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Editor: Professor Santosh Kumar

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Editor's Note

Disaster Management as a field encompasses varied facets which are worth researching on. Examining from pure scientific perspective to social and policy perspectives, disaster management issues have been studied for fulfilling various objectives from different sectors of work. Role and participation of people or community is a major thrust point in deliberating the aims of managing a disaster event. Traditional Knowledge and Community Participation has become the focus of the studies recently which highlight the critical human factor. Involving their citizens in preparing for disasters is the present challenge of the governments across the nations. The present issue of the Journal of South Asia Disaster Studies takes into account some of these flagged concerns.

Bashir Ahmad in his paper illustrates the role of Union Disaster Management Committee (UDMC) towards effective disaster management in Bangladesh. The utter ignorance of such bodies shall hamper the real purpose of forming them. The authors critically examine the potency of institutional mechanisms in the wake of cyclone Aila that affected Bangladesh severely.

Earthquakes have always captured the interest of the geo-scientists since long ago. Everyone intends to dwell in safe houses which are disaster proof. Ram Krishna Mazumdar *et al.* in their paper assesses the seismic vulnerability of Chittagong University of Engineering and Technology (CUET) campus for earthquakes based on Rapid Screening Procedure (RSP). They have prepared structural information database and presented it in Geographic Information System (GIS). Such analyses should be done on regular basis for all structures for timely detection of poor and vulnerable structures.

Mondal in his case study of Erendabari Char describes the indigenous knowledge of the resident community for protecting themselves from various disasters. Traditional knowledge is being recognized through the nature's indication in the form of bird and animal behavior. It is believed that they can gauge the upcoming disaster and warn through their signage. Involvement of local people in disaster planning has been thrusted on.

Community participation and community ownership in Disaster Risk Reduction are the key factors in reducing vulnerability of people and minimising the losses. With this theme the next paper by Verma and Agarwal emphasises on community based disaster preparedness approach for disaster risk reduction.

Religious sites are common place for disasters to happen. When these are coupled with their location on difficult terrain—near rivers, on hill top; the hazards are much more vulnerable to disaster events. *Mata Vaishno Devi* shrine is a popular Hindu goddess shrine where devotees come annually in large numbers. Ghosh in his paper tries to capture some of the natural and man-made vulnerabilities found in the Shrine route, which is operational round the year catering to 50,000 plus pilgrims per day during peak festive season. There is discussion on how to make the track route much safer by adopting mitigating measures and alternatives.

Reconstructing past climate and natural disasters in Kashmir valley using historical evidence as climate proxies is a paper wherein the authors have through chronological documents having past records about extreme events tried to analyse climate change in the area. Lot of reading of old books and publications has been done which give an insight into the climate of the region and can become a base for doing research for predicting the future. Not many studies are done; hence this paper shall be an insight into the western Himalayan region.

Another area of Himalayan region—Uttarakhand, has been studied for landslides and flash floods caused due to extreme rainfall and cloud bursts. Assessment of such disaster incidences is covered by Gupta and Uniyal with the help of satellite based images and various geological intricacies are discussed.

Psychological impact on mental health is another area which emerges in the post disaster scenarios and affects a large number of populations in case of a major disaster event. Post traumatic stress disorder (PTSD) is a major ailment that along with other physical and social injuries can shape the post disaster maladies of a society. Nasrin Tabassum in her paper covers Leh cloudburst event of 2010, a Himalayan region where it was found that women are more prone to psychological ailments post disasters.

Traditional knowledge again is emphasized in Sunanda Dey's paper wherein she takes a case study of an island in India and discusses the community's indigenous measures taken for facing annual floods. The community people have been using these local actions and remedies for protecting themselves. Over the period, with changing climate, these measures become forgotten or less acknowledged, but are realistic and need a second look by the scientific community, development experts and policy makers.

Natural and human induced disasters are occurring in all regions of South Asia. These disasters result in immediate, challenging and complex chaos, in the form of injuries not commonly seen in daily routines. On numerous occasions hospitals and health care setups receive large number of casualties, which make it difficult for them to treat, coordinate and respond. Hospitals and health care setups are already under pressure to care for patients who arrive during usual operations each day. To face these challenges and deal with issues, these systems need to improve organisational structure and leadership, establishment of supportive infrastructure, organized workforce, superior organisational capacity, information and communication, triage and transportation, logistics, and data collection system. The intend of Md. Yasar Shah from Pakistan in his paper is to emphasise the need for policy making regarding organisational structure, capacity building, and to provide guidelines for health care and emergency system in preparing for and responding to an MCI caused by different hazards in the country.

Notes on Contributors

- **Abul Khair**, Student, Department of Civil Engineering, Chittagong University of Engineering and Technology, Chittagong 4349, Bangladesh.
- **Akhter Alam**, Department of Geography, University of Kashmir, Hazratbal Srinagar Kashmir, India.
- **Bashir Ahmad**, Department of Geology, Sri Pratap School, M.A. Road, Srinagar Kashmir, India.
- **Bashir Ahmed**, Associate Professor and Chair, Department of Government and Politics, Jahangirnagar University, Savar, Dhaka, Bangladesh.
- **Chandan Ghosh**, Professor and Head Geohazards, National Institute of Disaster Management, Ministry of Home Affairs, Government of India.
- **Khurshid Ahmad**, Department of Statistics, Sri Pratap School, M.A. Road, Srinagar Kashmir, India.
- **M.S. Bhat**, Department of Geography, University of Kashmir, Hazratbal Srinagar Kashmir, India.
- **Md. Abdur Rahman Bhuiyan**, Director, Institute of Earthquake Engineering Research and Professor, Department of Civil Engineering, Chittagong University of Engineering and Technology, Chittagong 4349, Bangladesh.
- **Md. Jahangir Alam**, Professor, Department of Civil Engineering, Chittagong University of Engineering and Technology, Chittagong, Bangladesh.
- **Md. Sanaul Haque Mondal**, Independent Researcher, Rangpur, Bangladesh.
- **Md. Tarikul Islam**, PhD Researcher, Department of Government and Politics, Jahangirnagar University, Savar, Dhaka, Bangladesh.
- **Md. Yasar Shah**, Military College of Engineering, Risalpur, National University of Science and technology, Islamabad, Pakistan.
- **Nasrin Tabassum**, Ph.D Research Scholar, Department of Geography and Regional Development, Jammu & Kashmir University, India
- **Nazmus Sakib**, Student, Department of Civil Engineering, Chittagong University of Engineering and Technology, Chittagong 4349, Bangladesh.

- **Peeyush Gupta**, Project Scientist, Uttarakhand Space Application Centre, Dehradun, India.
- **Ram Krishna Mazumder**, Research Lecturer, Institute of Earthquake Engineering Research (IEER), Chittagong University of Engineering and Technology, Chittagong 4349, Bangladesh.
- **Sanjay Agarwal**, Director (Disaster Management), Ministry of Home Affairs, Government of India.
- **Swati Uniyal**, Research Scientist, National Remote Sensing Centre, Hyderabad, India.
- **T. A. Kanth**, Professor, Department of Geography and Regional Development, Jammu & Kashmir University, India.
- **Tanushree Verma**, Consultant, DM-Division, Ministry of Home Affairs, Government of India.

Role of Union Disaster Management Committee in Post-Disaster Response Management: Rural Bangladesh Perspective

Bashir Ahmed and Mohammad Tarikul Islam

Abstract

The paper attempts to focus the role of Union Disaster Management Committee (UDMC) towards effective disaster management in Bangladesh. The landscape setting and geographical setting of Bangladesh makes it one of the most disaster-prone countries in the world, highly vulnerable to natural disasters including large-scale flash flooding, tidal surges, typhoons and cyclones, earthquakes, droughts and suffering due to cold weather in the winter season. The national disaster management institutional structure acknowledges the importance of the institutional presence up to the local level for comprehensive disaster management. The existing structure has formal provision of disaster network up to the union level. This local level structure of UDMC was also found officially functional but after consultation with the local people as well as literature reviewed, it transpired that many common people are not aware of the institutional structure or the functioning of this structure, in particular. Case study of the particular Union also illustrated that, following cyclone Aila, UDMC meetings were organised several times but it could not play its due role other than a ceremonial role. Most of the UDMC members are not aware about their assigned role resulting in inefficiency in managing disaster. Even its role in ensuring quality of response programme is nominal, to a great extent.

Keywords: *Disaster, Response Management, UDMC, Cyclone Aila, Bangladesh.*

Introduction

The landscape setting and geographical setting of Bangladesh makes it one of the most disaster-prone countries in the world, highly vulnerable to natural disasters including large-scale flash flooding, tidal surges, typhoons and cyclones, earthquakes, droughts and suffering due to cold weather in the winter season. Every year people are suffering many things from these kinds of natural hazards. Among the major natural hazards in Bangladesh, cyclones and floods are very frequent along with riverbank erosion, droughts, flash floods, seasonal storms and tornadoes, as well as a few man-made hazards, such as fires, building collapses, ferry tragedies, road accidents, etc. Bangladesh is also at risk from earthquakes, tsunamis, the impact of climate change, along with a new dimension in urban risks due to its fast growing and increasing density of population. Climate change adaptation issues particularly need consideration both at a national and community level. This has great impact on the hazard frequency and severity, particularly in case of floods and droughts (Cuny, 1988).

Government of Bangladesh has already expressed its commitment to invest more in the risk reduction framework. Government is implementing several programmes to shift the whole paradigm of disaster management from a response and recovery culture to a risk reduction culture. However, an effective emergency response system remains at the forefront of disaster management efforts. In a developing country like Bangladesh about 75% people live in rural areas, and they are confronted with various natural disaster threats that endanger their existence. As per the revised Standing Order on Disasters (SOD), Union Parishad is the representative body of the local government that plays a vital role to ensure social safety and reduce disaster vulnerability of the people living in rural Bangladesh. Union Disaster Management Committee headed by the Chairman of the Union Parishad is responsible to fulfil the whole cycle of disaster management works under their dominion.

Union Parishad and Disaster Management in Bangladesh

The national disaster management institutional structure acknowledges the importance of the institutional presence up to the local level for comprehensive disaster management. Union Parishad is the lowest tier of the local government in Bangladesh. It is the representative unit of the local people and is dedicated to serving the rural people in many ways (Department of Disaster Management, 2012). The existing structure has formal provision of disaster network up to the union level. In this structure, the line agencies actually participate under the coordination of either UNO (the upazila administrative head) or at union level through the coordination of Union Parishad Chairman (which is an elected position).

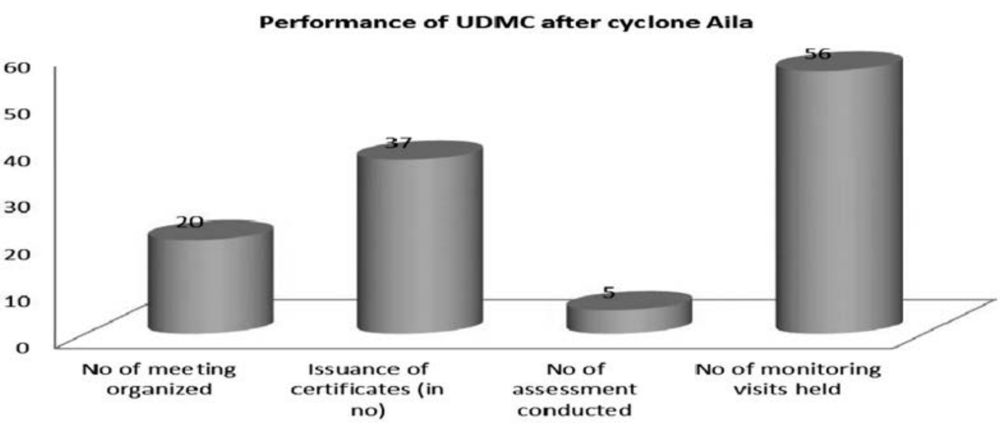
Responsibilities of Union Disaster Management Committee after Disaster Event

- Collect statistics of loss incurred in the disaster in the light of guidelines of DMB and Upazila DMC and send the same to Upazila DMC.
- Take steps for distribution of articles for rehabilitation received locally or from Relief and Rehabilitation Directorate and from any other source following the guidelines from DMB and Upazila DMC.

- Send accounts of materials received to UzDMC and donor agency (if the donor provided relief funds).
- Ensure that the people who were displaced due to hazard can return to their previous place. In this case, dispute (if any) regarding the land of the displaced people should not be an obstacle to returning to the place after the disaster.
- Arrange counselling for people suffering from psycho-trauma due to the disaster, with the collaborative support of experts and community elites.
- Ensure that the injured people are getting fair and just treatment from health service providers, if necessary; the committee can recommend Upazila and District level assistance.
- Arrange a lesson-learning session with the participation of concerned institutions and individuals on learning from, during and after the hazard, and
- In addition to the above, follow the SOD and instant orders of the appropriate authority. (Government of Bangladesh, 2010)

Effectiveness of UDMC: Study of Cyclone Aila Affected Uttar Bedkashi Union Disaster Management Committee

Cyclone Aila was the second tropical cyclone to form within the Northern Indian Ocean during 2009. The disturbance that was to become Cyclone Aila formed on May 21, 2009. Over the following days the disturbance slowly intensified into a cyclonic storm, named Aila, located approximately 350 km offshore. Cyclone Aila became a severe cyclonic storm on May 25, 2009. The system maintained a cyclonic intensity for approximately 15 hours after making landfall. Hitting during high tide, the cyclone brought with it tidal surges of up to 6.5 metres, affecting 11 coastal districts. Uttar Bedkashi is one of the Cyclone Aila affected unions under Koyra upazila of Khulna district in Bangladesh (UNDP, 2009). Following Cyclone Aila, Uttar Bedkashi UDMC performed different tasks which are presented through the chart below:



The above-mentioned chart illustrates that UDMC met 20 times right after Cyclone Aila and it issued certificates in favour of 37 NGOs for undertaking relief and rehabilitation programmes in response to Aila. The chart also shows that UDMC conducted assessment on Aila in different forms five times while it made monitoring visits 56 times to oversee different response and recovery programmes under its jurisdiction. In addition, UDMC extended its support and cooperation to Bangladesh Army and Water Development Board in rebuilding damaged dams surrounding this Union.

Analysing the facts and figures of the study, it is observed that this local level structure of UDMC was found more or less functional but after consultation with the local people it transpired that many common people are not aware of the institutional structure as well as the functioning of this structure. Local people, particularly of vulnerable groups, suggested that they have a very limited access to UDMC's meeting deliberations and decisions. This largely signifies that the local vulnerable group members have very limited information about the role, mandates and functioning of the disaster management committee at the ground level. There was no evidence of any role being played by UDMC in the pre-disaster period.

At the national level there is an apparently good indication of the government's engagement in disaster management through the coordination of different state departments, the UN, NGOs and even the private sector. However, the effectiveness of UDMC presence on disasters is limited. According to the local elites, the lack of financial and material resources forces this committee to work only intermittently and without being able to implement sound prevention programmes or projects that would help communities to decrease their vulnerability to future hazards. Preventive measures and initiatives for strengthening community capacity to withstand natural hazards are apparently still limited, especially as regards implementation of different interventions. General perception from the community level consultation revealed that disaster risk management is still a secondary priority and not well integrated into different programmes being implemented by Union Parishad.

It is, therefore, evident from the above discussion that Union Parishad is confronted with certain problems that stand in the way of effective disaster management in rural Bangladesh which include, among others, the following:

- Absence of disaster related information sharing facilities;
- Sluggish role of UDMC during non-disaster period;
- Lack of proper knowledge about disaster risk reduction concept;
- Inadequate training facilities for disaster risk management;
- Lack of coordination between elected representatives and government functionaries;
- Lack of technical equipment for disaster preparedness and disaster management; and
- Inadequate financial allocation for the disaster risk management programme.

Despite the constraints and limitations enumerated in the foregoing paragraph, Bangladesh has made good progress in mobilising capacity of the vulnerable people, including women and persons with disabilities, in Disaster Response Management and Disaster Risk Reduction through their active participation. There are initiatives to strengthen the local government system, especially at upazila and union level, with support from Development Partners. Presently, the local government bodies are conversant with disaster and climate risk issues but incorporating disaster risk into development planning process is not yet achieved, and proposed to be as pilot initiative by Ministry of Disaster Management and Relief through Comprehensive Disaster Management Programme (CDMP). Disaster management issues have been incorporated in the Union Information Resource Centre (UIC) managed by Prime Minister's Office's Access to Information (A2I) project.

Disaster Management Act 2012, Government of the People's Republic of Bangladesh, outlined objectives, approach, institutional arrangement, disaster area declaration, priority group, information management and media, funding, offence and trial, reward, international cooperation, priority actions (Government of Bangladesh, 2012). Disaster Management Bill 2012 passed by the National Parliament on September 12, 2012 has put a successful end to almost twenty years' efforts of the government and civil society actors. The proposed law was finalised after a thorough process of multi-sectoral and multi-stakeholder consultations to shape up the legal and institutional framework and financial, managerial and accountability mechanism described therein (Department of Disaster Management, 2012: 7-9). Through this enactment, the country is making all the citizens self-accountable to the disaster stricken people and the community for their action and inaction.

The objectives of the DM Act as set out in the Bill are to reduce the country's overall risks to disasters with appropriate risk reduction interventions, to more effectively implement emergency response and recovery measures after a disaster; to provide emergency humanitarian assistance to the most vulnerable and at risk communities; to strengthen the capacity of the relevant government and non-government organisations; to make their efforts well-coordinated and target oriented; and above all to establish a disaster management system capable of handling all hazards.

As per Disaster Management Act 2012, Department of Disaster Management (DDM) is established with a vision to perform the dual role of promotion of disaster risk reduction as well as disaster response and recovery works. DDM is also entrusted with responsibilities to capacitate DMC members across levels to play their role before, during and after disaster events.

Following the recent revision of the Standing Orders on Disaster (SOD), Comprehensive Disaster Management Programme (CDMP), a multi-donor disaster risk reduction programme under the Ministry of Disaster Management and Relief has directed its efforts to supplement DDM to sensitise Union Disaster Management Committees (UDMCs) regarding their new roles and responsibilities. DDM, with support from CDMP, also provides capacity building aid to the committee members to play their assigned role in local level coordination during disasters as well as supporting community preparedness to reduce disaster risks.

Conclusion

The business of disaster management cuts through every fibre of governance and civil society, which includes local governance. Disaster Management is not a revenue generating activity. It is seen as an expense, which has to be incurred because of legislative requirements. The opposite is of course true. Disaster Management, by virtue of its very definition, aims to prevent, mitigate, prepare for, respond to and recover from the effects of all disasters. It is through the linkage between disasters and development that the above is accomplished.

The linkage between disasters and development is an internationally accepted fact, which is supported by the United Nations. It is recognised that weak development can lead to disasters, but that sustainable development, which is sound, decreases the chance of disaster, removes the threat of disaster and reduces the impact that a disaster can have on society. Keeping this reality in mind, UDMC has to be made more functional in a way so that it could render its mandated tasks in the light of SOD and can reduce the disaster risk vis-à-vis cost of disaster response. It is found from the analysis that, at the moment, the Union Parishad in the study area does not have enough coverage and functioning for a concerted local level adaptive management of climatic risks. This needs to be strengthened at a fast pace.

If the Union Parishad and their respective UDMCs with active linkages among the Bangladesh Meteorological Department (BMD), Department of Agriculture Extension (DAE), Department of Environment (DOE) initiatives, and other local line agencies and local based NGOs can be coordinated and linked together, effectiveness of UDMC could properly be ensured. The steps cited below could be considered for effectiveness of the UDMC to address the challenges of disaster:

- Holding of regular meetings of UDMC both pre-, during and post-disaster phases;
- Provision of a dedicated fund for disaster risk reduction;
- Setting up a disaster warning station in each UP office;
- Provision of disaster shelter centre within the UP complex;
- Formation of Volunteer team under each UP for emergency response;
- Training on disaster preparedness and emergency response;
- Social awareness campaign on disaster management; and
- Rapid and timely coordination.

Apart from the above recommendations, community involvement in the process of hazard vulnerability and resources assessment, plan formulation and implementation of the preparedness and mitigation solutions leads to effectiveness of UDMC. Community participation in UDMC activities builds confidence, pride and capabilities to pursue disaster preparedness and mitigation as well as development responsibilities at the local level. Capacity building and public awareness activities through UDMC enables the communities to increase participation and, eventually, to sustain, even on their own, preparedness and mitigation activities. Concerned government departments, including Disaster Management Bureau, NGOs/INGOs, Development Partners and the United Nations should come forward to make each and every UDMC effective and efficient to serve the affected communities with appropriate disaster response and disaster risk reduction initiatives.

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Rapid Assessment Procedure for Seismic Evaluation of Existing Buildings: A Case Study for CUET Campus

Ram Krishna Mazumder, Abul Khair, Nazmus Sakib,
Md. Abdur Rahman Bhuiyan and Md. Jahangir Alam

Abstract

Bangladesh is located in a seismically moderate zone in the world seismic map. The presence of existing fault lines around this region are capable of producing damaging earthquakes in future. No large earthquake has been recorded in these faults for many years, which indicates a huge strength gathered underground that could cause serious earthquakes around the country. Frequently occurring and recent small-size earthquakes make us aware about the future risk. The Chittagong division is quite vulnerable to earthquakes as per the seismic zonation map of Bangladesh National Building Code (BNBC). One of the leading engineering universities of the country, Chittagong University of Engineering & Technology (CUET), has a campus located about 27 km away from the heart of the Chittagong city centre. This study aims to prepare a seismic vulnerability map based on Rapid Screening Procedure (RSP) at CUET campus. Structural information database was prepared and presented in Geographic Information System (GIS). The outcome of this study showed that most of these buildings are in good condition.

Keywords: *Assessment, Rapid Screening Procedure, Performance, Vulnerability.*

Introduction

Bangladesh is located in a seismically moderate region in the world seismic map prepared by Global Seismic Hazard Assessment Programme (GSHAP, 1992). An earthquake of even moderate size can produce massive destruction in major urban areas of the country, especially in Dhaka, Sylhet and Chittagong. There exist a few faults in this region that can cause strong earthquakes in the country. One of them is the Dauki fault at the area bordering Sylhet and the other one is Sitakunda-Taknaf fault at Chittagong. A recent study by Comprehensive Disaster Management Programme (CDMP) proposed five earthquake fault scenarios with a maximum possible earthquake (Mw) (as shown in Figure 1) with a value of Mw 8.0 and 8.5. No large earthquake has occurred in these faults for many years, which means a huge strength is gathered underground that could cause serious earthquakes in Bangladesh and its sourrounding region. Moreover, recent small size earthquakes in India, Pakistan and Myanmar make us aware about the future risks in this region.

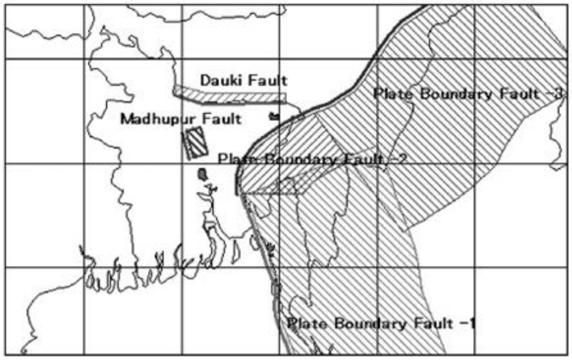


Figure 1: Earthquake Fault Model in Bangladesh (CDMP, 2009).

Chittagong University of Engineering & Technology (CUET) is one of the leading technical institutions in the country, located about 27 km off the Chittagong city centre. This region has a seismic coefficient of 0.15g in the seismic zoning map of Bangladesh National Building Code (BNBC, 1993). This map was based on Peak Ground Acceleration (PGA) considering a return period of 200 years. Recently House Building Research Institute (HBRI) completed a project to upgrade the existing BNBC code. Draft seismic design provisions of the building code have been submitted in December 2010 where the concept of Maximum Credible Earthquake (MCE) has been introduced correspond to a return period of 2475 means 2% probability of exceedance in 50 years. In this new seismic map, CUET falls in zone number 3 with a coefficient of 0.28 g (Al-Hussaini et al., 2012).

The campus area is situated in the hilly region near the side of the Chittagong-Kaptai road. It has been felt necessary to prepare a structural database of existing buildings at CUET campus. This study was undertaken by the Institute of Earthquake Engineering Research (IEER) to assess the seismic safety of existing structures by applying two-level based seismic vulnerability assessment technique. In the first level, Rapid Screening Procedure was applied by visualising the structural vulnerability parameters. In the second level, some of the reinforced concrete buildings were assessed by checking their structural integrity.

Methodology

It is neither feasible nor possible to assess all the buildings in detail level. RSP is generally applied before going in for a structural detail level of investigation. Simple risk assessment procedures are applied based on the structure's level of importance in terms of building use. Two major types of structures are present at CUET. One type is Reinforced Concrete (RC) frame structures with masonry infill and another is Unreinforced Masonry Buildings (URM) with flexible or rigid diaphragm. For an RC building, Turkish simple screening procedure (Ozcebe et al., 2006) was followed where the procedure contains two levels of assessment. The first level is called Walkdown Evaluation which does not require any analysis, and its goal is to determine the priority levels of buildings that require immediate intervention (Ozcebe et al., 2006). The second level is called Preliminary assessment when more in-depth evaluation of building stocks is required. In this stage, analysis requires data on the dimensions of the structural and non-structural elements in the most critical storey. For URM buildings, Rapid Visual Screening (FEMA 154) was applied.

Turkish Method (Ozcebe et al., 2006)

Tier 1 Assessment

A street survey procedure based on simple structural and geotechnical parameters that can be observed easily from the sidewalk. The time required for an observer for collecting the data of one building from the sidewalk is expected to be about 20 minutes. The parameters that are selected for representing building vulnerability in this study are the following:

1. The number of storeys above ground (1 to 7)
2. Presence of a soft storey (Yes or No)
3. Presence of heavy overhangs, such as balconies with concrete parapets (Yes or No)
4. Apparent building quality (Good, Moderate or Poor)
5. Presence of short columns (Yes or No)
6. Pounding between adjacent buildings (Yes or No)
7. Local soil conditions (Stiff or Soft)
8. Topographic effects (Yes or No)

The intensity of ground motion at a particular site predominantly depends on the distance to the causative fault and local soil conditions. The intensity zones are expressed accordingly, in terms of the associated Peak Ground Velocity (PGV) ranges.

Zone I : 60<PGV<80 cm/s
Zone II : 40<PGV<60 cm/s
Zone III : 20<PGV<40 cm/s

The selected buildings were mainly low-rise buildings with one to five storeys above ground. According to the proposed seismic map of BNBC code, for CUET campus the peak ground acceleration is around 0.25 g, considering site effects it can be taken as more than 0.35 g. Corresponding PGV can be taken as between 60 cm/s to 70 cm/s (Wu et al., 2003). Hence, for calculating performance score, Zone I (60<PGV<80) was considered.

Table 1: Base Scores and Vulnerability Scores for Concrete Buildings

Number of Storeys	Base Scores (BS)			Vulnerability Scores (VS)					
	Zone I	Zone II	Zone III	Soft Storey	Heavy Overhang	Apparent Quality	Short Column	Pounding Effect	Topo. Effects
1 or 2	100	130	150	0	-5	-5	-5	0	0
3	90	120	140	-15	-10	-10	-5	-2	0
4	75	100	120	-20	-10	-10	-5	-3	-2
5	65	85	100	-25	-15	-15	-5	-3	-2
6 or 7	60	80	90	-30	-15	-15	-5	-3	-2

The vulnerability parameters of a building are obtained from Walkdown surveys and its location is determined, the seismic performances score (PS) can be calculated by using Eqn. 2.1:

$$PS = (BS) - \sum (VSM) \times (VS) \tag{2.1}$$

Where BS is the Base Score defined in Table 1, $\sum$(VSM) is the Summation of Vulnerability Score Multiple and VS is Vulnerability Scores.

Tier 2 Assessment

The following parameters were chosen as the basic estimation parameters in the preliminary assessment level.

No. of storeys (n): this is the total number of individual floor systems above the ground level defined by "n."

(1) Minimum normalised lateral stiffness index (mnlstfi)

This index represents the lateral rigidity of the ground storey, which is usually the most critical storey. It is calculated by considering the columns and the structural walls at the ground storey. The mnlstfi parameter shall be computed based on the following relationship:

$$mnlstfi = \min (I_x, I_y) \tag{2.2}$$

where,

$$I_{nx} = \frac{\sum (I_{col})_x + \sum (I_{sw})_x}{\sum A_f} \times 1000 \quad , \quad I_{ny} = \frac{\sum (I_{col})_y + \sum (I_{sw})_y}{\sum A_f} \times 1000 \tag{2.3}$$

where $\sum(I_{col})_x$ and $\sum (I_{col})_y$ are the summation of the moment of inertias of all columns about their censorial x and y axes, respectively. $\sum (I_{sw})_x$ and $\sum (I_{sw})_y$ are the summation of the moment of inertias of all structural walls about their censorial x and y axes, respectively. I_{nx} and I_{ny} are the total normalised moment of inertia of all members about the x and y axes, respectively. $\sum A_f$ is the total floor area above ground level.

