Nexus of Social and Technological Approaches to Floods Early Warning System (EWS) in Disaster Risk Management

Khadija Javed Khan; Zohra Bano, Sohaib ur Rahman

Quality Assurance Group - Disaster Risk Management Fund (NDRMF) Islamabad - Pakistan

Abstract— Natural disasters are becoming more frequent and treacherous. Hundreds of lives are lost each year due to lack of preparedness and timely emergency warning to vulnerable population threatened by disasters. Pakistan features in the list of ten most vulnerable countries impacted by disasters during the last two decades. According to an estimate, in addition to loss of precious lives, natural disasters cause the country between 1.2 and 1.8 million dollars in economic losses annually. This paper explores two main consonants of "Disaster" and "Resilience". As nature strikes incongruously, two human responses are unfolded in consequence; firstly, intense waves of shock take over the people having seen the fatal injuries and loss of life as well as disruption in the routine of life. Secondly and in reaction, the will to withstand the ground emerges and thus resilience is born out of a strong determination against the destructive impacts of a natural disaster. Community resilience can be built by systematic interventions for risk assessment and creating social and technological systems firmly embedded in community's daily life instead of responding to emergencies on ad hoc basis. Three interlinked issues; namely gender mainstreaming, communication and use of technology are addressed here in the purview of floods Early Warning Systems (EWS). Some strategic and innovative approaches have been introduced for community engagement leading to effective preparedness and resilience building.

Index Terms— Natural disasters, flood, resilience building, gender vulnerabilities, preparedness, Early Warning System (EWS), communication.

.

————————————— ◆ —————————————

1. CONTEXT

Pakistan is located on the path of natural disasters. A large geographical stretch is located on the seismically active zone; there are frequent floods, flash floods and landslides, especially during monsoon. Besides, it is being visited by periodic droughts in many parts of the country. These disasters play havoc with the society and economy, causing loss of life, damage to livelihood and infrastructure and affecting orderly functioning of national and local institutions. According to a research, the number of occurrences in the last few decades has increased manifold, so has the intensity and the impact. [1]

Disasters pose challenges as well as opportunities to rethink the way of life and pay attention to the changing natural phenomena and surrounding environment.

The multi-hazard vulnerability and risk analysis (MHVRA) [2] conducted across country identified the following six disasters with varying frequency and intensity in one or more parts of the country causing both single and/or compound risk.

- Earthquake
- Floods
- Landslides
- Drought
- Tsunami
- GLOF (Glacier Outburst Floods)

Excessive rains also cause urban flooding where population density is high and there is overwhelming pressure on civil amenities. The urban flooding inundates urban infrastructures and has repetitive and systematic impacts on communities irrespective of their location within designated floods plains or near any waterbody. Recent studies quote 'the reasons for vulnerability to natural hazards is because of poor individuals, poor development material utilized as part of foundation, singular houses units and different structures' [3].

According to an estimate, natural disasters cause between 1.2 and 1.8 million dollars in economic losses annually [4]. Disasters increase population's vulnerabilities to cope with already existing poverty and social inequalities between men and women and marginalized groups including indigenous people and persons with disabilities.

The two pictures below give an idea of how people have to brave frequent flooding in citiies and villages. Sometimes putting their own life in danger to save meagre household assests.

2. UNDERSTANDING DISASTER TERMINOLOGY

Disaster is defined as 'an occurrence disrupting the normal conditions of existence and causing a level of suffering that exceeds the capacity of adjustment of the affected community' [5]. The US Federal Emergency Management Agency (FEMA) describes its manifestation as '… a natural catastrophe, technological accident, or human caused event that has resulted in severe property damage, deaths, and/or multiple injuries'. [6]

Risk is basically an element, factor or situation involving exposure to danger with a potential of gaining or losing something of value. [7]

Risk communication can be broadly understood as an iterative exchange or sharing of information related to the characterization, assessment and management of risk between and among different groups, including, such as regulators, stakeholders, consumers, media and general public. [8]

Hazard is defined as a dangerous substance, phenomenon, activity or situation, which has the potential to cause disruption or damage to people, their property, services and environment; [9] whereas vulnerability is a concept which describes factors or constraints of an economic, social, physical or geographic nature, which reduces the ability to prepare for and cope with the impact of hazards. [10] At institutional level, it is 'the (in) ability of the system to sustain or restore its basic functionality following a risk source or an event'. Vulnerability also refers to the (insufficient) absorption capacity of ad-

verse effects of a disruptive event and the time/speed and cost at which it is able to return to an appropriate functionality/equilibrium. [11] (Words in italics are added by the author).

Risk management includes activities to handle risks such as prevention, mitigation and adaptation. It often includes trade-offs between costs and benefits of risk reduction and choice of a level of tolerable risk. In risk management, the main approach is to prepare in advance and remain ready to handle disaster both at individual and institutional level. [12] Within this process is embedded the element of risk reduction. The UN International Strategy for Disaster Reduction (UNISDR) defines disaster risk reduction as, 'the action taken to reduce the risk of disasters and the adverse impacts of natural hazards, through systematic efforts to analyze and manage the causes of disaster, including through avoidance of hazards, reduced social and economic vulnerability to hazards, and improved preparedness for adverse events'. [13]

Resilience is the ability to cope with disasters, quick recovery towards resuming normal life and adaptation to new situation. Resilience is not built in one day. It has a dynamic and complex framework encompassing multi-disciplinary issues related to governance institutions, disaster risk management systems in place and communities' state of risk awareness and readiness. [14] Readiness is called 'the in-house insurance policy of disaster management'. [15]

3. INTERNATIONAL DISASTER RISK REDUCTION FRAMEWORKS

The international collective experience and knowledge helped to formulate systems that have the potential for broad application. Among the international frameworks, two cornerstones are Hyogo framework (2005-2015) and Sendai framework (2015-2030).

3.1 HYOGO Framework

Hyogo framework for action on Disaster Reduction was adopted in 2005 in the World Conference, held in Kobe, Hyogo in Japan, aiming at substantially reducing disaster losses by 2015. The framework consisted of five priority actions for achieving disaster resilience among vulnerable communities. [16] These were:

- Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.
- Identify, assess, and monitor disaster risks – and enhance early warning
- Use knowledge, innovation, and education to build a culture of safety and resilience at all levels
- Reduce the underlying risk factors
- Strengthen disaster preparedness for effective response at all levels.

