Early Warning System: People-centred Integrated Model Development in Pakistan

Authors:

1. **Muhammad Arshad Khan Khalafzai**
   MA Disaster & Emergency Management, York University, Toronto, Canada
   DRR Consultant, United Nations Children Fund (UNICEF), Pakistan Missions, 41-D, Street 42, P.E.C.H.S, Karachi Postal Code 75000, Pakistan
   Email address: khalafzai29@gmail.com; makkhalafzai@unicef.org
2. **Javeria Hassan Niazi**
   MS Public Policy, Beaconhouse National University, Lahore, Pakistan
   Research Associate, Center of Public Policy and Governance, Forman Christian College, Ferozepur Road, Lahore 54600
   Punjab, Pakistan
   Email address: jav.niazi@gmail.com; javerianiazi@fccollege.edu.pk

Abstract

The global climate is changing rapidly and disastrous events are increasing in number, intensity and severity. The situation demands for a proactive approach of **disaster risk reduction** (DRR). There is an inherent linkage between climate change and DRR since the former is expected to increase the frequency and intensity of natural hazards and the later demands for appropriate actions to take to reduce disastrous events. Therefore, there is a surge of interest in developing **early warning systems** (EWS) to cater to the needs of communities that are at risk of hydro-metrological hazards. However, developing effective EWSs needs a sound scientific and technical basis and a consistent focus on the people exposed to risks is a challenging task.

Pakistan, a natural hazards prone country, is in a great need to have an effective and efficient multi-hazard EWS which uses scientific data to analyze the risk perspective of the hazardous events. For this it is important to develop EWSs that meet the local conditions. Moreover, they are also essential investments that help saving lives, protecting property and livelihoods; contribute to the sustainability of development. They are far more cost-effective in strengthening coping mechanisms than is primary reliance on post-disaster response and recovery. However, lack of a suitable **people-centred** EWS and failure to warn people at risk in advance is one of the main causes for high levels of human, economic and environmental losses. In the natural hazards risk context, the EWS should be capable of detecting, in accordance with specific thresholds, the areas where adverse hydro-metrological hazardous events are expected within the next few days (for forecasts) and within the next few weeks (for predictions) and subsequently should have the ability to issue relevant timely warnings along with the required actions to be taken and localized information to the specific communities at risk.

Key Words: Climate Change Adaptation, Disaster Risk Reduction, Early Warning System, People-centred, Localized Information, Forecasts, Predictions.

Background

Over the past two decades, evidence has mounted that the global climate is changing rapidly and natural disastrous events are increasing in number, intensity and severity. Gravity of the situation demands for a paradigm shift from reactive approach to proactive one: From response and recovery to disaster risk reduction (DRR). There are solid reasons for the linkage between climate change and DRR since the former is expected to increase the frequency and intensity of natural disastrous events and the later demands for appropriate actions to take for reducing the disastrous events risks. Therefore, there has been a surge of interest in developing early warning systems (EWS) to cater to the localized needs of communities that are at risk of hydro-metrological hazards. However, developing effective EWSs not only need a sound scientific and technical basis, but also a strong focus on the people exposed to risks is a challenging task.

Pakistan, a natural hazards prone country, is in great need to have an effective and efficient multi-hazard EWS which uses scientific data to analyze the risk perspective of the hazardous events. For this it is important not only to develop a EWS that is suitable for Pakistan that meets the local condition such as socio-cultural, political, technological and administrative, but also are essential investments that help saving lives, protecting property and livelihoods, contribute to the sustainability of development, and are far more cost-effective in strengthening coping mechanisms than is primary reliance on post-disaster response and recovery.

Introduction

The scale and frequency of the hydro-metrological hazards such as floods and flash floods, tropical cyclones and storms, extreme weather conditions (including heat and cold waves) and droughts has increase increased in Pakistan due to the changes occurring in the global climate and inappropriate water management and human activities in hazard prone areas. While the number of people and economic assets located in such hazard prone zones continues to grow, effective hazard risk mitigation and preparedness planning becomes imperative that aims to reduce the likelihood and/ or the impact of the hazardous events. Their impacts can be mitigated through various structural, non-structural and preparedness measures. EWS is most important when it comes to natural hazard risk mitigation and preparedness.

To prevent heavy losses from such disastrous events, measures of adaptation and mitigation have to be taken. For such preventive, mitigation, and preparedness measures to be taken, EWSs need to be developed suitable for communities at risk. These systems can help curb the heavy costs that the country has to face. These systems can not only help people from the adverse impacts of natural disasters but can also contribute to protecting livelihoods of the farmers by issuing them timely weather forecast for hazardous events such as droughts and excessive rainfalls.

However, lack of an appropriate and robust **people-centred** EWS and failure to warn people at risk in advance is one of the main causes for high levels of human, economic and environmental losses. In the natural hazards risk context, the EWS should be capable of automatically detecting, in accordance with specific thresholds, the areas where adverse hydro-metrological hazardous events are expected within the next few days (in case of forecasts) and within the next few weeks (in case of long term predictions) and subsequently should have the ability to issue relevant timely warnings – along with the required actions to be taken and localized ample information provided to the specific communities that are at risk.

