna river is likely to become steady in next 24 hours which may start falling afterwards.*
- *The Ganges river is likely to continue falling in next 72 hours while the Padma river is likely to remain steady in the next 24 hours.*
- *The Surma river is likely to become steady in next 24 hours which may fall afterwards.*
- *The Kushiyara river is likely to rise in next 24 hours which may fall afterwards.*

Stations Above Danger Level (As on 31 October 2017, 09:00 am): Nil

River	Station Name	Rise(+)/Fall(-) (cm)	Above Danger Level (cm)
-	-	-	-

RAINFALL:

Significant rainfalls recorded during last 24 hrs ending at 09:00 AM today:

Station	Rainfall(mm)
Kutigram	97.0
Gobardha	75.0
Kurmia	65.0

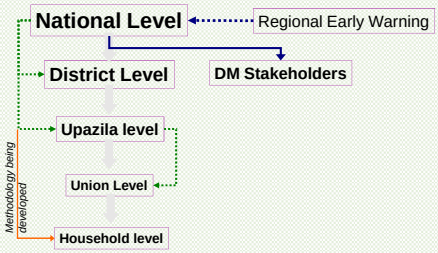
General River Situation

Monitored Water Level Stations	98	Steady	3
Rise	32	Not reported	4
Fall	81	*Above Danger Level*	0

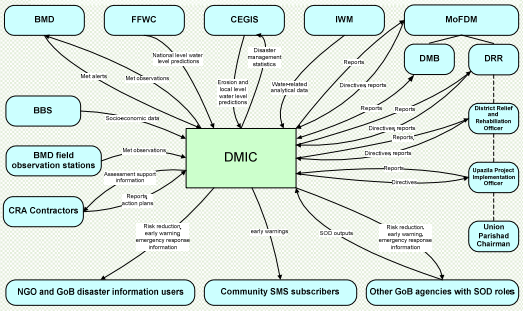
For Further Query, Feel Free to Contact:
01717371191, 01952253970

Sardar Uday Raihan)
Sub-Divisional Engineer
Duty Officer, FFWC, BWDB.
Cell no: 01952253970

Early warning forecasting in Bangladesh: Top-Down approach

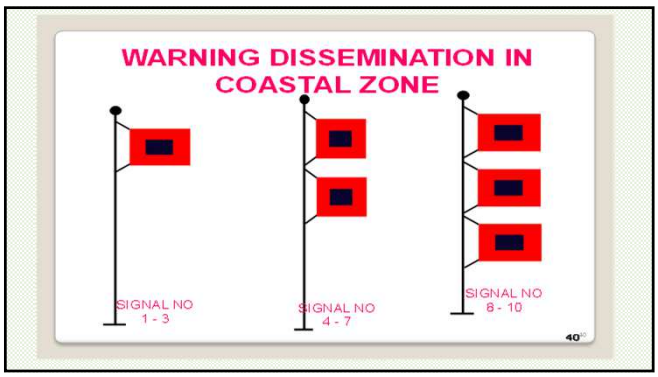


DMIC Information Flows



Storm surge waring system: Bangladesh

Signal No.	Location	Storm Condition	Storm Status	Comment
Distant Cautionary Signal No. 1	Distant Sea	Squally Weather	Storm may form	Only **Storm Status** has changed
Distant Warning Signal No. 2	Distant Sea	Squally Weather	Storm has formed	
Local Cautionary Signal No.3	Port	Squally Weather	Storm has formed	Only **Strom Condition** has changed
Local Warning Signal No. 4	Port	Storm	Storm has formed	
Danger Signal No.5	South Ctg. Port East Mongla Port	Severe weather	Light or moderate intensity	Only **Location** has changed
Danger Signal No.6	North Ctg. Port West Mongla Port	Severe weather	Light or moderate intensity	
Danger Signal No.7	Over Ctg. Port Over Mongla Port	Severe weather	Light or moderate intensity	
Great Danger Signal No.8	South Ctg. Port East Mongla Port	Severe weather	Great intensity	Only **Location** has changed
Great Danger Signal No.9	North Ctg. Port West Mongla Port	Severe weather	Great intensity	
Great Danger Signal No.10	Over Ctg. Port Over Mongla Port	Severe weather	Great intensity	