The Hyogo framework was implemented through collaborative efforts of all stakeholder states and regional institutions, and international organizations as well as civil society organizations, community-based organizations and volunteers, aca-

demia, media and private sector. [17] It was succeeded by Sendai Framework in 2015.

3.2 SENDAI Framework

The Sendai Framework for Disaster Risk Reduction 2015–2030 was adapted at the Third United Nations World Conference on Disaster Risk Reduction, held from 14 to 18 March 2015 in Sendai, Miyagi, Japan, which took into account the experience gained through the implementation of the Hyogo Framework for Action. Sendai adopted the following four priority areas:

Priority 1: Understanding disaster risk.
Priority 2: Strengthening disaster risk governance to manage disaster risk.
Priority 3: Investing in disaster risk reduction for resilience.
Priority 4: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction. [18]

The national disaster risk management strategies and action plans are guided by the above framework.

4. NATIONAL LEGISLATION AND INSTITUTIONS FOR DISASTER RISK MANAGEMENT

There are constitutional, legal, institutional and administrative frameworks for addressing emergencies and managing disasters. Most of the legislative and organizational decisions, however, were taken reactively in the aftermath of a disaster that shows a lack of foresight and proactive approach towards Disaster Risk Management. [19]

The first national legislation on disaster 'National Calamities (Prevention and Relief) Act' was enacted in 1958 to address both natural and human-made calamities including control and relief. [20] The Civil Defense Act (29 April 1952) was already in place to address war emergencies. The Act was amended in 1993 to expand its sphere to remedial measures against disasters. [21] Other relevant legislation is listed below.

- Emergency Relief Cell (ERC) established in 1970
- Federal Flood Commission established in 1977
- Pakistan Emergency Services Ordinance and Pakistan Emergency and Fire Code enacted in 2002
- Punjab Emergency Service Rescue 1122 2006
- Earthquake Reconstruction and Rehabilitation Authority (ERRA) established in 2005 (the notification was issued in 2009 and the ERRA Act was enacted in 2011)
- NDMA Act 2010 & establishment of National Disaster Management Authority, Provincial Disaster Management Authorities and District & Local Disaster Management Authorities
- Establishment of National Disaster Risk Management Fund (NDRMF).

The last two acts/actions resulted in the establishment of two major institutions NDMA and NDRMF.

4.1 Establishment of NDMA

In the aftermath of the catastrophic earthquake which struck northern Pakistan and Azad Jammu & Kashmir (AJK) in 2005, the National Disaster Management Ordinance (2007) was passed to develop a structured disaster management system and framework in Pakistan. This was replaced by the National Disaster Management Act, 2010, in which responsibility for disaster management was devolved to the Provinces while the National Disaster Management Authority (NDMA) [22] remains the lead agency at Federal level. It formulates and coordinates all national policies and strategies for disaster management.

4.2 Establishment of NDRMF

The National Disaster Risk Management Fund (NDRMF) [23] is among the few national organizations, found and raised for a specific purpose. Established in 2016 as a not-for-profit corporate entity under Section 42 of the Companies Act 2017 with the Securities and Exchange Commission of Pakistan, the NDRMF is the custodian of government grant to fund projects for reducing risks posed by frequent natural disasters across the country. The core activities are linked to 2 high priority national plans on disaster risk management namely National Disaster Management Plan (NDMP) and National Flood Protection Plan (NFPP IV).

5. DISASTER RISK MANAGEMENT CYCLE

Disaster risk management is mostly designed as a cycle [24] with four stages: preparedness, emergency response, recovery (short term)/reconstruction (long term), and mitigation, as sequential activities; each of which is being addressed in a given scenario. An enhanced concept divides the process to distinguish between risk management in pre-disaster and crises management in post-disaster scenarios.

Figure 1 DRM Cycle (NDRMF Literature)

Risk Management and Crisis Management aim at specific objectives and require specific strategies, competencies and resources. Risk Management is based on disaster forecasting in order to prepare in advance to avoid/protect against impending disaster whereas '(c)risis management is based on knowledge and reflexes that replace the normal functioning of

an organization. This implies the need for managers of crisis situations to have gained some experience in a practical or theoretical way' [25].

Disaster forecasting and use of technology are inseparable in disaster management [26]. Disaster forecasting requires extensive historic data collection, analytical tools and/or modeling skills, understanding of the processes involved in hazard identification, risk assessment and management, and the relationship between people's livelihoods and disaster preparedness. [27] 'It is often helpful to think about risk in a strategic and cultural context' [28] to make continuous adjustments to changing situations and absorb diversity across the whole spectrum of the society.

Disaster management is multi-dimensional and 'multi-institutional' across time and space. Experts are of the opinion that '(o)nly post-disaster relief is not a solution to the human suffering and economic and physical losses from natural disasters. A substantial reduction in the impact of natural disasters will be achieved through emphasis on pre-disaster activities including planning, prevention/ disaster mitigation and emergency preparedness while sustaining and further improving post disaster relief and management capabilities.' [29]

The preparedness depends on good planning, capacity building, resource mobilization, creating internal and external synergies, and developing the right public perception to handle various situations. Preparedness process is depicted by the authors in Figure 2 below.
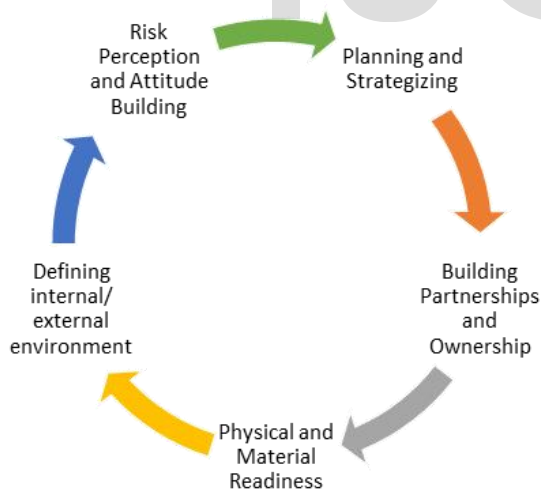

Figure 2 Disaster Risk Preparedness Process

6. DISASTER RISK MANAGEMENT PREREQUISITES AND CHALLENGES

Among the various requisites and challenges faced in the disaster risk management process, some are discussed in the follow paragraphs.