Research Methodology and Data Collection and Analysis

Methodology

Keeping in the limited scope and resource constraint to carry out the research, a simple yet an effective and efficient methodology was devised for qualitative data collection both from primary and secondary sources. The researcher's academic background, professional and technical knowledge and skills, and DRR contacts/ network have been really helpful in conducting this study despite time and other resource constraint. The study primarily based on qualitative data collected through DRR Key Informant (KI) interviews and by conducting Focus Group Discussions (FDG) among communities affected by the 2010 Super Floods and droughts during recent years. The primary and secondary data collected during the study was used for the analysis. For secondary data collection, the relevant literature was reviewed thoroughly.

Data Collection

In order to conduct the study, qualitative data acquired from different primary as well as secondary sources was analysed. For secondary data analysis, an ample amount of relevant literature was also reviewed. The literature reviewed included research articles, reports and papers on EWS written by academia, DRR researchers and practitioners.

Key Informant Interviews

The KIs (DRR professionals and experts) were selected randomly based on their professional experience and knowledge in the field of DRR and EWS. For their selection, the DRR Forum in Pakistan and other DRR networks were approached. Questions for the KI interviews were developed keeping in the scope and objectives of the study. The interviews were conducted at places and time convenient for the KIs. They were requested for permission to record their interviews using a voice recorder for the qualitative data collection and transcribing the interviews. The KIs who were interviewed include officials from following organizations:

- Pakistan Meteorological Department (PMD) both at the national and district levels,
- Global Change Impact Studies Centre, Pakistan (GCISC),
- National Disaster Management Authority (NDMA), Pakistan,
- Provincial Disaster Management Authority (PDMA), Punjab Province,
- District Disaster Management (DDMA), Bhakkar District, Punjab,
- The UN agencies such as UNESCO and UNOCHA, Pakistan Missions,
- INGO such as Malteser International and Save the Children, Pakistan Programs.

Focus Group Discussions

In order to have the community's perspective on the existing EWS and their impact on them during the 2010 Mega Flood disastrous events, different FGDs were conducted in the 'Kacha' area (low lying area along both sides of the River Indus) prone to the riverine flooding hazard located close to the Indus River in D.I. Khan District. The groups were consisted of the local community members while representing almost all segments of the society such as school teachers, farmers, social workers, NGO and Community Based Organization (CBO) workers and small business entrepreneur.

In order to collect data during the FDGs, a set of guidelines was developed directed toward different group members so as to acquire perspective of each and every member. During the process of the groups' discussions, various probing phrases were also used. To collect the qualitative data, the asked questions were designed in a manner that each one incorporated a number of variables. During the discussions, for convenience of the community members, local language was used to reduce language barriers. For accuracy, data was collected and transcribed by the researcher himself with the help of a young researcher. To conduct the FGDs, sizes of the groups were made as outlined by Kreuger (1994) which ranges between 6 and 12 individuals.

Qualitative Data Analyses

The group discussions and all the KI interviews were audio-taped and transcribed. This indeed facilitated the data management, analyses, and the production of this paper.

Limitations and Constraints

Scope of the study was limited keeping in time and resource constraint. Due to time constraint, literature review may not necessarily have covered larger amount of the secondary data required for an in depth qualitative data analyses. The primary data collected through the KI interviews may not essentially represent the larger population sample due to the fact that only the DRR community contacts at the national, provincial and district level were used on a random selection basis. As the funding provided and time allocated for the research was very small, both budget and time constraints played key roles.

Review of Literature

EWSs and their continuous improvements are integral parts of hazard risk mitigation and preparedness (Chen *et al.*, 2009). EWS protect the people by combining scientific monitoring and detection systems with social design factors and components to notify the people at risk (Sorensen, 1993). We take folding hazard as an example. Flood EWS have been developed and implemented in flood prone areas of developed countries such as the USA and the European countries (European Commission, 2009). Advanced flood EWS include climate change impacts. Flood EWS act as a trigger to implement response plans in areas identified as vulnerable to flooding. The flood EWS could provide advance warnings of different time scales (daily, hourly) (European Commission, 2009). Issuance of early warnings prior to a large hazardous event can save lives and reduce some of the potential impacts. However, designing, implementing, and sustaining EWSs in communities is a very big and challenging task. Developing an effective EWS requires that: 1) early warning and risk reduction be mainstreamed into a policy process; 2) governmental agencies have the capacity to be able to design and implement it; 3) participation of local communities to ensure that the people at risk are timely and adequately informed and alerted (Collins *et al.*, 2008). In addition, qualified DRR experts and professionals working for International Non-governmental Organizations (INGOs), NGOs and the United Nations (UN) agencies help the government in developing such systems.

Because of its very crucial role, attention to the flood EWS have continued to increase on the political arena over the last decade (Demeritt et al, 2007; DKKV, 2004; Parker and Fordham, 1996; Pitt, 2007; Van Berkom et al, 2007). Flood EWS that can provide warnings many days ahead of the actual events have become a key part of flood risk management strategies (De Roo et al, 2003; Patrick, 2002). Such systems would give all the stakeholders, especially the public, adequate preparation time and thus reducing the impacts of flooding (Penning-Rowsell *et al.*, 2000; Sene *et al.*, 2007).