Hazard map-based science communication: floods and storm surge

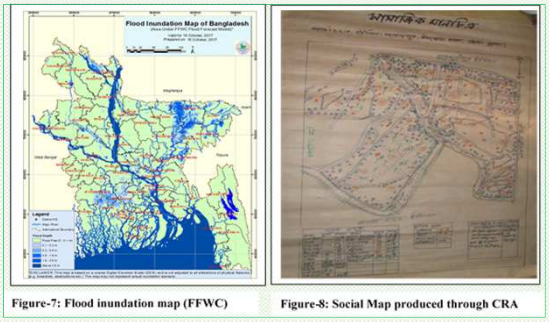
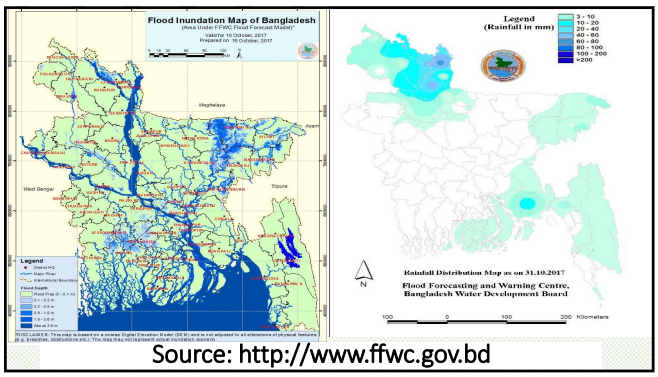


Figure-7: Flood inundation map (FFWC)

Figure-8: Social Map produced through CRA



Source: http://www.ffwc.gov.bd

W - Water level (cvwbi D”PZv)

A - Above (Dci)

DL - Danger Level (wec`mxgvi)

CM - Centimeter (‡mtwgt)

\+ Increasing (evovi m¤¢vebv)

-Decreasing (Kgvi m¤¢vebv)

-24 H - Next 24 Hour (cieZx© 24 N›Uvq)

** hgybv b`xi cvwb wmivRMÄ c‡q‡›U wec`mxgvi 42‡mtwgt Dci w`‡q cÖevwnZ n‡”Q|

** AvMvgx 24 N›Uvq hgybv b`xi cvwb wmivRMÄ c‡q‡›U 32†mtwg e„w× A_ev Kgvi m¤¢ebv Av‡Q|

Interactive Voice Response (IVR)

- **Dial 10941 or 1090 from any mobile**
- 1 For Sea going fishermen
- 2 For River port warning
- 3 For Daily Weather Bulletin
- 4 For Cyclone Warning
- 5 For Flood Forecast
- 6 For back to the main menu

Early Warning Dissemination through SMS

Selected Personnel Related to DM Committees

- *Chairman and Member Secretary of District Disaster Management Committee*
- *Chairman and Member Secretary of Upazilla Disaster Management Committee*
- *Chairman and Member Secretary of Union Disaster Management Committee*

37

Multifaceted social strategies for public engagement

- Television
- News bulletin
- Newspaper
- Announcement from he Mosque
- Social media: Facebook
- Community radio
- SMS (Short Message Service)
- Evacuation drills (BFSCD, NGOs)
- Observing international day for disaster risk reduction and national disaster preparedness day

Interdisciplinary communication: scientists to interdisciplinary scientists, and policy makers

- ESPA-Delta was a successful research project of IWFM, BUET
- Another research publications
- Self-publishing model of social strategy was undertaken with the Ministry of Disaster Management and Relief (MoDMR) under DECCMA project of IWFM
- REACH: Improving Water Security for the Poor'. REACH is an interdisciplinary research project
- Journal article, book chapter, final report, and oral presentation at the conference journal article, book chapter, final report, and oral presentation at the conference
- Training, internship, thesis