6.1 Disaster Baseline Information and Risk Perception

'There is a dearth of information and little understanding of the processes involved in hazard identification, risk assessment and management, and the relationship between people's livelihoods and disaster preparedness.'[30] Timely access to relevant and accurate information is essential to address disastrous situations. Difficulties are faced in collecting and assessing information and tracking record of disasters of the past to analyze and forecast future events and their impact on communities. On the other hand incomplete, inaccurate, unverified or irrelevant information poses a threat to preparedness action planning. In such a case, triangulation of information from various sources such as official and semiofficial reports and documents, print and electronic news media and direct input from communities help to create a credible picture of the issue. Testimonies from individuals directly affected with disasters enrich data available through scientific means. The risk perception is also developed through advocacy by subject specialists, researchers and leaders who could influence the opinion of the masses. [31]

The Regulatory Focus Theory of risk perception explains two modes of action: (i) protection (ii) promotion. The protection mode is said to be demonstrated mostly by those who have suffered disasters personally and out of fear, motivation and vigilance take protective measures against disasters; the promotion mode is displayed by people who have received information about disasters through media and watched the phenomena that raised a sense of responsibility and aspirations of goodwill to develop resilience among communities. [32] Regulatory focus theory is very effective in persuasive communication where the framing of the message is done in a way to find out patterns of behavior of receivers to build risk perception. [33]

6.2 Stakeholders' Roles and Responsibilities

Clarity in defining roles and responsibilities of stakeholders such as the government authorities, local administration, community members and other social actors is generally missing. The stakeholders' roles and responsibilities fall under the risk governance system that 'refers to the actions, processes, traditions and institutions by which authority is exercised and decisions are taken and implemented'. [34]. Risk governance is supported with three 'major strategies: (i) risk-informed strategy, (ii) cautionary/precautionary/robust resilience strategies (meeting uncertainties and potential surprises), and (iii) discursive strategies'. [35]

Having a strategy on paper is not enough as with the onset or/and at the occurrence of a disaster various unexpected situations emerged and many of the actions were carried out concurrently back and forth at multiple levels where various stakeholders are involved. If their roles are not clearly defined in the strategy against their competencies and scope, it causes overlapping of activities, loss of resources and ineffective operation.

Disasters also place undue pressure on women, children, elderly, infirm and people with special needs and aggravate their vulnerabilities. Paying particular attention to engage these groups from the beginning in the planning of the disaster risk management eases out their situation and builds confidence to tackle the unforeseen development during emergencies.

6.3 Psychological Consequences of Disaster and Social Fabric

Disasters cause psychological consequences such as panic, depression and fear caused by aggravated social and health conditions, food insecurity, interruption in communication and loss of coherence in collective thought and action. The scenario of having 'No Information' or 'Insufficient Information' puts everybody at a disadvantage. Hence, despite all the efforts to protect lives and assets, one is not fully prepared to tackle natural disasters efficiently and to the expectations of the public unless information is broadly publicized for **people in vulnerable conditions** (as defined in the crunch model below) [36] to react in time.

6.4 Community Resilience Building

A hazard becomes a disaster when it affects vulnerable communities, already suffering from poor social, economic and physical conditions. [37] According to 'Disaster Crunch Model' low socio-economic and environmental indicators cause vulnerability and expose the communities to disasters whereas high socio-economic and environmental indicators help to build resilience among communities to cope and recover as quickly as possible. [38] Resilience means the ability of exposed community not only to self-protect against disaster but also overcome and adapt to the effects which includes normalizing the functionality of social institutions and restoration of structures. Accordingly, the compound nature of resilience involves three aspects of resilience:

- ➤ Resilience of people/communities
- ➤ Institutional resilience, and
- ➤ Sustainable infrastructure

Building resilience of people is the toughest task. It requires a change in behavior through motivation, fear, vigilance or any other social, cultural and environmental factors that touch the heart of a particular individual and / or the community. Inclusiveness plays a positive role in resilience building. 'Promoting gender equality and women's empowerment continues to be a cornerstone of efforts to build inclusive community resilience.' [39] Women participation in the community resilience building not only provides higher headcount but also better quality of results.

6.5 Public Information and Communication Mechanism

During disasters, communication is interrupted, so is the flow of information creating chaos and panic among affected population. The conventional communication approaches, although apply generally in a variety of situations, do not sufficiently cater for risk communication where scenario is changing fre-

quently in the context of impending risks as a hazardous situation is unfolding. With the increasing use of internet, mobile phones and social media, the authorities have a whole range of instruments and means to reach out the masses. The traditional and non-traditional means continuous overlapping ensures that the messages are being circulated and repeated. The social and technological nexus makes a significant difference in effective communication, the one that gets positive and timely response from the receivers.

7. HUMAN RIGHTS AND GENDER EQUILIBRIUM – CHALLENGES AND STRATEGIES

How disasters impact the human rights situation, social and gender equilibrium and what strategies are in place to address these issues in the short, medium and long term?

There are a number of 'risk factors that create and/or increase vulnerabilities and contribute to the severity of disasters in Pakistan. That includes:

- i. Poor infrastructure and limited enforcement of existing building codes
- ii. Lack of timely warning systems
- iii. Limited awareness and education on disasters and response
- iv. Limited human resources/skilled and competent, and coordination among various government disaster response agencies
- v. Large number of impoverished communities susceptible of disasters. [40]

The impacts of natural disasters are gender differentiated. Women, girls, boys and men have distinct basic and strategic needs with distinct capacities to respond to disasters, consequently their vulnerabilities as a result of any kind of natural disaster also vary. Men generally have greater access to and control over income, land, economic resources, political power, and information; this may leave women at a disadvantaged position to cope with disaster. Therefore, women, girls, boys and men face different risk and are thus vulnerable to disasters in different ways.