According to Parker et al. (1995), however, unfortunately, flood warning dissemination and response systems are usually unreliable. “In many areas the chances of householders receiving a timely flood warning are quite low and the assistance given to flood victims is being eroded. Far fewer resources have been directed towards these components of Flood Forecasting and Warning Response Systems (FFWRS), and flaws in these systems are now becoming more obvious (Parker et al, 1995).” Parker et al argue that models of flood forecasting, warning and response systems usually involve hydro-metrological agencies, the police, local and disaster management authorities, emergency planners, the emergency responders and services, and communities at risk.

Process models to view FFWRS as systems comprise 4 key components: flood detection, flood forecasting, flood warning dissemination and response. In terms of flood loss reduction, the effect of flood detection and forecasting is dependent on effective warning dissemination and response. In regards to how long it takes to warn population about an event, most emergency response system can issue an effective warning to evacuation given 3 or 4 hours lead time. In an urgent threat situation, however, a warning can be disseminated with less than an hour time. But, then a significant population may not receive the warning timely (Sorensen et al, 1988). According to Conti et al (1994), current trends and research efforts are geared in the direction of cross-fertilizing multi-sensor information and GIS structures with the aim of forecasting and mitigating flooding hazard. Jones et al (2000) say flood forecasting and warning services constitute an effective and economical means of reducing loss of life and damage to property.

Gaps and Issues Identified in Existing Early Warning Systems Installed at Pakistan Metrological Department

1. The PMD Early Warning Model

- PMD is presently using end-to-end early warning model. Focus of the model is largely on natural hazardous events particularly hydro-metrological. There is very little or no attention given to the assessment of vulnerabilities of the communities affected by the hazards; no plan of actions is made when a warning is issued. The model is not based on a multi-hazard (all major hydro-metrological and agro-metrological hazards) or an Integrated Early Warning System.
- Flood Early Warning System (FEWS), a digitalized weather data analysis software, was installed at PMD years ago which is presently non-operational for a long time primarily due to lack of capacity of the PMD staff to update the system while calibrating the software by normalizing the supplementary data of disastrous events occurred afterwards into the system. Essentially, absence of the FEWS code (developed by an international consulting firm but not handed over to PMD) has therefore reverted back the PMD metrologists to the manual data analyses techniques - which are not efficient, speedy and reliable as the margin of human error in manual analyses significantly increases. Overlay of the GIS facility with the existing EWSs is non-existent. PMD possesses little or no technical (ICT) skills and capacity to integrate GIS analysis into a model that is a multi-hazard (integrated) EWS.
- While use of the GIS facility at PMD is very limited - only the weather condition maps are produced, this powerful tool can be very helpful in generating hazards (risk) assessed localized community at risk maps showing vulnerability of communities to various risks up to the village and/ or Union Council (UC) level.
- In northern and mountainous areas of Pakistan, there lacks dense networking of weather stations that significantly reduces PMD capacity to forecast adequately and accurately that can be very useful for the communities at risks of both disastrous events and extreme weather related losses.

2. Scientific, Administrative and Managerial

- The PMD EW information messages are generally vague therefore are not useful for the communities. Due to their very nature of complexities and technicalities it is hard for the local officers to decipher and understand them. The information does not provide with a set of instructions for expected actions to be taken to avoid a hazardous event turning into a disastrous event or allowing them to mitigate impact of such events.

- EW information is a combination of three things: 1) linkage between the PMD scientific data and hydro-metrological technical analysis, 2) vulnerability to multi-hazards risk analyses, and 3) the administrative authority. However, in Pakistan apparently, the science (PMD) is the head of administration and management since NDMA, PDMA DDMA especially administration at the grassroots level essentially rely upon the EW information messages full of technicalities and complexities that are very difficult to understand even by well-educated government officials. On top of that, the EW information by-and-large remains too vague to guide the communities of actions to be taken to mitigate their losses that they experience either due to extreme weather conditions (hazardous events) and/ or disastrous events.
- NDMA, PDMAs and especially DDMAs do not have a dedicated district disaster management team which significantly limits the ability of administration and management of EW information therefore cannot ensure that the communities at risk have timely, meaningful and useful access to the much needed information. No ad hoc arrangement, but rather dedicated work by key district management officials that are trained and have the required capacity to formulate the EW information messages and subsequently disseminate such messages to the end users clearly informing about the required actions to be taken by the community members that are at high risk of hazards.
- Although, there have been improvements in the normal weather forecasts. However, the problems is that the forecasts are not effective and useful primarily due to the fact that farmers and end users do not understand what does the messages that are too technical to fully understand to act upon by the communities at high risk such as lack of localized forecast encompassing the risk assessment cause significant agricultural produce losses thus badly affecting the rural livelihood of the small landholding farmer community.
- The irony is that only material losses that are loss of life and infrastructure are considered as major losses in result of disasters. Loss of livelihoods and socio-economic losses of small farmers and marginalized communities are not generally considered as significant.