Approaches of Social Strategy to Science Communication: SATREPS Project

- The dominant view of the SATREPS Project is to recognize the key notions of the community, and the knowledge of the specialized and non-specialized experts
- Adopting several proactive social strategies from the designing of research works
- The goal of this proactive science communication is to have a **palpable impact of the scientific works on disaster risk reduction** in Bangladesh and to influence the decision-making process through producing transparent and credible outputs of the research
- The SATREPS Project has taken good initiative to disseminate the results of the study

Scientific socialization of the SATREPs

- The scientific socialization of the SATREPs project, indeed, started with a **joint coordination meeting** at the beginning of the project between the Bangladeshi researchers and the Japanese counterparts.
- The joint coordination meeting typically focused on understanding of risk behavior and culture of communities for effective translation of knowledge into resilient development
- There also have been **ad-hoc science communication** at different levels among the scientists for co-design and co-solution of the problems of the research
- **Co-production** happens at several layers through engaging interdisciplinary experts, researchers, and laypeople in the research works
- Research plan from designing phase

Component I: Flood Disaster Risk Assessment and Mitigation

- The prime target of the component I are to (i) map sectoral risks of riverine and flash flood and to produce hazard maps, (ii) revisit the danger level of flood forecasting and warning system, (iii) assess extensive flood damage to identify which sectors like facilities, infrastructure are more vulnerable to flood hazard
- At the beginning, the scientists transfer the key ideas to various factions like public and senior officials of the government to create a solid notion of the research
- A novel approach to science communication is self-publishing model adopted under this component
- The researchers talked to the flood affected people of Gaibandha and Goawainghat, and to the concerned authorities of flood forecasting in Bangladesh
- Interaction at local level with the lower level administrative units like union parishad and Upazalia parishad also proliferate the capacity of the researcher to generate new knowledge

Contd.

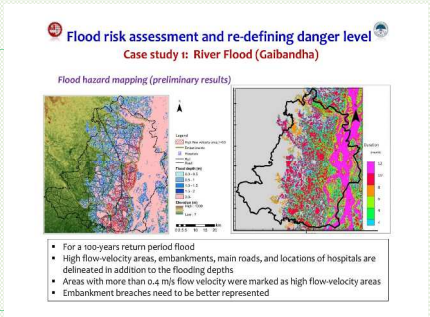
- Several communication meetings was held with Bangladesh Water Development Board (BWDB), Department of Disaster Management (DDM), Flood forecasting Warning Centre (FFWC), Geological Survey of Bangladesh (GSB), Local Government Engineering Department (LGED), and Planning Commission of Bangladesh
- Self-explanatory maps
- Integration of interdisciplinary experts like economists of BIDS and academia, policymakers

Flood Disaster Risk Assessment

- The danger level defined by BWDB is not clear
- Definition is quite old and arbitrary
- Considered damages to Aman and rural homesteads
- Information on danger levels not very meaningful for local people

- **Why flood hazard map?**
- land use planning
- Planning for structural flood mitigation options
- Identifying the areas susceptible to flood hazard, people, infrastructures at risk and to what degree they might me affected
- Damage aspects are taken into consideration
- Helping to locate the areas for evacuation and for evacuation planned

- **Flood risk maps**
- Using damage functions and hazards maps for different return periods for different sectors
- Translation to local level
- Easily understandable
- Large scale and small scale flood can be identified



Source: (Salehin, 2018)

Component II: Improved Strom Surge Warning and Evacuation Systems

- The warning system of BMD is generally criticized as:
- District level warnings are based on port oriented
- Too much qualitative
- Language of the warning is not familiar to the local people
- Lack of accurate quantification
- Damaged information is not mentioned
- Meanings of warnings 5,6 & 7 and meanings of warning 8,9 & 10 are similar

- Proposed warning system

Signal		Wind Speed (km/hr)
Cautionary Signal No.	2	20 - 40
Warning Signal No.	4	41 – 61
Damage Signal No.	6	62 – 87
Great Signal No.	8	88 – 117
Great Signal No.	9	118 – 170
Great Danger Signal No.	10	More than 171

Source: Haque, et al. (2018)

Contd..