(2) Minimum normalised lateral strength index (mnlsi)
It indicates the base shear capacity of the critical storey. In the calculation of this index, unreinforced masonry filler walls are assumed to carry 10 per cent of shear force that can be carried by a structural wall having the same cross-sectional area (Sozen, 1997). As in mnlstfi calculation, the vertical reinforced members with a cross-sectional aspect ratio of 7 or more are classified as structural walls. The mnlsi parameter shall be calculated by using the following equation:

$$mnlsi = \min(A_{nx}, A_{ny}) \tag{2.4}$$

where

$$A_{nx} = \frac{\sum (A_{col})_x + \sum (A_{sw})_x + 0.1 \sum (A_{mw})_x}{\sum A_f} \times 1000 \tag{2.5}$$

For each column with a cross-sectional area denoted by A_{col}:

$$(A_{col})_x = K_x . A_{col} \ (A_{col})_y = K_y . A_{col} \tag{2.6}$$

where k_x=1/2 for square and circular columns; k_x=2/3 for rectangular columns with b_x>b_y; k_x=1/3 for rectangular columns with b_x<b_y; and k_y=1-k_x

For each shear wall with cross-sectional area denoted by A_{sw}:

$$(A_{sw})_x = K_x . A_{sw} \ (A_{sw})_x = K_x . A_{sw} \tag{2.7}$$

where k_x=1 for structural walls in the direction of x-axis; k_x=0 for structural walls in the direction of y-axis; and k_y =1-k_x

For each unreinforced masonry filler wall with no window or door opening and having a cross-sectional area denoted by A_{mw}:

$$(A_{mw})_x = K_x . A_{mw} (A_{mw})_x = K_x . A_{mw} \tag{2.8}$$

where k_x=1.0 for masonry walls in the direction of x-axis; k_x=0 for masonry walls in the direction of y-axis; and k_y=1-k_x

(3) Normalised redundancy score (nrs)
Redundancy is the indication of the degree of the continuity of multiple frame lines which distribute lateral forces throughout the structural system. The normalised redundancy ratio (nrr) of a frame structure is calculated by using the following expression:

$$nrr = \frac{A_{tr}(nf_x - 1)(nf_y - 1)}{A_{gf}} \tag{2.9}$$

where A_{tr} = the tributary area for a typical column. (A_{tr} shall be taken as 25m^2 if nf_x and nf_y are both greater than and equal to 3. In all other cases, A_{tr} shall be taken as 12.5m^2); nf_x = the number of continuous frame lines in the critical storey (usually the ground storey) in x directions; nf_y = the number of continuous frame lines in the critical storey (usually the ground storey) in y directions; A_{gf} = the area of the ground storey, i.e., the footprint area of the building. Depending on the value of nrr computed from Eqn. 2.9, the following discrete values are assigned to the normalised redundancy score (nrs):

nrs = 1 for $0 < nrr \leq 0.5$

nrs = 2 for $0.5 < nrr \leq 1.0$

nrs = 3 for $1.0 > nrr$

(4) Soft storey index (ssi)

On the ground storey, there are usually fewer partition walls than in the upper storeys. This situation is one of the main reasons for the soft storey formations. Since the effects of masonry walls are included in the calculation of mnlsi, soft storey index is defined as the ratio of the height of the first storey (i.e., the ground storey), H_1, to the height of the second storey, H_2.

$$ssi = \frac{H_1}{H_2} \tag{2.10}$$

(5) Overhang ratio (or)

In a typical floor plan, the area beyond the outermost frame lines on all sides is defined as the overhang area. The summation of the overhang area of each storey, $A_{overhang}$, divided by the area of the ground storey, A_{gf}, is defined as the overhang ratio.

$$or = A_{Overhang}/A_{gf} \tag{2.11}$$

(6) Performance Classification

The Damage Index (DI) or the damage score corresponding to the life safety performance classification (LSPC) shall be computed from the discriminate function given in Eqn. 2.12.

$$DI_{LS} = 0.620n - 0.246mnlstfi - 0.182mnlsi - 0.699nrs + 3.269ssi + 2.728or - 4.905 \tag{2.12}$$

In the case of immediate occupancy performance classification (IOPC), the damage index can be computed based on the following Eqn. 2.13:

$$DI_{IO} = 0.808n - 0.334mnlstfi - 0.107mnlsi - 0.687nrs + 0.508ssi + 3.884or - 2.868 \quad (2.13)$$

In the proposed classification methodology, buildings are evaluated according to both performance levels. The steps to be followed are listed below. The Cut-off Value (CV) for each performance classification can be calculated using Eqn. 2.14. The LS_{CVR} and IO_{CVR} values shall be obtained from Table 2, based on the number of storeys above the ground level. The Cut-off Modifier Coefficient (CMC) values are adjustment factors, which introduce the spatial variation of the ground motion in the evaluation process. These values shall be taken from Table 3, based on the building location relative to the fault and the soil type at the site.

$$CV_{LS} = LS_{CVR} + |LS_{CVR}| \times (CMC-1),$$
$$CV_{IO} = IO_{CVR} + |IO_{CVR}| \times (CMC-1) \quad (2.14)$$

Table 2: Variation of LS_{CVR} and IO_{CVR} values with number of storeys

N	LS_{CVR}	IO_{CVR}
3 or Less	0.383	-0.425
4	0.430	-0.609
5	0.495	-0.001
6	1.265	0.889
7	1.791	1.551

Table 3: Variation of CMC values with soil type and distance to fault

Soil Type	Shear Wave Velocity (m/s)	Distance to Fault (km)				
		0-4	5-8	9-15	16-25	>26
B	>760	0.778	0.824	0.928	1.128	1.538
C	360-760	0.864	1.000	1.240	1.642	2.414
D	180-360	0.970	1.180	1.530	2.099	3.177
E	<180	1.082	1.360	1.810	2.534	3.900

(3) By comparing the CV values with associated DI value, calculate performance grouping of the building for LSPC and IOPC as follows:

If $DI_{LS} > CV_{LS}$ take $PG_{LS}=1$
If $DI_{LS} < CV_{LS}$ take $PG_{LS}=0$
If $DI_{IO} > CV_{LS}$ take $PG_{IO}=1$
If $DI_{IO} < CV_{LS}$ take $PG_{IO}=0$

To decide the probable expected performance level of the building the damage scores obtained from equations 2.12 and 2.13 should be compared with the storey dependent cut-off values obtained from equation 2.14. In each case, the building under evaluation is assigned an indicator variable of "0" or "1." The indicator variable "0" corresponds to "none, light or moderate damage" in the case of LSPC and "none or light damage" in the case of IOPC. Similarly, the indicator variable "1" corresponds to "severe damage or collapse" in the case of LSPC and "moderate or severe damage or collapse" in the case of IOPC. In the final stage, the building is rated in the "low risk group" if both indicator values are zero or in the "high risk group" when both indicator values are equal to unity. In all other cases buildings are classified as cases "requiring further study." Further investigations have indicated that these buildings generally lie in the moderate risk group.

Rapid Visual Screening

Rapid visual screening (RVS) of buildings for potential seismic hazards, originated in 1988 with the publication of the Federal Emergency Management Agency (FEMA) 154 Report, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook* (FEMA, 1988). RVS provides a procedure to identify, record and rank buildings that are potentially seismically hazardous. This screening methodology is encapsulated in a one-page form, which combines a description of a building, its layout and occupancy, and a rapid structural evaluation related to its seismic hazard. The RVS has been developed for a broad audience, including building officials and inspectors, and government agency and private-sector building owners, to identify, inventory, and rank buildings that are potentially seismically hazardous. Field screening of individual buildings consists of verifying and updating building identification information, walking around the building and sketching a plan and elevation view on the survey forms, determining occupancy class, number of occupants, collecting information of soil type, identifying potential nonstructural falling hazards, lateral-load-resisting system seismic performance attribute score modifiers (e.g., number of storeys, design date) and determining the final score by adjusting the basic structural hazard score with the score modifiers. The final score is the deciding factor as to whether further evaluation is required or not. A photograph of the building is required to justify the buildings properly. Table 4 represents the seismic regions classification depending on acceleration response. According to FEMA 154 RVS procedure the vulnerability parameters are described below:

(1) Number of Storeys: The number of storeys is a good indicator of the height of a building. This parameter is a good measure to identify the amount of damage it may sustain. On soft soils, a tall building may experience considerably stronger and longer duration shaking than a shorter building of the same type. If the building has 4 to 7 storeys, it is considered a mid-rise building. On the other hand, a building having 8 or more storeys is considered a high-rise building.

(2) Pre Code: This score modifier applies for buildings in high and moderate seismicity regions and is applicable if the building being screened was designed and constructed

prior to the initial adoption and enforcement of seismic codes applicable for that building type.

(3) Benchmark: This modifier is applicable if the building being screened was designed and constructed after significantly improved seismic codes applicable for that building type were adopted and enforced by the local jurisdiction. The year in which such improvements were adopted is termed the "benchmark" year.

(4) Year Built: Building age is tied directly to design and construction practices. Therefore, age can be a factor in determining building type and thus can affect the final scores. This information is not typically available at the site and thus should be included in pre-field data collection. If information on "year built" is not available, a rough estimate of age will be made on the basis of architectural style and building use.

(5) Plan Irregularity: This parameter includes buildings with re-entrant corners, where damage is likely to occur; buildings with good lateral-load resistance in one direction but not in the other; and buildings with major stiffness eccentricities in the lateral force-resisting system, which may cause twisting around a vertical axis. Buildings with re-entrant corners include those with long wings that are E, L, T, U, or + shaped.

(6) Vertical Irregularity: This includes buildings with setbacks, hillside buildings, and buildings with soft storeys. If the building is irregularly shaped in elevation, or if some walls are not vertical, then the modifier is applied.

(7) Soil Type: Soil type has a major influence on amplitude and duration of shaking, and thus structural damage. Generally, the deeper the soils at a site, the more damaging the earthquake motion will be. The six soil types considered in the RVS procedure are hard rock (type A), average rock (type B), dense soil (type C), stiff soil (type D), soft soil (type E), and poor soil (type F). If there is no basis for classifying the soil type, a soil type E should be assumed.

(8) Note: g = acceleration due to gravity.

Table 4: Regions of Seismicity with corresponding spectral acceleration response (FEMA 154)

Region of Seismicity	Spectral Acceleration Response, SA in horizontal direction (short-period, or 0.2 sec.)	Spectral Acceleration Response, SA in horizontal direction (long-period or 1.0 sec.)
Low	Less than 0.167 g	Less than 0.067 g
Moderate	Greater than or equal to 0.167 g but less than 0.500 g	Greater than or equal to 0.067 g but less than 0.200 g
High	Greater than or equal to 0.500 g	Greater than or equal to 0.200 g

The Final Structural Score, S, is determined for a given building by adding (or subtracting) the Score Modifiers for that building to the Basic Structural Hazard Score for the building. The result is documented in the section of the form entitled Final Score (see Figure 2). Based on this information, and the "cut-off" score selected during the pre-planning process, the screener then decides if a detailed evaluation is required for the building and circles "YES" or "NO" in the lower right-hand box (see Figure 2). FEMA 154 has three seismic zones where Chittagong region falls into moderate seismic zones for short-period structures with spectral acceleration less than 1.0 sec. As most of the buildings are less than 5 storeys, the study area falls in moderate seismic zone for RVS application. Soil type was considered as D in the FEMA 154 handbook considering expert opinion. Figure 2 shows an example of score modifiers for performance score calculation. Fundamentally, the final S score is an estimate of the probability (or chance) that the building will collapse if ground motions occur that equal or exceed the maximum considered earthquake ground motions. These estimates of the score are based on limited observed and analytical data, and the probability of collapse is therefore approximate. A final score of S = 2 implies there is a chance of 1 in 10^2, or 1 in 100, that the building will collapse if such ground motions occur.

OCCUPANCY			SOIL	TYPE	FALLING HAZARDS
Assembly Commercial Emer. Services	Govt Historic Industrial	Office Residential School	Number of Persons 0 – 10 11 – 100 101-1000 1000+	A Hard Rock, B Avg. Rock, C Dense Soil, D Stiff Soil, E Soft Soil, F Poor Soil	Unreinforced Chimneys, Parapets, Cladding, Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, *S*

BUILDING TYPE	W1	W2	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	S5 (URM INF)	C1 (MRF)	C2 (SW)	C3 (URM INF)	PC1 (TU)	PC2	RM1 (FD)	RM2 (RD)	URM
Basic Score	5.2	4.8	3.6	3.6	3.8	3.6	3.6	3.0	3.6	3.2	3.2	3.2	3.6	3.4	3.4
Mid Rise (4 to 7 stories)	N/A	N/A	+0.4	+0.4	N/A	+0.4	+0.4	+0.2	+0.4	+0.2	N/A	+0.4	+0.4	+0.4	-0.4
High Rise (>7 stories)	N/A	N/A	+1.4	+1.4	N/A	+1.4	+0.8	+0.5	+0.8	+0.4	N/A	+0.6	N/A	+0.6	N/A
Vertical Irregularity	-3.5	-3.0	-2.0	-2.0	N/A	-2.0	-2.0	-2.0	-2.0	-2.0	N/A	-1.5	-2.0	-1.5	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Pre-Code	0.0	-0.2	-0.4	-0.4	-0.4	-0.4	-0.2	-1.0	-0.4	-1.0	-0.2	-0.4	-0.4	-0.4	-0.4
Post-Benchmark	+1.6	+1.6	+1.4	+1.4	N/A	+1.2	N/A	+1.2	+1.6	N/A	+1.8	N/A	2.0	+1.8	N/A
Soil Type C	-0.2	-0.8	-0.6	-0.8	-0.6	-0.8	-0.8	-0.6	-0.8	-0.6	-0.6	-0.6	-0.8	-0.6	-0.4
Soil Type D	-0.6	-1.2	-1.0	-1.2	-1.0	-1.2	-1.2	-1.0	-1.2	-1.0	-1.0	-1.2	-1.2	-1.2	-0.8
Soil Type E	-1.2	-1.8	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
FINAL SCORE *S*															

COMMENTS	Detailed Evaluation Required YES NO

* = Estimated, subjective, or unreliable data
DNK = Do Not Know

BR = Braced frame
FD = Flexible diaphragm
LM = Light metal

MRF = Moment-resisting frame
RC = Reinforced concrete
RD = Rigid diaphragm

SW = Shear wall
TU = Tilt up
URM INF = Unreinforced masonry infill

Figure 2: Basic score modifiers for final score calculation (moderate seismicity zone).

Analysis and Results

A total of 61 existing buildings were considered for this study. There were a few buildings under construction which were not taken into consideration for the purpose of this study. Among the surveyed buildings, 56 per cent are RC structures, 38 per cent buildings are masonry with rigid diaphragm and the rest of the buildings are masonry with flexible diaphragm (see Figure 3). All these buildings are less than 6 storeys high. Figure 4 represents the number of existing buildings according to their storey numbers. The pie chart reflects that about 92 per cent of the buildings are less than 4 storeys high. Figure 5 shows the number of existing Masonry and RC buildings for different number of storeys. It has been found that most of the masonry structures are single-storeyed buildings.

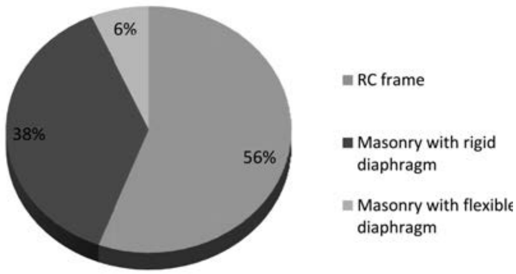


Figure 3: Building Types at CUET campus area.

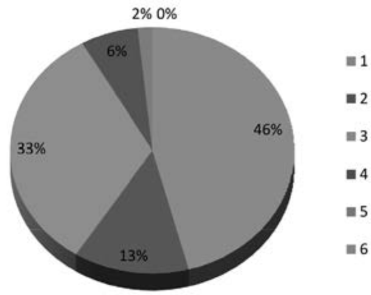


Figure 4: Buildings exist according to number of storeys.

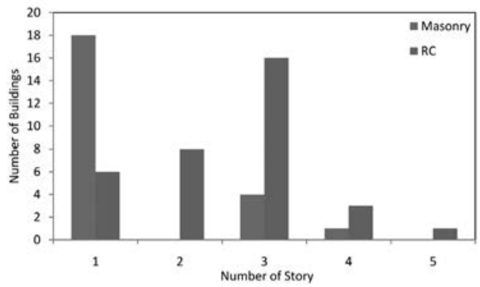


Figure 5: Number of RC and Masonry buildings according to number of storeys.

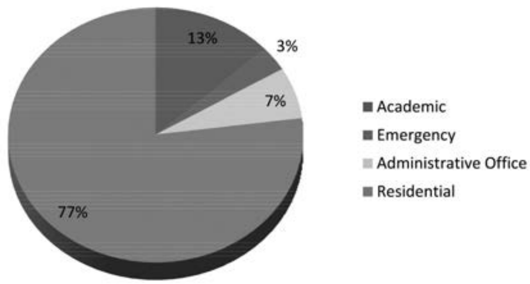


Figure 6: Occupancy class of the buildings.

Total buildings are classified into four categories based on their purpose of use. Figure 6 presents existing categories of building use in percentages. The majority of the buildings are used for residential purposes. Only 13 per cent of the buildings are used for academic purposes, 7 per cent buildings are administrative and 3 per cent are for emergency centres. Figure 7 shows the relationship between building occupancy class and their structural types. This relationship reflects that emergency centres and educational buildings are made by RC structures. From visible inspection, about 26 per cent buildings are found apparently in good condition, 69 per cent in moderate and the rest 5 per cent are poor (see Figure 8). Figures 9 and 10 are present relationships of building visible physical status with their building uses and structural types, respectively. From the engineering

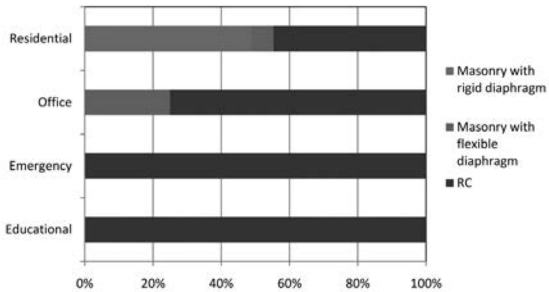


Figure 7: Relationships between Building Uses and Structural Types for CUET.

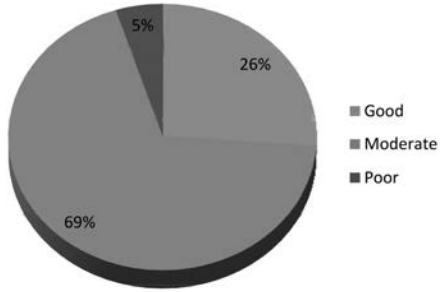


Figure 8: Building Apparent Quality.

judgment it was found that one of the emergency centres looks poor; all the other educational buildings are in moderate situation. The masonry buildings constructed with flexible diaphragm need to improve their physical state.

First stage assessment was basically Walkdown procedure consisting of Turkish level 1 and RVS. Turkish level 1 survey method was used for 34 RC structures. CUET is geographically situated in the hilly regions so that topographic effects are considered for the study. Figure 11 shows the information about existing vulnerability parameters for the RC buildings, however, soft storey parameters also checked for both types of building classes. There is no soft storey presence in the existing buildings at CUET. Only one building has heavy overhang cantilever floor area. Pounding effect exists for two structures.

In the level 1 survey, Performance Score (PS) calculated for each RC building. Figure 12 shows the calculated

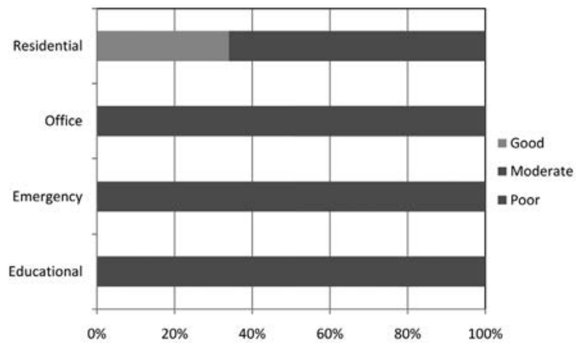


Figure 9: Relationships between Building Uses and Apparent Quality for CUET.

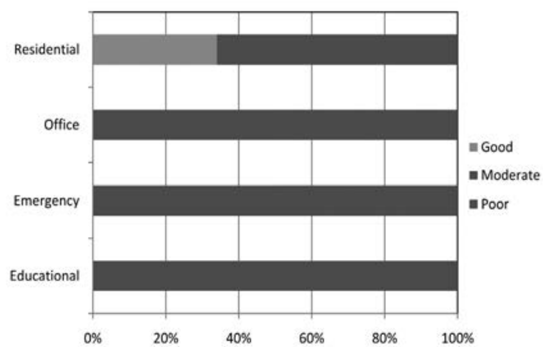


Figure 10: Relationships between Structural Types and Apparent Quality for CUET.

PS where blue and green lines are showing a margin for the performance classes. The building having a score above 75 is classified as low risk building. Buildings having a score below 50 are considered as high risk buildings. Scores ranging from 50 to 75 remarked as moderate risk class. Table 5 represents level 1 performance score variations with different number of storeys.

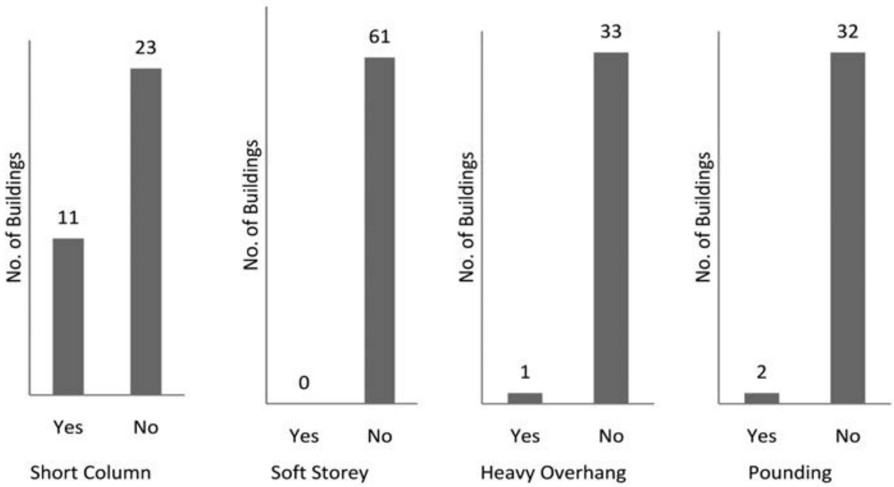


Figure 11: Existing Vulnerability Parameters

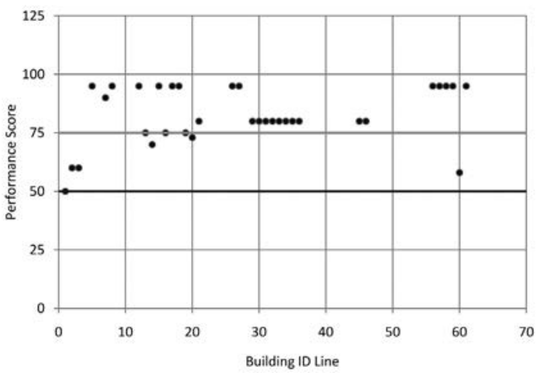


Figure 12: Performance Scores obtained from Walkdown survey.

The mean value of PS parameter is 87.56 with a standard deviation value of 12.55 for existing RC buildings. A normal distribution plot for the PS shows in the figure 13. For the Masonry buildings, FEMA 154 RVS method was considered in this study where a score greater than 1.0 can be considered as low risk as there was no specified classification prescribed. It has been observed that each of these masonry buildings has the same probability of collapse equal to 25 per cent. This is because of the similarity in type and configuration amongst the buildings.

Table 5: PS variations in the level 1 assessment

Number of Storeys	Performance Score (PS)			Total
	50	51-75	> 75	
1	0	0	6	6
2	0	0	8	8
3	0	5	11	16
4	0	3	0	3
5	1	0	0	1
Total	1	8	25	34

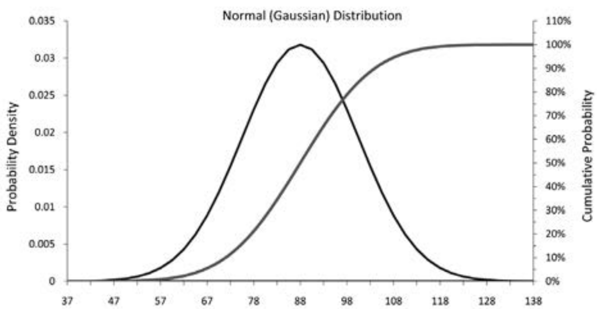


Figure 13: Normal distribution of PS.

In the Second level Turkish assessment, eight buildings were analysed based on building importance level in terms of building use. Academic and administrative buildings were preferred in this stage. Survey Identification number was assigned for each building as shown in Figure 15 (a). Two buildings (identity numbers 1 and 16) were assumed to be separated in two segments from their foundation. So, each of these two buildings is considered as a separate structure. Table 6 represents the summary of calculation values in level 2 assessment as per section 2.1.2. These building integrity values were checked after taking detailed structural floor sketches and preliminary assessment calculation steps prescribed in the methodology chapter. Figure 14 shows a typical ground floor sketch during the level 2 survey. All of the buildings (except 5 storeyed student hall) are low risk class. The hall building falls into moderate risk group. The survey results are represented in the Geographic Information System (GIS) maps (see Figure 15 and Figure 16). As the nearest Chittagong-Tripura fold belt was about 50 km away, so CMC value considered for the distance to fault was >26 km for the calculation of CV values. Table 6 shows that CV_{LS} and CV_{IO} are about 1.2 and 0.5, respectively, depending on the local soil conditions and building height. Redundancy of the building number C-15 is very low, rest of the buildings have good redundancy ratio for which value of nrs is equal to 3. It was found that only a single building contains heavy overhang.

Table 6: Summary of assessment results in level 2 of Turkish Assessment

ID No.	n	mnlstfi	mnlsi	nrs	ssi	or	DI_{LS}	DI_{IO}	CV_{LS}	CV_{IO}
C-1a	5	0.051	0.96	3	1.00	0.30	-0.0084	0.6551	1.5726	0.0012
C-1b	4	0.015	1.16	3	1.00	0.00	-1.4674	-1.3179	1.3661	0.7167
C-05	1	0.159	6.21	3	0.00	0.00	-4.481	-3.882	1.21	0.5100
C-08	2	0.028	6.64	3	1.00	0.00	-3.7076	-3.5244	1.2167	0.5002
C-13	3	0.044	2.73	3	0.89	0.00	-2.7218	-2.3568	1.2167	0.5002
C-15	2	0.008	1.73	1	0.86	0.00	-1.8387	-1.6853	1.2167	0.5002
C-16a	3	0.098	3.10	3	1.00	0.00	-2.4606	-2.361	1.2167	0.5002
C-16b	3	0.109	3.50	3	1.00	0.00	-2.5359	-2.4075	1.2167	0.5002
C-18	2	0.045	3.14	3	1.00	0.00	-3.0751	-3.1556	1.2168	0.5002
C-20	3	0.017	2.76	3	1.00	0.00	-2.3785	-2.2973	1.2168	0.5002

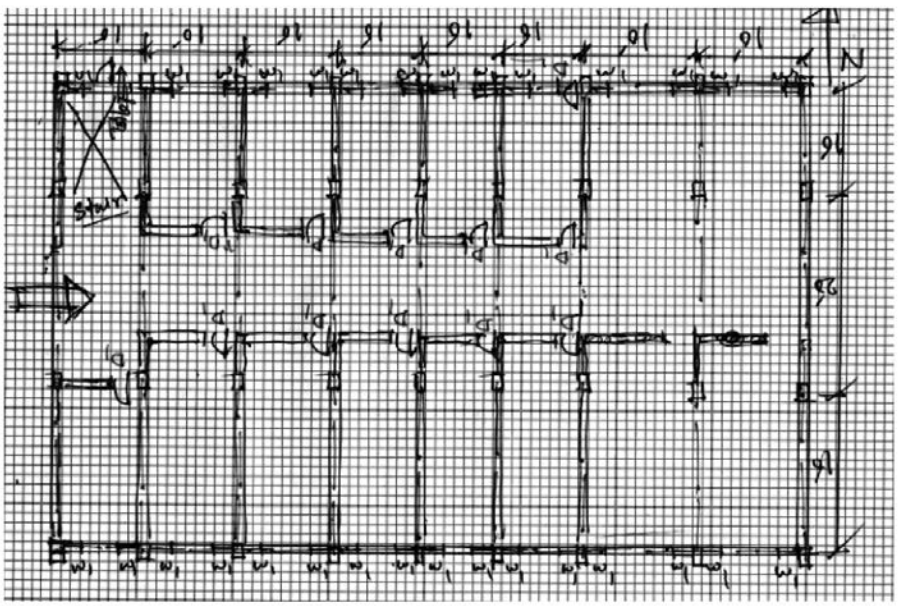
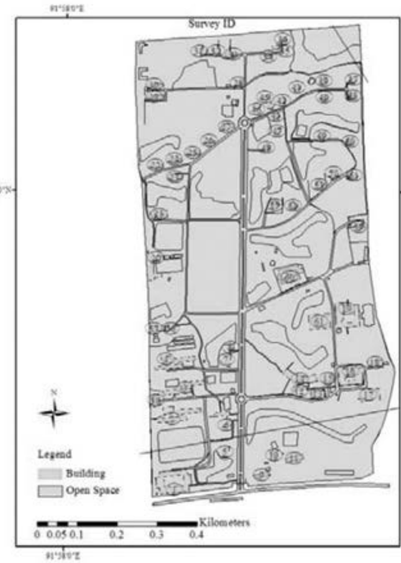
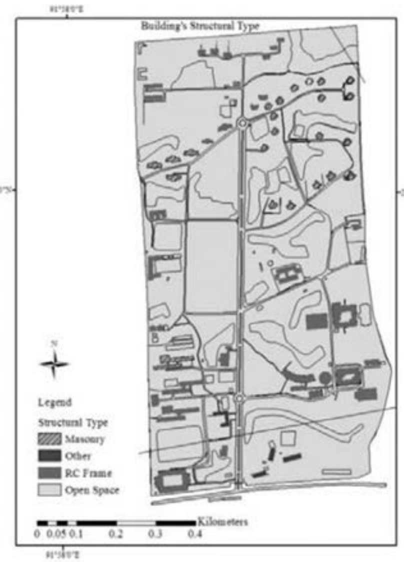


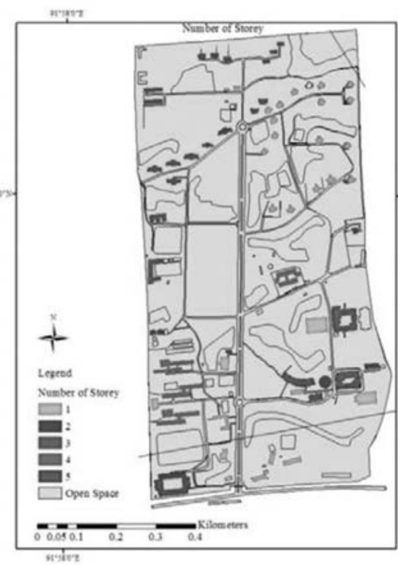
Figure 14: A ground floor sketch of a building.