3. Communication and Coordination: Guidelines and Operational Procedures

- There is a lack of effective linkages between local PMD chapters and district administration/ local government at the grassroots level. The PMD district stations/ offices collect data that is just sent to the PMD headquarter and the information message, after analysis, is sent back to the regional and district PMD chapters in the form of technical information. The information message is too technical, vague and therefore difficult to understand by communities that are at a high risk of extreme weather event. The district PMD sends fax to a few organizations and a TV channel and shares the information as it is without analyzing the risks at the local level – the information is by-and-large not localized.
- The EW information messages have several issues as they do not include precise and simple set of instructions for the expected actions taken by the community at risk of extreme weather hazardous events and/ or hydro-metrological disastrous events. Actually, the communities at risk are not provided the vital information before or during disastrous events. They do not know what needs to be done for example if they are advised to evacuate primarily because they are not told:
    a. When to evacuate,
    b. Where to evacuate,
    c. How to evacuate,

d. Which roots (are safe and short for safer and quick evacuation) should be used to evacuate,
e. How to protect community's assets, property and crops,
f. How to mobilize community resources to better cope with and respond to,
g. What services they will be provided with after evacuation,
h. Which camps they will be provided shelter and other basic lifesaving services such as safe drinking water and food.

- There is a lack of mechanism that ensures an effective linkage between the PMD chapters and the relevant government agencies at all levels particularly at the district level with district administration which has the authority to decide whether to evacuate (or not) communities in case of disastrous events and in case of extreme weather hazardous events.

4. Responsibility, Mandate and Accountability

- No government agency has officially and legislatively been assigned the responsibility of formulating the EW information message that encompasses not just weather related general information but also covers localized community-specific risk assessed information along with the required actions taken to mitigate the risks of hydro-metrological hazardous and disastrous events. In this context, ambiguity of the mandate of these agencies restrict any action of the government assigning responsibility for accountability should any agency does not fulfils its critical responsibility ensuring timely, accurate and meaningful dissemination of the EW information messages.
- Contrary to the EWSs established in the developed world where predefined and predetermined set of guidelines clearly outlining the acceptable margin of human error exists, PMD is reluctant to release simple, clear and precise meaningful EW information messages. One of the many reasons that PMD does not issue such messages is that its officials do not take responsibility to face any unwanted situation that could become a likely cause of bashing of the affected people due to the human error in the EW information. Therefore, this has been one of the major reasons that the PMD officials issue technically complex and sort of vague information which obviously cannot held responsible and thus accountable should an unwanted situation arise due to disaster losses. So, during disastrous events, the disinformation overwhelms credible and reliable EW information.

5. Capacity, Awareness and Agro-based Livelihoods

- Due to the lack of education and awareness and usefulness of the EW information, there is no community driven demand for an effective and robust EWSs and information messages to be provided to help preventing and/ or mitigating hydro-metrological hazardous and disastrous events. Such demand does not even come from the small farmers and the communities that mainly rely upon agro-based livelihoods as a means of their very survival who experience huge economic losses due to lack of the EW forecasts and predictions in the face of extreme weather conditions and disastrous events.

Future Directions

General

- The existing end-to-end EWS approach somewhat implemented in Pakistan needs to be transformed into the People-centered integrated EWS approach. Therefore, it is proposed that the contemporary model used in countries that have advanced EWS – the Integrated Early Warning (People-centered) System should be developed keeping in the local context which help ensuring effective coordination and communication both vertically and horizontally among all relevant government agencies (federal, provincial and district) and between various district government/administration line departments at the grassroots level.

- The proposed model should be based on an integrated multi-hazard (hydro-metrological) EWS that is fundamentally based upon the concept of “Interoperatability” – the concept that will be explained in detail in at the end when the suggested model is elaborated through a graphical presentation.
- This model should essentially have an overlay of Geographic Information System (GIS) analyses based on social, physical/ geographic, spatial, demographic, environmental, and economic vulnerabilities of the communities to the risks of the hazards.

Communication and Coordination

- PMD, NDMA, and particularly PDMAs and DDMAs need to coordinate and collaborate closely and effectively with each other at the national, provincial and district level to develop a mechanism formally to create linkages between and among all for timely, and meaningful EW information dissemination. However, the focus should remain at the district level since first responders are always the district authorities during disastrous events and emergency situations.
- ICT particularly electronic media including private TV and local FM Radio Channels, emails, telephones, cell phones should be effectively used to disseminate the EW information to the communities at (with a localized focus) risk including the officers of district government. PMD should add cell numbers of the key district administration officers and credible local NGOs and voluntary community based organizations to send text messages so that the EW information is disseminated immediately to act upon.

Scientific, Administrative and Managerial

- There needs to bring and maintain balance between science, risk analyses, formulation of the EW information messages and the information dissemination through effective administration and management of the entire process, right from scientific data collection to the required actions taken by the community at the risk of the hazards.
- Close and strong linkages between PMD (i.e. scientific data collected/ available) and the administrative and managerial authorities (who have the administrative power to issue and disseminate EW information) and among all levels of the governments, the PMD chapters, disaster management authorities, and other related agencies should be created removing the administrative, managerial and bureaucratic cumbersome procedures and bottlenecks.
- NDMA, PDMAs and especially DDMAs should have dedicated district disaster management team which preferably possess the relevant academic background and is equipped with the required skills, knowledge and experience. Ad hoc arrangement at all levels of the disaster management institutions should be replaced with full time professional staff equipped with all the necessary legal, administrative, and managerial authorities and financial resources.
- DDMAs needs to be made fully functional with minimum between 6 and 10 qualified staff empowered by their respective PDMAs to make grassroots level decisions and accordingly communicate them what actions the community members need to take - translating scientific information into action(s).