- A self-publication model was followed initially for effective science communication with Bangladesh Metrological Department
- The self-publication model informs that the research is capable to formulate modelling at root level like village and mouza
- Classification of houses such as pucca, semi-pucca, kutcha, and jhupri is made following technical definition of Bangladesh Bureau of Statistics (BBS)

- So, ideally, the best option is – improve the present cyclone warning system keeping signal numbers same but include the following information:
- Wind speed
- Surge depth
- Household status (damage information)
- Polder status
- Development of a three-dimensional damage level matrix that determines level of damages of houses
- The project will provide **reliable local level information** than BMD and most importantly damage information

Contd.

- Community engagement is also done directly to assess the reliability and validity of the outputs of the improved early warning system
- In this context, a field meeting with the community was done in Batiagacha upazila of Khulna and Sharonkhola upazila of Bagerhat district
- Training on the improved early warning system with the government and non-government agencies
- Engagement of young researchers
- Based on research findings, three (3) conference papers
- Cyclone hazard maps, furthermore, have been prepared based on historical cyclone track (1960 – 2009) for bettering understanding the future cyclone events

Component III: River Bank Erosion and Embankment Failure

- Component III aims to (i) review the existing research documents and collect relevant data from the field; (ii) to produce geographic information-based maps by investigating failure mechanisms of embankment, (iii) develop nature and low-cost friendly protection measures for sustainable development
- Due to working for a long period the scientists would able to share their research ideas and establish a linkage with Bangladesh Water Development Board, Local Government Engineering Development, and Planning Commission
- self-marketing approach: shared meeting
- Self-explanatory maps have highlight different legends and pictorial

Contd.

- Interdisciplinary communication team comprises of social scientists, gender specialists, engineers, environmentalists, and disaster specialists for co-production and co-evaluation of the developed knowledge
- Training program and workshop for exchanging the ideas and to co-design and co-evaluation of the projects
- The component III have promulgated a low-cost infrastructure for protecting river erosion in collaboration with Bangladesh Water Development Board and Kyoto University, Japan
- To institutionalize this indigenous BWDB contextualized this idea among the community people and engaged them at the phase of implementation
- A short documentary has also prepared by BWDP to create awareness and for a strong ownership
- Creating a funding opportunity for future research

Component IV: Flood Assisted Spreading of Deposited Toxic Substances

- The primary aim of the component IV is to examine the quality of water and to focus the pollutants which are negatively affecting health of urban poor community by flood in Dhaka city
- For scientists, this research is an excellent opportunity to engage various stakeholders including Department of Environment (DoE), the community
- This self-publishing meeting with DoE is, indeed, contextualize and familiarize the research problems
- social mapping is conducted through close interaction with the community people on Tongi Khal and Balu River for delineating possible sources of contamination during flooding in Dhaka city

Contd.

- At the pilot training on critical outputs of the study and invites opinions from the participants including academia, government officials, and practitioners
- Involvement of young researchers
- Peer-reviewed research publications have been produced for effective communication
- A workshop have been set for influencing the community, NGOs, and GOs about possible preventive measures for pollution and anthropogenic factors

Component V: Disaster Management Strategy for Resilient Society

- Component-V makes a bridge with various key factions of disaster management to mainstream scientific knowledge into policy implementation
- This mainstreaming starts with establishing a university network. At least 14 recognized public and private universities are now jointly working to mainstream disaster education at tertiary level
- The university network organized four (4) network workshops for sharing knowledge on disaster risk reduction
- The critical role of university network paves a way to produce course curricula on flash flood and urban flooding for undergraduate and graduate students

Contd.