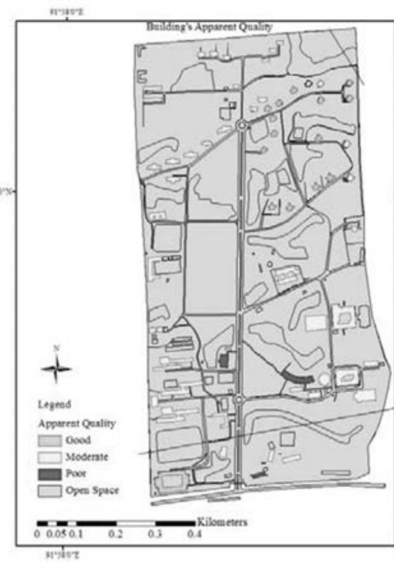
(a) Building Survey Identification Number



(b) Structural Types of the buildings

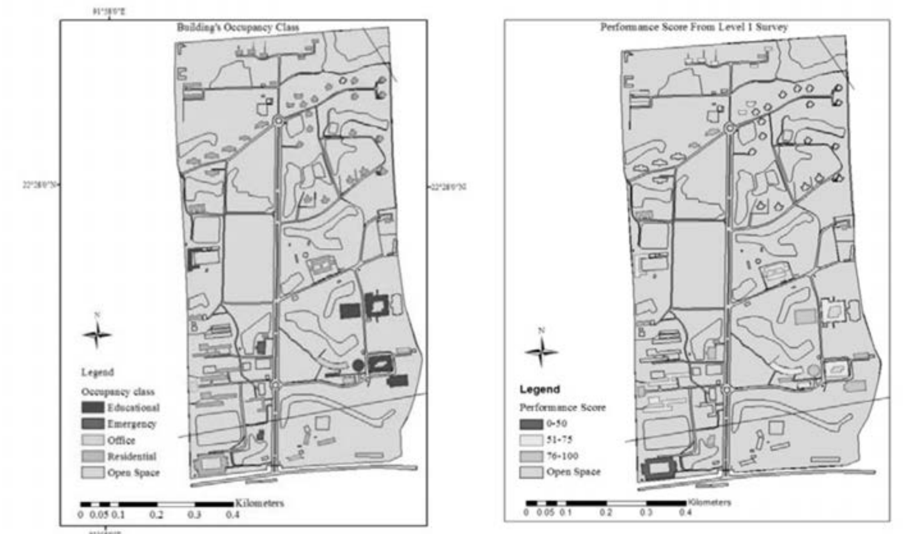


(c) Building's Number of storeys



(d) Apparent Quality of the Building

Figure 15: Structural Types, Building's Storey Numbers and Apparent Physical Quality.



(c) Building's Number of storeys (d) Apparent Quality of the Building

Figure 16: Occupancy types and Performance Scores.

Conclusion

This study presents a seismic vulnerability assessment technique on a small scale for the CUET campus area. RVS and Turkish methods are reliable procedures to mark a conclusion before starting any detail structural assessment. The RSP is the decisive indicator as to whether further detailed structural assessment will take place or not. Turkish method is reasonably acceptable because the structural pattern is very similar with other Bangladeshi buildings. From the study a rapid screening database was prepared which will be very useful before starting any future work at CUET. The Walkdown survey yielded the complete inventory of building stock in CUET campus. At the end of this survey it has been obtained that CUET campus contains mainly two structural types of buildings. Most of the buildings obtained good performance scores from level 1 assessment. Among the surveyed buildings, only 2 per cent of the buildings fall into the category, highly vulnerable to earthquake. RVS results are very similar for all masonry buildings. This is because all buildings of these type are constructed following a unique pattern in their elevation and plan shape. Masonry buildings need to be calculated in detail for more reliable risk identification. It was observed that building performance score decreases with increase in number of storeys. This study contains basic structural vulnerability information which will be useful for the policymaker to undertake future risk assessment and planning. Also, it is suggested that detailed analysis is required to be performed for the buildings having low performance in the level 1 and level 2 analyses.

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Disaster Management through Indigenous Wisdom: Voice from the People of Erendabari Char

Md. Sanaul Haque Mondal

Abstract

The geographical location and its land characteristics make Bangladesh one of the most disaster-prone countries of the world. This country is frequently hit by natural disasters like floods, river bank erosion, cyclone, droughts and tornadoes. Besides, this country is also highly vulnerable to earthquakes, arsenic poisoning, water logging, salinity, storm surge, etc. Island Chars in Bangladesh are geographically dislocated from the mainland and the people of these areas have been living with disasters for long. People from the extreme poor segment live in Chars and are vulnerable to disasters. But the people of the Chars have their own mechanisms to cope with disaster which have formed over numerous generations of habitation and practised long since. The present study tries to identify and reveal the indigenous myths and beliefs that exist in the community and finally establish a linkage with scientific knowledge. In most cases the Char people are ignorant about scientific prevention and survival strategies and therefore they have to rely on their indigenous wisdom. Hence the implication of indigenous knowledge is very useful as a means of survival of Char people.

Keywords: *Indigenous knowledge, Disaster management, Chars, vulnerability, coping strategies.*

Introduction

Due to its geographical location and its land characteristics, Bangladesh is recognised as one of the most hazard prone countries of the world. Bangladesh is frequently hit by natural hazards like floods, river bank erosion, cyclone, droughts and tornadoes. Besides, this country is also highly vulnerable to earthquakes, arsenic poisoning, water logging, salinity, storm surge, etc. Each and every year people have to face one or more hazard which turns into disaster. The people of Bangladesh are well adjusted to different disasters and find out the best methods for coping with them.

Chars are geographically dislocated from the mainland. Bangladesh is known as a riverine country. The geographical location of Bangladesh in the downstream section of the Ganges, the Brahmaputra and the Meghna basins (GBM Basins)—covers a combined total catchment area of about 1.7 million sq. km extending over Bhutan, China, India and Nepal.

More than 200 rivers flow through this country and 57 rivers come from a foreign country. Out of 57 rivers, 54 flow from India and 3 from Myanmar. These rivers have created several Chars by depositing sediment carried from upstream. Bangladesh is one of the most populous countries of the world. More than 140 million people live within 147,570 sq. km boundary. Seven per cent (7%) of Bangladesh's total area is occupied by rivers and the total length of those rivers is approximately 24,000 km. This figure indicates the need for land for the shelter of people. Due to the lack of land and others factors people live in Chars that are extremely vulnerable to natural hazards.

Indigenous knowledge refers to the unique traditional knowledge existing within and developed around the specific conditions of women and men indigenous to a particular geographic area. (Louise, 1998)

Indigenous knowledge is closely associated with the people's cultural belief and practices. Therefore, it cannot be easily understood from outside. It can be revealed by studying the songs, stories, proverbs, dance, myths, cultural values, beliefs, rituals, community laws, local language, agricultural practices, institutions of the people, etc. (Dekens,2007). Observation, interview and focus group discussion are well-known methodologies of research.

1.2 Objectives of the Study

The following are the objectives of the study:

- To find out and accumulate the indigenous knowledge that have been practising from the male line as an indication of disaster event and coping mechanisms for disaster risk reduction.
- To analyse the indigenous knowledge and find out the reasons for practising indigenous knowledge.
- To recommend the adaptation mechanisms and best practices for disaster risk reduction.

Methodology of Data Collection

This study has followed some socio-anthropological methods. Both primary and secondary data were collected from the field and different sources like books, websites, statistical data, etc., respectively. In order to collect the best information from the people regarding their myths, beliefs and practices for disaster management, the researcher needs to observe their livelihoods and adjustment scenario closely.

The stages of methods of study can be categorised into the following steps:

Collection of Secondary Data

Secondary data and information have been collected from different relevant sources like books, websites, Bangladesh Bureau of Statistics (BBS), etc.

Selection of the Study Area

Erendabari Char is located in Gaibandha district and disassociated by the Jamuna river from the mainland. This Char is highly vulnerable to flood and river bank erosion. It is really difficult to collect the indigenous knowledge practices from the people for the whole area; therefore three villages were selected for collecting the information. The names of the villages are: Zigabari (ward no. 2), Horichondi (ward no. 9) and Vatiapara (ward no. 5).

Collection of Primary Data

This research is a qualitative research. Therefore, for collecting primary data, several socio-anthropological methods were used in the field. The following methods were used:
(i) Focus Group Discussions (FGDs) with the aged people
(ii) Key Informants Interviews
(iii) Observations

Brief Study Area (Erendabari Char)

Erendabari is a union of Fulchhari upazila, Gaibandha. Erendabari union occupies an area 21,952 acres of land including river and Char. The union is surrounded by Jamuna river and several channels of Jamuna and Jinjiram river. This union is completely dissected by water from the mainland and it is a truly hard to reach area.

The waterway is the best way to reach Erendabari Char. From Balasi Ghat (under Fulchhari upazila of Gaibandha district) one can reach Erendabari Char by boat (shallow engine driven). It takes 2.5 hours to 3 hours to reach Erendabari Char. Road connectivity in Erendabari Char is not found significant. Main sources of household income are: 70.8% on day labour and share-cropping; 21.6% on cultivation; 7.6% on fisheries, non-agricultural labour, business and employment. Shops and other facilities are not so good. People are living through primary economic activity.

Field Findings and Discussions

People of Erendabari Char experience different types of disasters every year. From their experience, inhabitants are informed that a hazard will hit their locality but they do not have the option to leave Chars. Rather they find some other options to cope with disaster, which they have been practising since long. During field-based study, researchers tried to find out the indigenous knowledge that has long been practised by the community for disaster management. The indigenous knowledge is documented here, and is closely related to the behaviour of some animals, weather conditions, trees, wind direction, clouds, etc.

As understood through the discussions with the local community, they have learnt how to live, the ways of coping with disasters through the application of indigenous knowledge that they have inherited from the time-tested experiences of generations, and internalised through a process of socialisation. Field study has revealed that certain indigenous capacity for prediction possessed by the local people always helped them to anticipate disasters and take necessary precautions. Indigenous predictions are even more important as it was revealed during field study with the Char people that they are not well acquainted with modern technology as well as forecasting.

Char dwellers informed they can predict the occurrences of forthcoming disasters in their community. For gathering indigenous knowledge the study targeted the older generation, those who were 50 years old and above. The indigenous knowledge for disaster management is transmitted through the male line and preserved by the older generation.

A. Myths and Beliefs Regarding the Behaviour of Certain Animals

a. Behaviour of Ants

Story: *If red ants are climbing unitedly on the roofs of houses/trees with eggs on their backs, there is a possibility of flood within a few days.*

Reasons for practice and scientific explanation

Red ants cannot tolerate water and they have a strong smelling capacity. For this reason, they migrate from their own habitat to a dry and high area. Seeing the behaviour of ants, people of the Char areas try to prepare themselves to cope with the upcoming disaster. In most of the cases such type of indigenous precautions help Char people a lot.

b. Behaviour of Dragonfly

Story: *Islanders use another indigenous knowledge for weather forecasting. They observe the habits of dragonfly to know when it will rain or where there will be sunshine. People explained that an abundance of dragonfly in the month of* ***Asar*** *(mid-June to mid-August), indicates that flood will hit that year.*

Reasons for practice and scientific explanation

Female dragonfly deposits her eggs in water or places them inside the stem of an aquatic plant. Eggs hatch within one to three weeks under favourable climatic conditions. So islanders applied their indigenous concept if they found a huge number of dragonfly.

c. Behaviour of Waterfowl

Story: *People believe waterfowl (locally known as Dahuk) can predict flood through their behaviour. Commonly, people believe that the cry of waterfowl on dry land/a mound in Asharh (June-July) indicates flood that year. People can assume the water level seeing waterfowl's crying position from the ground.*

Reasons for practice and scientific explanation

Waterfowl lives near the bank of a river. So if they assume flood occurrence they will come to a dry place which is an indication of flood.

d. Eggs of Owl-birds

The indigenous methods used to predict flood include an owl laying eggs (locally known Pacha and in this poem Godi Sali).

Lyrics: *"Uttare dogmog, pocchime ban*
Godi Sali dim pare pathorer soman"
In English, it means,
"Cloud found in north, flood in west
Owl lays eggs as like as stone"

Reasons for practice and scientific explanation

Normally owl lays eggs of a standard size. But if eggs of owl are harder than normal and bigger than its standard size, then people can assume there will be a possibility of flood. People believe that for the survival of its generation, the owl lays such eggs that will not be destroyed by disaster.

e. Abnormal Behaviour of Certain Animals

Char people use a variety of methods to predict any occurrence of hazards using their indigenous knowledge. They can assume seeing the anomalous behaviours of stark, cow, dog, hen, etc. The common indigenous practices are given herein:

Story:

- *If stork enters a room in Ashar (June-July), it is an indication of tornado.*
- *If cows/dogs wail continuously at night, it indicates flood that year.*
- *If hens rise to the roof of the house at night, there is a possibility of flood that year.*
- *When snakes start to roam around the homestead areas, people start to expect flood.*

Reasons for practice and scientific explanation

People explained that abnormal behaviour of stork, cow, dogs or hen, is an indicator of disaster. Generally, cows/dogs never wail at night. But they have strong smelling capacity and can guess before a hazard hits.

B. Myths and Beliefs Regarding Wind Direction, Weather and Other Celestial Phenomena

a. Wind Direction

Char communities believe that hydrological hazards are acts of God. And they can easily guess upcoming disasters seeing the seasonal weather conditions or wind direction. The Char community believes an old proverb that has been used in weather observation for flood forecasting.

Proverb:
"Bhadro mashe pocchima bao
Verenda Bari diye bai nao"
In English, it means,
"Wind blows from west during Bhadro (August- September)
Boats will run above the high land"

Reasons for practice and scientific explanation

Normally, *Bhadro* (August- September) is characterised by bright days, grey skies and comfortable weather and the wind blows from the south. In exceptional cases, if the wind blows from the west in *Bhadro,* it indicates a high flood that year. *Verenda* (local name) is a one type of plant which is recognised as Castor Bean (Botanical name: Ricinus Communis). This is an annual plant and cannot tolerate water and it grows in dry and high lands. From indigenous practice, people believe that if the wind blows from the west in the month of *Bhadro*, then the level of flood water rises high and floods Castor Bean. Such assumptions help Char community to prepare themselves to face disasters.

In addition to these, regarding the wind direction, the islanders believe that a wind blowing from the north in *Srabon* (July-August) portends greater chances of a flood. This is because a huge amount of water is released from the Himalayas as a result of snow melting, resulting in a flood that year.

b. Weather Conditions

Story: *People believe that any occurrence of foggy weather except during Poush (December-January) indicates a possibility of flood that year.*

Reasons for practice and scientific explanation

Bangla calendar year is divided into six seasons: *Grisma* (summer), *Barsa* (rainy), *Sarat* (autumn), *Hemanta* (late autumn), *Shhit* (winter) and *Basanta* (spring). Each season comprises two months. *Shhit* spreads over the months of *Poush* and *Magh*. *Shhit* is characterised by cooler, foggy and dry conditions which is an exception from other seasons. So that foggy conditions, except *Poush*, indicate that huge amount of water vapour exists which will fall as rain onto the earth.

c. Celestial Phenomena

Char community uses a poem for weather forecasting.

Poem:

"Pochim Patila tar
Khal bil ekaker"

In English, it is translated as:

"Line in west sky
Everything will go under water"

Reasons for practice and scientific explanation

There is close relationship between rainbow and weather. Over the period, aged persons accept it as true that if a rainbow is found in the west, it indicates water and water everywhere.

C. Knowledge Considering Crop Yields

a. ***Story:*** The *Chars* community has a proverb relating to bumper production crop that has been used for disaster forecasting. The abundance of jackfruit and tamarind during harvesting season is a sign of flood or nor'wester.

The proverb states:

Ama dhan
Khathale ban
Tatule tufan

In English, it means,

"Bumper production of rice indicates bumper mango
Bumper production of jackfruit indicates high flood
Bumper production of tamarind indicates nor'wester."

Reasons for practice and scientific explanation

People of *Char*s are highly cautious about disasters. From generation to generation they have found that bumper production of specific crops is an indication of disaster. For example, mango prefers very hot, very humid to cool and dry, to very hot and arid climatic condition, and if such type weather prevails in a year, then it is also an indication of bumper production of paddy. Similarly, jackfruit cannot tolerate drought and production, as it depends on high rainfall. So that high production of jackfruit indicates there is a possibility of flood that year. For tamarind, dry weather is very important during the period of fruit development. So bumper production of tamarind indicates nor'wester of that year. Nor'wester is one type of thunderstorm that generally blows over Bangladesh usually in April-May from a north-westerly direction, locally known as Kal-baishakhi (Banglapedia, 2006).

D. Knowledge on Fish and Bank Erosion

Story: *Fish abundance also indicates river bank erosion. Abundance of Dwarf goonch (local name: Baghair; scientific name: Bagarious bagarious) also indicates river bank erosion.*

Reasons for practice and scientific explanation

Generally, *Baghair* fish prefers earthworms and they gather where earthworms are found in abundance. Earthworms live in loose and fertile soil, which is prone to erosion. So seeing the gathering of *Baghair* in the river, people assume there will be a possibility of erosion of that area.

Modern Practices for Disaster Risk Reduction

Disaster is common for the people of Erendabari Char. It is mentioned that people of Erendabari Char are more fatalist than realistic. Usually they think disaster is their fate and remain where they have been living for generations. Previously people only depended on their local knowledge and they could not make sufficient and effective preparations for minimising the disaster risk. But now people are becoming more aware about disasters. Several NGOs are working in Erendabari Char and working for reducing disaster risk. The most notable activities of DRR programmes are homestead plinth raising, embankment/earth road construction, providing income generating activities training, savings generation, nutritional support, building awareness regarding disaster, flood marker establishment, etc. People have built their houses that are best suited to adapt to the flood. However, to protect the homestead from flood, people have raised their homestead in their own interests, or with the financial assistance of different donor agencies. In addition to this, people have received knowledge for disaster preparedness and IGA training from different non-governmental agencies which enable them to adapt to the changing environmental conditions.

Disaster is common for the people of Erendabari Char. No doubt people have become more adapted to disasters. Disaster is an integral part of the community, which thinks it is a part of their daily life. In the past people have been coping in their own interest without much support from external agencies. Currently, people are more aware regarding disaster preparedness and mitigation. As it is hard to reach certain areas, even now indigenous prediction contributes a lot for disaster management. As a result, this has created an enabling environment to save their livelihoods from disasters.

Recommendations

- Indigenous practices are prevalent due to a need to mobilise disaster management actions at grass-roots level. It is the local community that is hit by disasters and therefore its members must directly understand local disaster risk and undertake measures to mitigate the consequences of impending disasters. So that integration of modern knowledge with indigenous knowledge, and involving community members in the dissemination process can contribute to building confidence and pride.
- Indigenous knowledge plays an important role for disaster management at local level. It is mentioned that indigenous practices have always come from traditional practices since long and people perceived knowledge from their own experience that is closely related to their traditional norms and beliefs. Indigenous knowledge may be different from community to community and place to place. Thus the documentation of indigenous knowledge is very difficult. But if it is possible to document indigenous knowledge from different aspects, it will help a lot for best disaster risk reduction practices.

Conclusion

With regard to rural people, indigenous knowledge practices for disaster management are very important considering both management and coping issues. Indigenous knowledge has passed on through hundreds of years and from generation to generation, community to community. Indigenous knowledge is generated through practical knowledge and no laboratory test has been done for it. But it plays an important role for disaster management at individual and community level. In Char areas where people have no access to modern technology, indigenous knowledge for weather forecasting based on observation of certain natural phenomena plays an important role to protect and save themselves. Chars are the hard to reach areas, therefore to address disaster risk reduction, setting holistic approach is important, as well as to have successful disaster risk reduction. Community based approach is very important for creating community ownership—which is one of the major preconditions for sustainable disaster management process.

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Towards a Disaster Resilient Community in India

Sanjay Agarwal and Tanushree Verma

Abstract

Community participation and community ownership in Disaster Risk Reduction are the key factors in reducing vulnerability of people and minimising the losses. Globally the focus of DRR has shifted to Community Based Disaster Preparedness (CBDP) approach to promote community involvement and strengthening of their capacities for vulnerability reduction through decentralised planning process. It is observed that communities have the potential to function effectively and adapt successfully during and in the aftermath of disasters.

In any urban/rural area, resilient community tries to identify the capacities to withstand disasters. They are aware about the institutions which may be of assistance to them to deal with such an event in responding to the disaster and also in absorbing its impact, maintaining and recovering from it. Thus, this concept of resilience is not only people-centric but also includes institutional dynamics and interaction of the environment to climate-related disasters.

Keywords: *Community resilience, Disaster Risk Reduction, Climate Change Adaptation, Preparedness.*

Introduction

Globally communities are facing a series of new challenges, ranging from climate change to the energy crisis from food insecurity to citizens' insecurity, from financial and economic crises to growing global inequalities. Frequent and intense weather events, societal and environmental stresses are becoming increasingly uncertain and unpredictable. As a result despite all concerted efforts by way of development interventions, many current approaches have only a partial impact. Systematic and more effective approaches and strategies are needed so as to enhance the abilities of vulnerable communities to deal with and counter the economic, social and environmental risks. It is in this context that the idea of resilience is significant for policy and practice.

In conventional emergency management, communities are viewed in spatial terms as groups of people living in the same area or close to the same risks which are complex and often not united. There will be difference in wealth, social status and labour activity between people living in the same area, and there may be more serious divisions within the community. Individuals can be members of different communities at the same time linked to each other by different factors like location, occupation, economic status, gender, religion, etc. People may join together for common goals and separate, once their resilience has been achieved. From Hazards perspective, the spatial dimension is an essential element in identifying communities at risk but this must be linked to an understanding of the socio-economic differences and dynamics within the area at risk, not only to identify vulnerable groups but also to understand the diverse factors that contribute to vulnerability. The Community does not exist in isolation but its business services and infrastructure must also be taken into account. The level of community resilience is not only influenced by capacities outside the community in view of emergency management services but also by other social and administrative services, public infrastructure and a web of socio-economic-political linkages with the wider world. Virtually all communities are dependent on external service provider to a greater or lesser extent.

Everyone in the community, including the government and key sectors, need to understand the basic facts on the risks faced, warning and evacuation process. Public information campaigns and community drills should be coupled with other lifesaving measures such as the placement of warning signs for various hazards and for evacuation routes. It is also essential to ensure that marginalised groups in the community and people with special needs are taken into consideration when developing and implementing education and awareness strategies.

Literature Review on Community Resilience

Chaskin (2001) noted that community is exemplified by asset of characteristics and operates through the agency of people to accomplish specific purpose. Community characteristics include a sense of community, a level of commitment among community members, the ability to solve problems and access to resources.

The Centre for Community Enterprise (2000) defines community resilience: a resilient community is one that takes intentional action to enhance the personal and collective capacity of its citizens and institutions to respond to, and influence the course of social and economic change. Gunderson and Holling (2002) indicate that resilience is persistence borne out of change and adaptive renewal cycles.

Berkes and Seixas (2005) emphasised that factors related to resilience included learning to live with change and uncertainties, nurturing diversity, combining different kinds of knowledge and creating opportunity for self-organisation.

John Twigg (2007) in a literature on Characteristics of Disaster Resilient Community found that a "disaster-resilient community" was ideal. No community can ever be completely safe from natural and man-made hazards. DRR is therefore the collection of actions, or process, undertaken towards achieving resilience. He further mentions that like vulnerability, resilience is complex and multifaceted. Different features and layers of resilience are required to deal with different kinds and severity of stress.

A comprehensive study of Red Cross Red Crescent Societies on tsunami operation (June 2012) indicates that the concept of resilience is to build the capacities of communities to face the uncertainties associated with climate change. It further emphasises that a safe and resilient community is organised, knowledgeable and healthy, with infrastructure, services, economic opportunities and can manage its natural assets. Harris, McLaughlin, Brown and Becker (2000) define Disaster Resilient Community as mitigating the impacts of change through adaptation in stressed in Natural Resources.

Literature on Good practice in Community based Disaster Risk Management developed under GoI-UNDP, DRM Programme (2002-2009) indicates that Awareness Generation, Institutional strengthening and legal framework, Capacity Building, Gender Mainstreaming and Convergence are five key areas to be addressed for ensuring community resilience.

However, Colussi (2000) noted that Resilient Communities do not simply respond to disruptions. They work intentionally to enhance personal and collective capacity to respond to and influence change. Berkes and Seixas (2005) stress the capacity-building element of resilience. Costello and Johns (2006) emphasise that resilient communities develop capacity through their response to crisis. Those responses strengthen community bonds and resources and develop the community's capacity (Chenoweth and Stehlik, 2003). Kretzmann and McKnight (1993) focus on assets, defining community capacity as a set of assets that exist within and among community members, local associations and institutions.

Why Resilience?

Sometimes changes are gradual and things move forward in roughly continuous and predictable ways. At other times, changes are sudden, disorganised and turbulent, reflected in climate impacts on vulnerable regions. Evidence points to a situation where periods of such abrupt changes are likely to increase in frequency and magnitude. This challenges the adaptive capacity of societies. Therefore, resilience approach focuses on the dynamic interplay between periods of gradual and sudden change and how to adapt and shape the changes. Focus on resilience means putting greater emphasis on what communities can do for themselves and how to strengthen their capacities, rather than concentrating on their vulnerability to disaster or their needs in emergency.

Resilience as a concept compels external intervention agencies to bring the focus back to communities, their capacities and local institutions of democratic governance. The inherent strengths of people, households and communities based on cultural contexts and diversity of conditions and ways of living are recognised while exploring the idea of resilience. Recognising that the term "community" encompasses diverse groups of men and women, children and youth, elderly, people with disabilities, and other vulnerable groups, *a resilient community is one that is able to prepare for, adapt to and live through shocks, while preserving its basic assets*. However, the criteria that make communities resilient differ from place to place. Building resilience encompasses a broad range of interventions—from Relief to Recovery, as well as Preparedness and Prevention, Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA).

Resilience and Disaster Resilient Community

A disaster resilient community is practically completely safe from natural and man-made hazards. It is the safest possible community that has the knowledge to design and build in a natural hazard context, minimising its vulnerability by maximising the application of DRR measures. DRR is, therefore, the collection of action or process undertaken towards achieving resilience.

The concept of *resilience* is increasingly gaining focus in DRR and has progressively moved away from a "predict and prevent" paradigm in the context of specific hazards, *to preparing and building the capacity of communities* who face a wide range of rapid onset shocks and slow onset stresses. The latter is increasingly relevant as we face future *uncertainties* associated with *climate change*. "Resilience" is generally seen as a broader concept than "capacity" because it goes beyond the specific behaviour, strategies and measures for risk reduction and management that are normally understood as capacities. However, it is difficult to separate the concepts clearly. In everyday usage, "capacity" and "coping capacity" often mean the same as "resilience."

Resilience is the capacity of a system, be it an individual, a forest, a city or an economy, to deal with change and continue to develop. It is about the capacity to use shocks and disturbances like a financial crisis or climate change to spur renewal and innovative thinking. Resilience thinking embraces learning, diversity and above all the belief that humans and nature are strongly coupled to the point that they should be conceived of as one socio-ecological system. Using this approach, the system of community resilience can be understood as:

- Capacity to absorb stress or destructive forces through resistance or adaptation.
- Capacity to manage, or maintain certain basic functions and structures, during disastrous events.
- Capacity to recover or "bounce back" after an event.

The Hyogo Framework for Action (2005-2015)

The Hyogo Framework for Action (HFA) 2005-2015 is the first plan to explain, describe and detail the work that is required from different sectors and actors to reduce disaster risk. Actions set out under HFA, collectively known as Disaster Risk Reduction Measures, must be continuously implemented in order to achieve resilience to future hazards. It is a guiding framework on disaster reduction emphasising substantial reduction of disaster losses, in lives, in the social, economic and environmental assets of communities and the country. The HFA outlines five Priorities of Action and offers guiding principles and practical means for achieving disaster resilience. Its goal is to substantially reduce disaster losses by 2015 by building the resilience of Nation and Communities to disaster.

Key Themes for Strengthening Community Resilience

Meeting Basic Needs (food, water, shelter and health) is a prerequisite to building resilient communities. The people who are unable to meet their basic needs, whose day-to-day focus is survival, do not have the capacity to build resilience. This is particularly important in deciding when to commence Community Based DRR programmes in a post-disaster situation. *Building Assets* (physical, natural, financial, social, political and human) are seen as critical "buffers" to withstand shocks and stresses. A distinction is made between those assets within the control of the community, and access to *External Assistance and Resources* (for example post-disaster assistance from local government or NGOs). However, assets and resources alone are insufficient. It is the *quality* of those assets which determines the safety and resilience of a community. Assets need to be robust, diverse, well located, and equitably distributed. Ensuring that there is redundancy within the system, such as stockpiles of assets or back up power supplies, is also important. For example, a community may have houses, but they need to be strong enough to withstand disaster. Finally, but perhaps most importantly, is the *capacity* of the community to adapt to change, self-organised, act and learn from experience, factors which ultimately enable communities to mobilise their assets and resources.