Blaikie et al also establish links between poverty and vulnerability to stress their view that "the phrase 'natural disaster' suggests an uncritical acceptance of a deeply engrained ideological and cultural myth' and while questioning this myth argue that extreme events cause disasters to vulnerable groups of people who are exposed to it. [41]

Addressing these vulnerabilities purely on the administrative and technological basis is not effective. Thus a strong and implantable gender action plan for disaster risk management is required. Such a plan follows a well-defined multi layered strategic approach in the short, medium and long term.

7.1 Short Term Strategy

In the short term, the preparedness process includes community-based interventions such as providing sporadic trainings to combined or separate groups of male and female community members. Due to lack of gender specific disaggregated data, it is not possible to have nation-wide figures about this activity to highlight the extent of women participation in such trainings and the impact thereof. Therefore the priority is to collect missing information and conduct an analysis to have a clear picture of the existing disparities and work out solutions to overcome these disparities. Without reliable data the medium and long term strategies are ineffective.

7.2 Medium Term Strategy

In the medium term, Gender and Development Standards which are designed as part of the national policies for protecting and promoting equal rights of women, girls, men and boys in disasters are implemented. This is based on UN human rights agenda that ensures that all human beings irrespective of their cast, creed, ethnicity, religion and disability are treated equally and have equal participation in decision making process, accessing and controlling resources and services.

7.3 Long Term Strategy

In the long term, one of the most critical element is the assertion of 'political will', right from the top leadership to the last echelon of governance that makes decisions at the local level. People depend on leaders for direction and reassurance particularly during crisis. Building resilience with proper planning and development strategies to ensure socio-economic uplift of masses saves the chaos and panic during a disaster. People also need both material and moral reassurance that their lives will not be drastically changed due to disasters and that there is an efficient mechanism to make their losses good without delay. Besides, having some 'resources and competencies' within the community including technological knowhow helps to maintain calm during disasters.

An honest dialogue and meaningful communication among stakeholders is imperative. What is construed by 'meaningful communication' in the context of disaster risk reduction is discussed in the following section.

8. CONCEPTUAL UNDERPINNING OF DISASTER RISK COMMUNICATION

How to engage stakeholders and carry out uninterrupted communication for effective disaster response?

The 'risk communication is multi-directional that includes both formal and informal messages, and purposeful and unintentional ones. In today's super mediated environment, risk professionals must also recognize that any risk message they seek to communicate is likely to compete with multiple conflicting messages from unofficial sources. Successful risk communication requires an understanding of the target audience, including the best means for reaching the audience: a credible or trusted source; and a message that has ideally been pre-tested to ensure its effectiveness'. [42] Further, the success of risk communication depends upon personal relevance and appropriateness of messages. [43]

The risk communication purpose, timings and messages are situational and, in many cases, created haphazardly. Consequently, warnings sent out to diverse receivers at the onset of a disaster, result in effects that depend on receivers' characteristics e.g. their physical strength, psychomotor and cognitive ability as well as economic and social resources. [44] The lack of clarity of warning messages also cause recipients to spend more time in seeking and processing information instead of preparing for protective action. [45]

'Risk communication infrastructures, Renn emphasized, should meet three challenges that arise during risk debates: (1) decisions based on factual evidence and probabilities; (2) assessment of institutional performance, expertise, and experience; and (3) consideration of conflicting worldviews and value systems.'[46] '…As per the R. E. Kasperson's conceptual framework of SARF, the notion of secondary and tertiary impacts of the initial risk event can spread through 'ripple' effect to other individuals and groups regardless of proximity to the risk that could have impact on people in multiple ways including indirect social and economic impacts, resulting in poor risk management, weak reaction by relevant institutions, community conflicts and blaming each other for failure to mitigate risk.' [47] The persuasive communication as advocated by the Regulatory Focus Theory helps generate responses to those messages which are framed based on the patterns of behavior of receivers. [48]

8.1 A Case Study of Flood Early Warning System (EWS) Communication

Pakistan is frequented by natural disasters, most recurrent of which is the monsoon floods that inundate huge area of land, destroys standing crops and displaces mostly rural population. There is a network of rivers, canals and natural streams across Pakistan. The Indus River that originates in Tibet from the glacial streams of the Himalayas enters Pakistan in the northeast, and runs southwestward across Pakistan, about 2,900 km (1,800 mi), and falls in the Arabian Sea. The principal tributaries of the Indus are the Sutlej, Beas, Chenab, Ravi, and Jhelum rivers. [49] During the monsoon season, thousands of cusec water passes through the river system, over flooding huge areas of agricultural land. The floods of 2010 have played havoc with the lives and livelihood of people. Some 20 million people were affected in the floods and 1,985 precious lives were lost. Crops on an area of 5,171,026 acres were dam-

aged; besides, houses and public infrastructure was destroyed heavily. In the aftermath, the government took some decisions including establishing National Disaster Management Authority (NDMA. [50] Among other actions, government departments step up efforts to strengthen early warning systems. An Early Warning System (EWS) is a term used for various technologies, techniques and systems (e.g. radars, GIS, weather towers, telemetry systems) used to gather data/information that is required for forecasting natural phenomena which might turn into a natural disaster given the conditions on ground.

The flood early warning system uses, among other technologies, the Hydro-meteorological Gauges that include Rain Fall gauges to catch rainfall in the collection funnel as well as sensors to measure precipitation. The Stream/River Gauges measure the amount of water flowing through a stream or river over a fixed period of time. Discharge and velocity measurement are also done using various gadgets. Another common standard for flood warning is based on Telemetry system with a central data center and remote station unit. The central data center is an overall point of monitoring and operation of the entire hydro-meteorological network having the following key features:

i. GIS based Visualization of entire network
ii. Real time data collection
iii. Alarm and Warning escalation
iv. Reporting
v. Cloud based storage with zero downtime [51]

The flood warning systems are effective only if the regular real-time data is being collected, analysed and dissemination to the relevant organizations responsible to inform responsible departments and the public of any impending natural event so that necessary measures for the timely protection of communities are taken.