- This university network influences the interdisciplinary scientists to engage in scientific research. For instances, five field-based research projects on interdisciplinary issues of disaster management
- Field-based storytelling case study reports
- Peer-reviewed articles and scientific papers for sources are also prepared for dissemination of scientific knowledge
- Like university-based social space, a NGO network is also developed for bridging between theoretical and pragmatic works
- Pilot training on eight (8) training modules
- Other communication materials such as booklet and leaflet are also used to articulate scientific knowledge of SATREPs project

University Network: academic engagement

- 1st University Network Workshop (05 Sep. 2015)
- 2nd University Network Workshop (7-8 February 2016)
- 3rd University Network Workshop (02 August 2016)
- 4th University Network Workshop (15 February, 2018)

University Network workshop


NGO Network workshop: Dialogue

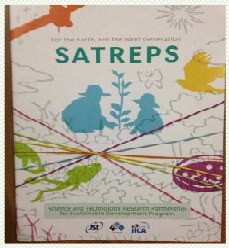
- 1st Dialogue on "Role of NGOs in Disaster Management in Bangladesh"
- 2nd NGO workshop (6 Nov 2017)
- 3rd NGOs workshop and pilot training on 14 February, 2018

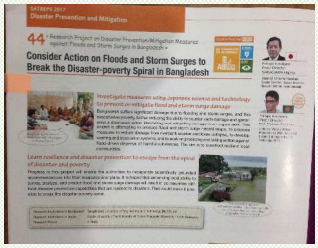
Key outcomes: Course Curricula

Flash flood
- **Undergraduate/Graduate**
- **Government officials**
- **Practitioners and NGOs**

Urban flooding
- **Undergraduate/Graduate**
- **Government officials**
- **Practitioners and NGOs**

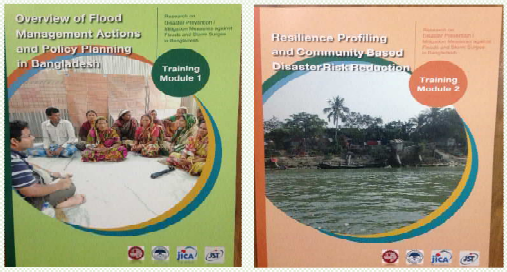
Booklet & leaflet for communication



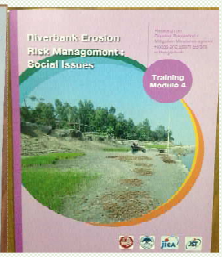


Leaflet of the project

Training modules for effective communication



Training module for communication



Examples: Implication of Community Hazard Maps

- Hiroshima City has the highest risk of sediment disaster in Japan
- The national government, thus, established **the Act on Sediment Disaster Countermeasures**, which became effective in 2001
- Hazard maps are distributed to local citizens to call attention to sediment disasters
- A "Hazard Area Map on Sediment Disaster" shows the relation between sediment disaster hazard spots (i.e. debris-flow hazard torrents, slope-failure hazard spots and landslide hazard spots), evacuation places and evacuation routes. Furthermore, information on sediment related disaster warning areas is given by direct mail to people living in the area, which is prone to a sediment disaster. Together with the **"Hazard area map of sediment disaster"** and "Municipal disaster prevention plan", the mail calls for the need for precaution and evacuation in case of heavy rain
- In 2005: Sediment-related Disaster Special Warning Areas" and distribution of such hazard maps the Erosion prepared by the Sediment Control Division of the Ministry of Land, Infrastructure, Transport and Tourism
- These hazard maps must be produced by **all heads of municipalities** who must also ensure the smooth precautionary evacuation of residents through the dissemination of information (source: Shaw, 2014)

Examples: Community involvement in Japan

- Japan has made successful progress in disaster risk reduction
- A successful science-based risk communication was made by the Kyoto University through a school disaster education program after a number of catastrophic typhoons in 2004
- The university introduced the program in collaboration of Saijo City education board. The broad aim of this program was to build a bondage between school and community through observing situation of affected people
- A "mountain watching" program was actually introduced for the participants including children, inhabitants living in mountain areas, teachers, local government authorities, and forest officials. Indeed, the participants paid an extensive attention to perceive the devastating damage crated by typhoon
- During this period another relevant program like "town watching" was also introduced for the people living in plain land of Saijo city
- Initially, "town watching" program was applied in 5 elementary schools whereas "mountain watching" program was for three junior high schools (Shaw, 2014)
- A school-community linkage was established through engaging the students with the community. The students talked to the affected people for gathering extensive knowledge and integrated this knowledge into education system
- After the project period the education board of Saijo city continued this disaster education program and institutionalized in the education process (Shaw, 2014).