The areas relating to Community Resilience and Disaster Risk Reduction are as under: (Source: John Twigg: *Characteristics of a Disaster-resilient Community*, 2007)

Table 1: Community Resilience and Disaster Risk Reduction

Thematic area	**Components of resilience**
Governance	Policy, planning, priorities and political commitment
	Legal and regulatory systems
	Integration with development policies and planning
	Integration with emergency response and recovery
	Institutional mechanisms, capacities and structures; allocation of responsibilities
	Partnerships
	Accountability and community participation

(Table 1 continued)

Risk Assessment	Hazards/risk data and assessment
	Vulnerability and impact data and assessment
	Scientific and technical capacities and innovation
Knowledge and Education	Public awareness, knowledge and skills
	Information management and sharing
	Education and training
	Cultures, attitudes, motivation
	Learning and research
Risk Management and Vulnerability Reduction	Environmental and natural resource management
	Health and well-being
	Sustainable livelihoods
	Financial instruments
	Social protection
	Physical protection; structural and technical measures
	Planning regimes
Disaster Preparedness and Response	Organisational capacities and coordination
	Early warning systems
	Preparedness and contingency planning
	Emergency resources and infrastructure
	Emergency response and recovery
	Participation, voluntarism, accountability

Indicators of Community Resilience

Change is a constant force, in nature and in society. Research suggests that resilience pertains to the ability of a system to sustain itself through change via adaptation and occasional transformation. A community can develop resilience by actively building and engaging the capacity to thrive in an environment characterised by change. It is a mechanism to mitigate the impacts of disaster on local communities and its characteristics which foster community resilience and may be measured through set baseline indicators. By establishing baseline indicators, it becomes possible to monitor changes in resilience over time in particular places and to compare one place to another. Different variables may be utilised to measure ecological indicators and their impact on resilience provided below:

Table 2: Suggested components for baseline indicators

Indicator	Variables
Ecological	■ % Land area in 100-year flood plain ■ % of land affected by Soil erosion ■ % Green space/undisturbed land ■ % Forested land cover (wildfire potential) ■ % Land with hydric soils (liquefaction) ■ % Wetland loss (ecosystem services)
Social	■ Educational inequality ■ Physicians/10,000 (health access) ■ Elderly (%) ■ Racial/ethnic/Gender inequality ■ Transport challenged ■ Communication challenged ■ Crime rate (per 10,000) ■ Special needs (% pop. with disabilities) ■ Health coverage (% pop. with coverage) ■ Population wellness (% black infant mortality rate)
Economic	■ Housing capital/Homeowners/land owner (%) ■ Employment (%) ■ Household income ■ Poverty (% of poor people as per set parameters) ■ Number of employment sector ■ Female labour force participation (%)
Institutional	■ Formulation of DM Acts and Policies ■ Disaster Management plan at various levels. (Village, District, State/National) ■ Constitution of authority to implement the DM plan ■ Allocation/Utilisation of fund in emergency services ■ Mainstreaming of DR in various other governmental schemes
Infrastructure	■ % of population having access to regular power ■ Status of Road Connectivity to the remotest areas ■ Available facility of transportation ■ Housing facilities under social welfare schemes and status of entitlement given to poor and needy people
Community Competence	■ Political fragmentation/status (% registered voters) ■ Social connectivity ■ Dependency ratio (debt/revenue) ■ Internal migration (%) ■ Social capital (fund available commonly with church, temple, etc.) ■ % of population trained in various skills of Disaster Management

Approaches and Basic Elements of Community Resilience

Despite all its progress over the last quarter century, South Asia remains home to four out of every 10 of the world's poor; 600 million of South Asia's 1.5 billion people live on less than $1.25 per day. Almost half the children below five are underweight, accounting for more than half of the world's undernourished children. Imbalances in economic growth, inequality among castes, classes, between genders, and a region beset by disasters, have added to the suffering of the poor and those most vulnerable and marginalised. Preparedness and mitigation efforts in South Asia have so far been fragmented, lacking a strong link between national strategies, plans, and existing disaster risk reduction, agricultural, and other relevant policies. This disconnect partly stems from a lack of conceptual understanding and partly due to the ongoing debate as to what constitutes adaptation, and what represents good and sustainable development.

The 2004 Indian Ocean tsunami was one of the worst disasters, causing immense suffering for millions of people. The lessons drawn emphasise how to reduce the impacts of all natural hazards, which may support to build a safer, more resilient future for all people worldwide. Lack of knowledge and inadequate preparation was a major cause of the extensive losses and impacts. The deaths of hundreds of people in the later tsunami that hit Java, Indonesia in 2006 illustrated the same problem and underlined the need to systematically address the vulnerability of populations to natural hazards thereby enhancing the community resilience.

Every day, people around the globe are threatened by storms, floods, droughts, landslides, earthquakes and other natural hazards, and suffer because of their social, economic, geographic and environmental circumstances. However, disaster risks can be countered through approaches such as public awareness campaigns, knowledge of hazards and vulnerabilities, community preparedness programmes, early warning systems, evacuation plans, long-term land use planning and environmental protection, and the application of sound building codes. Through these means, governments and communities can help people to become more resilient to hazards and their impacts reducing the chance of turning a hazard into a disaster.

Globally the approach towards disaster management is shifting from relief and response-centric to a balanced approach including prevention, mitigation, preparedness and recovery. Building Community Capacity for creating resilience to various local hazards is an important strategy of preparedness activities. A few of the important elements of community resilience are:

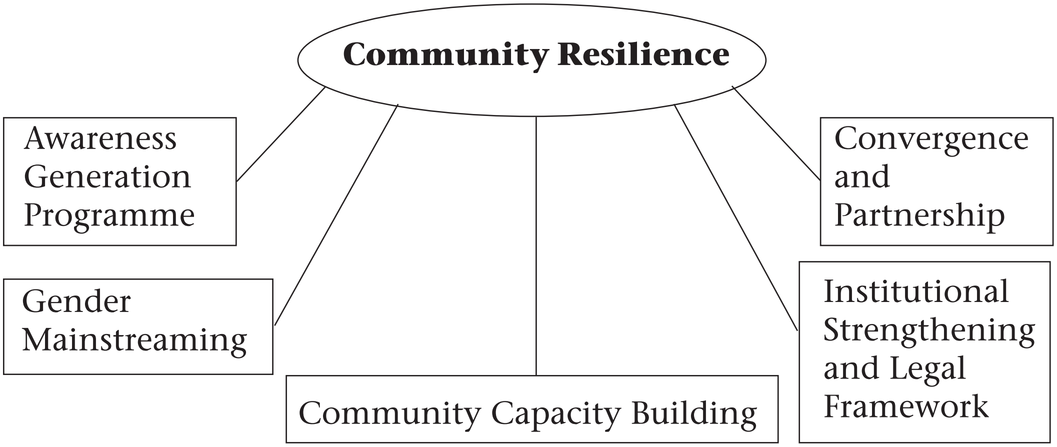

Figure 1: Community Resilience

Awareness Generation Programme

Awareness generation is pertinent for creating capacity by improving infrastructure and training people and finally availability and management of resources of every kind, to cope with natural or human induced hazards and to prevent them from turning into disasters. For the purpose of generating awareness on the theme of disaster risk management amongst a cross section of the population, there could be various modes like the involvement of the local folk troupes, fairs and exhibitions, print and electronic media, etc. Not only these, but socio-religious institutions could also play a vital role in generating awareness amongst the community. Awareness messages could also be inserted with other documents issued by the different government departments and agencies like:

- Fees receipts issued by educational institutions under education department may print some slogans on School safety.
- Toll-Tax receipts issued against the Road Tax of National Highway Authority in the State could be used for spreading awareness for Road Safety with small messages.
- Similarly, electricity and water bills issued by Government Departments may also contribute to awareness generation.
- District authority may circulate pamphlets with safety tips on local hazards with daily newspapers.

Indeed, when it comes to generating awareness about disaster risk management which can so profoundly affect human life and livelihood, societies can and must use every means available to spread the safety messages. The methods mentioned above are extremely simple and cost-effective, therefore they can be implemented throughout the country with regional modifications.

In order to assist the State Governments in capacity building and awareness generation activities and to learn from past experience, including sharing of best practices, under GoI-UNDP Disaster Risk Management Programme (2002-9), the Ministry of Home Affairs compiled/prepared a set of resource materials developed by various organisations/ institutions to be replicated and disseminated by State Governments based on their vulnerabilities after translating it into the local languages. It covers planning to cope with disasters; education and training; construction toolkit; and information, education and communication toolkit including multimedia resources on disaster mitigation and preparedness. Similarly, the State Disaster Management Authorities, constituted under the Disaster Management Act, 2005 in various States, also developed different types of Information materials on localised hazards in regional languages.

Gender Mainstreaming

The relationship between men and women are powerful forces in every culture. It has been noted from the experiences of various disasters in the past that men and women were affected by disasters differently, and most of the deaths were of women, children and aged persons during disasters. Poor access to resources, gender based division of labour and women's primary domestic responsibility, make women more vulnerable to disasters. In addition to that, inadequate facilities, lack of control/ownership over domestic economic resources, inadequate availability of nutritious food, especially for nursing and pregnant mothers, etc., make women vulnerable in a post-disaster situation. Therefore, gender and culture specific needs should be taken into consideration when designing the relief package.

Gender based discrimination in distribution of relief materials

In parts of India's Tamil Nadu state that were affected by the 2004 Indian Ocean tsunami, it was found that both elderly women and men were excluded from some assistance when relief was meditated through communities' traditional local authority organisations. It was due to the mistaken assumption that they require little food for their survival. (Source: C. Pincha, 2008)

At the global level efforts have been taken to promote gender equality in DRR which focus on advocacy and awareness raising, along with support for policy changes and gender mainstreaming in intergovernmental processes.

In Asia, some progress has also been made in producing information, guidelines and capacity building on the issue of gender mainstreaming. Recognising the fact that men and women need to be responded to and prepared differently due to their varying needs, in a post-disaster situation, the Disaster Risk Management Programme (2002-9) of GoI-UNDP was aimed at integrating a gender sensitive environment cutting across all its initiatives, and at a regional level these efforts have made some progress. Special emphasis was given on training women volunteers in search and rescue, first-aid, fighting, etc., which helped not only prepare the women community members, but also helped children and the aged in crisis management. Women volunteers in all the districts, especially women community members, teachers, aanganwadi workers, Women Sarpanch or members of Gram Panchayat, etc., were trained. These trained volunteers further went into the community to spread awareness and train women community members on the do's and don'ts in case of a disaster.

Community Capacity Building

Successfully reaching out to women in Pakistan

In Pakistan, the National Lady Health Worker programme hired local women to deliver treatment for minor ailments and immunisation and reproductive health services in their communities. After the 2005 earthquake, over 8,000 communities and lady health workers were mobilised along with mobile health teams to serve more distant areas. They targeted female members of the households as the key recipients, given their important role in educating young children and looking after the household. The approach was successful in:

- Creating awareness within the communities on hygiene and sanitation issues.
- Highlighting the issues and roles of women within the family and community.
- Raising the status of women by highlighting their key roles in family education and health care system.

(Sources: A. Dimitrijevics, 2007 and IFCR, 2006)

A combination of all the strengths and resources available within a community, society or organisation can reduce the level of risk, or the effects of a disaster. Capacity may include physical, institutional, social or economic means as well as skilled personal or collective attributes such as leadership and management. Capacity building is acquiring existing resources, organisation and training of personnel and coordination of such training for effective management of disasters.

Capacity Building is recognised by Government as an essential component in the process of community development, and in ensuring that communities fully engage with local and regional regeneration initiatives. A few of the important components of Community Capacity Building are:

- People who are willing to be involved
- Skills, knowledge and abilities
- Community cohesion
- Ability to identify and access opportunities
- Motivation and the experience to carry out initiatives
- Community organisation, supportive institutions and physical resources
- Leadership and the structures needed for participation

Training of masons on Earthquake Resistance Construction in Nepal
Earthquake Risk Reduction and Recovery Preparedness (ERRRP) programme initiated by UNDP/BCPR with the support of Government of Japan implemented by Ministry of Physical Planning & Works, Department of Urban Development, Government of Nepal. The project focuses on capacity building programme through training, sensitising people and giving awareness. It also involved establishing linkages with partners at different levels for earthquake disaster mitigation to transfer the technology of earthquake construction to reduce the impact of potential earthquake and respond to disaster more effectively. The principal aim of the course was to create an awareness about seismic hazards on structural systems among the participants who were masons and were engaged in construction of buildings. It also aimed at enhancing the knowledge and skills of existing skilled workforce involved in building construction business, i.e., masons, carpenters, steel fixers/bar benders, etc.
The training was provided both on theoretical and practical aspect of earthquake resistant construction keeping in view the local hazards. It was emphasised that mason training along with construction of earthquake resistant buildings are the most important parameters of earthquake vulnerability reduction in earthquake prone areas. As an important outcome of the programme, it was decided by Government of Nepal that those house owners who came up with building design and followed the building code in the process would get 50% tax reduction. (Source: Training Programme on Earthquake Resistant Construction of Buildings for Masons in Birendranagar, Government of Nepal)

- Economic and financial resources
- Enabling policies and systems.

Institutional Strengthening and Legal Framework

The strong community-based approach, with trained human resources made available at village, district and state levels, and the entire DM planning process linked to development plans supported by institutionalisation of disaster risk management in policy framework, are the very foundation for the sustainability of disaster management activities.

Towards effective community resilience building, India has put in place a legal and institutional framework for disaster management. Enacting the Disaster Management (DM) Act in 2005, DM policy in 2009, setting up of disaster management authorities at national, state and district levels, creation of a dedicated fund for disaster response, establishment of National Disaster Response Force and State Disaster Response Force, setting up National Institute of Disaster Management for training, establishment of the National Emergency Operations Centre, and modernising Fire Services, have strengthened disaster management system in the country.

Convergence and Partnership

Disaster Risk Reduction is not a sector in itself but must be implemented through the policies of other sectors, in particular, those of agriculture, water resources, health, land use, environment, finance and planning. There are also linkages with other policies, most notably poverty eradication and planning for sustainable development, and education and science. A comprehensive Disaster Risk Management strategy is a Sectoral approach which

The schemes/programmes for mainstreaming of DRR in India

- Livelihoods: *Mahatma Gandhi National Rural Employment Guarantee Scheme* (MNREGS) guarantees the "right to work" and ensures livelihood security in rural areas by providing minimum of guaranteed wage employment in a financial year to every household whose adult members volunteer to do unskilled manual work.
- Housing: *Indira Awas Yojana* (IAY) and *Rajiv Awas Yojana* (RAY) to provide housing to those Below Poverty Line in rural and urban areas respectively;
- Health and nutrition: *National Health Mission* (NHM) to provide health security, especially to women, children and the poor residing in urban and rural areas; *Integrated Child Development Services* (ICDS) to improve the nutritional and health status of children in the age group of 0-6 years and enhance the capability of mothers to look after the health and nutritional needs of the children; *Janani Suraksha Yojana* (JSY) to reduce maternal and neonatal mortality by promoting institutional delivery among poor pregnant women; *National Food Security Act, 2013* to provide subsidised foodgrains through public distribution system (PDS) to ensure food security and livelihoods support;
- Education: *Sarva Shiksha Abhiyan* (SSA: Education for All) to address the educational needs of children in the age-group 6-14 years by strengthening educational infrastructure in terms of opening of new schools, construction, renovation and expansion of school buildings and providing other amenities like textbooks, etc.; The *Mid Day Meal* (MDM) Scheme aims at providing hot, cooked mid-day meal with the stipulated, nutritive and calorific value to students up to the 8th grade.
- Urban development: *Jawaharlal Nehru National Urban Renewal Mission* (JNNURM) to encourage reforms and fast-track planned development of identified cities for efficiency in urban infrastructure and service delivery mechanisms, community participation, and accountability of ULBs/Parastatal agencies towards citizens. The guidelines are being revised to incorporate provision of Earthquake Mitigation and Disaster Management in the preparation of City Development Plan as well as Detailed Project Reports to ensure overall safety.

(Source: Building Community Resilience—Turning Vulnerability into Resilience. India Contribution to HFA2) actively involves the role of different stakeholders at all levels of Government as well as the private sector, selected representatives from local community and civil society organisations to implement the legislative framework and to provide coordination and monitoring mechanism.

Challenges for Strengthening Community Resilience

- Limited administrative, financial and technical capacities of local level functionaries and elected representatives to undertake development activities in a risk-sensitive manner;
- Effective inclusion of DRR aspects in social protection programmes, including Centrally Supported Schemes with direct impacts on building community resilience to disasters and climate change, remains a challenge;
- Recovery programmes are mostly implemented in a cost-intensive way, with large-scale technical assistance, using funds meant for developmental activities;
- CBDM initiatives are being implemented in isolation and as a project with limited life cycle, without adequate integration in ongoing development programmes;
- Absence of formal mechanisms/guidelines for the participation of the private sector in local level disaster response, risk reduction, and recovery;
- Ratio of uninsured to insured losses in disasters in India is very high. The insurance sector is expected to become a prime player in the area of disaster reduction in the country. Risk transfer mechanisms such as insurance against disasters have not been successful in India, requiring investment of public funds in recovery and reconstruction after disasters.

Conclusion

Communities can develop resilience by actively building and engaging the capacity to thrive in an environment characterised by change, and therefore community resilience is an important indicator of social sustainability. Community Resilience compels external intervening agencies to bring the focus back to communities for enhancing their capacities and strengthening the local institutions of democratic governance for sustainable development with social equity.

Towards effective building of community resilience, India has put in place a legal and institutional framework for disaster management, setting up disaster management authorities at various levels, financial mechanism for disaster response and institutions for capacity development. However, it has been observed that integration and mainstreaming of DRR in various governmental schemes/programmes are yet to be done. There are a number of gaps in knowledge, capacity, and experience of government, academic institutions, and local bodies/administration and at community level. Various interventions, namely, research, adequate tools, knowledge, infrastructure, fund allocation are to be addressed in advance at different levels so that a long-term perspective may be developed to minimise the impact of disaster on society thereby building community resilience leading to sustainable development.

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Landslides Vulnerability and Protection Measures Along Mata Vaishno Devi Yatra Track, J&K State, India

Chandan Ghosh

Abstract

Mata Vaishno Devi Yatra Track often faces rainfall induced landslides, rock falls and other incidents, which mostly arise from the ill-conditioned hill slope stabilisation measures coupled with haphazard constructions. Increasing multimodal traffic along the track affects the Yatris as well as various establishments, including shelter sheds, shopping arcades and buildings. Though the frequency and severity of landslides has not been so much crucial, this paper addresses some of the natural and man-made vulnerabilities found in the Yatra Track, which is operational round the year, and catering to 50,000 plus pilgrims per day during the peak festive season. It also explains portending situations along the 13-km long Yatra Track and suggests some of the mitigation alternatives including bioengineering by Vetiver grass. The possibility of adequate allowance for an escape path at some of the potentially risky spots, and future extension of services, such as widening of existing track, strengthening of retaining structures, slope training measures by adopting rock bolting, nailing, geo-netting and reinforced earth retaining structures, etc., have been explained in the paper.

Keywords: *Landslides, rock falls, retaining structures, gabion wall, geonetting, soil nailing, mitigation, slope stabilisation.*

Societal Relevance

Landslide aspects in the country are concerned with the introduction of methods for quicker cleaning of debris in order to reduce social impact and property loss, and have been found effective as short-term measures. India has recognised the value of establishing landslides early warning and response protocol, rather than continuing to adopt an ad hoc approach each time they appear mainly during the rainy season. This paper explains the vulnerable situation along the Yatra Track starting from Katra and suggests some mitigation measures to curb landslides, rock falls and stampede management.

Introduction

Mountain regions are often subjected to rising temperatures, transformation of glaciers, extreme hydrometeorological events, which affect the hydrological regimes of meandering rivers, scores of ethnic cultures, and diverse ecosystems. The entire Himalayan range, including Mata Vaishno Devi Shrine area, has been prone to landslides (Figure 1), forest fire and earthquake induced secondary hazards such as rock falls with additional problems due to enormous crowd control specially during the festive season. Therefore, it is important to identify potential rock shooting zones and damage being inflicted on the facilities, and subsequently mapping potential landslides prone area so that appropriate structural mitigation measures such as breast walls, shotcreting, netting, soil nailing, rock bolting, anchoring, gabions, geomats, brushwood mats, etc., can be undertaken. Moreover, some non-structural mitigation measures along the Yatra Track , such as display of landslides warning sign, providing proper in-plane and cross-drainage along the track, allocating first aid kits and training of Shrine Board staffs, providing protective railings all along the track, facilitating more resting places and emergency escape routes, need periodic evaluation and maintenance.

Mata Vaishno Devi Shrine Board (MVDSB), Govt. of J&K was set up in August 1986 under the provisions of The Jammu and Kashmir Shri Mata Vaishno Devi Shrine Act, 1988. The main objective of the Act was to provide for better management and governance of the Holy Shrine of Shri Mata Vaishno Devi (Figure 2) and its endowments including the appurtenant lands and buildings. An effort was made in May 2009 to apprise the Shrine Board Authority and its 2,000+ staff members on the importance of disaster preparedness while managing surging pilgrims from 1.4 million in 1986 to the tune of 10.1 million in 2011. Figure 3 shows the number of pilgrims visiting the shrine from 1986 to October 2012. As many as 82.44 lakhs of pilgrims visited the shrine till September 2012 and 78.1 lakhs during the corresponding period in 2011. Figure 4 shows the intensity of pilgrim visits during 2011-12. The aim of the site visit was to assess the feasibility of various structural and non-structural

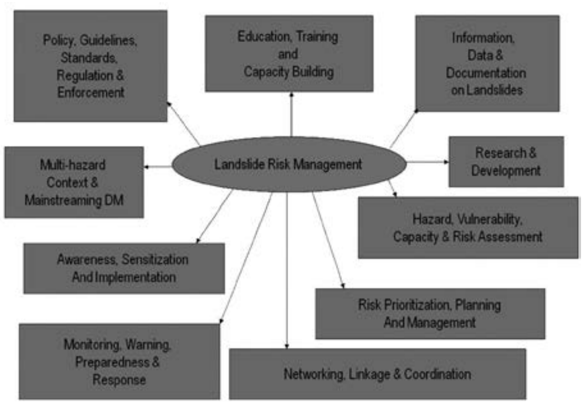

Figure 1: Landslides risk management system in India (NDMA, 2010).

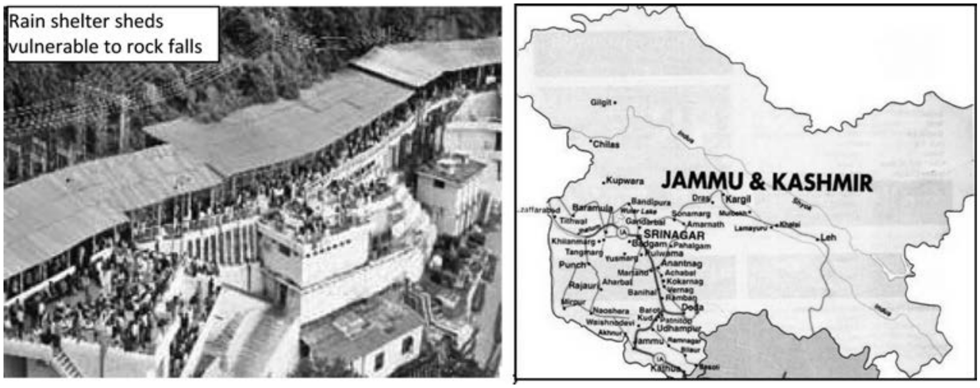

Figure 2: Devotees at the main Bhavan complex during September 2012.

mitigation measures likely to be undertaken in association with all stakeholders. It was also an attempt to get into the initial phase of Disaster Management plan implementation with a hands-on approach involving the shrine staff employed at various levels in the entire management board.

Katra town is located at 32.98°N, 74.95°E. It has an average elevation of 754 metres (2,474 feet). Geological study of the holy cave has indicated its age to be nearly a million years. The oldest recorded reference to the temple is of Guru Gobind Singh's visit to the shrine in the 16th century. The outer Hill Division covering Katra comprises Siwaliks, Murrees and Dogra Slates types of Geological Formations. The higher mountains North and East of the Katra town area are formed of Sirben which are also called as "Great Lime Stones." This

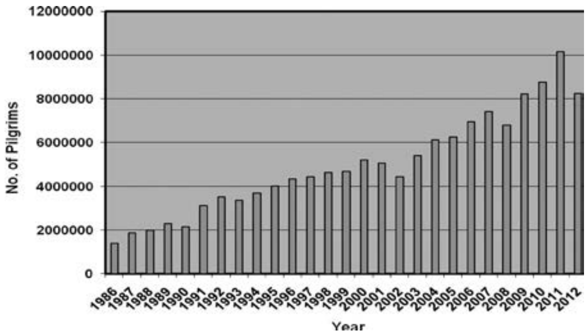

Figure 3: Number of Pilgrims visiting the Shrine complex from 1986 to September 2012.

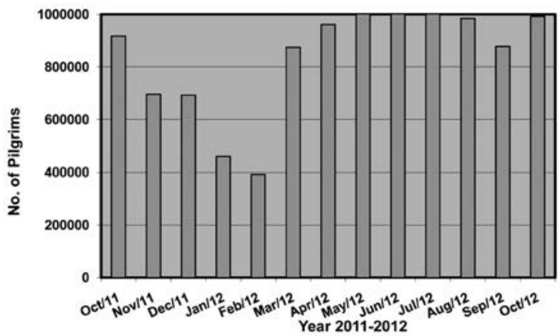

Figure 4: Pilgrims visit round the year with peaks during May-June and September-October.

carbonate complex in which dolomite is predominant is thrust onto the Siwaliks along steep NE dipping main boundary thrust. This tectonic line separates the Siwalik from the Murree zone in the North. Many forms of stromatolites, intraformationalbreccias, oolites, fine laminations and lenticular arenaceous layers occur. Chert is very common in these rocks. There are also arenaceous and quartzite beds (Khatri, 1999).

The major triggering factors for landslides are heavy rainfall, snowmelt run-off, earthquakes, volcanic activities and human modification of mountain slopes during road construction and facility creation for the people. Natural dams created by earthquake induced landslides and avalanches are also a significant hazard in mountain areas, and are particularly common in NW and NE higher Himalaya. It is recognised that analysis and design of landslides protection measures in the highly seismic prone areas involve the interplay of a wide variety of related disciplines, such as seismology, geology, geomorphology, soil and rock dynamics, and applied mechanics. Therefore, geotechnical engineers need to be well aware of the advances and technical developments in these fields (Bhandari, 2006), or to be properly advised in these matters in order to accomplish cost-efficient and safe designs.

The buildings and shopping arcades at the Katra bus terminus and also along the Yatra track are overly deficient in disaster-resistant measures likely to arise from fire, landslides and earthquakes (Zone IV as per Indian Standard Code IS 1893-2002). In many places steep slopes with unprotected free falling rock/soil blocks and inadequate prevention measures were found. The track is always full with human traffic as well as Ponies carrying pilgrims and other essentials items required for the pilgrims while they are on their Yatra. In a majority of the places the remedial measures undertaken are either inadequate or their efficacy has gone outdated. While enormous effort has been made for all-round welfare of the Yatris, this paper highlights some of the problematic areas where appropriate remedial (structural and non-structural) measures are urgently required. Some mitigation measures in the form of preventing rock shooting, re-strengthening of unplanned and ill-planned buildings shall be either not plausible or not feasible to build upon due to inaccessibility. It has been noted that landslide problems along the track got aggravated due to slope cutting and inappropriate stabilisation measures thereafter. Each site needs specific treatment as well as remedial measures depending on the materials available vis-à-vis construction feasibility and suitability of the techniques to be devised.

Landslides Prone Areas

Landslides in India are spread over 22 States and 2 UTs including J&K, Himachal Pradesh, Uttarakhand, Arunachal Pradesh, Assam, Meghalaya, Mizoram, Manipur, Nagaland, Sikkim, Tripura, Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Goa, Maharashtra and Puducherry. The most sensitive areas are the Himalayan belt, Nilgiris, Western and Eastern Ghats. India has more than 15% of its territory prone to various degrees of landslide hazard, frequently affecting human life, livelihood, livestock, living places, structures, infrastructure, and natural resources in a big way. In addition to direct and indirect losses, landslides cause significant environmental damage, societal disruption and strategic concern. Landslides constitute a serious hazard that causes substantial human and financial losses in the country. It is estimated that on an average hundreds of lives and approximately hundreds of crores of rupees annually are lost directly or indirectly due to landslide problems in India.

Worldwide, landslides cause thousands of casualties and billions in monetary losses annually and India is no exception (Bilham, and Ambraseys, 2005). Frequently landslides occur in areas where the soil is saturated from heavy rains or snowmelt. They can also be started by earthquakes, changes in groundwater, disturbance or change of a slope by man-made construction activities, or any combination of these factors. A variety of other natural causes may also result in landslides. Recent M6.9 (September 2011) earthquake on the Sikkim-Nepal border caused several landslides, and some of the strategic roads in the north of Sikkim are yet to be reconstructed. In the last couple of years there have been several cases of landslides along the Vaishno Devi Yatra track and whatever protection measures are taken to curb further onslaught of such happenings need to be evaluated.

Vulnerability along Yatra Track

Landslides are a frequent threat during heavy rainfall along the entire track. Increasing load of moving traffic along the track threatens to cause severe damage to the Yatris as well as various establishments, including shelter sheds. Even these shelter sheds are vulnerable to rock shooting. In a majority of the places the remedial measures undertaken are either inadequate or they have ceased functioning as per situational demand. The buildings and shopping arcades at the Katra bus terminus and also along the Yatra track are overly deficient in hazards resistant measures likely to be arising from fire, landslides and earthquakes (Zone IV). In many places steep slope with unprotected free falling rock/ soil blocks and inadequate prevention measures were found. The track remains full with human traffic and in many places there is scarcely any provision for an escape route.

While enormous effort has been made for the all-round welfare of the Yatris, this paper shall highlight the problematic areas where appropriate remedial (structural and non-structural) measures are urgently required. The approach road from Katra bus stop to the entrance gate is not protected by railing in the left side. It has a deep gorge, is prone to accident and the road is not wide enough to take the traffic load. Traffic jams are a regular feature.

There are no regulations and building bye-laws in effect in the entire region, including Katra Town. Hence mitigation measures in the form of preventing rock shooting or re-strengthening of unplanned and ill-planned buildings shall be either not plausible or may become a costly mandate for the Shrine Board. Yet with proper site investigation and instrumentation the potentially risky areas can be identified first and mapped in suitable mode and then be rectified by adopting modern disaster safe technology. Site specific measures for landslides, weak buildings and track stability shall be chalked out after GIS mapping and total station survey. The possibility of adequate allowance for the escape path at potentially risky spots and future extension of services such as widening of Track, strengthening of retaining structures, cost saving measures by adopting new techniques of earth retaining structures, etc., shall be devised after detailed investigation.