Responsibility, Mandate and Accountability
Early warning and forecasting does not inevitably mean that there is an exact narration of extreme weather hazardous or disastrous events that will (or will not) happen. Forecasts are based on possibilities and predictabilities. Therefore, there is a need to develop a mechanism to calculate and decide what margin of error should be acceptable in order to avoid the perception (or misperception) of being blamed for misleading EW information - balance the best case scenario and worst case scenario.

Community Based Early Warning Information Dissemination
In order to overcome the administrative and managerial bottlenecks and reduce the communication gap between the district administration and community at risk, the CB EWS approach can be very helpful in ensuring that the EW information not just reaches to all the community members but is also understood accurately to perform the desired actions that are needed to take. Such community based localized EWS are far better than without it in terms of their impact. However, they are very complicated to be established.

Climate Change, DRR and Early Warning Systems
It is recommended that the climate change adaptation assimilated models designed for farmers and those engaged in agro-based livelihoods should be used allowing them to develop their skills with the changing climatic conditions and environment thus adapt to the atmospheric changes.

Capacity Building, Awareness and Training
One of the major gaps that we have in the country is the lack of human capacity. In Pakistan, the required moderate equipment and technology such as radars, ground monitoring stations and satellite weather monitoring system is available to monitor the hydro-metrological hazards thus there is as such no technology issue. It is primarily due to the fact that now we can better use simple and cost effective technology by applying innovative techniques and methods while having trained and skilled human resource. Therefore, there is a need to develop the PMD staff capacity while developing and promoting international linkages and encouraging the staff to be informed about and use the international research carried out in the field.

Conclusion

Suggested Model: Proposed Early Warning System

In Pakistan, presently, end-to-end early warning model is being used to some extent. Focus of the model remains largely on hazards particularly hydro-metrological. As stated earlier, very little or no attention is given to asses vulnerabilities of the communities to the risks of natural hazards and desired actions taken by them should an early warning is issued. The model does not include a multi-hazard (major hydro-metrological and agro-metrological hazards analyses) titled as “InterOperatability” along with an overlay of Geographic Information System (GIS). Both the components of the model recommended to be implemented as a pilot project are elaborated as under:

Inter Operatability of Different Data Systems:

A multi-hazard (major hydro-metrological and agro-metrological hazards) integrated EW model essentially grounded on the concept of digesting and analysing all hydro-metrological and agro-metrological data acquired from different sources such as radar data, ground station data and satellite service data on different natural hazards including floods, droughts, cyclones/ storms and extreme weather conditions (excessive or less rains, extreme heat and cold waves). The integrated multi-hazard scientific data analyses using effective and efficient software that has the capability of calibration titled here as **“Interoperatability”** of different data systems shown and graphically presented in the following figure. The Interoperatability (multi-hazard) model would provide following information:

- Nature of the hazard(s) i.e. hydro-metrological and/ or agro-metrological
- Onset of the hazard(s)
- Intensity of the hazard(s)
- Duration of the hazard(s)
- Extent of the hazard(s)
- Impact of the hazard(s)
- Frequency of the hazard(s) e.g. monsoon or extreme (heat or cold waves) weather spells occurring such as during the season of monsoon.

Localized Hazard Risk Analyses using GIS Tools

In addition to the interoperatability of different data systems, the suggested EWS model would essentially have an overlay of GIS analyses to identify risks posed to a particular community at the Union Council level or village cluster level during a particular time period. The GIS hazard risk analyses shall include social/, demographic, geographic area/ spatial, and environmental i.e. assessing vulnerabilities of the communities to the risks of the hazard(s). Such GIS analyses need to be localized, community-specific and geographic-specific. They should be scenario based providing different impact scenarios. For example, if there is two, three and four feet flood water calculated for an anticipated flood disastrous event, then how much geographic area and population would be affected. The analyses would also generate risk maps showing high, moderate and low risk areas in a particular UC, Tehsil and/ or District, and would provide minimum following information:

- Which specific geographic area i.e. village(s) or UC(s) of a Tehsil/ District will be affected?
- How much area (square meter/ kilometre) will be affected?
- When is the event expected to occur and its duration?
- What would be possible/ anticipated losses?
- Which populations will be affected?
- What actions the people/ community at risk needs to take?
- What are higher grounds/ safe locations that can be used for shelters?
- Which (alternate) evacuation routes are safer and quickest?
- Which area(s) or location(s) are safer and can be used as camps or shelters?
- Where schools, hospitals and government buildings are located?
- Which schools, hospitals and government buildings are safer and which are not?

Depending upon availability of dataset and SHP files of the dataset, more in depth vulnerability to risk analyses such as social, demographic, gender, age, ethnicity, language and socio-economic class can be conducted to inform the communities at risk in a manner that they have ample, credible and reliable information to make informed decision to protect their lives, livelihoods (livestock) and property.