CRA and RRAP in Bangladesh

- Risk-based science communication is about the development of Inclusive Risk Reduction Action Plan (IRRAP) in Durgapur upazila of Netrokona district in Bangladesh
- In 2014 flash flood caused a great deal of damage to infrastructures such as roads, embankments, and standing crops
- In reducing the devastating effects the DIPECHO VII developed an Inclusive Risk Reduction Action Plan (IRRAP) in two unions of Durgapur upazila through multi-stakeholders consultations
- The process targeted chairman and members of union parishad, teachers, farmers, guardians of school going children, businessmen, and special groups such as women, person with disabilities (PWD), and children
- A participatory approach was followed to include all views of all stakeholders, including ideas of vulnerable groups
- At the beginning, the entire process provided a short training workshop with the participants on how to analyze community hazards and risk following community risk assessment (CRA) techniques

Contd.

- During CRA process the local inhabitants identified their potential risks, vulnerabilities, and potentialities
- The community also developed a hazard map and indicated areas prone to flash flood, roads, embankments, houses, and crop fields through group consensus and consultation. Finally the group consultation process developed a Risk Reduction Action Plan (RRAP) and identified major key actions based on priority of risks
- After recommencement of a joint CRA, the UDMC and WDMC took initiative to repair roads, tube-well, embankments and tried to revive the livelihood of vulnerable groups.
- The participants also developed four schools and a transition school with the help of DIPICHO VII, which were also used as flood shelters during emergency situation
- The key challenge of this process was that conservative mind-sets of local people destabilized the participation of women. However, social learning of RRAP was that the rustic people were more enthusiastic and devoted to lessen their risks by applying their own developed community-based risk reduction action plan

Challenges towards science communication of SATREPs

- Effective science communication takes a long time to uptake the outputs at field level. As a result, a great challenge to the SATREPs project is about its' sustainability. Funding is a key challenge for sustaining the scientific innovations of the project at community and at institutional level
- The research has produced some specific hazard maps for flood and storm surge. It is very imperative for the researchers to validate these maps with the community to unfold the critical issues of maps. Simplification of scientific language is also required for these hazard maps
- The research findings of improved early warning and evacuation system, has not been possible to implement at field level due to sensitiveness of early warning and forecasting. As, BMD is not ready to apply the outputs of the research. Early warning is so susceptible and directly linked to human lives. Thus, without evidence-based research and practical it is very hard to achieve public trust on early warning

Contd..

- Limited knowledge of the community on warning system is also a barrier to create mass awareness about early warning. In addition, fatalistic attitude discards belief of the people on early warning
- The research has taken initiatives to revisit the danger levels. These redeveloped initiatives has not been implemented at field level.
- Another key limitation is that the implementing agencies in Bangladesh are not communicating with the scientists. Because, there is no solid relationship between the scientists and the implementing agencies. Thus, institutional system is important to address values for application of science and technology into decision-making
- A low-cost nature friendly is also installed in Sirajganj hard point for protection river erosion under the project. For developing ownership with the community a long-term monitoring plan is required. But, there is uncertainty due to lack of sufficient fund after the project period.

Contd.

- In some cases, simplification of scientific language is very difficult
- Organizational culture
- Public trust in science play in shaping public attitudes about specific emerging technologies
- People values' personal systems become an important basis for decision making for audiences when they think about these technologies
- The perceived cost and timelines of research

Way forward

- Academic engagement for more demand-revenue scientific innovation is required to document disaster management practices into academic knowledge. In addition, there is a need of balance between demand-revenue research and community-need based research.
- A wide extensive dissemination of results is also required to educate different level of stakeholders. Self-publication approach could be applied to other relevant stakeholders working in the areas of disaster management
- Engagement of academicians and students are important from schooling and university in community activities and services for disaster risk reduction. These such types of activities can bring a change in risk behavior and can create awareness about disasters. It is suggested by the study that one (1) compulsory community engagement course can be introduced for the undergraduate students
- For smooth application and sustainability of the research results, field school on different disaster prone areas can be established in collaboration with the NGOs

Contd.