It is noted that landslide problems along the track got aggravated probably due to dangerous slope cutting and inappropriate stabilisation measures thereafter. All these problems shall be addressed after proper site investigation. Each site needs specific treatment as well as remedial measures depending on the materials available and construction feasibility and adequacy of the techniques to be devised. Some of the sites may not be accessible and are to be left unattended. Adoption of slope stability measures is an art which has to be exercised on frequent site visits by experts available in the country. Some specific areas along the Yatra track are:

- The area covered from Banganga-Bhavan is highly prone to landslides that threaten to cause severe damage to the Yatris and establishments. Some of the protection measures are taken but with high cost sans engineering of the same.
- Tracks are mostly created out of cutting the slope with little understanding of the geology and geotechnology
- Several landslides protection measures, such as breast wall, retaining walls, taken so far have either gone out of service or new techniques are not yet promoted.
- Almost all the buildings and establishments or facilities constructed along the track are earthquake resistant or not, a mere look on the same reveal abject conditions.
- Construction methodology adopted in a steep hilly terrain needs to be improvised for longer sustenance.
- Along the new track major landslides/rock fall areas have to be investigated and mitigation measures taken, suited to local conditions or facility.
- Aside from the old buildings the new buildings under construction requires structural review as per Indian codes

Vulnerable constructions

While landslides are prevalent along the Yatra track, so are the vulnerabilities due to haphazard constructions and their intractable maintenance. Some of the visible vulnerabilities in buildings are shown in Figures 5 to 9 and obvious danger spots are highlighted in each photograph. As these are the usual type of constructions being followed in unauthorised manners, nothing much could be done due to socio-cultural deficit in realizing the secondary effects of landslides. Quality control in construction are either difficult to adopt in the hilly region or they are not properly explained in the form of guidance manuals. Indian codes are mostly silent in many such issues in hill areas, where routine methodologies are not well documented. Moreover, constructions are usually carried out based upon needs and usage in such steep terrain because of the Pilgrim pressures but construction feasibilities are not routinely examined technically. Therefore, quality control aspects become least important for construction in difficult terrain and meticulous inspections of the built up facilities along the Yatra Track need to be built up in active cooperation with the Shrine Board.

Figure 5: (a) Entrance gate at Katra is likely to be affected in case of earthquake shaking as slender columns and slabs are not supported on load-bearing beam. (b) New constructions have poor quality concrete with thin columns (less than 300 mm wide). Irregular array of secondary beams and columns with floor projections outside, which are extremely vulnerable to earthquake shaking.

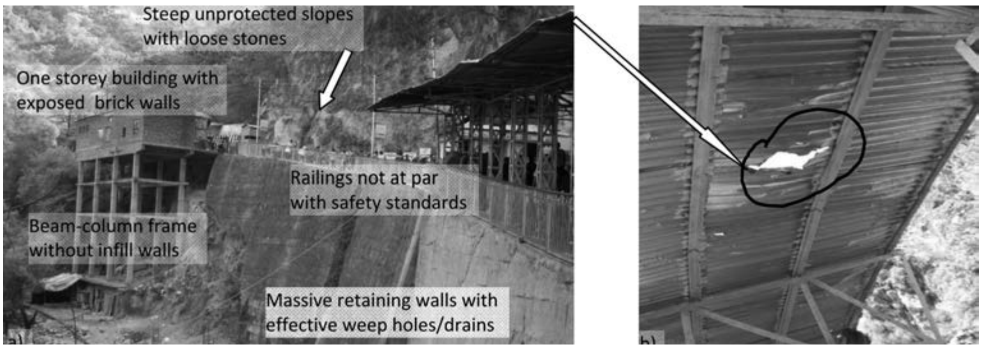

Figure 6: (a) Massive conventional retaining wall as high as 12 m with inadequate pathway for pilgrims, steep unprotected slopes and fragile rain shelter sheds; (b) lying flat underneath steep slope that is often affected by rock falls.

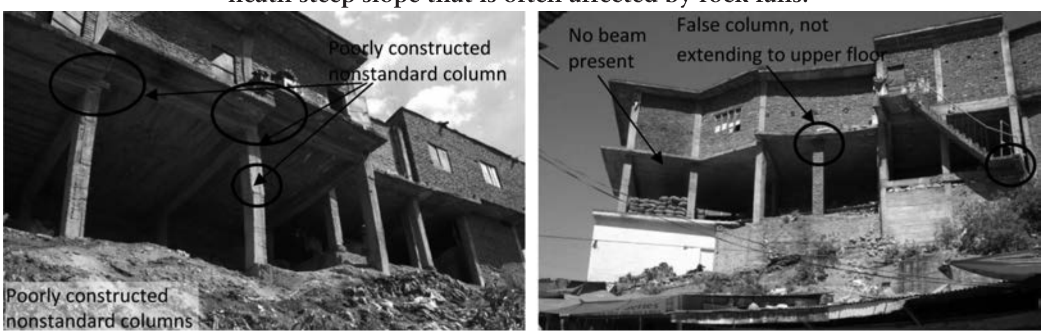

Figure 7: Such poor quality buildings lying at the hilltop are some of the most vulnerable establishments along the track. Some are load-bearing and some are not. Columns sizes are not as per standard quality and design. Even mild shaking due to earthquake may cause a collapse in such establishments. The construction is so poor that no strengthening measures are feasible.

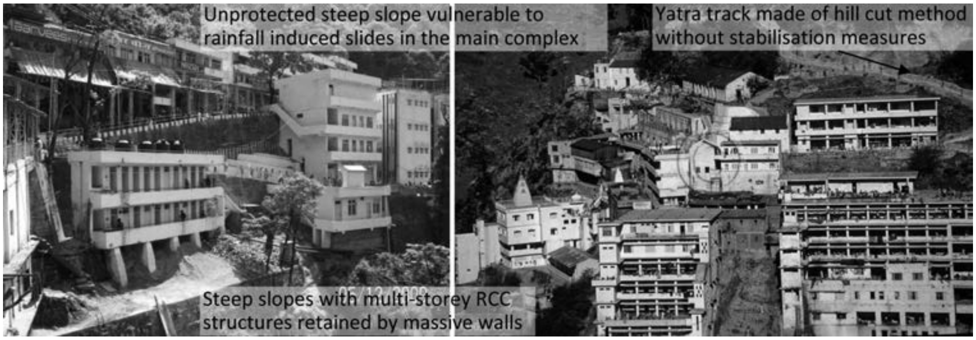

Figure 8: Vulnerable multi-tier infrastructures in the main Bhavan complex leaving little or no scope for effective rescue operations during earthquake and rainfall induced land slippages.

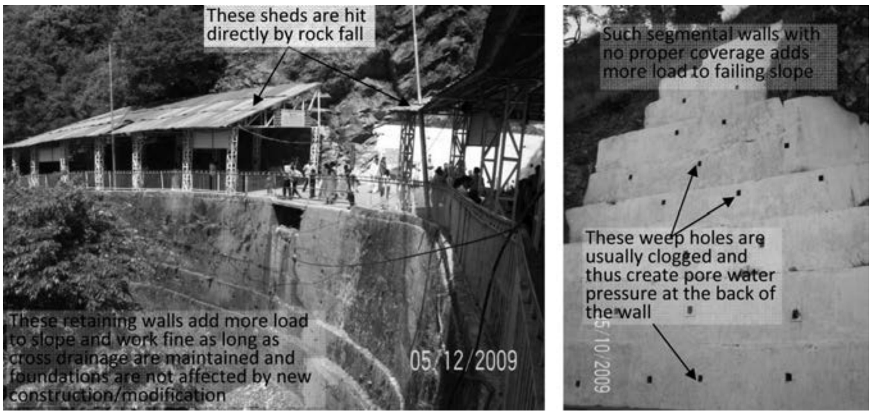

Figure 9: Massive retaining walls supporting Yatra track with weep holes in regular intervals that remain non-functional due to improper filter alignment.

Non-structural issues and vulnerability

A quick assessment of the shrine sites vis-à-vis preparedness for a disaster indicated the following important points. This raises a need of an immediate action to make the shrine safer for devotees and staff working there.

- The shrine is visited by a large number of devotees from all backgrounds. At any time during the peak season, around 20,000 devotees may be present at Bhavan, Ardhkwari or Katra. Considering the growing number of visitors to the shrine it is expected that the total number of visitors may reach 10,000,000 in a year.
- The terrain of the shrine area and en route is undulating and dangerous due to landslides, rock falling and forest fire prone slopes. The roads are narrow with no exit or free space.
- The Bhavan, Ardhkwari and Katra entry point areas are informally built without any consideration for emergency exit of people.

Figure 10: (a) Link road not having drainage measures along the Yatra track. (b) Track has heel protection blocks but without safety railing for Yatris.

Figure 11: (a) With low height breast wall, slopes along the Yatra track were not protected properly. (b) They can be netted and nailed as per demand of the actual site situation. (Photo: Geobrugg)

Figure 12: (a) The breast walls provided here cannot function properly during heavy rain induced landslides. These can be replaced with more environment friendly reinforced earth/soils nailed wall, which are not only flexible and cost-saving but also resilient against earthquakes. (b) Application of wire mesh stitched with geonet for protecting one such steep slope. (Photo: Geobrugg)

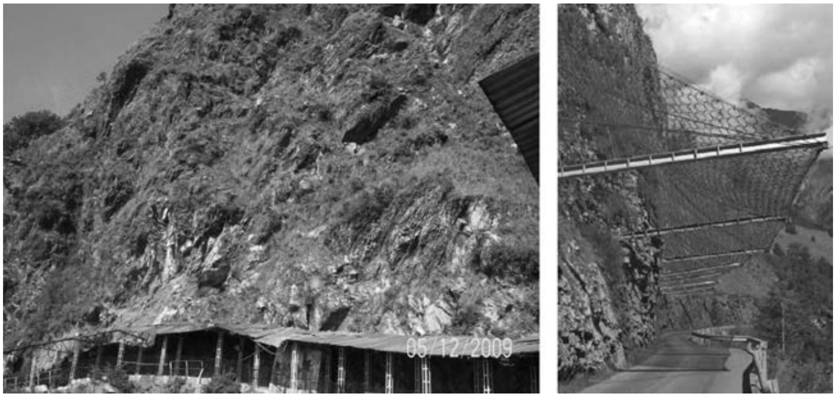

Figure 13: (a) Shelter sheds are severely damaged by rock falls due to bad design. (b) Alternative design of rock fall protection. (Photo: Geobrugg)

Figure 14: (a) Unprotected rock slope with no proper drainage. (b) Slope protection by nailed wire netting. (Photo: Geobrugg)

- The shops, full of ignitable items, on the way to the shrine line both sides of the road and pose danger of fire hazard, as there are no fire fighting instruments installed or training given. There is no safety practice followed in the construction or layout of these shops.
- Being in the Himalayas these areas are also prone to earthquake, heavy rainfall, snow, avalanche, forest fire, etc.
- No major motor communication was yet available and all supplies depend on animal or human transport.
- There are some alternative routes in case of emergency and mock drill kind of exercise are done but there is always a chance leading to total cut-off of the shrine or any location on the route. Helicopter service is available only at a single location.

- Present disaster management practices adopted are rudimentary and do not have support of necessary information/details about the area, e.g., topography or existing facilities.
- The practices being followed currently (e.g., unplanned circuit for devotees at Bhavan, non-comprehensible signboards or maps) lead to unnecessary confusion.
- The narrow route to take devotees to the shrine does not have enough and easily accessible exit points.
- Devotees begin their climb without much information on what is expected on the routes or at the shrine or due to inclement weather. No map or detailed information sheet is provided to them. However, Pilgrim are least bothered about the sufficiency of such contingencies till crisis takes over by.
- Most of the visitors climb the hill at night. Though there is good provision of street lights it is not ensured that the existing signboards, etc., are properly lit.
- There are no maps of the area available. Even if a few were made in the past these are not readily available or accessible in digital format (e.g., in case these are demanded by an external agency, say National Security Guards or CRPF, to neutralise a terrorist act, or to manage disaster).
- There is no information on the topography of the shrine, the routes and surrounding areas, which is a must for managing disaster.
- A high degree of confusion prevails amongst the devotees, in the absence of proper guide maps, regarding the facilities available and their location, and routes for different places. The existing signboards, their style of communication, level of details shown fail to address this need. The local management may know partly about the facilities but the visitors are always new to the site.
- The devotees ask their doubts to the people on duty (sweepers, security guards, priest, etc.) which lead to latter's distraction from duty and also cause irritation on many occasions.
- A master plan was reportedly made some 12 years ago for Bhavan but since then a lot more construction has taken place. Whether master plan remains on paper mode or futuristic action oriented protective measures are taken up or not, only regular inspection and review of the vulnerability reducing measures will tell.
- Reporting an emergency to the DM Cell (say, by mobile phone or wireless) is presently based on the rough location on the route or elsewhere, as no land marking system exists, which may delay the action time.
- Extraordinary measures taken for the shelter shed are vulnerable to rock shooting related disasters because of their disposition which is prone to direct impact of the falling rocks.

Protection Measures

Landslides protection measures, such as rock bolting, soil nailing, reinforced earth wall, geo-netting, are plenty yet many of these techniques are not available in the Indian codes. However, taking concepts from foreign codes as well as some of them are already outlined in the Indian Road Congress, there is still a systemic lag in the adoption of the same in the hill road construction agencies of country. Several agencies are getting updated with landslides protection measures across the globe but having none of them adapted in the construction of manual of road construction organisation of the country, it's right time to take up pilot studies. Some of the simple yet elegant techniques are presented in Figures 10 to 14.

Recommendations

A. Reconnaissance Site survey, Terrain mapping by 3D-LiDAR scanning and total station survey:

To produce 3D topographic mapping (at 1m intervals, if not smaller or may be larger intervals, suiting the site conditions) in at least 1:2000 scale or lower scale suiting site conditions, and prospective mitigation requirements, for the entire disaster prone area. The same shall be digitised and presented in GIS platform so that all facilities/establishments/pilgrims movements in the entire Yatra path and arrival of Pilgrims from nearby railway stations and by road can be effectively monitored/controlled/administered from the DM control room. By using CCTV camera at vulnerable positions and deploying modern landslide early warning system in place with GIS interface, the DM authority shall be in a position to check disasters/danger in wait in 24X7 mode.

B. Soil/rock investigation, borehole logging, fault mapping and soundness testing of the rocks slopes:

- To identify potential rock shooting zones and damages being inflicted on the resting shelters/facilities and subsequently mapping potential landslides prone area so that appropriate structural mitigation measures such as breast walls, shotcreting, geo-netting, soil nailing, rock bolting, etc., can be undertaken.
- To devise non-structural mitigation measures along the Yatra Track such as display of warning signs by digital dash board , allocating first aid kits and training of Shrine Board staff on duty, providing protective railings along the Yatra Track, facilitating more resting places and emergency escape routes, etc.

C. Based on data obtained from items A and B, Hazard and risk mapping of existing establishments such as buildings, shops shall be made in GIS platform:

- The digitised maps shall highlight the entire area with qualitative attributes: high, moderate, low and no risk zones.
- Identify shelter area in case of possible stampede or landslides and also indicate possible mode of future extension incorporating disaster safe developmental planning

Steps Ahead

Based on the inspection of landslides and built infrastructure vulnerabilities along the Yatra Track following measures are to be taken:

- Route map for detailed investigations, testing and data collection from the site leading to various possible solutions to the landslides problems induced by unplanned infrastructure developments and overstressing of the facilities during the peak season.
- Preparation of Hazard Map based on Image interpretation in GIS platform and adapting various details of the project site highlighting various spots that need due attention from impending disasters such as rock falls, forest fire, rain fall induced landslides.
- Detailed assessment of vulnerable establishments such as buildings, retaining walls, track conditions, etc., along the Yatra Track, including slope geometry and storm water draining facilities.
- Identification of spots along the Track that need various non-structural measures, such as providing safety railings, escape routes, display boards, etc.
- Identification and prioritisation of landslide/rock falls prone area and taking up site specific mitigation measures.

Conclusions

It is noted that landslides problems along the track gets aggravated due to feasibly dangerous slope cutting and inappropriate stabilization measures thereafter. Each site needs specific treatment as well as remedial measures depending on the materials available and construction feasibility and adequacy of the techniques to be devised. Some of the sites may not be accessible and to be left unattended. Based on the site inspection, it has been found that there is no regulations for adopting building bye laws. Hence mitigation measures in the form of preventing rock shooting or re-strengthening of unplanned and ill-planned buildings are either not plausible or may become costly mandate for the Shrine Board. Yet with proper site investigations and instrumentation the potentially risky areas can be identified first and mapped in suitable mode and then to be rectified by adopting modern disaster safe technology. Site specific measures for landslides, weak buildings and track stability can be chalked out after LiDAR survey. Possibility of adequate allowance for the escape path at potentially risky spots and future extension of services such as widening of Track, strengthening of retaining structures, cost saving measures by adopting new techniques of earth retaining structures, etc. is to be devised after detail investigation. After all adoption of slope stability measures is an art, which has to be exercised on frequent site visits and decision making through observational method by experienced geotechnical professional.

Acknowledgements

The author highly appreciates the active cooperation received from the SMVDSB and various line departments including CRPF, J&K Police for facilitating the site visit in May 2009 along with Dr. Bharat Lohani, IIT, Kanpur, Dr. Swati Mitra, Consultant, NIDM and Mr. Amitabha Singhal, Emergency Communication Expert, Delhi.

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Reconstructing Past Climate and Natural Disasters in Kashmir Valley: Using Historical Evidence as Climate Proxies

Bashir Ahmad, Khurshid Ahmad, Akhter Alam and M. S. Bhatt

Abstract

Reconstructing past climate and natural disasters in Kashmir valley using historical evidence as climate proxies is a paper wherein the authors have through chronological documents having past records about extreme events tried to analyse climate change in the area. Lot of reading of old books and publications has been done which give an insight into the climate of the region and can become a base for doing research for predicting the future. Not many studies are done; hence this paper shall be an insight into the western Himalayan region.

Keywords: *Past Climate Record, Kashmir Valley, Historical Evidence, Climate Proxies.*

Introduction

Knowledge of the magnitude, frequency and impacts of natural disasters is limited by the fact that instrumental records are largely restricted to the twentieth century. Indeed most precision instrumentation and systematic data gathering exercises stem from the most recent half century. As a result there is an increasing interest in extending the climatic record back as far as possible using other methods. In this perspective historical climatology can provide a valuable evidence on past climate related events (Pfister et al., 2001), and their impact on contemporary society. This paper provides a preliminary investigation related to weather extremes and natural disasters reported by the noted native scholars of Kashmir. It will focus on the years covered by one particular set, currently known as *Rajatarangini*, the surviving text of which runs from 2000 BC up to the beginning of Mughal annexation of Kashmir in AD 1586; and later from different Persian and English sources from medieval period up to the beginning of instrumental climatic era (AD 1891) in Kashmir. This investigation takes place against the background of current global climate change and alongside negative impacts of weather extremes and natural hazards, from which human and economic losses have grown, worldwide, in recent decades (Easterling et al., 2000). Kashmir is not immune from these issues, and there is considerable concern over the effect of climate change on many social and economic sectors, including energy supply and agriculture. Possible increase in the frequency and intensity of weather extremes, such as flooding, windstorms and drought, arising from global warming (Karl, 1999); and the resulting consequences for human society are currently areas of major international research (World Bank, 2010). However, with mounting evidence of significant climate variations across Europe and other parts of the World in recent decades, centuries and millennia, alongside evidence of present global warming, these views have altered. Records of variables such as temperature and precipitation over the last thousand years are especially significant, since within this time frame, several notable climate shifts are identified or proposed, such as those centred predominantly on Europe and the Northern Hemisphere, including the "Medieval Warm Period" (MWP, AD 900-1300) (Goudie, 2002) and "Little Ice Age" (LIA, AD 1350-1850) (Grove, 2001). These natural climate oscillations invite comparison with past climate trends in Kashmir which were at least partially influenced by human activities (Drew, 1875; Lawrence, 1895).

Further, important considerations are apparent regional variations in the timing and intensity of climate shifts and changes. There is growing awareness that events like the MWP and LIA were not truly global in character, varying widely across regions even within North West Europe (McElwain and Sweeney, 2004). Researchers are now looking for detailed and accurate reconstructions of variables (such as temperature and precipitation) at as fine a level as possible (either yearly or monthly) in as many regions as records can be developed, in order to gain a definitive picture of the Earth's past climate. Variables other than those mentioned above are important. Since one of the main issues related to impacts of global warming concerns possible increasing extreme weather, long records of extreme events are needed to understand how their frequency and intensity relate to more general climate trends. The *Rajatarangini* and later *Persian* historical sources have the potential to provide a long and detailed record of extreme events in Kashmir as far back as possible, alongside information on societal response to these climate extremes.

Geological and Physiographic Background

Kashmir Valley is north-west-verging Neogene-Quaternary inter-mountain basin with distinct elongate NW-SE asymmetric disposition (74-75.30' E, 33.30'-34.30' N) bounded by Zanaskar mountain range in the north/north-east while Pir Panjal range does the same in south/south-east. Kashmir Valley owes its origin to tectonic upheaval of Pir Panjal range that began about 4 millennia ago along the Panjal Thrust. Panjal Thrust together with the younger Murree Thrust bound the south and south-eastern side of the Kashmir Valley; the north and north-eastern side appear to be bounded by the faceted spurs projecting from Zanaskar Range (Figure 1).

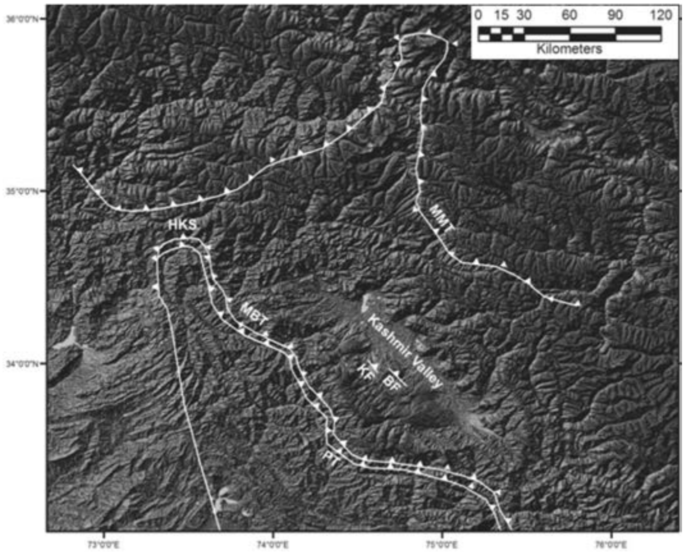

Figure 1: Seismotectonic map of the Kashmir Valley with MMT (Main Mantle Thrust) in the north and two imbricate thrust sheets Panjal Thrust (PT) and Main Boundary Thrust (MBT) running parallel all along the Pir Panjal range. Two out of sequence thrusts KF (Kolbug Fault) and BF (Balapur Fault) running almost parallel to each other along the Pir Panjal range. HKS: Hazara Kashmir Syntaxis.

The slopes bounding the basin exhibit a different morphology depending both on their lithology and structural setting, are possible loci for disastrous landslides and snow avalanches. The length of the valley, lying north-west and south-east, is parallel with the structural grain of the chief ranges in the north-western portion of the Himalayas. The size of the Valley may be measured in two ways, one reckoning from summit to summit of the mountains bounding it, the other counting only the valley floor, that is, nearly the flat part, that lies enclosed by them. The part which is comparatively low and flat is about 135 km long from NW-SE and in width it varies from 32 to 40 km; it has an area of 4,921 km^2 and is prone to disastrous floods with 4 years' recurrence interval. The basin floor lies at about 1,500 masl. Whereas the north-western and south-western ranges reach an elevation of about 4,000 m and 4,500 m respectively. Barring bounding mountain ranges, most of the Kashmir Basin is apron with 1,300 m thick weakly consolidated Quaternary sediments, known as Karewa deposits and younger river alluvium.

Type of Information and Sources Consulted

The oldest historical record of the Kashmir Valley is *Nilamata Purana* written by Neel Muni during the sixth or seventh centuries AD. It is in Sanskrit language and describes the cultural and social aspects of Kashmir. Then there are a series of books written between the eighth and twelfth centuries that describe the socio-political, socio-economic and cultural aspects of Kashmir. Notable among these are *Kuttanimata Kavya* by Damodragupta

(8th century), *Ksamaya-matrka*, *Desopadesa-narmamala*, *Desvataracarits* and *Nrpavali* by Ksemendra (eleventh-twelfth century), *Katha Saritsagara* by Somadeva (eleventh century) and *Vikramankadevacarita* by Bilhana (eleventh century). Next comes a succession of three books giving the history of Kashmir from ancient times to medieval period. These are *Rajatarangini* written in 1148-1149 by Kalhan Pandit, covering the period from 2448 BC to AD 1148; *Rajavali* by Jonaraja, covering the period up to AD 1459; *Jainarajatarangini* later extended up to AD 1477 by Cirivara Pandit, a disciple of Jonaraja; and the *Rajavali Pitaka* by Prajya Bhatta covering the period up to AD 1586. These books are in Sanskrit script and have been translated into English by Jogesh Chandra (Dutt, 1887) under the title *Kings of Kashmira*. Kalhana's *Rajatarangini* has also been translated by M. A. Stein, the twentieth century archaeologist and historian; he also attempted locating the places and the exact chronology to the events mentioned by Kalhana in *Rajatarangini*. Among all these Sanskrit chronicles, Kalhana's *Rajatarangini*—along with its successive chronicles, *Rajavali, Jainarajatarangini* and *Rajavali Pitaka*—stands as a benchmark historical record for exploring ancient to medieval history of Kashmir including its historical geography, climate and topography. The chronicle with its distinct geographical character of the country enables us to restore with precision the truly historical record of the events (with year, month and day) of Kashmir Valley which it suffered from the natural hazards like floods, earthquakes, droughts, famines and crop failures. Later on *Rajavali*, *Jainarajatarangini* and the *Rajavali Pitaka* are full of extreme event details. In fact there is a complete chapter dedicated to the flood scenario in *Jainarajatarangini*. From the fourteenth century up to the sixteenth century (AD 1320–1586), Kashmir had witnessed a Sultanate period mostly influenced by the Persian culture which made a profound impact on its history as revealed by numerous manuscripts written by notable historians of the time. By the late sixteenth century Kashmir history switched from the native control to English influence. From the late eighteenth century down to early twentieth century Kashmir came under the occupation of the Afghans (AD 1753-1819); followed by Sikh rule (AD 1819-1846) and finally Dogra regime (AD 1846-1947) too have recorded their histories under alien influence. In general, from the ninth century up to the eighteenth century, the reliable content of the annals ranges from notices of battles, sackings of religious settlements and the obits of notable persons, to lengthy narratives of events, more common later on, and often exhibiting characteristics of on-the-spot reporting. Also included are natural phenomena, e.g., comets, aurorae, unusual and extreme weather conditions, harvest reports, crop failure and disease. Strictly speaking, there are no continuous observations of weather in the annals. Unremarkable weather was not reported. However, there are many observations of several months duration, commenting on the character and severity of notable seasons.

Findings

From the earliest times historians have described the various aspects of Kashmir Valley including its topography and climate. To begin with *Alberuni*, a tenth-century scholar, has given a clear geographical account including the wind system and climate, followed by the twelfth-century noted scholar Kalhana. Later, Mirza Hyder Duglat in his book *Tarikh-i-Rashidi* (1546) described the climate of Kashmir as temperate with four seasons. While Abul Fazl (the sixteenth-century scholar) equates the climate of Kashmir Valley and periodicity of its seasons with Iran and India respectively. Later on *Rajavali, Jainarajatarangini,* and the *Rajavali Pitaka* are full of extreme event details. In fact there is a complete chapter dedicated to the flood scenario in *Jainarajatarangini*. However, they do not contain much information on natural hazards. Apart from these works, we have gone through the entire sources for Kashmir history available in the University of Kashmir and different State departments, including Research and Publication Library and State Archives department. These include books and manuscripts mostly in Persian and Arabic.

Compared to this, the number of climate events mentioned increases suddenly from the sixteenth century. These books do not record history in *sensu stricto*. Absence of any mention about natural calamities like famines, floods or earthquakes, therefore, cannot be considered their deficiency. In the second case, the maximum period of time covered by Kalhana's *Rajatarangini* concern events that had long passed into oblivion. That is why the early period in *Rajatarangini* is in far less detail than the latter period. Finally, the contemporary chroniclers were either court scribes or closely associated with the ruling class. Their interests lay in the achievements of the rulers whom they pass on to succeeding generations as successful, brave and benevolent kings. The other events like natural calamities that normally would attract the attention of an impartial historian could not be expected to have been of interest in the measure it ought to have. In contrast to the situation that we notice until the fifteenth century, the number of climate extremes mentioned in historical records increases from medieval times, specifically from the sixteenth century owing to indigenous Persian sources and influx of European travellers who have immensely contributed to the history of Kashmir in the form of travelogues; so does the number of historians, mostly unrelated to rulers.

Apart from climatic description from medieval times to modern history of Kashmir, the nineteenth-century European travellers especially had recorded similar observations by equating the climate of Kashmir with that of Switzerland, England and France. From the account of above-mentioned scholars it seems that the chroniclers were gifted and alert observers of nature and humans. Their account, perhaps for the first time, enables a more detailed glimpse at typical situations of physical and psychological stress in which people were thrown by the vagaries of climate extremes. It is very likely that such incidents were common during their lifetime or living memory.

The onset of systematic weather observations in the Kashmir Valley at a time scale varying from hourly to weekly is associated exclusively with the establishment of the central meteorological observatory at Srinagar in AD 1891. However, early instrumental data from Kashmir dates back to 1834, when Baron Hugel made his daily weather observations using standardised thermometer, and described/characterised the weather of Kashmir in his famous book, *Travels in Kashmir*. Similar observations were made by Schlagintweit and others in 1856 at Srinagar, followed by Bates in 1864-65. While travelling from Kashgar to Kashmir, Belev (1873-74), made his temperature recordings at Srinagar. In fact, records of the nineteenth century (Drew, 1875; Lawerence, 1895) show that the glaciers in Kashmir were pushed forward to their most advanced positions, until the early twentieth century. Prior to the instrumental weather observations, parameteorological phenomena (refer to once-off unusual weather events or anomalies) are found in Kashmir chronicles, which is well supplied with these events, including wind storms, flooding, extreme frosts, and snow, etc., which can serve to highlight shifts in underlying climate regimes. However, reports of extremes are often accompanied by descriptions of their effects on society, useful analogues for possible future impacts, often dating from AD 900.