Any event or intervention that takes place around water is bound to affect the communities living on the banks and in the vicinity; henceforth, it is vital for any EWS to address and resolve some fundamental question right at the planning stage, e.g.:

- Who is/are the sender(s) of the warnings? What is the hierarchy of responsibility to various stakeholders in the chain of communication?
- What kind or nature of messages to be sent?
- What are the most effect means to use?
- Who are the audiences/receivers of the warning system messages?
- What is the anticipated response from the receivers (community)?

- What is the probability and extent of the losses/damages to be avoided from the disaster?
- What is the level of technological compatibility with community competencies to respond?

Due to a strong focus on modern technology and equipment that most of the early warning systems seek, there is a visible gap between the hard and soft approaches to communication. Building EWSs without building connections with the communities is not an effective way to disaster risk reduction. Community's active engagement is thus strongly needed. The following actions help to create an environment of cooperation between the local administration (technology) and the community (society).

- Public warnings to be followed by an action plan in anticipation of evacuation of people or transferring people to safe places;

- All the available resources are deployed to execute the plan with community engagement, starting with identifying focal persons, equipping, training and assigning responsibilities;

- In the case of evacuation, the means of transportation and construction of safe places such as raised platforms or designated shelters to be indicated in each locality to avoid overcrowding and panic during evacuation process;

- Carrying out mock exercises among staff and communities to practice evacuation prior to any disastrous event that contribute significantly to the success of the evacuation plan;

- Repeat above actions to build community habits which turn into automatic actions. Responsible organizations monopolize on frequent community training and rehearsal as part of preparedness.

Much work is needed to build community capacity to deal with disastrous situations physically and psychologically. In many cases, people are afraid to leave their homes and meager assets unattended due to fear of theft, and loss or destruction. This is partly due to the reason that no insurance coverage is available at that level because the insurance companies are reluctant to take risk with the low-income population segment on one hand and the families, on the other, cannot afford to buy insurance and pay regular premium. Only government post-disaster compensation schemes are in place to affected masses.

In the light of the above arguments, a communication approach is developed. The approach is called 'Butterfly' due to its symbolic application to the communities located on both sides of the river, seemingly divided, but conjoined by a common cause.

8.2 Premise of Butterfly Communication Approach

In this novel approach, the disaster risk communication premise is built on three principles:

- Communication is cross-sectional
- Communication is continuous
- Communication has consequences

The cross-sectional communication is supposed to be multi-directional vertically and horizontally meaning across various hierarchical levels and among diverse stakeholders.

The continuity of communication entails that before, during and after a disaster, there is an exchange of messages among all concerned stakeholders which lead to action(s) with positive or negative consequences for stakeholders.

To demonstrate the idea, the model supposes that multiple channels are used to receive and disseminate information related to the forecast of an impending disaster, for example flood disaster to the communities located at the banks of the river on both sides. The primary hub and secondary hubs manage the flow and keep up with the changing situations.
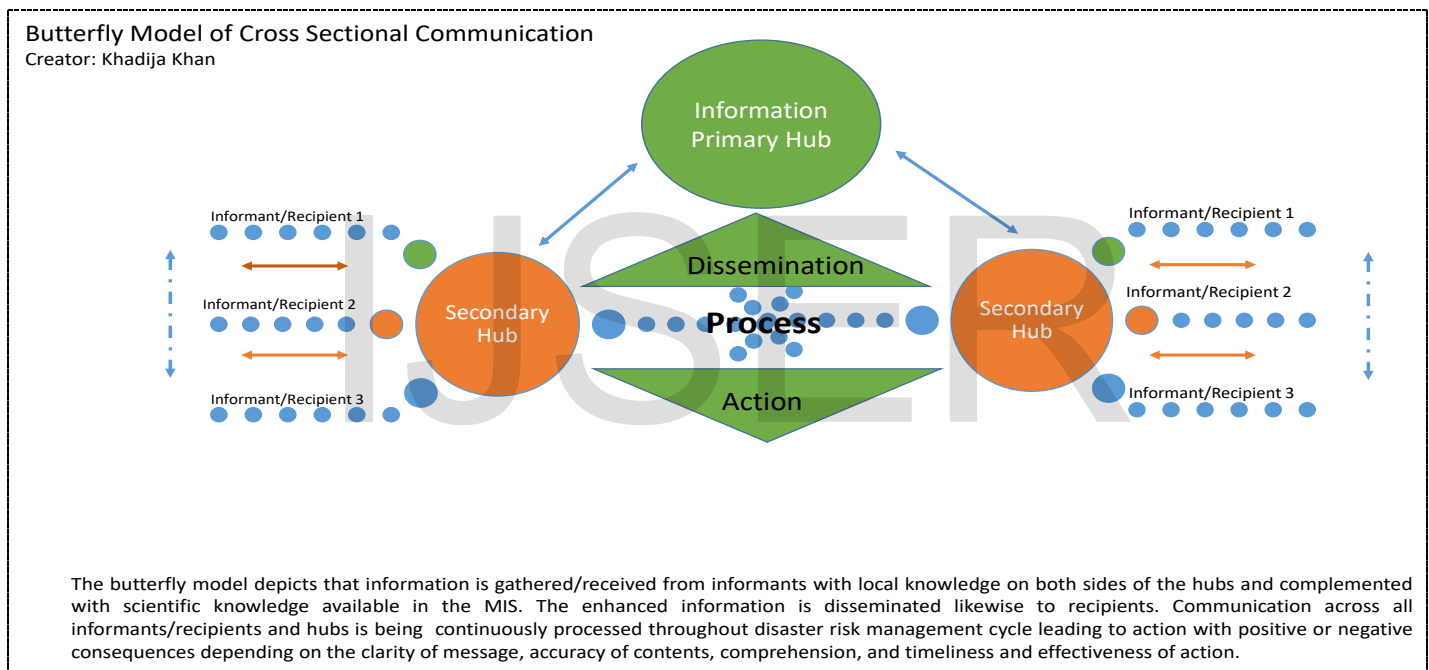
Model's graphical representation is depicted below.