EW Information Message Formulation: Overlay of InterOperatability of Data Systems and Localized GIS Risk Analyses

While the Interoperatability would ensure quick, speedy and computerized multi-hazard scientific data analyses, GIS would help ensuring that layer to layer localized geographic, spatial and socio-demographic analyses are conducted to provide the communities all possible vital information, which is critical in reducing the risks of hazardous event(s). The model would also outline and guide in following:

- How a simple, clear and localized EW information message will be formulated?
- Who would be responsible to formulate the message?
- How EW information would reach to the end-user/ community members?
- What formal and informal mechanism and channels would be used?
- What mediums of communication (local level) would be used to ensure that EW messages reach to the end user/ community?

Explanation of the Suggested Model for Proposed EWS

Following is the suggested EW model processing mechanism of hydro-metrological multi-hazard scientific data analyses (Interoperatability) overplayed by GIS localized risk analyses at PMD. This will generate people-centred integrated EW information and message for dissemination. The process of data analyses and flow of the EW information from PMD to the community level will be as under:

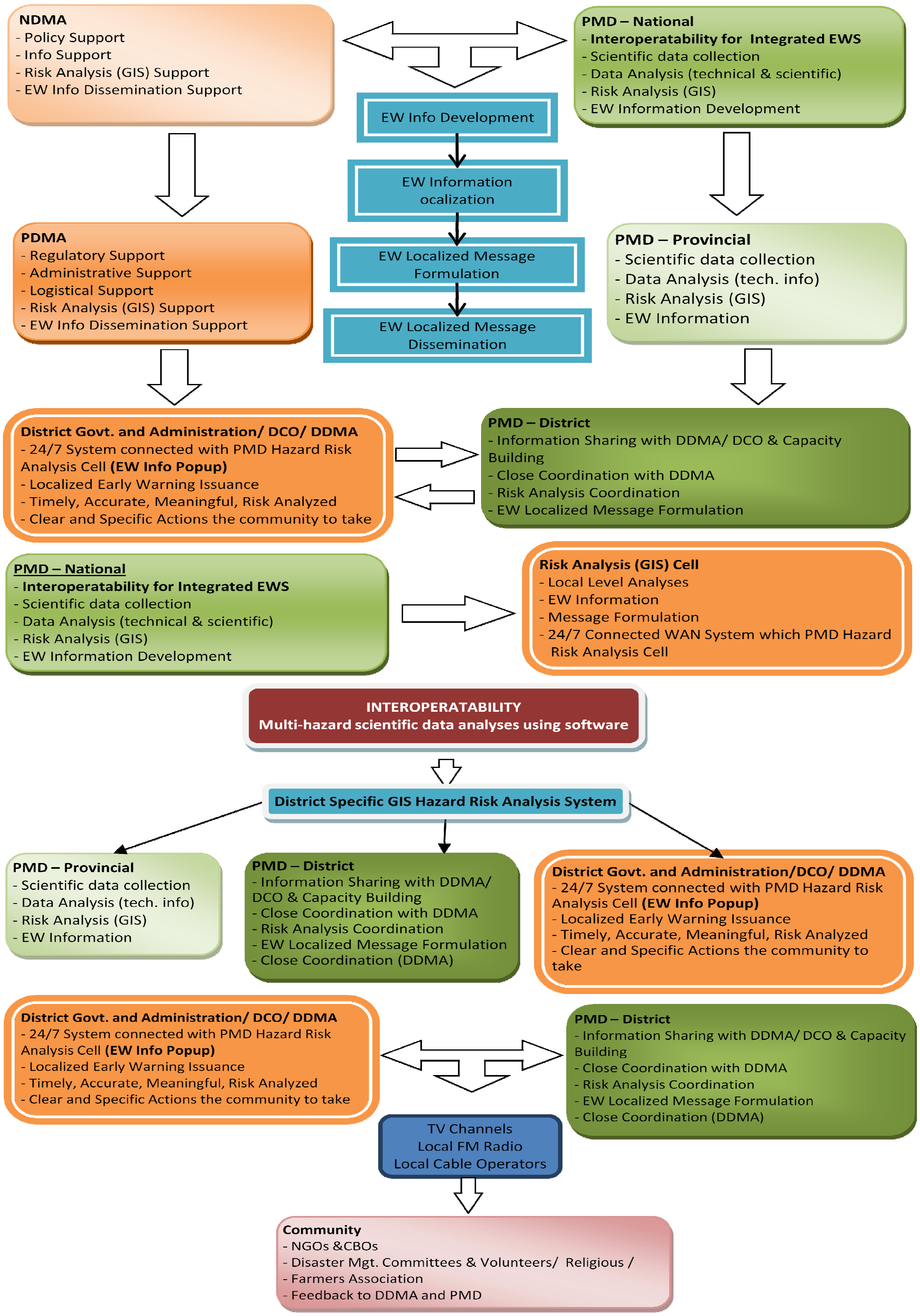
- Scientific data collection by PMD headquarters through: 1) Rader data acquisition procedure, 2) Ground Station data coding services, and 3) Satellite data coding services, etc. All these data acquisition and coding procedures are different. Presently, the data are analyzed through different manual methods which encounter several problems such as a significant amount of time is needed for manual analyses, margin of human error is huge, and lack of a multi-hazard hydro-metrological data modeling. Solution to these issues is use of “Interoperatability” tools and technique by the PMD experts.
- Overlay of GIS localized, geographic and socio-demographic analyses will be conducted jointly by a qualified and trained team of GIS and disaster management experts in a well equipped cell established at the PMD headquarter.
- After conducting analyses through “Interoperatability” and GIS tools at PMD, EW information message - encompassing simple, clear and precise set of instruction along with the desired actions taken by the community at risk - will be generated in a shortest possible time.
- The moment the EW information message is generated at the main computer station/ system installed at PMD it will pop-up/ displayed simultaneously – within no time or within minutes – on the computer systems installed at DDMA/ DCO office dedicated for EWS and information dissemination.
- At the same time, the EW information messages will also pop-up and displayed on the systems installed at PDMA and NDMA. However, the EW information dissemination priority office(s) would be DDMA/ DCO office since they are the first (government officials) to respond to any hydro-metrological hazardous event and/ or agro-metrological hazardous events. The relevant DDMA/ DCO and the respective PDMA offices will remain focal points of the information messages to be communicated promptly and precisely.
- The EW information messages will be processed both for: 1) The agro-metrological hazardous events that could affect the farmers’ agricultural produce and can several impact rural population’s agro-based livelihoods, and 2) the hydro-metrological disastrous events that can severely affect populations and property at risk.
- The suggested model will be implemented as a pilot project in one or two selected districts of a province that are prone to the hydro-metrological disastrous events and/ or agro-metrological hazardous events.
- While piloting the project, all relevant government officials especially the key personnel of the DDMA/ DCO office including district administration’s key departments such as Agriculture Department and Revenue Department.
- Key officials of DDMA, PDMA and NDMA will be trained on the EWS: How the suggested model will work. Precise roles and responsibility of the organizations involved