Results and Discussion

Kashmir Valley witnessed agricultural recession and crop failures due to untimely rain and snowfall resulting in frequent floods and famines intermittent with mega droughts. Impacts of floods, droughts and famines from the sixteenth to the nineteenth centuries have contributed to environmental induced migration, cultural separation, population dislocation and the collapse of the state administration. Indirect data relating to weather conditions includes reports of harvest failures, found in chronicles, often linked to poor weather conditions. Less directly, records of prices of agricultural produce (like grain) vary according to supply, linked to growing conditions and weather. Other factors, with more tenuous climate-links, but still useful, include famine and disease reports. Droughts and famines have mainly affected the city population, particularly since the end of the 1700s, with severe impacts on food security and, ultimately, occurrence of famine. For instance the great flood of AD 1640-42 followed by the famine of AD 1642-43 wiped out 438 villages in Kashmir, and even their names did not survive. The great famine of AD 1745-46 took a heavy toll of 38% of the village population. Population statistics of the nineteenth century (Figure 2) shows that in 1815 the population of the Kashmir Valley was estimated to be 8,00,000; and in 1835 it was calculated not to exceed 2,00,000 persons, to which number it had, in twenty years, been reduced by 75%. While later estimates of 1873 shows 168.52 % increase in population in just 38 years. Again in 1891 the population rose to 9,49,041 persons which shows a net increase of 92.93% in just 18 years. And an overall

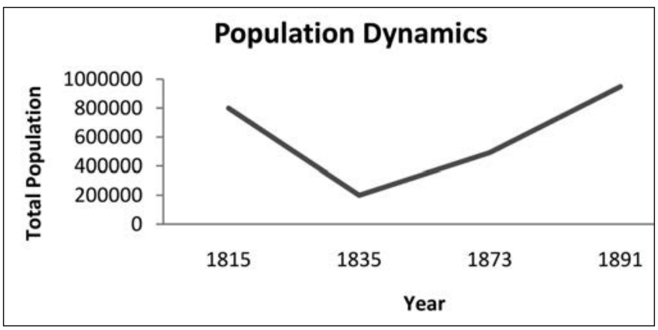

Figure 2: Population Statistics During the Nineteenth Century.

trend shows 18.5% increase in population during a period of 75 years. Thus, a drastic reduction in population during the nineteenth century was caused by dispensation of floods, famines, droughts and awful, intermittent appearance of cholera and epidemics.

In the following analysis, unreliable reports were removed. Basic trends in annalistic entries concerning severe weather are drawn from the annals of Kashmir covering AD 900-1900, derived from seventy-one reliable entries. Figure 3 shows notable variations in the frequency of these entries. Extremes do not occur evenly through time. It should be noted that Figure 3 does not include indirect entries, but does include entries concerning flooding or drought, famines, severe cold, untimely snow, etc., reports of which are taken as sufficient evidence to infer underlying weather conditions (that is, severe flooding indicates precipitation) in Kashmir. Future work will examine the indirect evidence in the annals.

Figure 3 represents discrete entries directly referring to "severe" weather and, clearly, the occurrence of extreme events exhibits significant variations through time, ranging from two events at the lowest to thirty-two at the highest. In terms of analysing changes in the climate behind these events, better use of the data is made by separating entries reporting different phenomena (such as drought and flooding), which arise from very different underlying weather conditions. It should also be noted that single entries may report several phenomena, like wind and snow. Separating these allows increased quantities of data for analysis. The range of reported phenomena includes Flood, Snow Fall, Drought, Freezing, Poor Harvest, Excessive Cold, Excessive Heat, Excessive Rainfall, Miscellanies including unspecific "terrible weather" reports.

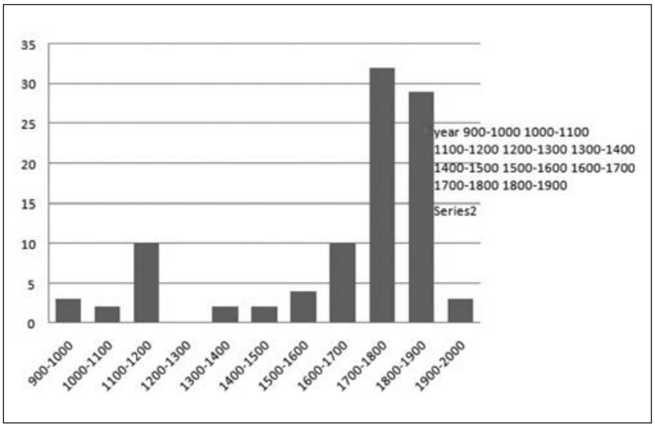

Figure 3: Chronicle Entries Concerning Climatic Extremes (from Historical sources).

Again Figure 4 shows more frequent occurrence of extreme warm weather than cold in the period AD 1700-1900, whereas the period AD 1200-1300 is devoid of any data. Also of interest are apparently contradictory trends between phenomena which one might more sensibly consider related. Figure 4 shows that extremes of freezing (which on the basis of this evidence are rarer than warm extremes in Kashmir) do really decrease in frequency even as reported cold events increase. Though the numbers are too few to make broad comments, they do serve to emphasise the complexity of the climate system and the large degree of variability that may occur by natural climate means

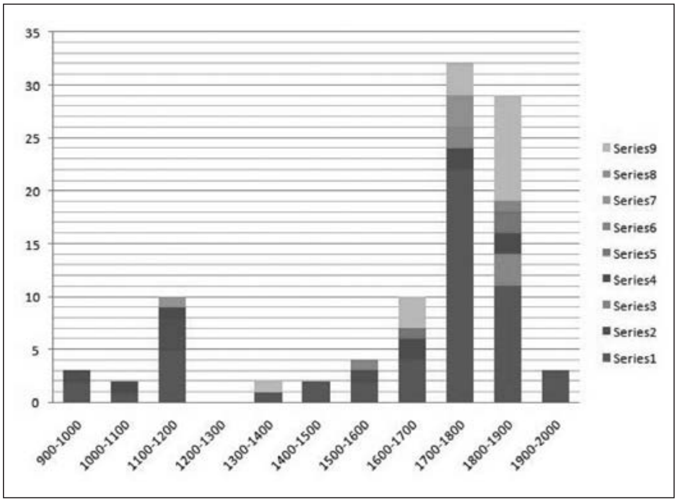

Figure 4: Temperature related reports. Series 1: Flood; 2: (snowfall); 3: Drought; 4: Freezing; 5: Poor Harvest; 6: Excessive Cold; 7: Excessive Heat; 8: Excessive Rainfall; 9: Miscellanies.

alone. Also evident is that periods of increased extreme cold weather, for example, do not necessarily imply that the climate was consistently colder, as the reports of drought and heat illustrate. Can anything be said with this evidence of supposed climate phases such as the "Recent Warm Period" and its occurrence in Kashmir? With evidence from Kashmir history only, it is premature to attempt definitive comments. Thus, an important point to remember is that Kashmir should not be expected to have experienced the same intensities or timing of trends as elsewhere in Europe, and the temptation to look for convenient trends fitting nicely with other regions should be avoided.

Conclusion

With annals of such high quality and volume and considering the use made of similar European and Asian sources, it is surprising that the climate information in the Kashmir annals has not been systematically exploited. Great potential now exists for extending our record of weather extremes back to AD 900, one of the longest in India. Being situated in the path of the main western disturbances developing in the Mediterranean Sea, Kashmir may perhaps be expected to have shown more sensitivity in the past to climate changes than other North-West European areas. There seems to be a wide range of driving forces that affect and modify the impact of climate extremes on humans and socio-economic sectors. However, floods have been the most reported natural disaster events in the history of Kashmir, resulting together in multiple socio-economic stresses, including mortality due to disease intermittent with climate driven famines. However, the nineteenth century increase in flood events testifies to the fact that dominant drivers of the upward trend of floods were mainly controlled by the incessant and long rains during the springs and summers which in Kashmir is a known climatic attribution. By examining past trends in Kashmir's crucial geographical location, useful lessons may be learned regarding the occurrence of future extremes in NW Himalayas, and their possible regional patterns and extent, as anthropogenic influences impact upon the global climate system. Future work aims to extend and develop the analysis of climate information presented here to all the available North Indian annals, and compare trends to other sources of climate information in Kashmir as they are developed. It is certainly high time that these remarkable national resources are given the credit they deserve. They still have much to teach us.

Acknowledgements

Thanks are due to all people at Srinagar Archives Department who helped in collating the details of historical climate. We in particular thank Shagufta Qayoom, Shaheena Akhter of Archives Department and as usual Shams-ud-din Shah and M. Y. Alie for providing us with necessary literature pertaining to the subject.

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Landslides and Flash Floods Caused by Extreme Rainfall Events/Cloudbursts in Uttarkashi District of Uttarakhand

Peeyush Gupta and Swati Uniyal

Abstract
Uttarakhand, an area of Himalayan region, has been studied for landslides and flash floods caused due to extreme rainfall and cloud bursts. Assessment of such disaster incidences is covered with the help of satellite based images and various geological intricacies are discussed.

Keywords: *Landslides, Flash Floods, Cloudburts, Uttarakhand, Uttarkashi* .

Introduction
Evolutionary history of the concentrated seasonal precipitation and cloudburst make the district of Uttarkashi prone to a number of natural hazards. The area is frequently devastated by landslides, cloudbursts, flash floods, floods, avalanches, lightning, hailstorms and earthquakes. These incidents cause sudden and severe damage to life and property in many parts of this area. Geological instability of the region, together with high atmospheric precipitation, is responsible for widespread landslide occurrences in the region. The rocks of the region are characterised by multiple structural discontinuities and the relationship of these with surface slopes often make conditions favourable for landslides to occur. Once instability is introduced, the hill slopes often become chronically prone to landslides. The problem of landslides is aggravated during the monsoon season due to (i) enhanced pore water pressure, (ii) increased weight of the rock mass and (iii) reduced frictional forces. There could be various reasons for such events but the main seems to be the inherent geology of the Himalayas and heavy rainfall. Torrential rains, generally called cloudbursts, or extreme rainfall are frequent events in the region. The cloudbursts occur suddenly, and are a short duration

concentrated precipitation phenomenon. During this time of concentrated precipitation in a particular location, specially at higher elevations, 100 mm to 250 mm of rainfall per day may occur. Most of the time cloudbursts/extreme rainfall events result in flash floods, causing enormous destruction of life and property in the area of occurrence. This type of incidents have been reported from all parts of Indian Himalayan region (1960, 1968, 1971, 1973, 2003, 2010 and 2012, etc.) causing huge loss of life and property. In general it is observed from almost all parts of the Indian Himalayan region that during the rainy season (June-September) many landslides at various locations are triggered, disturbing vehicular traffic, electricity, drinking water supply and telephones.

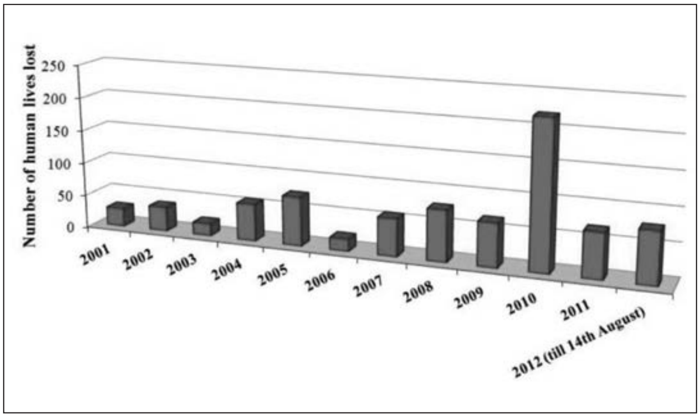

Figure 1: Year-wise loss of human lives due to landslides and flash floods in Uttarakhand.

River System

The Ganga, Yamuna and Tons form the major river system of Uttarkashi district. All these rivers have various tributaries in their basin. In Himalayan Rivers, broad bed widths alternate with narrow constricted gorges. The majority of Himalayan Rivers have a tendency to flow for some distance in structural troughs parallel to the mountains, but again they take an acute bend to flow in deep transverse gorges, at places hundreds of metres in depth. The rivers have formed deep valleys, narrow or broad in accordance with lithology. Most of the rivers flowing in the Himalayan region are antecedent. In general, the dendritic pattern is common. All the main rivers make a steep descent in their longitudinal profiles in the first phase and afterwards their gradient is less steep. It is the land of Uttarkashi district that gives rise to two great and revered rivers of India, the Bhagirathi, called the Ganga in the plains, and the Yamuna. The Ganga coming up in the glaciers “gaumukh” traverses 128 km in Uttarkashi district before flowing down farther. Hardly ten km away from Gaumukh is the place “Gangotri” of great from the west of Bandarpuch peak, and revered highly is the place “Yamunotri” situated nearby, visited by pilgrims. The third important river of this district is Tons besides a host of tributaries that drain these areas.

Flash Floods

Most of the rivers in Himalayan terrain flow through narrow gorges abutting moderate to steep slopes, having sharp bends and meet tributaries on steeper slopes. As the river flows downstream the valley becomes comparatively wide and less steep. The occurrence of flash floods, particularly in a narrow river valley, seems to be one of the much feared causes of some of the major cloudbursts or landslides or glacial lake outburst. Rolling of debris by cloudburst or landslide along the constricted course of the rivers leads to a temporary damming of the

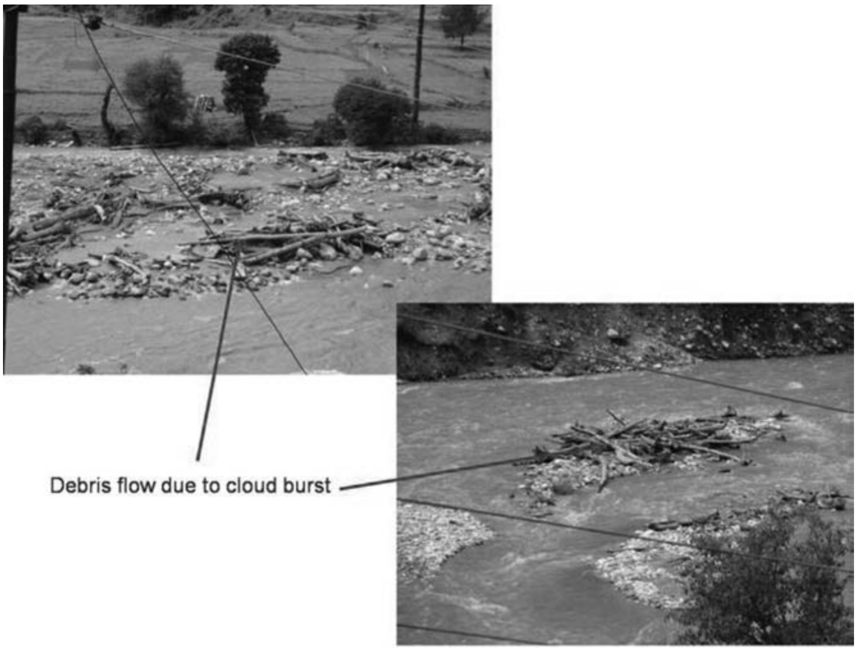

Figure 2: Human dwellings adjacent to river valley prone to flash floods.

river flow, resulting in the creation of temporary lakes. It is when the back water pressure of the lake exceeds the retention capacity of the barrier, that the accumulated water gushes downstream with mighty force inundating otherwise safe settlements. The majority of the settlements are located on the middle slopes. However, in the areas where fluvial terraces exist people would prefer to exploit such flat areas adjacent to the rivers (Figure 2).

A high discharge during the summer is an annual feature of all snow fed rivers of Indian Himalayas, which dumps a huge amount of sediment downstream. This melting is mainly due to change in temperature (winter to summer). This rise in temperature is basically responsible for the fast melting of snow and glacier lying in the source area of the respective rivers. Sometimes the high melting along the debris is able to choke the stream and create a temporary dam on the one hand, and on the other, the high melting is able to burst the temporary glacial lakes in the headwaters region.

Figure 3: Ground observation of Metrological disaster affected area.

Cloudburst/Debris Flow on Yamunotri NH 94

Site observations were carried out from August 22 to August 24, 2012. The catastrophic landslides of Uttarkashi district, which took place on August 4, 2012, have been subjected to field investigation. Our study indicates that combinations of several factors were responsible for this tragedy, but the action of water during the cloudburst was the main triggering factor. A detailed survey of the area has revealed very heavy precipitation on that date and Uttarkashi, Bhatwari, SangamChatti, Maneri, Assi Ganga, Hanuman Ganga, Kharadi, Naitwar Umala Chani, Nuranu, Kalap and Pujeli were affected out of these Uttarkashi was the worst hit. The debris flow along the gullies uprooted the trees and removed heavy boulders because of the high velocity and turbidity of the water. Along the narrow margins trees and removed heavy boulders temporarily dammed the streams. According to the villagers, similar devastating tragedy had also taken place in Kharadi, situated on the left bank of the Yamuna River. Cloudburst occurred in the Hanuman Ganga, and maximum damage occurred in Kharadi.

Affected Area

The cloudburst/landslide affected areas are: Kharadi, Janki Chatti, Hanuman Chatti, Sangam Chatti, Assi Ganga, Bhankoli, Sauri gad, Mori, Naitwar, Pujeli, Liwari, Kalab, Nuranu, Fitari, Fafrala Sankri, Dharasu band, Dunda, Tiloth, Naitala, Bhatwari. Figure 4 represents the pre-disaster condition.

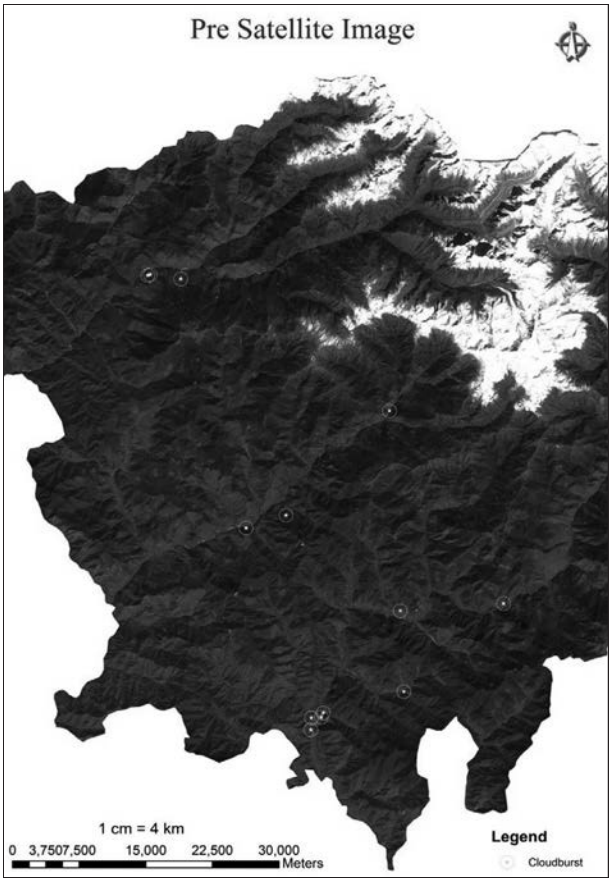

Figure 4: Pre satellite Image of Study Area.

Metrology of the Study Area

In general the Indian Himalayan ranges are on the south facing slope and critical determinants of the Indian subcontinental climate. In winters they serve as an effective barrier to the intensely cold continental air blowing southward to India. This helps to keep India warm in the winter (Agarwal and Narain, 1991). Invariably climatic conditions fluctuate from hot and sub-humid, tropical to cold, temperate and alpine compounded with glacial features. According to Mani (1979), the climate of Indian Himalayas is governed by the extra-tropical weather systems of Asia, which during winter moves from west to east, bringing rains in western Himalayas, and during summer from east to west, causing monsoon rains in eastern and central Himalayas. The northern slopes of Himalayan ranges get more snow accumulation and glacial action. Due to difference in altitude there is high variation in the precipitation all across the IHR. Eastern and western Indian Himalayan ranges receive more than 60 per cent of its total rainfall during monsoon period (June-September). The temperature is also influenced by the altitude of IHR at various locations. The foothills and valleys are warmer than the middle and high altitude. Many of the high altitude areas experience snowfall in winter season and remain snow covered for four to five months. The incidents of mass movements and flash floods are more frequent and common during the rainy season. It is because of slope stability which is partly related to the water saturation caused by prolonged and sometimes high rainfall. Apart from duration, the intensity of rain also varies time to time. It is observed that the there are many occasions in the IHR when a day's (24 hours) rainfall exceeds 100 mm and leads to several types of mass movements.

The metrological stations are Hanuman Chatti, Harsil, Bhatwari, Tekla. They intimate air temperature, wind speed, wind direction, atmospheric pressure, humidity and rainfall from August 1 to August 10, 2012.

Table 1: Metrological Parameter

STATION	DATE	AIRTEMP	WIND_ SPEED	WIND_ DIRECTION	ATMO_ PRESSURE	HUMIDITY	RAIN_ FALL
HANUMAN CHATTI	08-01-2012	16.8	0	359.2	968.9	96	58
HANUMAN CHATTI	08-02-2012	17.8	0	359.2	967.2	95	58
HANUMAN CHATTI	08-03-2012	16.6	0	359.2	965.8	0	58
HANUMAN CHATTI	08-04-2012	13.7	0	359.2	969.3	0	58
HANUMAN CHATTI	08-05-2012	15	0	359.2	970.2	98	58
HANUMAN CHATTI	08-06-2012	18.6	0.9	309.9	969.7	82	58
HANUMAN CHATTI	08-07-2012	20	0	359.2	970.2	77	58
HANUMAN CHATTI	08-08-2012	18.3	0.6	326	969.5	81	58
HANUMAN CHATTI	08-09-2012	16.1	0	359.2	969	95	58
HANUMAN CHATTI	08-10-2012	16.9	0.5	345.1	970.2	84	58
HARSIL	08-01-2012	18.2	1.9	35.2	970.6	81	127
HARSIL	08-02-2012	19.4	1.1	37.1	968.4	78	127
HARSIL	08-03-2012	16.5	0.9	45.9	967.9	89	127
HARSIL	08-04-2012	14.6	0.8	16.1	970.8	90	128
HARSIL	08-05-2012	15.5	0.9	345.1	972.2	87	128
HARSIL	08-06-2012	17.6	1.4	246.8	971.9	84	128
HARSIL	08-07-2012	21.4	0.4	66	972.2	66	128
HARSIL	08-08-2012	20.2	2	147.1	970.8	70	129
HARSIL	08-09-2012	19.6	3.3	48.9	970.1	70	129
HARSIL	08-10-2012	16.3	0.1	113.9	972.3	85	129
BHATWARI	08-01-2012	19	0	359.2	925	90	320
BHATWARI	08-02-2012	19.3	0	359.2	925	91	320
BHATWARI	08-03-2012	-40	0	359.2	925	0	320
BHATWARI	08-04-2012	-40	0	359.2	925	0	320
BHATWARI	08-05-2012	-40	0	359.2	925	0	320
BHATWARI	08-06-2012	-40	0	359.2	925	0	320

(Table 1 continued)

BHATWARI	08-07-2012	-40	0	359.2	925	0	320
BHATWARI	08-08-2012	22.1	0	359.2	925	78	320
BHATWARI	08-09-2012	19.7	0	359.2	925	86	320
BHATWARI	08-10-2012	20	0	359.2	925	84	320
TEKLA	08-01-2012	22.8	0	359.2	925	75	246
TEKLA	08-02-2012	23.1	0.7	49.9	925	77	246
TEKLA	08-03-2012	22.6	0.1	0	925	79	246
TEKLA	08-04-2012	20.3	0.6	212.1	925	76	246
TEKLA	08-05-2012	23.5	0.3	348	925	78	246
TEKLA	08-06-2012	25	1.3	254.2	925	74	246
TEKLA	08-07-2012	26	0.4	16.1	925	72	246
TEKLA	08-08-2012	27.3	0.1	110	925	66	246
TEKLA	08-09-2012	25.9	0.2	266.9	925	72	246
Tekla	08-10-2012	25.2	0	359.2	925	74	246

(Source: MOSDAC-ISRO)

Geological Set-up

Tectonically the Himalayas comprise four separable major litho-stratigraphical units, i.e., Siwalik, Lesser, Central Crystalline and Tethyan group (Table 2). These groups are separated from each other by a major tectonic contact known as Main Boundary Thrust (MBT), Main Central Thrust (MCT) and Tethyan Thrust, and these thrust contacts are traceable all along the Himalayan belt. The Indo-Gangetic Plains in the extreme south are separated by the Himalayan Frontal Fault (HFF) from the ruggedly youthful Siwalik Hills. Highly rugged conical peaks and steep sided valleys are the prominent physiographic features in Higher Himalayas. Whereas lower Himalayas contain comparatively less steep slopes with truncated

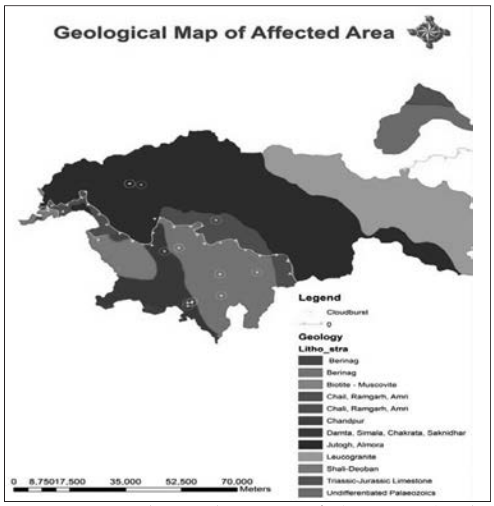

Figure 5: Geological set-up of the Uttarkashi district.

spurs and almost flat hilltops. The main ridge or major water divides generally follow the Himalayan trend, i.e., NW-SE and conform to the tectonic trends of the Himalayas. Thus, the area is geologically controlled by the major structures and lithology as well. The valley generally contains well developed fluvial and fluvioglacial terraces. The higher Himalayas generally contain thin regolith with scant vegetation and almost no population. The higher peaks remain snow-clad throughout the year. Gently sloping grounds are thickly populated. Various terraces lie along the valley sides, used for settlement and agriculture by the inhabitants.

Table 2: Stratigraphic sequence of Uttarkashi district.

S. No	Formation	Bhagirathi Valley	Jain's Classification (1971)
1	Nagni Thank	Pujargaon Metavolcanics Gamri Quartzites Kot Metavolcanics	Gamri Quartzite, Dunda Quartzite
2	Shyalana	Limestone and Dolomite	Part of lower Uttarkashi Limestone, Upper Uttarkashi Limestone, Khatturkhal Limestone Dilichi Dolomite
3	Uttarkashi	Sartali Slate	Pokhri and Dhanari Slate
		Netala Quartzite	Netala Quartzite, Bareti Quartzite, part of lower Uttarkashi limestone
Source: N. C. Agarwal and Gopendra Kumar, *Himalayan Geology*, vol. 3.			

Slope

Slope is an extremely significant characteristic in landslide incidents. In the shear slope areas landslides are gentler than the moderate slope areas. The majority of landslides occur on 100 and 250, although the areas of highest association occur in the slope between 40 to 45. Again, the high association of landslides with steeper slope angles is likely to be a reflection of widespread shallow superficial earth slide development on the steeper exposed slopes. In the rugged sloping areas landslides are more common than the gentle slope terrain. Whether laying a road section, constructing a dam, selecting a site for heavy industry, or planning a resort, the terrain slope characteristics of an area are a primary consideration. In fact, terrain slope characteristics affect the entire building process, from selecting a facility's location, to planning its layout in the area.

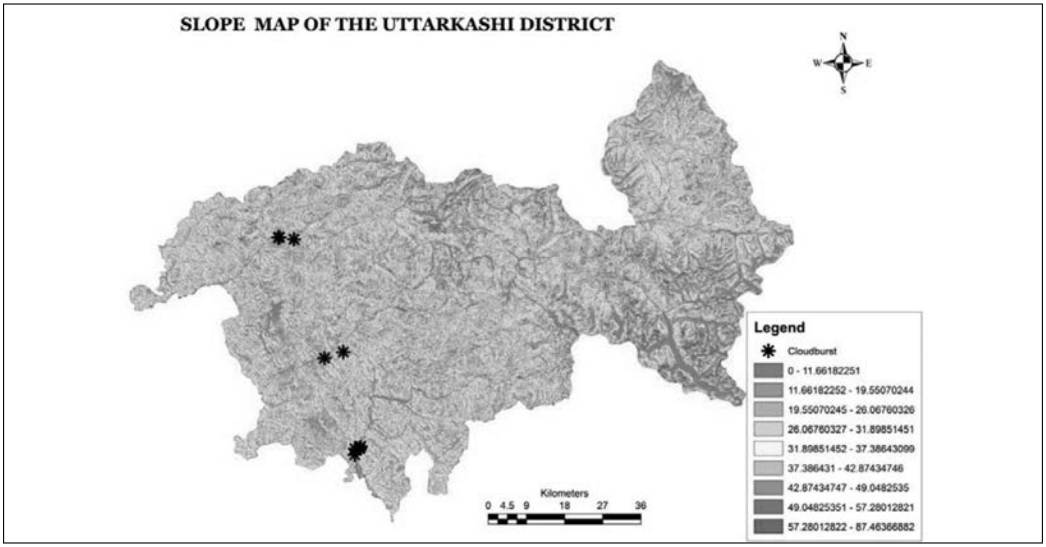

Figure 6: Slope map of the study area.