Butterfly Model of Cross Sectional Communication
Creator: Khadija Khan

Information Primary Hub

Informant/Recipient 1
Informant/Recipient 2
Informant/Recipient 3

Secondary Hub

Dissemination

Process

Action

Secondary Hub

Informant/Recipient 1
Informant/Recipient 2
Informant/Recipient 3

The butterfly model depicts that information is gathered/received from informants with local knowledge on both sides of the hubs and complemented with scientific knowledge available in the MIS. The enhanced information is disseminated likewise to recipients. Communication across all informants/recipients and hubs is being continuously processed throughout disaster risk management cycle leading to action with positive or negative consequences depending on the clarity of message, accuracy of contents, comprehension, and timeliness and effectiveness of action.

Figure 2 Butterfly Communication Model

8.3 Application of Butterfly Communication Approach

A government set up of an Early Warning System consisting of telemetry systems at various locations provides constant updates on the rising level of water in rivers/dams at actual sites. Normally the communities living in these areas are aware of the threat and also watch over changing situation in the rivers (and/or dams) due to monsoon rainfall. From experience the communities know the approximate timing and intensity of floods and prepare to protect their crops, livestock and assets. Community knowledge transferred directly or through designated focal person, and telemetry system data are combined and interpreted at the primary and secondary

hubs to assess the situation and make decisions if and when to evacuate the locality to minimize losses.

8.4 Highlights of Butterfly Communication Approach

i. Sender/Receiver Nexus

This system is interactive and incorporates features from various communication models, e.g. use of various communication channels recommended in the Shannon and Weaver's Model. [52], [53] The sender, the official in charge of the EWS hub, uses both informal and formal channels to gather information, respectively, the reports based on the scientific and technological data output and reports from the community designated focal person (informant) who plays the role of an intermediary to facilitate communication between the community and the hubs.

The text of the message is reformed and updated as new information is received, the noise is taken out, the clarity is enhanced and specific instructions are added for the receiver.

During this process both the initial message and repeated / enhanced message are encoded and decoded twice placing greater emphasis on the warning. The main challenge in this exchange is the responsibility of the community focal person to validate information at his/her end before passing on to the hub or vice-versa.

ii. Origin/ Destination looping of the Message

The origin of information and destination are in the loop likewise. The hub officials observing real time changes in situation through the telemetry system/EWS check and verify if there were any messages from the community about rising water at a particular site of the river affecting residents in that vicinity, so that timely decisions are taken to implement emergency plans. The plans are supposedly prepared earlier with community engagement and backed up by necessary resources. To avoid panic and excessive load of information on destination community, the flow of communication during emergencies is carefully monitored.

iii. Language, Text and Tone of the Message

In a heterogeneous community like in Pakistan with dozens of regional languages and local dialects in addition to the national and official languages (Urdu and English respectively), the selection of language, wording of the text and the tone require good alignment with cultural and social norms for effective response by the communities. Broadcasting and disseminating multi-lingual messages is always an advantage. The disaster risk management vocabulary is part of the communication throughout the cycle and frequently publicized through various media tools, particularly televised and broadcast flood situation and early warnings.

iv. Gender Equality and Attention to Vulnerable Groups

Most importantly, the messages include specific information, instructions and/or directions for both male/female population as well as for children, elderly, infirm, pregnant women, and people with disabilities to ensure protection of human rights, address public health and hygiene matters and protection from harassment throughout disasters risk management cycle. Women's role as care-givers is significant in ensuring the well-being and safety of the family and in communicating the messages in the locality using social networks.

v. Use of Communication Technology

Numerous communication channels including electronic and print mass media and social media are available to keep the population informed of the disaster/flood risk. With the overwhelming acceptance of mobile phones and free of charge

applications, electronic channels are most effective in warning community focal persons who could further spread the message with various means available locally including the mosque announcements. Timing is utterly important in this case. During the day time, access to electronic media helps to get the message across a large number of people in the way of disaster. But, at night times, it is limited to certain means such as the warning sirens that wake up the community to the risk of disaster. People pay heed to the siren, church/school bells or firing sounds better as well as loudspeaker announcements in the locality. Drum beating is also accepted as a means of public announcement in some communities.

vi. Feedback and Continuous Improvement,

Communication process is not complete unless the feedback from stakeholders, especially from communities is obtained, analyzed and incorporated in the system for continuous improvement. The feedback comes through various channels and in various forms. However, an established monitoring and evaluation system of disaster risk management provides systematic, regular and useful feedback for decision makers to continuously stay on top of knowledge and build and maintain an efficient information and communication management system such as conceptualized in the above 'Butterfly Communication Approach'. The 'Butterfly Communication model' is supported by the concept of 'double loop learning' [54] pursued for continuous improvement.

9. INTEGRATION OF TECHNOLOGY AND SOCIAL MEDIA

How and to what extent the smart digital systems work for good governance; and enterprise GIS-enabled multi-hazard mapping and disaster risk management application help in decision making?

One important lesson learned as cited above is a lack of baseline data and relevant information to help in risk identification, assessment and mitigation as part of preparedness to save lives, livelihoods, community and public assets and critical infrastructure, consequently minimize human and economic losses of a natural disaster. The role of technology is emphasized in addressing some of the challenges discussed in the article.

9.1 Hi-tech Digital System / Application for Disaster Risk Management

One of the key issues in disaster risk management is related to the gap of technological knowledge between experts and the public. As has been advocated in many other instances that crises impact people with vulnerabilities including being uninformed and/or unprepared to react to the call of an early warning system (EWS).

On technological front, Pakistan has seen tremendous growth in the last few years. Apart from the general usage of Information and Communication Technologies (ICTs) and digital tools, it is imperative to mention that mobile technology espe-

cially, 3G and 4G mobile internet has bypassed many predictions in terms of its penetration.

Here, primary focus is on exploring how digital/ICT tools can play an enabler's role in building resilience against natural disasters. In this regard, a Hi-tech Digital System/Application as a proposed model is presented aiming to:

i. Develop a data bank of disaster prone areas;
ii. District profiling of major hazards areas;
iii. Development of GIS enabled enterprise application;
iv. Recommend capacity building initiatives specific to utilization of digital tools, and system/applications for vulnerable groups and relevant Government Departments in light of the pre and post disaster situations.