at all the three levels especially at the district and provincial levels will be assigned. Precise, workable and robust SOPs – two to three pages - will be developed for the pilot project to be experimented to assess its effectiveness and efficacy.

- The selected communities, NGOs, CBOs, farmers association and community disaster management organization/ committee(s) will also be trained on the pilot intervention of the proposed model. The community volunteers, social workers, religious clergy and youth will also be engaged and trained in dissemination of the EW information messages particularly the information pertaining to the (localized) GIS community at risk geographic and demographic analyses.
- Government and private TV and Radio channels, local media especially FM radio and Cable TV and registered cell phone users of the community at risk - the proactive community members trained on the EWS - will also be provided with the timely, accurate, meaningful and risk assessed information. The EW information message will also include the actions that the community will be advised to take in order to mitigate the risks of the agro-metrological hazardous events and/ or hydro-metrological disastrous events. In this regard, role of the district chapter of PMD and DDMA/ DCO office will be very crucial.
- In the suggested EW model, the district and provincial chapter(s) of PMD will effectively collaborate with and provide support to the DDMA/ DCO office and the line departments and the respective PDMA.

CBOs, NGOs, farmers' associations, volunteers and community disaster management organization(s)/ committee(s) will also be provided with the EW information massages by the PMD including its district chapter(s) and the relevant DDMA/ DCO office(s).

Figure 6.1
Decentralized People-centred Integrated Early Warning System



Acknowledgement

The authors would like to acknowledge the continuous support, valuable comments and useful guidance of Oxfam GB. The study could not have been accomplished without their financial help. We would also like to thank the officials from Pakistan Metrological Department (PMD), National Disaster Management Authority (NDMA), Provincial Disaster Management Authority (PDMA), District Disaster Management Authority (DDMA), Save the Children, Malteser International, Global Change Impact Studies Centre, Pakistan (GCISC), The UN agencies that is United Nations Educational, Scientific and Cultural Organization (UNESCO) and United Nations Office of Coordination for Humanitarian Assistance (UNOCHA), and the flood and drought prone/ affected communities of D.I. Khan District for their cooperation in providing us with the information we needed for the study.

References

Basher, R. (2006). Global early warning systems for natural hazards: systematic and people centred. UN-ISDR Platform for the Promotion of Early Warning (PPEW), Goerresstrasse 30, 53113 Bonn, Germany.

Cloke, H., Pappenberger, P. (2009). Ensemble flood forecasting: A review. Journal of Hydrology 375 (2009) 613–626. Retrieved on September 15, 2010, from www.elsevier.com/locate/jhydrol

Collins, M., Kapucu, N. (2008). Early warning systems and disaster preparedness and response in local government. University of Central Florida, Orlando, Florida, USA. Disaster Prevention and Management Vol. 17 No. 5, 2008, pp. 587-600 *q* Emerald Group Publishing Limited 0965-3562 DOI 10.1108/09653560810918621

De Roo, A. et al. (2003). Development of a European flood forecasting system. International Journal of River Basin Management 1, 49–59.

De Roo, A., et al. (2006). The Alpine floods of August 2005: What did EFAS forecast, what was observed, which feedback was received from end-users? EFAS 25, Post-event summary report, European Commission, EUR 22154 EN, p. 94.

Demeritt, D. et al. (2007). Ensemble predictions and perceptions of risk, uncertainty, and error in flood forecasting. Environmental Hazards 7 (2), 115.

Dietrich, J. et al. (2008). Combination of different types of ensembles for the adaptive simulation of probabilistic flood forecasts: hindcasts for the Mulde 2002 extreme event. Nonlinear Processes in Geophysics 15, 275–286.