Slope Aspect

There is some association of landsliding with slope aspect, with a tendency for landslides to develop preferentially on south-east to east facing slopes. The number of landslides in these faces are, SE 12%, SW 20%, NW 18% , W 16% and South face 24%. This is consistent with directional trigger mechanism such as intense rainfall from tropical storms that mostly frequent the study area from ESE or SSE. A reasonable explanation of this pattern may be that slope aspect affects the density of shallow debris slides by limiting the development and thickness of drier slopes. To some extent, this interpretation may also be applicable to the

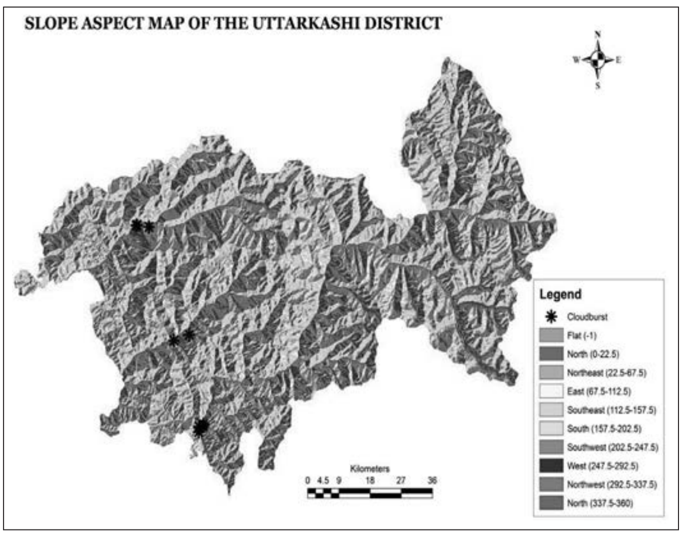

Figure 7: Slope aspect map of the study area.

development of debris slides in the study area slopes. Deep-seated landslides are less likely to be influenced by slope aspect, due to the overriding controls of lithology and structure. The elevation of study area varies from 800 m to 4,200 m within the distance of about 100 km. More than 50% of the catchments of Teesta basin lie above 800 m. Therefore the Teesta Basin of Sikkim can be classified as a high altitude basin. Only 25% of the catchments lie below 2,000 m. These are ridge, rocky, cliff, escarpment, landslide zone, low mountain (>1,000 m). The slope aspect categories represent the number of degrees of east and they increase in anticlockwise direction, that is, 90 degrees is north, 180 degrees is west, 270 degrees is south and 360 degrees is east. The slope directions in the study area are: North 0-22.50, North-east 22.5-67.50, East 67.5-112.50, South-east 112.5-157.50, South 157.5-202.50, South-west 202.5-247.50, West 247.5-292.50, North-west 292.5-337.50, North 337.5-360.0.

Landslide Hazard Zonation

Hazard indicates the probability of occurrence within a specified period of time and within a given area of a potentially damaging phenomena, e.g., a landslide. "Landslide hazard/susceptibility zonation" refers to the division of a land surface into homogeneous areas or domains and their ranking according to the different degrees of actual/potential hazard caused by the mass movement. In the recent past, various methods and techniques have been proposed to analyse the causative factors of landslides and produce maps portraying the probability of occurrence of similar phenomena in future. Broadly these methods can be classified as direct and indirect methods. The direct method consists of geomorphological mapping wherein the past and present landslides are identified and assumptions are made on the factors leading to instability, following which zonation is made of those sites where failures are most likely to occur. The indirect method includes two different approaches, namely, the heuristic (knowledge driven) and statistical (data driven) techniques. In the heuristic approach, factors influencing landslides, such as rock type, slope,

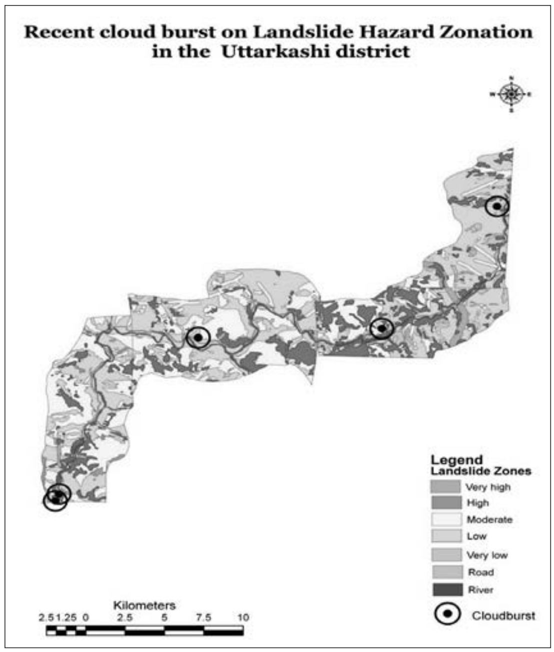

Figure 8: Landslide Hazard Zone with cloudburst location.

Figure 9: High slopes are prone to sliding.

landform, land use, etc., are ranked and weighted according to their assumed or expected importance in causing mass movements. This is normally based on a priori knowledge available to experts on various causes of landslides in the particular area of investigation. In the present study, a combination of expert opinion and statistical technique has been used to arrive at weightages for landslide Hazard Zonation. Risk means the expected number of lives lost, persons injured, damage to property, or disruption of economic activity because of a particular natural phenomenon. Vulnerability means the degree of loss to a given element (or set of elements) at risk resulting from the occurrence of a natural phenomenon of a given magnitude. Element at risk means population, properties, economic activities and so on, at risk in a given area. Specific risk means the expected degree of loss due to a particular natural phenomenon. Basically terrain is analysed with respect to various geo-environmental factors and each factor or theme is divided into a number of classes. Then each theme and each class is evaluated according to their influence factor on causing landslide. Then finally all the themes are integrated using certain mathematical formulae to prepare the zonation map. This Hazard map is grouped into several classes of probability, i.e., very high, high, moderate, low and very low. Hazard maps aim to predict where failures are most likely to take place without any clear indication of when they will take place. However these hazard maps can be used as a guide for future development of infrastructure, settlements and any other construction to avoid future disasters. Figure 8 has been prepared by assigning the relative numerical weightage of each facet incorporating various thematic maps like lithology, structure, slope, relief, land use/land cover, soil, drainage density and rainfall, etc., through Geographic Information Systems (GIS). The results were validated for each of the hazard zones. The maximum cloudburst occurred in very high and high hazard zone.

Causes of Flash Flood and Cloudburst Flood

A combination of factors appears to contribute to flash floods and cloudbursts. The fragile geology and torrential rain plays a significant role in destabilising the Himalayan terrain. The entire Himalayan belt is tectonically and seismically a very sensitive domain. Strong tetanised rocks and fragile mountain slopes (Figure 9) are vulnerable to the onslaught of rain. The cumulative effects of past earthquakes in such a zone certainly aggravates these phenomena. Apart from inherent character, natural factor, anthropogenic changes, such as change in land use, deforestation, increase in population, developmental schemes, etc., also play a significant role in increasing the frequency of landslides (Valdiya, 1987).

Though in each of the incidents the causative factors are incident-specific but still all the factors have a close relation with each other.

The gradient of bedrock channels is a semi-independent variable and is not directly determined by the hydraulic regime. Factors such as physical characteristics of local lithology and the tectonic movements in the Himalayan region influence the channel gradient. Compared to the small rivers, large rivers are most susceptible to even minor changes in their slope induced by active deformation. The precipitation threshold value for triggering landslide debris floods has not been studied for Indian Himalayan region, which takes into consideration all relevant parameters such as slope angle, geology, soil type, vegetation and soil situation. According to Li and Wang (1992) in Chinese mountain commutative precipitation of 50-100 mm in one to two days and daily precipitation of about 50 mm was enough to precipitate small-scale shallow landslides; two days commutative precipitation of 150-200 mm led to an abrupt increase in the number of large landslide of debris flow. Intense rainfall, even of short duration, causes shallow and quick landslides, whereas prolonged rainfall intensity over 10 minutes intervals (to identify short bursts of intense rainfall), of rainfall on the day before and of rainfall immediately before an event, predict the occurrence of landslides and debris flow.

Control and Management of Flash Floods and Cloudburst Floods

The most common natural hazards in the Indian Himalayan region is landslide and associated phenomena, which causes maximum damage to nature and man-made environment every year, particularly during the monsoon period. Generally the flash flood is associated with landslide (of different origin). Though a combination of several factors like tectonic disturbances, weak lithology geological structure (local/regional), seismic events, loose soil cover, hydrological behaviour, land use and anthropogenic activities in association with rainfall, temperature and aspect are responsible for triggering landslides or associated phenomena. Each such type of incident requires site specific control and management. Still some general measures are required for the entire Indian Himalayan region. It is evident from our study that maximum landslides or debris flow, the main reasons for flash flood, are rainfall induced. If systematic rainfall threshold values for triggering landslide/debris flow studies is done for the whole Indian Himalayan region, then a management plan for stabilisation can be suggested easily using bioengineering measures. Landslide hazard zonation on micro level is another important aspect of control and management of flash floods in the Himalayan region. Microzonation can help in prediction of any future occurrence of landslide/debris flow in the given set of conditions. If the early warning could float to local residents, at least lives could be saved. Due to increase in population, the village person sometimes migrates to the areas adjacent to the riverbed. On account of availability of water and fertile land for agricultural production, people prefer to stay there. These areas are most vulnerable to flash floods. The areas lying in the danger zone of floods should be demarked and banned from such cultivation/settlement. Flash floods and cloudbursts are natural calamities, and it is difficult to predict the exact place and time of such occurrence in the Himalayas. But still, if we can put in sincere efforts for understanding in depth the scientific reasons for flash floods and cloudbursts, we may certainly come away from the fury and havoc created by such incidents. The following suggestions may be helpful to cope up with or reduce the long-lasting effects of flash floods and cloudbursts:

- Awareness about hazards/natural disasters among villagers.
- Details on geology, land use and land cover and soil types.
- Detailed studies of long-term data including precipitation, intensity and duration.
- Identification of flash flood prone areas, construction should be banned in the areas prone to recurring flash floods and other such natural hazards.
- Threshold values for triggering landslide and debris flow (location specific).
- Micro Level Hazard Zonation.
- Implementation of mountain risk engineering techniques.
- Early Warning Systems.

Conclusion and Recommendations

The area around NH 94 faces serious slope stability and metrological disaster problem during the current monsoons (year 2012). As discussed in the previous sections, the area has a history of mass instability and interplay of many processes has rendered the area highly vulnerable. So far as possible excavation should be minimised and the slope material should not be disturbed. Enhanced pore water pressure during heavy rains facilitates slope instability. It is therefore required that excess water be drained out from the slope material. In view of the narrow valley habitation and landslide threat, the local population is advised to stay away from subsidence and landslide affected areas. The households living in the zone of narrow valley and landslide prone area are at the same time required to be shifted to alternative safer locations. Landslides occur frequently in Uttarkashi region. This is due to the inherent geology, slope conditions and the high intensity of rainfall that not only contributes to rapid erosion and weathering of rock mass but also increases the ground water level decreasing the stability of slopes. The increasing anthropogenic activity in the sensitive zones contributes to increase the instability of active slopes in the Indian Himalayan region. Incremental increases in such incidents and increase in population in the areas of IHR could be the cause of more damage to life and property in future. Owing to the remoteness of the affected, or in high altitude, areas generally the rainfall data are not available. If normal rainfall data is not available then we cannot think of the desired data for extreme rainfall from most of the affected areas. The extreme rainfall, threshold value of triggering of landslides in a particular region, and return period of extreme rainfall events, are also not available as on date. Therefore, such data and in-depth studies on those parameters are required to understand the phenomenon and to suggest preventive measures to cope with or minimise the damage to life and property in the Indian Himalayan region for future.

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A Psychoanalysis of the 2010 Cloudburst in Leh

Nasrin Tabassum and Professor T. A. Kanth

Abstract

In the midnight of August 6, 2010, Leh in Ladakh region of J&K experienced cloudburst which led to flash floods in Leh town and nearby villages. Disasters can cause serious mental health and other psychological disorders. These consequences take the form of acute stress response, acute stress disorder, Post-traumatic stress disorder and a variety of other disorders. The study of two disaster hit localities of Leh town and Choglamsar village of Leh district shows that 70% of the patients were women which indicates that women are more vulnerable to psychological problems, post disaster. A total of 545 psychological patients were recorded. Out of which 83% of the patients developed Acute Stress Response, 15% developed Acute Stress Disorder and 3% developed Post-traumatic Stress Disorder. Sixty per cent of the patients were from the age group 20-40 years, 35% patients above 40 years and only 5% below 20 years. Seventy per cent of the patients were from the labour class which indicates that people with lower socio-economic status are associated with increased post-disaster distress. This paper makes an attempt to highlight the vulnerability of people post disaster to psychological disorders.

Keywords: *Cloudburst, Psychological Disorder, Post-Traumatic Stress Disorder, Vulnerability, Psychosocial Support.*

Introduction

Psychological disorder occurs when a person is directly or indirectly exposed to a life-threatening event, and in the experience of this serious threat to life, the person's response is one of intense horror, fear and/or helplessness. The World Health Organisation defines disasters as any occurrence that causes loss of human life, deterioration of health and health services on a scale sufficient to warrant an extraordinary response from outside the affected community. Therefore an experience of trauma in a population is common after a disaster event, because when faced with a disaster the experience of terror and helplessness in people is similar all around the world, whatever their cultural background. In the midnight of August 6, 2010, Leh experienced cloudburst which led to flash floods in Leh town and nearby villages. It rained at a peak intensity of 150mm/h causing loss of human life and destruction. The Sonam Norboo Memorial hospital of Leh was badly damaged and dysfunctional. The injured were shifted to Army Hospital, Leh. A total of 233 persons died (207 civilians, 5 foreigners [1 unidentified], 26 army personnel), and 100 were reported missing. It is estimated that about 9,000 were affected. There were flash floods, and the Indus River and its tributaries and waterways were overflowing. Over 1,235 houses were damaged.

Study Area

Leh district of Ladakh region is located in the temperate latitudes between the Karakoram and Himalaya Ranges. It is a semi-autonomous region in the Indian State of Jammu and Kashmir that is characterised by high altitude, extreme aridity, and marked variation in diurnal and seasonal temperatures. Owing to its strategic location, and to unresolved border disputes with Pakistan and China, the region has been host to a large and permanent military presence over the past 50 years. Leh district is situated between 32 to 36 degrees North latitude and 75 to 80 degrees East longitude and at an altitude ranging from 2,900 metres to 5,900 metres. Leh district is scattered on an area of 82,665 sq. km

Latitude: 34º 10′ N - Longitude: 77º 35′ E (Leh Town)
Latitude: 34 º 06′ N - Longitude: 77º 35′ E (Choglamsar) STUDY AREA

(includes 37,555 sq. km under illegal occupation of China) which makes it the largest district in the country having 112 inhabited and one uninhabited village.

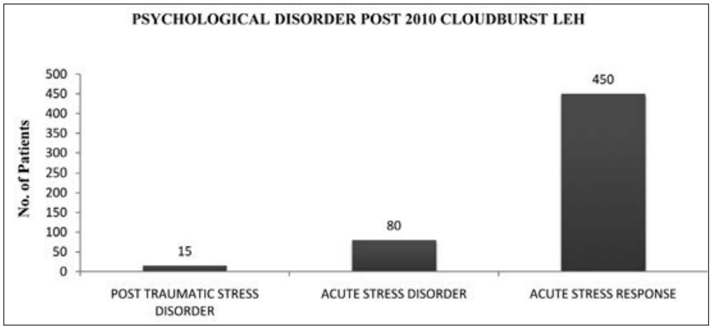

Figure 1: Shows the psychological disorder post 2010 Leh cloudburst.

Psychological impacts include emotional signs such as anxiety, depression, and grief. They also include behavioural effects such as sleep and appetite changes, ritualistic behaviour, and substance abuse. In most cases, the observed effects are mild and transitory, the result of normal people, responding normally, to a very abnormal situation (Gerrity and Flynn, 1997). Few disaster victims require psychiatric diagnosis and most benefit more from a crisis counselling orientation than from a mental health treatment orientation, especially if their normal social support networks of friends, relatives, neighbours, and co-workers remain largely intact. However, there are population segments requiring special attention and active outreach. These include children, frail elderly and people with pre-existing mental illness, racial and ethnic minorities, and families of those who have died in the disaster. Emergency workers also need attention because they often work long hours without rest, have witnessed horrific sights, and are members of organisations in which discussion of emotional issues may be regarded as a sign of weakness. Psychological effects affect different levels of functioning, including cognitive (perceptions and memory as a basis for thoughts and learning), affective (emotions), and behavioural. Social effects pertain to altered relationships, family and community networks, and economic status (UNICEF 2005). The experience of a life-threatening traumatic event and concurrent experience of horror or terror after a disaster is not in itself a psychiatric illness, but it can result in one of three emotional responses that could potentially develop into a mental illness. After the August 6, 2010 Cloudburst, a total of 545 psychological patients were recorded. Out of which 83% of the patients developed Acute Stress Response, 15% developed Acute Stress Disorder and 3% developed Post-traumatic Stress Disorder. (Figure1)

Acute stress response is a response which can be experienced within minutes of the stressful event, and involves a person feeling dazed and disoriented, or agitated with panic. This response lasts no longer than 2 or 3 days, and often resolves in a few hours. This psychological response was recorded highest among the patients in the aftermath of Leh Cloudburst. A total of 450 patients developed acute stress response.

Acute stress disorder has a similar symptom response as the Acute Stress Response, but the occurrence lasts for a minimum of two days to a maximum of one month, and occurs within four weeks of the traumatic event. Acute stress disorder was the second highest recorded disorder among the patients with 80 patients suffering from this psychological disorder.

Post-Traumatic Stress Disorder

(a) Persistent re-experiencing of the traumatic event, recurrent and intrusive recollections of the events of the disaster, recurrent distressing dreams in which the disaster is replayed, intense psychological distress or physiological reactivity on exposure to internal or external cues that symbolise or resemble an aspect of the traumatic event or experiences in which the victim acts or feels as if the event is actually re-occurring.

(b) Persistent avoidance of stimuli associated with the trauma and continued numbing of general responsiveness, efforts to avoid thoughts or feelings or conversations about the disaster, efforts to avoid activities, places or people that remind the victim of the trauma, inability to recall important parts of the disaster experience, markedly diminished interest or participation in significant activities, feelings of detachment or estrangement from others, restricted range of affect, or a sense of a foreshortened future, without expectations of a normal lifespan or life.

(c) Persistent symptoms of increased arousal, difficulty falling or staying asleep, irritability or outbursts of anger; difficulty concentrating, hyper vigilance, exaggerated startle response.

Male-Female Psychological Patients

The study of two disaster hit localities of Leh town and Choglamsar village of Leh district shows that 70% of the patients were women which indicates that women are more vulnerable to psychological problems post disaster. (Figure 2) Women are more vulnerable than men to get psychological symptoms. Men may suppress their feeling of distress as it is thought that men are more capable and strong in the aftermath of a disaster. Men are more likely to express psychological distress through substance abuse and other acting out behaviours like interpersonal violence. The interaction of gender and various social/family factors highlights the interconnectedness of vulnerability factors. While men typically cope using individual and immediate decision-making, women use their social network to process and work through problems (Kawachi and Berkman, 2000). Traditionally, women have been assigned the role of caregiver, a role that may lead to increased stress levels in the aftermath of

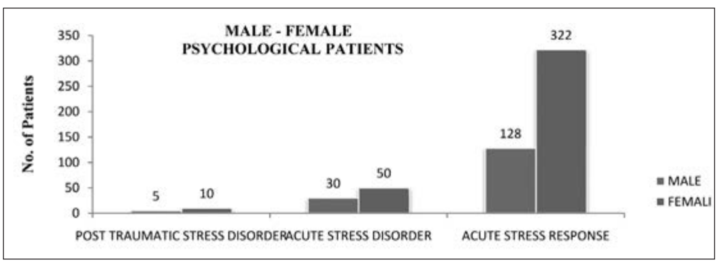

Figure 2: Shows the male-female ratio of the psychological patients.

a disaster. First, for women who are primary caretakers, the extra stress of caring for children and the home may fall disproportionately on them. A mother is always associated with higher disaster-related distress as she will think and become worried about her children first in times of a disaster. There may be something about the traditional caregiving role that leads to vulnerability.

Age Group

In terms of age, middle-aged adults appear to be the group most affected by disasters. Of the patients 60% were from the age group 20-40 years, 35% patients above 40 years and only 5% below 20 years (Figure 3). The middle age group may have more burdens and stresses, such as caring and providing support for a family that may be amplified in the aftermath of a disaster. The females in the middle group are more vulnerable to psychological distress because they are in the crucial stage of their life, i.e., 20-40 years, they are worried about their future and moreover they are in the productive phase of their reproductive cycle.

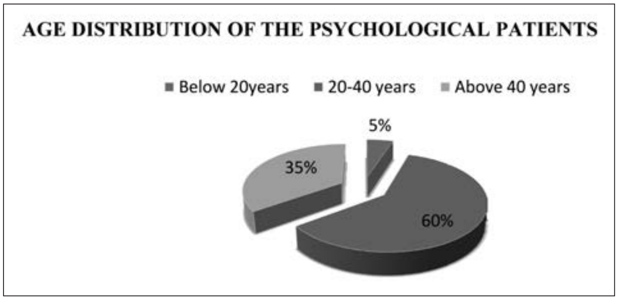

Figure 3: Shows the age distribution of the psychological patients.

Socio-Economic Status

The impact of disaster on poor people is much more. The poor suffer from income fluctuations and also have limited access to financial services and resources in the aftermath of a disaster which makes them more prone to depression and other types of psychological disorder. Moreover, vulnerability to disasters is a complex issue, as it is determined by the economic structure, the stage of development, prevailing social and economic conditions, coping mechanism, risk assessment, frequency and intensity of disasters, etc. The impact on the poor could be losing access to some basic needs, services, reversals in accumulation of physical and human capital, and perhaps an effect on the mental health of the individual leading to stress, depression and other types of psychological disorder. In

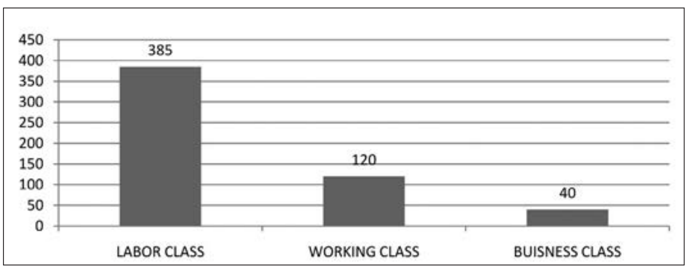

Figure 4: Shows the socio-economic status of the psychological patients.

case of Leh Cloudburst, the majority of the patients were from the labour class, i.e., 70% patients, and 22% of the patients were from the working class. Only 7.33% of the patients were from the business class.

Psychosocial Support in Leh District

After any disaster there is a need for a multi-pronged approach to relief and care, of which psychological support forms an integral part. Psychosocial support in the context of disasters refers to comprehensive interventions aimed to address a wide range of psychosocial problems arising in the aftermath of a disaster. These interventions help individuals, families and groups to restore social cohesion and infrastructure along with maintaining their independence and dignity. Psychosocial support helps in reducing the level of actual and perceived stress that may prevent adverse psychological and social consequences among disaster affected people. In any disaster the magnitude of psychosocial and mental health problems is enormous. Apart from logistic and material help, the sufferings of human beings will require psychosocial and mental health interventions. It has been recognised that most of the disaster affected persons experience stress and emotional reactions after disaster as a normal response to an abnormal situation, and are able to cope well with a little psychosocial support. However, a significant proportion of people are not able to cope effectively with the situation in the absence of appropriate/adequate support system and they experience significant signs and symptoms requiring psychosocial support and mental health services. Prior to Leh Cloudburst of 2010 the district had no trained doctors in psychosocial care. After the disaster various national and international NGOs rushed to Leh to provide psychosocial support. Experts from TISS, EMA and MSF trained the doctors, pharmacists, ANM and other medical staff from the Sonam Norboo Memorial Hospital of Leh. The NGOs which were involved in humanitarian crisis response and psychosocial support in the aftermath of Leh Cloudburst 2010 are Care, MSF, Oxfam, Red Cross, St. John Ambulance, World Vision, TISS, Health Inc. and EMA.

Other Forms of Psychosocial support

(a) *Psychological First Aid* The main idea behind psychological first aid is that, just as people with little medical knowledge and experience can provide first aid to people in need, so people with no psychotherapy practice can provide relief and support to disaster-struck communities. Feelings such as empathy and compassion can make a difference for hopeless and confused people (Reyes and Elhai, 2004).

(b) *Psychological Education* is meant to help the affected individuals respond in a proactive and efficient manner and to reduce the psychological and social impact that is usually associated with such experiences. Some of the ways to do so are the distribution of leaflets and brochures depicting common responses to stress and means to counteract it, public discussions in which people are encouraged to get involved, to make plans and contribute to a community reconstruction project. The media plays an essential role in helping psychological education achieve its aim.

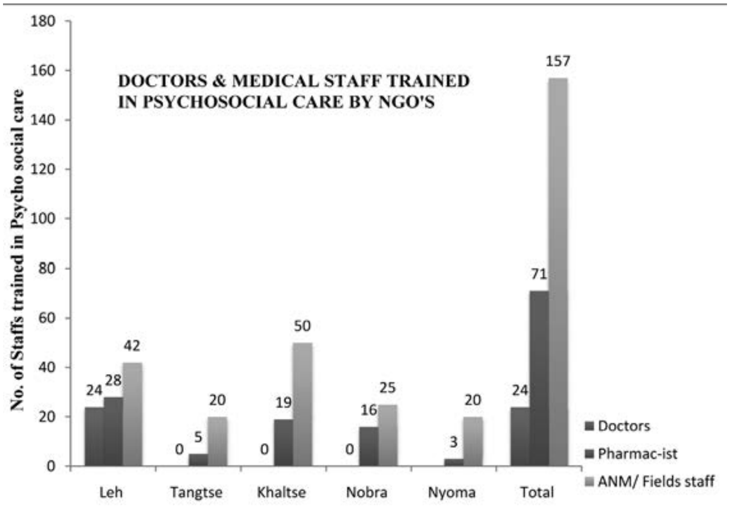

Figure 5: Shows doctors and medical staff trained in psychosocial care.

Results and Conclusion

This study was conducted to find out the difference in the psychological impact of disaster among individuals. The paper makes an attempt to highlight that vulnerability to psychological disorders post disasters is registered more in case of women, middle aged group people and people with low socio-economic status. It is the women and poor people who need extra care and support after a disaster. Women and people with low socio-economic status are more vulnerable to psychological distress. All disasters cause death, loss of property, damages and destruction which are very much visible to we human beings but what is not visible to the human eye are the mental agony, trauma and stress of the survivors who have suffered losses of their near and dear or sustained damages of their assets and property. After a disaster, the emotional reactions among individuals may vary from individual to individual and this also may usually undergo changes over time depending upon the individual capacity and socio-economic condition of that individual. A well functioned psychological support system should be there in Leh with more and more doctors being trained in psychosocial care so that the people of Leh are able to cope with any kind of trauma post disaster. Relief and rehabilitation should also include increased awareness of psychological disorders and the symptoms of post-traumatic stress disorder and its alleviation through education on developing coping mechanisms.

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Indigenous Knowledge in Disaster Risk Reduction and Climate Change Adaptation: Case of Mishing community on Majuli Island, Assam

Sunanda Dey

Abstract

The indigenous knowledge which is possessed by the tribals and native community people around the world is in form disaster risk reduction measures adopted by the communities for the impeding impacts of disasters. They have been using these local actions and remedies for protecting themselves. Over the period, with changing climate, these measures become forgotten or less acknowledged, but are realistic and need a second look by the scientific community, development experts and policy makers. The present article describes the indigenous knowledge of mishing community of Assam which they adopt for annual floods affecting their habitat.

Keywords: *Indigenous Knowledge, Disaster Risk Reduction, Floods, Majuli Island, Assam*

Introduction

In the times when climate change has become a regular jargon being used in disaster mitigation policies, the role of indigenous knowledge or the traditional knowledge becomes more imperative. Development professionals are talking about climate change adaptations and disaster risk reduction measures to cope with the impacts of disasters but a small number of them are aware of the potential of indigenous knowledge, that too with the Midas touch of sustainable development. Indigenous (and non-indigenous) communities have been adapting for centuries to climatic trends and extremes (Brokensha et al., 1980; Campbell, 1990, 2006; Inglis, 1993; Nunn and Britton, 2001; Gaillard, 2007; Nunn et al., 2007; Anchorage Declaration, 2009). Whilst some have experienced losses, other communities have adequately recovered through "building back better" or "building back safer."

Broadly defined, indigenous knowledge is the systemic information that remains in the informal sector, usually unwritten and preserved in oral tradition rather than text. Indigenous knowledge helps in natural resource management which is really crucial for the well-being of the overall environment and sustainability. It is referred to as traditional environmental/ecological knowledge or traditional knowledge in different places. Deborah McGregor (2004) in an article says that Traditional Ecological Knowledge (TEK) as a construct of broader society is a relatively recent phenomenon, and the field that supports the acquisition of environmental knowledge from Aboriginal people has rapidly grown over the last two decades. In part, TEK has emerged from the growing recognition that Indigenous people all over the world developed sustainable environmental knowledge and practices that can be used to address problems that face global society. David Suzuki, scientist and environmentalist, writes, "My experience with Aboriginal people convinced me ... of the power and relevance of their knowledge and world view in a time of imminent global eco-catastrophe." The international community has also recognised the important role Indigenous people and their knowledge can play in global society. In 1987 the Report of the World Commission on Environment and Development (or the Brundtland Report) recognised the important role of Indigenous people in sustainable development. Five years later, at the United Nations Conference on Environment and Development, the Convention on Biodiversity (CBD) was signed. The CBD reiterated the important role of Indigenous people and their knowledge for achieving sustainable environmental and resource management.

Case Study of Majuli Island

The Mishings are a tribe settled mostly in the districts of Dibrugarh, Lakhimpur, Sibsagar, Jorhat, Darrang, and Goalpara of Assam. Ethnically, the Mishings are mongoloid and belong to its Indo-Tibetan group. They belong to the tribal groups of Miyongs, Padams and Nishis of Arunachal Pradesh. It is said that the Mishings migrated from the hills of Arunachal to the plains of Assam about eight centuries ago and it continued up to the first part of the nineteenth century. Although they identify themselves as Mishing and regard it to be the correct name of their community, they have been identified by the term Miri by the people of Assam and as mentioned in the list of scheduled castes and tribes of India.

The Mishing people speak Mishing dialect. Their language belongs to the northern Assam branch of the Tibeto-Burman languages. There are almost 500,000 speakers of the language. It is also known as Plains Miri or Takam. The speakers of the language inhabit mostly Lakhimpur, Sonitpur, Dhemaji, Dibrugarh, Sibsagar, Jorhat, Golaghat, Tinsukia districts of Assam. The Assamese language is as popular amongst them as their own dialect though pronunciation and expression in Assamese is not sound. The Mishings came into contact with the Ahom in the early part of the sixteenth century. In all probability they know Assamese language since then. In the later period Assamese language was the medium of the Gosains and Brahmins who converted them into Hinduism. Assamese is the official language of working in Assam, so in Majuli Island. The villagers can also understand Hindi to some extent and Bengali also. But the proportion of the villagers is less comparatively. The Mishing script is roman based. The premier literary body of Mishing language is known as "Mising Agom Kébang."