- The SATREPs project has established an academic network. This network can work as a change agent for storing data on different disasters. Thus, a data hub can be introduced in different areas so that the researchers can collect data on a particular area of disaster management
- For more implication of research outputs, an effective science communication can be done through inter exchanging the faculty members and students. Even, knowledge sharing program can be organized at different universities
- The community people have confusions on early warning and forecasting system. To overcome the confusions a pilot simulation or drill can be organized to overcome the confusion of BMD and local people
- Social campaign is needed to create awareness about early warning. A good initiative could be taken to distribute posters with signal numbers and information on damage probability at every union office and at the community level. The people will watch this and getting accustomed with the information. Thus, when BDM will warn the people about any disaster, they will understand that will instigate to take prompt evacuation action before disaster occurs

Contd.

- Early warning dissemination apps can be developed and distributed among the community people and youth or volunteers that will enhance the activities of Cyclone Preparedness program
- Without political interest it is not possible to implement research findings at the field level. Thus, research findings should be brought to political leaders and community people through common language. For examples, hazard maps, flood damage maps can be shared with them and feedback can be incorporated.
- Maps should be more self-explanatory with sufficient features so that common audiences including inhabitants, policy planners, and other experts are able to anticipate risks and make risk-based decisions.
- Collaborative monitoring plan comprising academia, policy makers, and practitioners is needed to address proper investment and demand of the community and to focus the gaps.
- Finally, it is revealed from the study that there is a question of sustainability of the research innovations. Though some innovations have been implemented at field level, a collaboration is required to continue the project. In this context, alternative funding sources can be explored for sustaining the scientific innovations

References

- Banu, K. D. and Sami S. O. (2014). Social marketing concept and application of social marketing on organizations. *International Journal of Advances in Management and Economics*, 4:1- 7.
- Fujita, K., & Shaw, R. (2014). Community Practices of Transmitting Daily and Disaster Information in Reihoku Area. R. Shaw (ed.), *Community Practices for Disaster Risk Reduction in Japan*, Disaster Risk Reduction, DOI 10.1007/978-4-431-54246-9_10, © Springer Japan 2014
- Fujita, K., Shaw, R., & Nakagawa, H. (2017). Social Background of River Erosion Areas in Bramaptra and Ganges Rivers: Implication for Japanese Hazard Mapping Technology in Bangladesh. *DPRI Annuals*, No. 60 B.
- Hetland, P. (2014). Models in Science Communication Policy: Formatting Public Engagement and Expertise. *Nordic Journal of Science and Technology Studies*, 2(2), 5 – 17.
- Hibino, J., & Shaw, R. (2014). Role of Community Radio in Disaster Management: Reflections from Japan. In: R. Shaw (ed.), *Community Practices for Disaster Risk Reduction in Japan*. Springer: Tokyo.
- Illingworth, S. and Prokop, A. (2017). Science communication in the field of fundamental biomedical research. *Seminars in Cell & Development Biology*, 70:1 – 9.
- Nasreen, M., Hossain, K. M., Azad, A. K., & Hassan, K. (2014). *Best Practices of Strengthening Resilience and Safety in Schools and Communities in Bangladesh*. Research Report. DeSHARI Consortium Bangladesh: Dhaka.
- Salehin, M. (2018). Training module on Flood Disaster Risk Management and Mitigation. Paper was presented at a pilot training held on 14 February. 2018 at Institute of Water Flood Management, BUET.
- Shaw, R. (2014). Typhoon, Flood and Landslide Related Disasters in Japan: Role of Communities. In: R. Shaw (ed.), *Community Practices for Disaster Risk Reduction in Japan.* Springer: Tokyo, 33 – 47.
- Shaw, R., Izumi, T., & Shi, P. (2016) Perspectives of Science and Technology in Disaster Risk Reduction of Asia. *International Journal of Disaster Risk Science*, 7:329-342
- Takeuchia, Y. and Shaw, R. (2011) Possible Risk Communication Framework in Typhoon Affected Areas of Taiwan. *Asian Journal of Environment and Disaster Management.* 3(2): 63–175.

Thanks to all & ?