Etkin, D. Medalye, J. and Higuchi, K (2011). Climate Warming and Natural Disaster Management: An exploration of the issues. Received: 30 November 2009 / Accepted: 31 August 2011 # Springer Science+Business Media B.V. 2011. D. Etkin Disaster and Emergency Management, Faculty of Liberal Arts and Professional Studies, York University, 4700 Keele St, Toronto, Ontario, Canada, M3J 1P3 e-mail: etkin@yorku.ca. J. Medalye Political Science, Faculty of Liberal Arts and Professional Studies, York University, Toronto, Ontario, Canada. K. Higuchi Faculty of Environmental Studies, York University, Toronto, Ontario, Canada.

Garcia, L. (2002). Overview of Early Warning Systems for Hydro-metrological Hazards in Selected countries in Southeast Asia. Asian Disaster Preparedness Center, PO Box 4 Klong Luang, Pathumthani 12120 Thailand.

Glantz, M. (2007). Heads Up: Early Warning Systems for Climate, Water and Weather. Published in 2009 in Japan and in 2007 by the Tsinghua University Press in Beijing, China.

Hopson, T., Webster, P. (2008). Three-Tier flood and precipitation forecasting scheme for South-East Asia. Retrieved on September 25, 2010, from http://cfab2.eas.gatech.edu/

Hopson, T., Webster, P., (2007). A 1–10 day ensemble forecasting scheme for the major river basins of Bangladesh: forecasting severe floods of 2003–2007. Journal of Hydrometeorology.

Inforesources (2009). Disaster Risk Reduction: A Gender and Livelihood Perspective. InfoResources, Länggasse 85, 3052 Zollikofen, Switzerland. Tel.: +41 31 910 21 91, Fax: +41 31 910 21 54, info@inforesources.ch www.inforesources.ch.

Jones, J.L., Haluska, T.L., Williamson, A.K. and Erwin, M.L. (2000). Updating flood inundation maps efficiently: building on existing hydraulic information and modern elevation data with a GIS", US Geological Survey Open File Report 98-2002, available at: http://wa.water

Krueger, RA. (1994). Focus Groups: A Practical Guide for Applied Research. Thousand Oaks, CA: Sage Publications.

Lanza, L., Conti, M. (1994). Remote sensing and GIS: potential application for flood hazard forecasting. Institute of Hydraulics, University of Genova, Genova, available at: http://spatialodyssey.ursus.maine.edu/gisweb/spatdb/egis/eg94208.html.

Lin, G., Huang, P., Chen, G. (2009). Using typhoon characteristics to improve the long lead-time flood forecasting of a small watershed. Department of Civil Engineering, National Taiwan University, Taipei 10617, Taiwan. Journal of Hydrology 380 (2010) 450–459

Parker, D., Fordham, M., Tunstall, S. and Ketteridge, M., (1995). Flood warning systems under stress in the United Kingdom. Disaster Prevention and Management Volume 4 · Number 3 · 1995 · pp. 32–42 © MCB University Press ISSN 0965-3562.

Penning-Rowsell, E., Tunstall, S., Tapsell, S., Parker, D. (2000). The benefits of flood warnings: real but elusive, and politically significant. Journal of the Chartered Institution of Water and Environmental Management 14, 7–14.

Sene, K., Huband, M., Chen, Y., Darch, G. (2007). Probabilistic flood forecasting scoping study. Joint Defra/EA Flood and Coastal Erosion Risk Management R&D Programme, R&D Technical Report FD2901/TR.

Sorensen, J. (1992). Assessment of the Need For Dual Indoor/Outdoor Warning Systems And Enhanced Tone Alert

Sorensen, J., Mileti, D. (1988). Warning and evacuation: answering some basic questions. Industrial Crisis Quarterly 2 (1988) 195-209. Elsiever Science Publishers, B.V, Amsterdam, Netherlands.

Technologies In The CSEPP, ORNL/TM-12095. Oak Ridge, TN: Oak Ridge National Laboratory.

UN/ISDR (2006). Global Survey of Early Warning Systems: United Nations Inter-Agency Secretariat of the International Strategy for Disaster Reduction (UN/ISDR) International Environment House II, 7-9 Chemin de Balexert, CH 1219 Chatelaine, Geneva 10, Switzerland. isdr@un.org www.unisdr.org.

UNISDR (2005). Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters. The World Conference on Disaster Reduction adopted the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters.

UNISDR (2008). Climate Change and Disaster Risk Reduction. Weather, Climate and Climate Change, Briefing Note 1, International Environment, House II, 7-9 Chemin de Balexert, CH 1219, Chatelaine, Geneva 10, Switzerland. Tel: +41 22 917 8908/8907, Fax: +41 22 917 8964, EMail: isdr@un.org, Postal Address: UNISDR Palais des Nations CH-1211 Geneva 10, Switzerland.

United Nations Environment Program: Climate Change Introduction; Environment for Development Retrieved on 20 June 2012 from http://www.unep.org/climatechange/Introduction.aspx

Venton, P. and S. La Trobe (2008). Linking Climate Change Adaptation and Disaster Risk Reduction; Tearfund 100 Church Road, Teddington, TW11 8QE, United Kingdom, Tel: +44 (0)20 8977 9144 www.tearfund.org, www.adpc.net.