Majuli's economy is predominantly an agrarian rural economy with more than 75 per cent of its population earning their livelihood from agriculture and allied activities like fishery and animal husbandry. *Agriculture*: Out of the total arable land of 30,556 hectares, the net area sown is 28,452 hectares, with a cropping intensity of 175.70 per cent. The principal crops grown are paddy of three varieties, namely, summer paddy, winter paddy and autumn paddy, rape and mustard, wheat, pulses, potato, garlic and sugar cane. Among the pulses grown in the island are black gram, green gram and peas. Sugar cane and arum are grown in the char areas of the island. *Animal Husbandry*: It is not only subsidiary income to about 80 per cent of the families but also generates employment for thousands of people. A large number of cattle and goat farms are there in the islets or char areas. Piggery and pottery are two important sources of income for the tribal families, particularly the women folk. *Fishery*: About 20 per cent of the total geographical area of the island is covered by water throughout the year. With 152 natural registered fisheries and more than 200 cultured fisheries, about 10% of the population of Majuli earns their livelihood through fishery. Climate change and disasters impact the agricultural productivity of the farmers which crucially affects the sustaining capacity of the inhabitants.

Disaster Preparedness by Mishings of Majuli Island

The Mishings have their own preparedness plans for the annual floods. The house structure, management of food storage and rescue boats is vital to Mishings. The traditional *Chang ghars* are built by them where the impacts of flood are least observed, as it saves their belongings during high floods. The bamboo used houses on stilts are their cultural identity and is an indigenous method of protection and adaptation to the local environment.

Non-governmental organisations help them in reconstruction of their houses if any are damaged during floods, and also provide economic relief through national schemes like Indira Awas Yojna to build their houses. The newly formed *chang ghar*s are modified in the building material used, keeping the original design intact. Though some educated Mishings have started to build Assamese-style house in some parts of Majuli Island—Jengraimukh. They are now more oriented towards modern living, though their number is very low now.

Nowadays due to NGOs penetrating into the lives of Mishing, they are well prepared to face the wrath of floods. There are posters in Assamese language through which they are taught about cleanliness and hygiene to be maintained during flood times and otherwise. Mishing people are provided sanitation kits, soaps and for ladies—sanitary pads to be used in general life and specially during disasters. They are told by posters about rescue operation methods, in times of emergency evacuation, personal hygiene to be maintained during floods and in case someone falls ill, the symptoms to detect the disease.

For the protection of food items during times of flood the NGOs help villagers of a village, or a group of villages, in constructing granaries. These granaries are built on strong foundations instead of bamboo stilts which are their traditional types. The granary's base pillars are covered by steel sheets so that it gets protected from attack by rodents and other small animals. The construction is traditional in design but the parts constituting it are modern, so that the sentiments of the villagers are intact and also the purpose of building a strong, protective granary is attained. For this NGOs sponsor, sometimes also villagers contribute to their capacity.

Ham radio sets are provided to locals before the onset of floods to communicate. Boats are also provided which are used to rescue people during floods. Otherwise bamboo constructed temporary boat kind planks are provided. Besides, every villager knows swimming. They also sow deep water rice which is their specialty. This kind of rice can withstand floods and after the floods can be harvested without worrying about the result. These are sown in low lying areas of the island. In high line areas they grow *saali* paddy which is another kind of rice.

Early Warning Systems for Floods

There are some signals from nature which it provides before any major event that is about to happen. The people living in consonance with nature are able to detect and identify them and can protect themselves in time. Tribal people are masters in this. Mishing community has their own set of early warning signs which help them prepare and know about the upcoming natural event. Related to floods, they have some signs and symptoms. The nearest river to the Mishing people in Majuli is Brahmaputra and its tributary Luit. When they observe soil sediments coming downstream, they can get an idea of how heavy the rains would be. If soil sediments are flowing in the river before the onset of monsoon, it signals that floods will come. That is, the rains would be heavy leading to floods. Another warning system that works for them is observing the rain pattern. If during the beginning of the rainy season, it rains heavily for the first week, or more than ten days continuously, it predicts heavy flooding. During such times Mishing community and other community people are evacuated to higher ground. Again, when wild animals start to retract to higher ground, it shows floods are approaching.

Besides this, the local information system is quite active during flood season or the rainy season. Regular updates are circulated by radio and ham radios to the villagers about approaching floods or any unpleasant natural event. Some localised radio stations are opened up, or a local body operation centre is set up which updates them on hourly basis or as the situation demands. Nowadays television has penetrated into the lives of the Mishing community, so live updates help people to assess the situation properly and act accordingly.

Indigenous Methods of Mishings

Patterns of Houses: the Mishing villages are situated on the banks of the river or a stream. A typical Mishing village usually consists of a population of less than one thousand living in about a hundred households. The houses in the village always face running water. They are generally constructed close to one another without much thought for planning of the village. Unlike an Assamese village, the Mishing villages present a bleak landscape because the Mishing houses are seldom surrounded by kitchen gardens or fruit trees, although lately they have started planting some trees near their houses.

A Mishing village is distinguished by typical long dwelling houses (*Chang ghar*) which are built on a bamboo platform raised about six feet above ground on wooden poles. The width of the house is about 20 feet and its length depends on the size of the domestic family that occupies it. Nowadays the trend of nuclear families has shrunk the size of the houses. A Mishing house is not partitioned into small rooms but the entire domestic group lives in one single large barrack-like hall. Each house has an extended verandah in the front. There are only two doors in the house, one in front and the other in the rear. There are no windows in the house. The architectural pattern of the Mishing house has no variation in any form in the entire community, though recently the more economically sound families have constructed brick pillars instead of wooden pillars for their house foundation, or have renovated their traditional house with contemporary building material. The traditional thatched roof is replaced with tin sheets in some dwellings.

A Mishing house built on a platform is highly adapted to the frequent floods that visit most parts of upper Assam and specially the riverine tracts. During normal floods, a Mishing village looks like a vast canvas with the houses quite above the water level. Unless the flood rises as high as seven feet, the Mishing house is quite safe. During the floods, the daily life of the people is modified but is not disrupted. The cattle are of course taken to a higher ground, but the poultry and pigs which every household possesses are housed on the raised pigsties and platforms. Each household also owns a few large boats and dugout canoes and instead of walking from one house to another, during the flood season they just row their canoes to visit others in the village. Thus the social life of the people is not greatly disrupted.

Every Mishing—man, woman and child—knows swimming and rowing and they are well adapted to the environmental conditions. The floods usually occur in late May and continue up to mid-July. If floods are not serious, they are in a way beneficial for the people. First, it is like annual cleaning underneath their houses, and secondly, the flood waters also deposit rich silt on their fields which enriches its fertility. The last major flood in recent history came in July 2008, the latest being the 2012 floods when three waves of floods happened and ravaged the island badly.

Farming Methods: Mishings are exclusively settled agriculturists. In their original home in the hill, they practised shifting cultivation and after migrating to the plains, they did not totally abandon this practice. They could practise shifting cultivation initially in the plain because there were vast tracts of grasslands and forests in the alluvial plains of upper Assam. With the availability of fresh land the Mishing seldom stayed at one place permanently. They moved to a new site after a few years soon after the fertility of the soil was exhausted. The Mishings in Majuli Island grow *saali* paddy in high line areas and deepwater rice in low line areas. This is so because they do not waste their agricultural produce because of floods which come every year. The deep water rice is not affected by flood waters and can be harvested after the floods recede. The main problems for farmers are soil erosion and sand deposition in their fields when the water level recedes. Large chunks of land are lost to the river Brahmaputra. When flood water enters the land, it brings sand along with it which remains, affecting the fertility of the land.

Early Warning Symptoms: Mishing community people have developed some expertise on the forthcoming floods indicators which help them to forecast a flood and normal rains. The older generation are experts because of the experience they have had over the years. One of the warning signs is observing the river system flowing near them. If there are soil sediments coming through river flows before the onset of the monsoon, it indicates flooding for the year. Another indicator is rain at the beginning of the season. If the situation is such that it rains continuously for one week at the beginning of the rainy season, it indicates heavy floods.

The Mishing community when affected with disaster has its own ways and means to cope with annual flood events; external assistance, whatever received, if not in the desired form is of no use to them. This is depicted in the above description of external help which they get from non-governmental organisations during preparedness phase and during disaster times. Indigenous people are really sensitive about their cultural norms and practices, and thus when they have to adjust to something totally alien, they succumb to extinction in extreme cases. This issue was a concern when NGO people were there on Majuli island to help rebuild the resilient Mishing community and Majuli island on the whole. In the present case of the Mishing community, indigenous disaster risk reduction measures which exist in the form of their cultural native practices and rituals, incorporating climate change adaptation, were introduced in the development policy of the local government. In the process the community benefits by becoming better equipped to deal with future impending disasters and sustain the aggravated impacts due to climate change.

Conclusion

In today's times when development practices are followed rampantly with a closed mind, the significance of indigenous knowledge is being forgotten. In times of disaster when relief and rehabilitation works are going on, the basic needs of the affected community are not met, according to their needs, and in the form in which they require it. There have been incidents of communities being offered tinned food (in Africa) as relief food material but it has not helped the aggrieved people as they did not know how to use it. The culture and social norms which are followed by the indigenous people of a place need to be kept in mind when they are being helped in the aftermath of a disaster. The unique practices which they follow for specific purposes need a space in crisis times or they lose spatial correlations and it can endanger their identity. This shall be a huge obstacle for them.

Today's rate of change may be reducing the viability of indigenous knowledge; it should still be considered a valuable knowledge base, which it may be pertinent to draw on for devising new technologies or techniques for climate change adaptations (Shea, 2003; Campbell, 2006; Gaillard, 2007; Anchorage Declaration, 2009) or disaster risk reduction measures. The integration of indigenous and scientific knowledge may strengthen the ability of indigenous communities to cope with climate change, whilst retaining their traditional practices (Kelman et al., 2009; Mercer et al., 2008, 2009, 2010).

The case study of Mishing community of Majuli Island shows how eco-friendly development in the areas where indigenous people reside can be made by incorporating indigenous knowledge, disaster risk reduction and climate change adaptations. The assimilation of indigenous knowledge supports the disaster risk reduction plans made for local environment as they have evolved over a period of time incorporating various aspects and needs of ecology and ecosystems. The native measures used for disaster mitigation are in sync with the local environment and needs and thus adapt smoothly without disturbing the flora or fauna much as compared to some totally unfamiliar activity which can be exploitative or endangering the local biodiversity of the place.

Note: The case study presented in the text was conducted in the month of November 2010 as part of MPhil dissertation.

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Disasters and Mass Casualties: Preparedness and Response of Health Care Organisations

Muhammad Yasar Shah

Abstract

Natural and human induced disasters are occurring in all regions of Pakistan. These disasters result in immediate, challenging and complex chaos, in the form of injuries not commonly seen in daily routines. Because on numerous occasions hospitals and health care set-ups receive a large number of casualties, which make it difficult for them to treat, coordinate and respond. Hospitals and health care set-ups are already under pressure to care for patients who present themselves during usual operations each day. Health care and emergency health care systems are already facing stress and massive challenges.

To face these challenges and deal with issues, these systems in the country need to improve organisational structure and leadership, establish supportive infrastructure, organised workforce, superior organisational capacity, information and communication, triage and transportation, logistics, and data collection systems.

The intention of this term paper is to emphasise the need for policymaking regarding organisational structure, capacity building, and to provide guidelines for health care and emergency systems in preparing for and responding to an MCI caused by different hazards in the country. This paper will prove itself in providing practical information to support comprehensive MCI care in response to substantial hazards. This paper focuses on two areas:

- *Management preparedness and response to a hazard event in the country, and*
- *Effective care of patients in the Pre-hospital and hospital environments during an MCI event.*

Keywords: *Disaster Management, Hospital, Mass Casualties, Healthcare Organisation, Triage, Mass Casualty Incidents, Pakistan.*

Introduction

The purpose of this paper is to offer national planning for supporting Emergency and health care services during Mass Casualty Incidents (MCI), which always has the potential of overwhelming the health care and emergency sector. This paper will help in providing policy and guidance to assist the health care services to prepare and plan for large incidents of particularly serious proportions involving large numbers of fatalities. It will back up a constant approach in managing mass casualty incidents throughout the country. Health care set-up's ability to respond to mass casualty incidence throughout the country should be a concern to all emergency services. Success in taking care of mass casualty incidents requires the health care workers to deal with immediate rescue and treatment, movement of survivors to medical facilities, and the competence of those local health care facilities. This paper will be providing guidelines to help local emergency planners, donors, and other stakeholders to develop plans regarding mass casualties during different disasters.

The main objectives are to:

- Decrease mortality and morbidity rate by means of strengthening clinical and emergency responses, and enhancing decision-making during MCI event.
- Decide and identify leadership initiative systems that enhance readiness for and reaction to MCI event.
- Improve communication, reliability, incorporation, and coordination, between the emergency management and medical response society.
- Enhance the capacities of health care system to ensure ample health care services in MCI events.
- Improve the quality of existing preparedness and response plan for Mass Casualty used emergency and health care entities.
- Offer an instrument that can be practised during drills and less intensity emergency situation.

Background

Our society, environment and citizens are suffering from the effects of both human induced and natural disasters. A disaster is defined as a severe disruption of the functioning of society, causing widespread human, material or environmental losses which exceed the ability of affected society to cope on its own resources (UNDHA, 2001). Population trends like density and growth, resettlement and migration, ill-planned urbanisation, environmental degradation and climate change are the main factors contributing in natural hazards. Comparing with the past, at present the mortality rate due to natural and human induced hazards is on the rise. The global economic cost related to these hazards is also on the rise (Masozera et al., 2007).

Population growth and unplanned development increased disaster threats due to rise in vulnerabilities. The changing socio-economic and demographic trends are the contributing factors in increased vulnerability. For example, if a high-scale earthquake or flood struck an open field with no use creates little or no danger. Comparatively, an earthquake with less magnitude or flood with weak intensity can cause significant damage to livelihood, economy, materials and human lives in more populated areas or urban settings.

A mass casualty incident can be defined as "an event resulting in a number of victims large enough to disrupt the normal course of emergency and health care services" (PAHO/ WHO, 2010).

An unexpected hazard related MCI requires an instant response; interrupts transportation of casualties, interrupts communication systems, supplies, disturbs health care services and health care and emergency workers and may overcome the capacity of community and responding organisations.

Although natural and human induced hazards are common in the country, our emergency and health care system has minimal resources and skills in taking care of casualties resulting from natural hazards and violent activities. Earthquakes, floods, landslides, road traffic accidents and bomb blasts, resulting in heavy and complex injuries, are not commonly treated and seen in our daily settings. Lack of facilities, insufficiency in response potential might lead to rise in mortality and morbidity. It will ultimately result in increased level of stress and fear within the community.

During an MCI event a large number of people sustaining complex injuries poses an exclusive management challenge for emergency management and health care workers. They receive a huge amount of patients in a short period of time, creating havoc. This rise in surge within a short period of time stresses the ability of systems, resulting in compromise and confusion.

The constant and growing risk of violent actions, increased number of natural hazards in past decades in the country, combined with increased vulnerabilities calls for proactive approach of preparedness and response to these conditions. Health care and emergency facilities and public and private set-ups and health care professionals must work together to make sure that plans and procedures are there to address some basic and important challenges:

- Accommodate, assess, and take care of increased number of injuries,
- Quickly recognise and treat the seriously injured,
- Assess and evaluate response efforts during disasters, and
- Perform Strategic planning and carry out mock exercises, drills for future events.

This paper will focus on the key problems and challenges in health care set-ups response and preparedness during the three care domains related to MCI:

1. Patient Triage and Pre-Hospital Care
2. Allocation and Transportation
3. Emergency and Hospital care.

Types of Hazards

Exposure of Pakistan to natural disasters can be classified as moderate to severe. Natural hazards, including earthquakes, floods, epidemics, GLOF, landslides and avalanches, threaten Pakistani society. There are a number of human-induced hazards as well posing risk including civil conflicts, urban and forest fires, oil spills and internal displacement of population, which in turn affect the country's environment and economy as well.

Prioritising hazards in terms of their scale and occurrence as high are floods, earthquakes, and social conflicts that have caused massive damages and losses of lives in past decades.

Types of Injuries

There are different standard injury classifications systems adopted globally for blasts and other hazards. The one devised by Centres for Disease Control and Prevention (CDC) in 2010, is utilised in this paper. According to CDC, injuries due to different hazards and blast can be classified as primary, secondary, tertiary, and quaternary. Primary injuries produced from different events can be easily seen on the victim's body, directly damaging the internal organs primarily responsible for circulation, e.g., heart, lungs, ears, gastrointestinal tract and brain as well. Secondary trauma injuries mainly resulting from penetrations and blunt traumas not directly caused by the hazard itself but caused by sharp objects and fragments dislodged during the event. Tertiary injuries including penetrating trauma and blunt injuries resulting during movement of the casualty during hazard, e.g., being drowned in flood. Quaternary injuries previously known as miscellaneous injuries are those injuries resulting from hazards and exaggeration of existing medical conditions. The injuries include crush injuries caused during structural collapse, burns, fractures, head injuries, and penetrating abdominal trauma.

Disasters and Emergency Health Care System

The havoc produced at the site of an MCI is consequently transferred through all phases of the organisation response. The confusion and havoc most of the time results in the interruption of communication, disordered transportation of the victims, confusion among health care workers, shortage of supplies, and can devastate the capabilities of health care set-ups. The health care system can reduce the chaos and confusion during an MCI with earlier planning, emergency plans, and practices regarding emergency management.

Planning regarding mass casualties necessitate innovation in certain fields, including pre-hospital management, hospital surge capacities, patients distribution and management, leadership management, controlling crowd and relationship with media.

Throughout an MCI, health sector will be facing increased stress, raised demands and reduced resources availability.

Private Health Sector in Pakistan

The infrastructure of the private health care sector in Pakistan is deficient in organisation with no specific standards. There is an extensive inconsistency in the provision of care in private sector in health sector ranging from very well established tertiary health care hospitals to general disorganised and unauthorised health units. It is argued that very few hospitals in the country in private set-up are well-equipped with proper staffing, equipment and supplies in the country (EMRO, WHO, 2007).

Level of Responses

The declaration of mass casualty incident is dependent on the primary assessments and reports of the initial responding teams at the scene. There are some factors that have to be considered while initiating an MCI including site of the event, reported number of fatalities, types of exposure, potential causes and capacities. In standardising the notification of an MCI event, ruling out its impacts, and determining the appropriate use of recourses during the event, classification of levels of responses to mass casualty incidents is necessary. Establishment of responses is based on the nature of the event and resources required to tackle it.

Level I: Normal Response

A devastating single or simultaneous event that can be easily managed using normal local response by the set-up, with no compromise on capabilities of the services to respond to other emergencies. This type of response will most likely have a significant impact on the routine operations of local health care facility. The number of casualties that can be handled through normal response are reported to be 10 or less.

Authorities of the incident have determined that an early response is sufficient to meet the event requirements.

- The emergency department (ED) may demand supplementary resources as required.
- Emergency Department will communicate and alert other departments within the hospital at will.
- Examples: Residential and industrial fires with multiple injuries, road traffic accidents, etc.

Level II: Community Emergency Response

An overwhelming single or simultaneous event that may require a significant commitment of additional resources, which will result in interruption of activities of local health care set-ups and community health care systems. Authorities have determined that the magnitude of the event is strong enough to require implementation of expanded resources. The number of casualties that can be handled through community emergency response are 11-20 or less.

- Authorities notify monitoring and rapid response service centres of Level II event condition.
- Monitoring and rapid response makes suitable announcement as per local practices.
- All local health care set-ups and community health care centres are notified of possible rush of patients, and receive back information of staffing and resources available. The administrations can then call for additional manpower and resources as needed.
    - Administration can also consider off-duty human resources.
    - Examples: Extended fire and accidents, earthquake, floods, etc.

Level III: Minor Disaster Response

A destructive single or concurrent events that is more likely to extend beyond the capacities of local health care and emergency set-up and their additional resources, requires a multidimensional approach. It will require the involvement of other domains of society. Minor disasters will have considerable effect on local and regional health care system. The number of casualties that is usually reported in minor disasters is 100 or less.

- Authorities should declare a local status of emergency.
- Local emergency operations centre should be initiated for the monitoring and coordination of the event.
- For additional support and resources the status of the event is determined.
- Local, regional and national health care set-ups are informed about the status of the event, number and types of patients.
- Examples: Extended earthquake, airplane crash, terrorist attacks and use of explosives, widespread civil disturbances.

Level IV: Major Disaster Response

An overwhelming event that is more likely to extend beyond capacities of local authorities and hospital surge capabilities, and need a wide range of state and government assistance. State of emergency is declared by local authorities.

- Regional emergency operations centre should be initiated for the monitoring and coordination of the event.
- National and regional emergency operational centre demands for assistance.
- Authorities inform regional, local and national health care facilities for pediatric, burn and trauma of event, including number, types of patient, and types of injuries.
- Examples: Huge earthquake, heavy floods, tornado with loss of infrastructure, and terrorist attack.

Level V: Catastrophic Disaster Response

In catastrophic disasters health care and emergency response is completely overwhelmed, and ineffective. Massive national and international assistance is required in the event with catastrophic magnitude. State of emergency is declared at the national level with information from regional and local authorities. The number of casualties that is usually reported in minor disasters are 1,000 and above.

- National emergency operations centre is initiated for the monitoring and coordination of the event, it will also alert local, regional, national health care and emergency set-ups.
- Examples: Earthquake of 2005, floods 2010, terrorist attacks.

Common Challenges for Hospitals

Predicting Patient Surge

As soon as the MCI strikes, numbers of patients with complex injuries are likely to rush towards the closest health care and emergency set-up. Patients being carried towards health care set-ups encounter different problems like transportation issues, security problem, aftershocks or prolongation of event, secondary effects, e.g., structural collapse. The havoc and stress produced during hurry and huge amount of casualty results in failure of the system. Equilibrium between numbers of victims and care standard is disturbed.

Health care system should devise an emergency plan to tackle initial rush of wounded patients who can walk. Patients with minor injuries with psychological trauma and who can walk, often rush towards or self-transport towards health care and emergency facilities immediately after the event, often creating chaos. They mostly arrive before the severely injured victims, and for several hours they might keep on arriving. They occupy beds, and devastate the health care and emergency set-up which receives them and interrupts management of seriously wounded victims. As stated that in an MCI, priority should be given to critically wounded patients (Schultz CH, Koenig KL, 1996).

Delays in Declaring a Mass Casualty Event

Declaring an MCI is relatively a challenging task. An official announcement and declaration of an MCI is typically made by an officer or person with authority. Delay in declaring MCI can produce negative effects. There are three common delays that usually take place while declaring an MCI that make it difficult for hospital to manage a surge.

Late Recognition of Event

Event severity detection is the main issue for the authorities of health care and emergency systems. Inadequate or ineffective understanding about the situation is the main issue producing insufficient response.

Delayed Notification and Activation

Using reactive approach causes interruption in delivering definitive care and life-saving interventions. In reactive approach the emergency system is activated according to the situation; if the system is activated in a judicious manner, many lives can be saved. To avoid delay using a proactive approach with simultaneous and full launching of all crisis systems is required, followed by gradual removal of MCI supported by information gathered.

Sluggish Mobilisation of Resources

In reactive approach slow and linear conversion from routine process to suitable response results in delay. The phase of conversion must be non-linear, immediate, and proactive in extent and scale. Ineffective planning and arguments lead to sluggish establishment and should be set aside until after the response.

Time Constraints

The reaction towards an MCI event should be mainly based at local level and needs quick intervention. Routinely exercised local emergency plans will function effectively and will never fail. Integration of the plan into regular operations will make it more effective.

Limited Health Care Workforce

The numbers of health care workers available in daily routine are never enough to respond to an MCI. For effective response off-duty staff will have to report to their concerned departments, but they may not be able to report and respond during an emergency either for the reason that they cannot arrive at the Emergency department or are worried about their own safety or that of relatives. To minimise errors shortage of staff should be addressed as the health care system in Pakistan is suffering already from staff shortages and lack of funds (WHO, 2010). Planning must include provision of staff to government sectors and provision of funds.

Management of Patient Surge

Planning

Each health care facility should have a coordinated and collaborated emergency plan.

Standard Operating Procedures (SOPs), checklists, plans, protocols, and symbols facilitate hospital administration and curtail confusion during crisis. In severe stress, confusion amongst individuals can be managed by SOPs. Prepared crisis protocols must be used and implemented as decision-making is always difficult during a crisis. While preparing protocols it should be ensured that they are short, easy, workable, practical and rationalised. Interaction with other key organisations should also be considered in preparing protocols. The plan should be evaluated on a continuous basis, including lessons learned and experiences gained.

Surge Capability and Capacity Map

Health care and emergency facilities should formulate comprehensive map of available external and internal resources. It should also include the set-up's ability to respond to an MCI, appropriate contact information and potential resources as well. It must be updated, transparent and shared with key stakeholders of the organisation.

Mock Exercises and Drills

Drills and mock exercises should be performed prior to an MCI event on regular basis. It will help in identifying flaws and errors. Exercises can be performed at different levels with management, health care workers, community representatives, and all other individuals responsible for response to an emergency. These exercises should be on regular intervals, and updated. There are four levels of drills which are effective and important:

- Specific or vertical drills for tasks oriented, particularly to mass casualty events.
- Table-top (horizontal) exercises for senior personnel.
- Functional drills for all those individuals in charge.
- Real Time and full-scale drills with full contribution from all hospital staff.

In exercises and drills performances must be systematically and logically assessed with contribution from other health care set-ups, response groups. Issues identified must be tackled properly before the next drills.

Redundant Systems

At some stage in crisis communication failure, failure of equipment and infrastructure may occur. To reduce distraction and delay in rush management, redundant systems should be established for contingencies. For electrical shut down, communication break-up, health care set-ups must have contingency plans. Emergency department should be designed in a way that it should reduce likely risk and improved work-flow with minimal interruptions throughout the surge.

Triage and Level of Care

During an MCI the triage system used differs in many aspects from conventional triage system. Following an MCI, large numbers of victims are brought into an emergency department; the health care resources are inadequate. To offer health services to large number of casualties, health care workers can modify the standards of triage and care provided at individual levels, so that the greatest number of people can be saved and thus reduce the terrible outcomes of injuries. A simple but very effective technique of triage for crisis categorises victims into two basic categories, as either walking or non-walking, and is used during emergencies. The victims that can walk do not usually need immediate emergency medical services and including the individual with psychological trauma who are not injured but exposed mentally to the event. The victims that cannot walk or non-walking are individuals who should be investigated and treated on urgent or emergent basis. There must be two health care workers for triage of the patients at the entrance of emergency department, trained in trauma care. A secondary triage team may be needed if the first team is overwhelmed by the surge of victims.

Lerner BE, Schwartz RB (2008) supposed that the following guidelines should be integrated into practice:

- We should build up flexible triage practices which are only based on consistent criteria for mass casualty and struggle for a system that is easy to remember, simple, and agreeable.
- Appropriate for all age groups and population.
- Easily adjustable for modification in resource available and circumstances.
- We should design a colour-coded condition oriented protocols, in which red means immediate treatment is required, delayed for yellow, green for minimal, and black deceased or near to die.
- Reduce work burden of extra documentation on triage team.

Withdrawing the Emergency Status

Just like quickly preparing transitioning from routine to status of emergency is necessary, a quick return to normal activities has the same importance. Debriefing of health care workers will reduce the exhaustion caused by the event and will help in gathering important data for future emergencies.

Resources

It is essential to organise and mobilise sufficient number of qualified and skilled health workers during an MCI event. There is some expertise which will be essential for functioning during an MCI event in an ED including emergency physicians trained in trauma, surgical services with anaesthesiology, orthopaedic surgery team for different fractures, nurses, pharmacy staff to ensure sufficient supplies during MCI, blood bank workers, radiology operators, administration, and support.

Some of the important factors that should be considered are:

Trauma Training and Continuing Education

- This education and training must be compulsory for everyone working inside ED.
- Doctors and nurses and paramedics should have up-to-date knowledge.

Leadership

- Health care authorities and senior members of the health services should attend mock exercises and be an integral part of the drills for its effectiveness.

Human Resource Requirements

- These matters should be addressed, and policies regarding human resource must be prepared.
- Compensation for extra work hours, and injuries should be provided to ensure timely availability.
- Arrangement of transportation and incentives for calling in off-duty hospital staff.

Conclusion

The idea in this term paper is to highlight the need regarding the training and preparation of policymakers and health care and emergency workers to respond to an overwhelming event in an effective, preplanned and organised manner. This paper has mainly focused on the response of first responders, health care and hospital administration, and emergency department staff, as they have a great role in responding to mass casualty incidents. The paper discusses the concept of modified triage system, declaration of emergencies, problems faced during responses, allocation of resources and mobilisation of individuals responsible for response. This paper offers authorities and leaders intervening guidance in formulating policy and plan to meet the needs of specific situations. Effective and timely preparation is the key to success.

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2. Contributions are considered for publication only on the understanding that they are not published already elsewhere, that they are the original work of the authors(s), and that the authors assign copyright to the SAARC Disaster Management Centre, New Delhi.

3. Standard length of papers is 6000 words, but shorter/longer contributions are also welcomed. They should be typed, double spaced on one side of the paper with margins of 3 cm.

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6. Title, author's name, full address and brief biographical note should be typed on a separate sheet.

7. An abstract of 100-200 words and about 5 key words should also be typed on a separate sheet.

8. Figures, maps and diagrams should be precisely and boldly drawn to permit photographic reproduction. Use single quotation marks (except for quotes within quotes).

9. Notes should appear at the end of the text.

10. Referencing in the text should be as follows: (Brinkley 2006:157).

11. Recommended style for the bibliography is: Brinkley, D (2006) The Great Deluge-Hurricane Katrina, New Orleans and the Mississippi Gulf Coast. New York. Harper Collins. Weibull, A. (1994) 'European Officers' Job Satisfaction and Job Commitment', Current Sociology 42 (3): 57-70.

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SAARC Disaster Management Centre
IIPA Campus, I.P. Estate,
Mahatma Gandhi Road, New Delhi 110002
Phone: 91-11-23702445, Fax: 91-11-23702446
Email: director.sdmc@gmail.com