9.2 Benefits of proposed Digital System/Application

i The digital system helps in calculating losses based on the disaster simulation including cost estimation of affected public infrastructure and government buildings, private houses, livestock and vegetation.

ii The digital system helps executing agency in procuring in advance and stockpiling goods that can be delivered to affected areas including tents or boats, material, consumables, food items and medicines to affected communities, and maintaining record to replenish the same in the future.

iii This module integrates disaster risk management and disaster risk reduction intervention with social media for campaigning and information dissemination. This will help executing agency to keep the general public aware about relief operation and seek their assistance by finding the force of volunteers for relief operation.

iv This system also enables the user to monitor against different parameters in light of the DRR project interventions.

v This supports collection and maintenance of disaggregated data base in light of the geographical division, hazard zones, land, livelihoods and any significant information required by the DRM.

CONCLUSIONS

In the light of literature references and the discussion on three main questions under sections 7, 8 and 9, it is a foregone conclusion that natural extreme events turn into disasters mostly for people with vulnerabilities when exposed to such events. This knowledge leads the way to direct efforts towards mitigating vulnerabilities during disaster preparedness phase and build resilience of particularly the marginalized groups of the society.

The responsibility primarily lies with the authorities at various tiers such as the central, provincial, regional and local administrations for development of adequate policies and disaster management plans and ensuring availability of resources and delivery mechanism.

The community on the other hand is expected to take a proactive approach and extend collaboration to local administration and specialized institutions in the implementation of policies and action plans. It includes monitoring performance of responsible officials, providing feedback and recommending improvement.

Following the voice of our conscience that works around people and their wellbeing; the conclusions drawn strongly talk about the element that concern people, thus developing a nexus of social and technological resources.

1. Preparedness is not just about awareness raising of people but also ensuring personal safety and livelihood under the overall umbrella of human rights, including food security, economic stability equitable resource distribution, provision of civil amenities, infrastructure, transportation, means of communication, and functional education and health systems. Thus far to **remove vulnerabilities of the majority of population at risk**. The conclusion is made in the light of arguments with reference to Pressure and Release (P&R) model [55], according to which low socio-economic indicators create pressure on people and make them more vulnerable to extreme events.

2. Preparedness is also a 'state of mind' and is linked with **risk perception that shapes the attitude of people to act collectively**. Resilience is built through continuously adapting to changing situations, assembling resources and diverting energies towards what requires to be done to withstand a disaster. This leads to community-based disaster risk management (CBDRM) to locally assess and define risk, motivate action including developing community rescue plans, training and skills enhancement to use certain equipment for safety measures and immediate response in case of a disaster. Investment in equipment is matched with investment in training of people. How good is a fire extinguisher when there is no operator to handle it in the community?

3. No matter how you define disaster and disaster risk management cycle, the fact remains that the countries, in particular developing countries have to enhance the understanding of the people faced with frequent disasters about taking stock of their capacities and assets that could be applied in managing risk at the local level in the first place. The gaps had to be met by the relevant area administration for which '**political will' had to be mobilized for allocation of necessary technical, financial and human resources**. In this process effective, meaningful and genuine participation of communities is of immense importance. Preparedness is not about getting the latest technology to install EWS, but to create community consciousness and enhance capacity with resources and tools

to react to EWS warnings appropriately in order to minimize losses.

4. Disasters cause disruption to a smooth-running society, its institutions and governance systems. That obviously affects and/or pronounce socio-economic inequalities and political power imbalance, consequently **human rights concerns** arise from time to time. Taking care of special groups whose vulnerabilities are already known to the society such as women (and among women, girl child, young girls, pregnant women), children, elderly, sick, persons with disabilities, indigenous people, ethnic minorities and people below poverty line, politically marginalized groups and immigrants.

5. Disasters affect human rights situation in the way that the best and the worst of the society is exposed. One such issue is ensuring the **equitable distribution of resources** and services during disasters. Whereas each and every member of the society is saddened over the losses and contributes in recovery and rebuilding social and economic fabric, in certain situations where authorities fail to provide timely sufficient support to cover needs of the affected population, differences arise. The struggle to survive makes some people or groups to usurp others' right to food, water, shelter and critical means of living including overtaking their space. Physical and sexual abuse of women and children and demeaning behavior with ethnic groups, weak and the poor becomes common and instances of theft, robbery and physical fights take place during the disaster. A proper **accountability mechanism** should be put in place and strictly complied with as part of disaster management.

6. Lastly, the more **aware**, **well-informed, trained and equipped members of the society** are, the higher is the level of preparedness and better and more efficient use of resources and technological support. It calls for a closer interaction between the local administration and communities, active community participation at various levels of decision making and multi-channel information flows, to support our model of disaster preparedness, risk reduction and resilience building.

ACKNOWLEDGMENT

DISCLAIMER

Ideas and opinions expressed in the article are of the authors and not owned by the organization.

REFERENCES

[1]. Institutionalization of Disaster Risk Management in Pakistan, Muhammad Yahhya Maqbool & Dr. Shahzad Hussain, ISSRA Papers 2014

[2]. National Disaster Management Authority (NDMA) reports

[3]. Flash Floods Vulnerability Assessment of Village Kotla Mohsan Khan, Peshawar, Pakistan, Asian Preparedness Partnership/Research by Students of Centre for Disaster Preparedness and Management (CDPM), University of Peshawar, 2016-2018, p. 80

[4]. NDRMF Strategic Business Plan 2018-2020

[5]. http://apps.who.int/disasters/repo/7656.pdf

[6]. http://www.businessdictionary.com/definition/disaster.html

[7]. Society for Risk Analysis (SRA), Core subjects of Risk Analysis, Updated August 2018 https://sra.org/sites/default/files/pdf/SRA%20Core%20Subjects%20-%20R2.pdf

[8]. Society for Risk Analysis (SRA), Core subjects of Risk Analysis, Updated August 2018 https://sra.org/sites/default/files/pdf/SRA%20Core%20Subjects%20-%20R2.pdf

[9]. Asian Disaster Preparedness Centre, Bangkok

[10]. Asian Disaster Preparedness Centre, Bangkok

[11]. Society for Risk Analysis (SRA), Core subjects of Risk Analysis, Updated August 2018 https://sra.org/sites/default/files/pdf/SRA%20Core%20Subjects%20-%20R2.pdf

[12]. Society for Risk Analysis (SRA), Core subjects of Risk Analysis, Updated August 2018 https://sra.org/sites/default/files/pdf/SRA%20Core%20Subjects%20-%20R2.pdf

[13]. Integrating Disaster Risk Reduction into the CAA and UNDAF, UN Development Group, 2009

[14]. https://www.unisdr.org/we/inform/terminology#letter-r

[15]. Important Elements of Disaster Management and Mitigation and Design and Development of A Software Tool, Gurumurthy Vinjayn Iyer & Nikos E Mastorakis, Proceedings of the 7th WSEAS International Conference on Mathematics & Computers in Business & Economics, Cavtat, Croatia, June 13-15, 2006, pp102-121

[16]. UNISDR

[17]. https://www.unisdr.org/we/coordinate/hfa *22 Nov 2018*

[18]. https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf

[19]. Institutionalization of Disaster Risk Management in Pakistan, Muhammad Yahhya Maqbool & Dr. Shahzad Hussain, ISSRA Papers 2014

[20]. Institutionalization of Disaster Risk Management in Pakistan, Muhammad Yahhya Maqbool & Dr. Shahzad Hussain, ISSRA Papers 2014

[21]. Institutionalization of Disaster Risk Management in Pakistan, Muhammad Yahhya Maqbool & Dr. Shahzad Hussain, ISSRA Papers 2014

[22]. http://www.ndma.gov.pk

[23]. http://www.ndrmf.pk

[24]. https://www.gdrc.org/uem/disasters/1-dm_cycle.html 22 Nov 2018

[25]. Crisis simulation scenario building methodology that considers cascading effects, Clement Judek, Abla Mimi Edjossan-Sossou, Thierry Verdel, Kathleen Van Heuserswyn, Fredri Verhaegen, IDRiM (2018) 8 (2)

[26]. The Role of Technology in the Disaster Management Cycle, CommonTime Enterprise Mobility Blog. CommonTime (UK) 22 Nov 2018

[27]. NDRMF Strategic Business Plan 2018-2020

[28]. Australian Institute of Company Directors, Recognition and Management of Risk, p.26; companydirector.com.au

[29]. Important Elements of Disaster Management and Mitigation and Design and Development of A Software Tool, Gurumurthy Vinjayn Iyer & Nikos E Mastorakis, Proceedings of the 7th WSEAS International Conference on Mathematics & Computers in Business & Economics, Cavtat, Croatia, June 13-15, 2006, pp102-121

[30]. Risk Analysis, Vol. 8, No. 2, 1988, The Social Amplification of Risk A Conceptual Framework, Roger E. Kasperson et al, pp.177-187

[31]. NDRMF Strategic Business Plan 2018-2020

[32]. http://en.wikipedia.org/w/index.php?title=Regulator_focus_theory&oldid=884778617 retrieved May 2019

[33]. http://en.wikipedia.org/w/index.php?title=Regulator_focus_theory&oldid=884778617 retrieved May 2019

[34]. Society for Risk Analysis (SRA), Core subjects of Risk Analysis, Updated August 2018 https://sra.org/sites/default/files/pdf/SRA%20Core%20Subjects%20-%20R2.pdf

[35]. Society for Risk Analysis (SRA), Core subjects of Risk Analysis, Updated August 2018 https://sra.org/sites/default/files/pdf/SRA%20Core%20Subjects%20-%20R2.pdf

[36]. Capacity Building in Asia using Information Technology Applications (CASITA) Module 4

[37]. Integrating Disaster Risk Reduction into the CAA and UNDAF, UN Development Group, 2009

[38]. Capacity Building in Asia using Information Technology Applications (CASITA) Module 4

[39]. Global Facility for Disaster Reduction and Recovery, Annual Report, 2018

[40]. Technology Mediated Disaster Risk Reduction in District Peshawar, Asian Preparedness Partnership/Research by Students of Centre for Disaster Preparedness and Management (CDPM), University of Peshawar, 2016-2018, p. 146

[41]. At Risk (2nd Edition) Natural hazards, people's vulnerability and disasters; Ben Wisner, Piers Blaikie, Terry Cannon, and Ian Davis; Routledge, UK, 2003

[42]. Society for Risk Analysis (SRA), Core subjects of Risk Analysis, Updated August 2018 https://sra.org/sites/default/files/pdf/SRA%20Core%20Subjects%20-%20R2.pdf

[43]. Risk Communication Emergency Response Preparedness: Contextual Assessment of the Protective Action Decision Model, Robert L. Heath et al, Risk Analysis – an International Journal Vol. 38, N0. 2, 2018 pp.333-344

[44]. The Protective Action Decision Model: Theoretical modifications and additional evidence, Michael K Lindell, University of Washington, Seattle, USA, January 2012

[45]. The Protective Action Decision Model: Theoretical modifications and additional evidence, Michael K Lindell, University of Washington, Seattle, USA, January 2012

[46]. Risk Communication Emergency Response Preparedness: Contextual Assessment of the Protective Action Decision Model, Robert L. Heath et al, Risk Analysis – an International Journal Vol. 38, N0. 2, 2018 pp.333-34

[47]. Risk Analysis, Vol. 8, No. 2, 1988, The Social Amplification of Risk A Conceptual Framework, Roger E. Kasperson et al, pp.177-187

[48]. http://en.wikipedia.org/w/index.php?title=Regulator_focus_theory&oldid=884778617 consulted on May 2019

[49]. http://www.wildlifeofpakistan.com/IntroductiontoPakistan/riversofPakistan.htm

[50]. NDRMF Strategic Business Plan 2018-2020

[51]. Government of Khyber Pakhtunkhwa Irrigation Department, Hydrology Irrigation Division, Peshawar

[52]. https://thevoony.com/shannon-weavers-model-of-communication/ consulted on 28 June 2019

[53]. Argyris, C. & Shon, D., Theory in Practice, San Francisco, 1974

[54]. http://www.instructionaldesign.org/theories/double-loop/

[55]. http://en.wikipedia.org/w/index.php?title=Regulator_focus_theory&oldid=884778617 retrieved May 2019